UTE TSK TÉCNICAS REUNIDAS ASHUGANJ NORTH	Ashuganj Power Station Company Ltd. (APSCL)	

ASHUGANJ COMBINED CYCLE POWER PLANT PROJECT (NORTH)

UTS PROJECT NO. 7485	**UNIT: BOILER FEED WATER PUMPS**
PURCHASE ORDER NUMBER (P.O.R) 074850503 / F557	**EQUIPMENT : LAC**

REVIEW RESPONSE BY PURCHASER:

Purchaser review and comments do not indicate either responsibility or liability for accuracy and completeness of this document or alter any contractual terms and conditions:

☐ REJECTED	☐ Reviewed With Comments	☒ Review. Without Comments
☐ COMMENTS AS NOTED	☐ REVIEWED AS BUILT	☐ FOR INFORMATION

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INDEX

Pump Division

Type:	**WXH**
Size:	**6x16WXH-11**
Flowserve reference:	**COS-14-10P40397**
Project:	**ASHUGANJ NORTH**
Customer:	**TSK–TÉCNICAS REUNIDAS**
Equipment/ Item No.:	
M152095	**20LAC10AP001**
M152096	**20LAC20AP001**

USER INSTRUCTIONS: INSTALLATION, OPERATION, MAINTENANCE

CONTENTS

During initial start-up of this equipment, it is essential that all of the instructions in this manual be adhered to strictly. It is recommended that the services of a Flowserve service supervisor be obtained to assure trouble-free operation. In some cases, start-up in the presence of a Flowserve service supervisor may be a contractual requirement for continuation of warranty. Check your contract.

To schedule a service supervisor, please contact Flowserve.

1 INTRODUCTION AND SAFETY

1.1 General

These instructions must always be kept close to the product's operating location or directly with the product.

Flowserve's products are designed, developed and manufactured with state-of-the-art technologies in modern facilities. The unit is produced with great care and commitment to continuous quality control, utilising sophisticated quality techniques, and safety requirements.

We are committed to continuous quality improvement and being at your service for any further information about the product in its installation and operation or about its support products, repair and diagnostic services.

These instructions are intended to facilitate familiarization with the product and its permitted use. Operating the product in compliance with these instructions is important to help ensure reliability in service and avoid risks. The instructions may not take into account local regulations; ensure such regulations are observed by all, including those installing the product. Always coordinate repair activity with operations personnel, and follow all plant safety requirements and applicable safety and health laws and regulations.

These instructions should be read prior to installing, operating, using and maintaining the equipment in any region worldwide. The equipment must not be put into service until all the conditions relating to safety noted in the instructions, have been met.

1.2 CE marking and approvals

It is a legal requirement that machinery and equipment put into service within certain regions of the world shall conform with the applicable CE Marking Directives covering Machinery and, where applicable, Low Voltage Equipment, Electromagnetic Compatibility (EMC), Pressure Equipment Directive (PED) and Equipment for Potentially Explosive Atmospheres (ATEX).

Where applicable, the Directives and any additional Approvals, cover important safety aspects relating to machinery and equipment and the satisfactory provision of technical documents and safety instructions. Where applicable this document incorporates information relevant to these Directives. To establish approvals and if the product itself is CE marked, check the serial number plate and the Certification. (See Section 9, *Certification*).

1.3 Disclaimer

Information in these User Instructions is believed to be reliable. In spite of all the efforts of Flowserve Corporation to provide sound and all necessary information the content of this manual may appear insufficient and is not guaranteed by Flowserve as to its completeness or accuracy.

Flowserve manufactures products to exacting International Quality Management System Standards as certified and audited by external Quality Assurance organisations. Genuine parts and accessories have been designed, tested and incorporated into the products to help ensure their continued product quality and performance in use. As Flowserve cannot test parts and accessories sourced from other vendors the incorrect incorporation of such parts and accessories may adversely affect the performance and safety features of the products. The failure to properly select, install or use authorised Flowserve parts and accessories is considered to be misuse. Damage or failure caused by misuse is not covered by Flowserve's warranty. In addition, any modification of Flowserve products or removal of original components may impair the safety of these products in their use.

1.4 Copyright

1.5 Duty conditions

This product has been selected to meet the specifications of your purchaser order. The acknowledgement of these conditions has been sent separately to the Purchaser. A copy should be kept with these instructions.

The product must not be operated beyond the parameters specified for the application. If there is any doubt as to the suitability of the product for the application intended, contact Flowserve for advice, quoting the serial number.

If the conditions of service on your purchase order are going to be changed (for example liquid pumped, temperature or duty) it is requested that you/the user seek our written agreement before start up.

1.6 Safety

1.6.1 Summary of safety markings

These user instructions contain specific safety markings where non-observance of an instruction would cause hazards. The specific safety markings are:

DANGER This symbol indicates electrical safety instructions where non-compliance would affect personal safety.

This symbol indicates safety instructions where non-compliance would affect personal safety.

This symbol indicates safety instructions where non-compliance would affect protection of a safe life environment.

CAUTION This symbol indicates safety instructions where non-compliance would affect the safe operation or protection of the pump or pump unit.

This symbol indicates explosive atmosphere zone marking according to ATEX. It is used in safety instructions where non-compliance in the hazardous area would cause the risk of an explosion.

Note: This sign is not a safety symbol but indicates an important instruction in the assembly process.

1.6.2 Personnel qualification and training

All personnel involved in the operation, installation, inspection and maintenance of the unit must be qualified to carry out the work involved. If the personnel in question do not already possess the necessary knowledge and skill, appropriate training and instruction must be provided. If required the operator may commission the manufacturer/supplier to provide applicable training.

Always coordinate repair activity with operations and health and safety personnel, and follow all plant safety requirements and applicable safety and health laws and regulations.

The instructions in this manual are intended for the guidance of personnel with a general training in operation and maintenance of centrifugal pumps. It is our hope that you will become acquainted with its content as an aid to better pump performance.

1.6.3 Safety action

This is a summary of conditions and actions to prevent injury to personnel and damage to the environment and to equipment. (For products used in potentially explosive atmospheres Section 1.6.4 also applies.)

This manual contains instructions for installation, operation, and maintenance and servicing of your Flowserve Centrifugal Pump. It has been designed to provide safe and reliable service. It is both a pressure vessel, and a rotating machine; therefore, the operators must exercise good judgment and proper safety practices to avoid damage to the equipment and surroundings, and prevent personal injury.

It is recommended that your Safety Department establish a safety program based upon a thorough analysis of industrial hazards. Before installing, operating, or performing maintenance on the pump and associated components described in this manual the safety program must be reviewed by maintenance and operating personnel prior to installing, operating or performing any maintenance on the pump and its components.

It is important that due consideration be given to those hazards which arise from the presence of electrical power, high-pressure, high-temperature liquids, hot oil, toxic liquids or gases, and/or flammable liquids or gases. Proper installation and care of protective guards, shutdown devices, and over-pressure protection equipment shall also be considered an essential part of any safety program.

DANGER Also essential are special precautionary measures to prevent the possibility of applying power to the equipment at any time when maintenance work is in progress. The prevention of rotation due to reverse flow must not be overlooked.

In general, all personnel should be guided by all of the basic rules of safety associated with the equipment and the process.

CAUTION PREVENT EXCESSIVE EXTERNAL PIPE LOAD
Do not use pump as a support for piping. Do not mount expansion joints, unless allowed by Flowserve in writing, so that their force, due to internal pressure, acts on the pump flange.

CAUTION ENSURE CORRECT LUBRICATION
(See Section 5, *Commissioning, startup, operation and shutdown*).

CAUTION START THE PUMP WITH DISCHARGE VALVE PART OPENED (Unless otherwise instructed at a specific point in the user instructions.)
This is recommended to minimize the risk of overloading and damaging the pump motor at full or zero flow. Pumps may be started with the valve further open only on installations where this situation cannot occur. The pump outlet control valve may need to be adjusted to comply with the duty following the run-up process. (See Section 5, *Commissioning, startup, operation and shutdown*).

CAUTION NEVER RUN THE PUMP DRY

CAUTION INLET VALVES TO BE FULLY OPEN WHEN PUMP IS RUNNING AND DURING START UP
Starting up or running the pump at zero flow or below the recommended minimum flow continuously will cause damage to the seal.

CAUTION DO NOT RUN THE PUMP AT ABNORMALLY HIGH OR LOW FLOW RATES
Operating at a flow rate higher than normal or at a flow rate with no back pressure on the pump may overload the motor and cause cavitation. Low flow rates may cause a reduction in pump/bearing life, overheating of the pump, instability and cavitation/ vibration.

CAUTION UNDER NO CIRCUMSTANCES IS THE PUMP TO BE OPERATED WITH ANY SAFETY DEVICES RENDERED INOPERATIVE

DANGER NEVER DO MAINTENANCE WORK WHEN THE UNIT IS CONNECTED TO POWER

HAZARDOUS LIQUIDS
When the pump is handling hazardous liquids care must be taken to avoid exposure to the liquid by appropriate siting of the pump, limiting personnel access and by operator training. Wear protective clothing in the presence of caustic, corrosive, volatile, flammable, or hot liquids. If the liquid is flammable and/or explosive, strict safety procedures must be applied. Do not allow sparking, flames, or hot surfaces in vicinity of the equipment. ***Gland packing must not be used when pumping hazardous liquids.***

DRAIN THE PUMP AND ISOLATE PIPEWORK BEFORE DISMANTLING THE PUMP
The appropriate safety precautions should be taken where the pumped liquids are hazardous.

FLUORO-ELASTOMERS (When fitted.)
When a pump has experienced temperatures over 250 ºC (482 ºF), partial decomposition of fluoro-elastomers (eg Viton) will occur. In this condition these are extremely dangerous and skin contact must be avoided.

HANDLING COMPONENTS
Many precision parts have sharp corners and the wearing of appropriate safety gloves and equipment is required when handling these components. To lift heavy pieces above 25 kg (55 lb.) use a crane appropriate for the mass. Consult current local regulations.

GUARDS MUST NOT BE REMOVED WHILE THE PUMP IS OPERATIONAL
The unit must not be operated unless the guard(s) is bolted in place. Failure to observe this could result in injury to operating personnel.

THERMAL SHOCK
Rapid changes in the temperature of the liquid within the pump can cause thermal shock, which can result in damage or breakage of components and should be avoided.

NEVER APPLY HEAT TO REMOVE IMPELLER
Trapped lubricant or vapour could cause an explosion.

HOT (and cold) PARTS
If hot or freezing components or auxiliary heating supplies can present a danger to operators and persons entering the immediate area action must be taken to avoid accidental contact. If complete protection is not possible, the machine access must be limited to maintenance staff only, with clear visual warnings and indicators to those entering the immediate area. Note: bearing housings must not be insulated and drive motors and bearings may be hot.

If the temperature is greater than 68 °C (175 °F) or below 5 °C (20 °F) in a restricted zone, or exceeds local regulations, action as above shall be taken.

1.6.4 Products used in potentially explosive atmospheres

This section only applies to products used in potentially explosive atmospheres.

Measures are required to:

- Avoid excess temperature
- Prevent build up of explosive mixtures
- Prevent the generation of sparks
- Prevent leakages
- Maintain the pump to avoid hazard

The following instructions for pumps and pump units when installed in potentially explosive atmospheres must be followed to help ensure explosion protection. Both electrical and non-electrical equipment must meet the requirements of European Directive 94/9/EC.

1.6.4.1 Scope of compliance

Use equipment only in the zone for which it is appropriate. Always check that the driver, variable speed coupling (if included), drive coupling assembly, seal and pump equipment are suitably rated and/or certified for the classification of the specific atmosphere in which they are to be installed.

Where Flowserve has supplied only the bare shaft pump, the Ex rating applies only to the pump. The party responsible for assembling the pump set shall select the coupling, driver and any additional equipment, with the necessary CE Certificate/ Declaration of Conformity establishing it is suitable for the area in which it is to be installed.

The output from a variable frequency drive (VFD) can cause additional heating affects in the motor and so, for pumps sets with a VFD, the ATEX Certification for the motor must state that it is covers the situation where electrical supply is from the VFD. This particular requirement still applies even if the VFD is in a safe area.

1.6.4.2 Marking

An example of ATEX equipment marking is shown below. The actual classification of the pump will be engraved on the nameplate.

II 2 GD c 135 ºC (T4)

Equipment Group
I = Mining
II = Non-mining

Category
2 or M2 = High level protection
3 = normal level of protection

Gas and/or Dust
G = Gas; D= Dust

c = Constructional safety
(in accordance with prEn13463-5)

Maximum surface temperature (Temperature Class)
(See Section 1.6.4.3.)

1.6.4.3 Avoiding excessive surface temperatures

ENSURE THE EQUIPMENT TEMPERATURE CLASS IS SUITABLE FOR THE HAZARD ZONE

Pumps have a temperature class as stated in the ATEX Ex rating on the nameplate.

The surface temperature on the pump is influenced by the temperature of the liquid handled. The maximum permissible liquid temperature depends on the temperature class and must not exceed the values in the table that follows.

Temperature class to prEN 13463-1	Maximum surface temperature permitted
T6	85 °C (185 °F)
T5	100 °C (212 °F)
T4	135 °C (275 °F)
T3	200 °C (392 °F)
T2	300 °C (572 °F)
T1	450 °C (842 °F)

The responsibility for compliance with the specified maximum liquid temperature is with the plant operator.

If an explosive atmosphere exists during the installation, do not attempt to check the direction of rotation by starting the pump unfilled. Even a short run time may give a high temperature resulting from contact between rotating and stationary components.

Where there is any risk of the pump being run against a closed valve generating high liquid and casing external surface temperatures it is recommended that users fit an external surface temperature protection device.

Avoid mechanical, hydraulic or electrical overload by using motor overload trips, temperature monitor or a power monitor and make routine vibration monitoring checks.

In dirty or dusty environments, regular checks must be made and dirt removed from areas around close clearances, bearing housings and motors.

1.6.4.4 Preventing the build up of explosive mixtures

ENSURE THE PUMP IS PROPERLY FILLED AND VENTED AND DOES NOT RUN DRY

Ensure the pump and relevant suction and discharge pipeline system is totally filled with liquid at all times during the pump operation, so that an explosive atmosphere is prevented. In addition it is essential to make sure that seal chambers, auxiliary shaft seal systems and any heating and cooling systems are properly filled.

If the operation of the system cannot avoid this condition the fitting of an appropriate dry run protection device is recommended (eg liquid detection or a power monitor).

To avoid potential hazards from fugitive emissions of vapour or gas to atmosphere the surrounding area must be well ventilated.

1.6.4.5 Preventing sparks

To prevent a potential hazard from mechanical contact, the coupling guard must be non-sparking and anti-static for Category 2.

To avoid the potential hazard from random induced current generating a spark, the earth contact on the baseplate must be used.

Avoid electrostatic charge: do not rub non-metallic surfaces with a dry cloth; ensure cloth is damp.

The coupling must be selected to comply with 94/9/EC and correct alignment must be maintained.

1.6.4.6 Preventing leakage

The pump must only be used to handle liquids for which it has been approved to have the correct corrosion resistance.

Avoid entrapment of liquid in the pump and associated piping due to closing of suction and discharge valves, which could cause dangerous excessive pressures to occur if there is heat input to the liquid. This can occur if the pump is stationary or running.

Bursting of liquid containing parts due to freezing must be avoided by draining or protecting the pump and ancillary systems.

Where there is the potential hazard of a loss of a seal barrier fluid or external flush, the fluid must be monitored.

If leakage of liquid to atmosphere can result in a hazard, the installation of a liquid detection device is recommended.

1.6.4.7 Maintenance to avoid the hazard

CORRECT MAINTENANCE IS REQUIRED TO AVOID POTENTIAL HAZARDS WHICH GIVE A RISK OF EXPLOSION

The responsibility for compliance with maintenance instructions is with the plant operator.

To avoid potential explosion hazards during maintenance, the tools, cleaning and painting materials used must not give rise to sparking or adversely affect the ambient conditions. Where there is a risk from such tools or materials, maintenance must be conducted in a safe area.

It is recommended that a maintenance plan and schedule is adopted. (See Section 6, *Maintenance.)*

1.7 Warning labels summary

1.8 Specific machine performance

When the contract requirement specifies performance parameters to be incorporated into User Instructions, these are included in Section 10.1. Where performance data has been supplied separately to the purchaser these should be obtained and retained with these User Instructions if required.

1.9 Noise level

When pump noise level exceeds 85 dB_A attention must be given to prevailing Health and Safety Legislation, to limit the exposure of plant operating personnel to the noise. The usual approach is to control exposure time to the noise or to enclose the machine to reduce emitted sound. You may have already specified a limiting noise level when the equipment was ordered, however if no noise requirements were defined then machines above a certain power level will exceed 85 dB_A. In such situations consideration must be given to the fitting of an acoustic enclosure to meet local regulations.

Pump noise level is dependent on a number of factors - the type of motor, the operating capacity, pipework design and acoustic characteristics of the building.

2 TRANSPORT AND STORAGE

2.1 Consignment receipt and unpacking

Immediately after receipt of the equipment it must be checked against the delivery/shipping documents for its completeness and that there has been no damage in transportation. Any shortage and/or damage must be reported immediately to Flowserve Pump Division and must be received in writing within one month of receipt of the equipment. Later claims cannot be accepted.

Check any crate, boxes or wrappings for any accessories or spare parts that may be packed separately with the equipment or attached to side walls of the box or equipment.

Each product has a unique serial number. Check that this number corresponds with that advised and always quote this number in correspondence as well as when ordering spare parts or further accessories.

Your pump was carefully checked at the factory prior to shipment to ensure compliance with the requirements of your order. It is suggested that the pump be inspected upon arrival for damages or signs of rough handling. If any damage is found and/or parts are missing, notify the carrier and nearest Flowserve office immediately. Failure to do so may affect the validity of the warranty.

The condition of the skid and covering is indicative as to the way the shipment was handled. Broken skids, torn coverings, bent hold-down bolts, broken straps, etc., indicate rough handling.

Inspect all covers over pump openings and piping connections. The protective covers on the pump nozzles should be in place and undamaged. If covers or seals for the covers are damaged or loose, they are to be removed, and a visual inspection made of the accessible interior areas for accumulation of foreign materials or water. Install or replace covers and fasten securely.

Inspect the preservative coating on the various parts. If necessary, renew the preservative in areas where it has been rubbed off or scraped to restore the parts to the "as shipped" condition.

Inspect all painted surfaces. If necessary, touch up the areas where paint has been chipped or scraped. Paints and preservatives used are either Flowserve standard or special as required by the contract specification.

The driver end cover, screens, and conduit box should be visually inspected for damage.

Shipping documents should be checked to determine satisfactory arrival of any special tools, loose parts, and/or spare parts (if provided), which are usually preserved and packed in a box attached to the skid.

2.2 Handling

Boxes, crates, pallets or cartons may be unloaded using fork-lift vehicles or slings dependent on their size and construction. Consult current local regulations.

2.3 Lifting

⚠ Careful attention must be paid to lifting the unit. Improper lifting can result in severe injury to personnel and/or damage to the equipment. Only qualified personnel trained in proper methods of lifting equipment should attempt to rig and lift this equipment.

⚠ CAUTION To lift pump and baseplate or just baseplate, sling baseplate from all lifting eyes provided. Failure to do this may result in permanent deformation of baseplate.

⚠ CAUTION Assure that coupling(s) are disconnected before lifting equipments.

⚠ The suction casing/discharge casing nozzles, and/or any auxiliary equipment or piping, should never be used to support the weight of the pump-driver unit, or any of its parts.

⚠ CAUTION Be sure that the lifting slings and/or chains are positioned to take equal strain so that twisting or sudden movement will not occur. Control lines around the pump or driver, are suggested to prevent the unit from swinging or flipping over

⚠ Make sure that any equipment used to lift the pump or any of its components is capable of supporting the total weight encountered (see General Arrangement drawing). A crane must be used for all pump sets in excess of 25 kg (55 lb.). Ensure that all parts are properly rigged before attempting to lift. Consult current local regulations.

⚠ Fully trained personnel must carry out lifting, in accordance with local regulations. The driver and pump weights are recorded on their respective nameplates or mass-plates.

2.4 Storage

⚠ CAUTION If it is necessary to store the pump any length of time before installation, find a location where it will be protected. The nozzle and piping connection covers provided with the pump should be left in place during storage.

CAUTION The pump driver should not be stored in a damp atmosphere without special protection. Refer to driver instruction manual for storage instructions.

2.4.1 Rust preventive

The internal parts of pump are coated with a thin-film of polar-type rust preventive. This can be removed by flushing with petroleum solvents. External machined surfaces are protected with a durable, drying-type rust preventive. This can be removed with kerosene or other solvent.

External non-machined surfaces are painted. Parts ordered separately are protected with a thin-film of polar-type rust preventive. This can be removed with petroleum solvents.

2.4.2 Extended storage requirements for horizontal pumps

2.4.2.1 General

During extended periods of storage prior to installation and from the time of installation until commercial operation, precautions must be taken to protect the pump from deterioration. The various parts of the pump are protected prior to shipment by applying varying grades of preservative and paint. However, during shipment and handling, the preservatives are subjected to conditions that can cause their removal. Also, during extended periods of time, the preservatives may deteriorate. The following procedures should be followed to prevent deterioration of the pump during the extended storage period. These procedures may also be supplemented by the experience of the persons performing the tasks.

It should be noted, that unless otherwise agreed to, full responsibility and costs associated with the storage and inspection of this equipment rests with the customer.

CAUTION If pump is equipped with a mechanical seal and is stored or has not been run for 1 year or more, the mechanical seal must be removed before start-up and faces re-lapped to guard against the possibility of seal leakage. When reinstalling the seal, new circular joint rings and gaskets must be used.

CAUTION If pump is equipped with a mechanical seal, the seal should be coated with preservative, boxed and stored in a warm dry place.

CAUTION It is recommended that pump be stored completely assembled.

2.4.2.2 Storage area

When selecting a storage area, the following should be taken into consideration:

- deterioration of the equipment will be proportionate to the class/type of storage provided
- expenses involved in restoring the equipment at time of operation will be proportionate to the class/type of storage provided

CAUTION If at all possible, the pump and its component parts should be stored indoors where they will be protected from the elements. If it is not possible, precautions must be taken to protect them from the elements. Regardless of whether storage is inside or outside, the storage area should be vibration-free.

CAUTION All packages marked for inside storage must be stored indoors.

CAUTION The pump and its components when stored outdoors should be protected from dirt, dust, rain, snow or other unfavourable conditions by coverings of heavy gauge plastic sheets, canvas, waterproof burlap or other suitable coverings.

CAUTION All equipment must be placed upon skids or blocks to prevent contact with the ground and surface contaminants. Equipment must be adequately supported to prevent distortion and bending.

CAUTION Fill the bearing housings with the recommended oil to the bottom of the shaft. Flowserve does not recommend rotating the shaft on a periodic basis.

2.4.2.3 Storage preferred (dry)

2.4.2.3.1 Customer Inspection and Maintenance

The stored equipment is to be placed on a periodic schedule by the customer.

The responsibility for setting up an inspection and maintenance schedule rests with the customer and will be dependent upon the class/type of storage provided and the storage conditions. It would be expected that initially inspection would occur weekly, then, depending upon the inspection reports being favourable or unfavourable, inspection would continue weekly, monthly, or quarterly, as may be determined. Inspection reports must be kept on file.

Each inspection should consist of a general surface inspection:

a) Pump and pump rotor supports are firmly in place.

b) Pump covers over openings are firmly in place.

c) Pump covering, plastic or tarps, is firmly in place. Any holes or tears must be repaired to prevent entrance of dirt or water.

d) Pump covers are periodically removed from openings and interior accessible areas inspected. If moisture has accumulated or surface rusting occurred, dry out and clean or re-coat with preservative.

e) Loosen suction casing/discharge casing drain plugs or flanges to allow seepage of any accumulated moisture.

f) If rusting occurs on exterior surfaces, clean and repaint or re-coat with preservative.

g) Periodically remove bearing covers and inspect for accumulation of moisture, rust and foreign material. As required, clean bearings and bearing housings and re-preserve. Install bearing cover and secure it to assure maximum protection. Bearings removed for storage should be coated with preservative wrapped in oil/wax paper and stored in a warm dry area.

h) Check individually wrapped parts for signs of deterioration. If necessary, renew preservative and wrapping.

2.4.2.3.2 Six Months Prior To Installation
Six months prior to the scheduled installation date, a Flowserve representative is to be employed to conduct an inspection. All costs involved during inspection, dismantling, restoration, replacement of parts, and re-assembly will be the responsibility of the customer. All necessary labor, tools, and cranes will be supplied by the customer. This inspection will include (not necessarily in its entirety) but not be limited to, the following:

a) An inspection of all periodic inspection records as kept on file by the customer, and all inspection reports that have been compiled during the storage period.

b) An inspection of the storage area to determine the "as stored" condition of the equipment prior to any protection covers being removed.

c) An inspection of the equipment with protection covers and flange covers removed.

d) Depending upon the length of time the equipment was stored, the class/type of storage provided, (i.e.: indoor, heated, unheated, ground floor, concrete floor; outdoors, under roof, no roof, waterproof covering, on concrete, on ground) and as a result of the inspection of a, b and c above the Flowserve representative may require a partial or complete dismantling of the equipment.

e) Dismantling may necessitate restoration of painted or preserved surfaces, and/or replacement of gaskets, circular ring joints, packing and/or mechanical seal and bearings.

Upon completion of the inspection, the Flowserve representative shall submit a report to the customer, and to the Manager of Customer Service (Flowserve), stating in detail the results of the inspection.

2.4.2.3.3 One Month Prior To Installation
One month prior to installation of the equipment, a Flowserve representative is to be employed to conduct a final inspection. This final inspection will be made to assure that the requirements of the six month inspection report were satisfactorily completed and that the equipment is ready for installation.

Upon completion of this inspection, the Flowserve representative shall submit a final report to the customer, and to the Manager of Customer Service (Flowserve) advising the results of the final inspection.

2.4.2.4 Storage non-preferred (wet)
It is not recommended that the rotor be subjected to extended periods of submergence or wetting prior to start-up. However, it is recognized that in some cases, a long period of time may lapse from installation until commercial operation.

If the pump must be stored after being installed and wetted, the following inspection and maintenance procedures should be performed:

a) Isolate pump - tag (seal) all valves.

b) Preserve the pump internals:
- Corrosive Pumpage (such as water). Fill the pump as much as possible with a suitable corrosion inhibitor and, if required, seal off any openings. Flowserve recommends the use of Protecsol 649L which is a water soluble, vapour corrosion inhibitor. It is ideally suited for wet or dry corrosion protection of equipment during short term / long term lay-up periods of up to 24 months. Protecsol 649L corrosion inhibitor does not need to be removed prior to placing equipment back into service. For detailed instructions, inquires, and to purchase this product call: Ashland Specialty Chemical Company, Drew Industrial Division, Phone # 1-800-526-1015 and request Maintenance Chemical Marketing.
- Non-Corrosive Pumpage (such as oil). Fill pump with pumpage to the highest level possible. Periodically open drain connections to drain off

any moisture that may have accumulated. Refill to highest level possible. Drain and inspect pump prior to start-up.

2.4.3 Storage requirements for drivers
Generally storage must be indoors and dry. See the specific manufacturer's storage requirement.

2.4.4 Storage requirements for lube system
See the specific manufacturer's storage requirement.

2.4.5 Storage requirements for other equipments
See the specific manufacturer's storage requirement.

2.5 Recycling and end of product life
At the end of the service life of the product or its parts, the relevant materials and parts should be recycled or disposed of using an environmentally acceptable method and in accordance with local regulations. If the product contains substances that are harmful to the environment, these should be removed and disposed of in accordance with current local regulations. This also includes the liquids and/or gases that may be used in the "seal system" or other utilities.

Make sure that hazardous substances are disposed of safely and that the correct personal protective equipment is used. The safety specifications must be in accordance with the current local regulations at all times.

3 PUMP DESCRIPTION

3.1 Configurations

The WXH type pump is a multistage, high pressure ring section design pump with a balance disc type construction. It is available in a wide range of sizes and stages to accommodate a wide spectrum of needs.

WXH pumps are available in the following configurations:

- Single or double suction first stage impeller
- With or without intermediate stage take-off connection
- Different sizes
- Different bearings configurations

3.2 Name nomenclature

The pump size will be engraved on the nameplate typically as below:

6X14WXH-6

Nominal discharge flange diameter

Nominal impeller diameter

Commercial pump type

Number of stages

The typical nomenclature above is the general guide to the WXH configuration description. Identify the actual pump size and serial number from the pump nameplate. Check that this agrees with the applicable certification provided.

3.3 Design of major parts

Flowserve Pump design incorporates hydraulic and mechanical improvements resulting from years of experience in building this class of equipment.

These units are dependable, efficient and durable, and include outstanding features such as COMPLETE AXIAL and RADIAL BALANCE. Full protection is provided against corrosion, erosion and cutting. Throughout this manual, numbers (in parentheses) following part names--such as "shaft [2100]" indicate reference to the Sectional Assembly drawing and parts list included in the manual.

The pump is of the double suction type, i.e., all impellers face in one direction, except the first stage impeller which is a double suction impeller. Liquid enters through two suction openings in the first stage impeller (each one at one side of the suction head), passes through the first stage impeller, and through the other stages impellers in succession and leaves through a discharge opening at the opposite end.

The first stage impeller is enclosed by the suction casing [1130]. The suction casing directs the flow of liquid from the suction nozzle to the first stage impeller.

Surrounding each succeeding impeller is a stage casing [1150.1/2/3/14/29] which contains the fluid passages. Diffusion vanes efficiently convert a portion of the velocity energy of the liquid leaving the impeller into pressure energy. This process is repeated through each successive stage, each adding its increment of head or pressure. Liquid leaving the last stage diffuser passes into an annular space in the discharge casing and out the discharge nozzle. Diffusers [1410.1/2/7] are used in preference to volutes because their hydraulic construction provides flexibility, efficiency and complete elimination of radial thrust at all conditions of operation.

3.3.1 Suction casing

The cast steel suction casing [1130] closes the suction end of the pump and houses the suction passage and flange. It also serves as the mounting for the radial bearing housing, includes machining for stuffing box sealing and is drilled for insertion of the rods. The pump mounting feet are also machined into the sides of the suction casing.

3.3.2 Casing

The casing consists of a series of stage casings [1150.1/2/3/14/29], and diffusers [1410.1/2/7], incorporating the hydraulic passages and impeller inlet chambers. The casing assembly is held in alignment by interlocking joints of close tolerances and held together between the suction and discharge casings with tie bolts and circular joint rings between each stage to seal the pump from leaking to atmosphere. This construction simplifies assembling and dismantling operations. Contact between the stage casings and diffuser is maintained by the clamping force of the tie bolts.
The stage casing diffuser design assures absolute concentricity with all diametral fits machined at one setting.

3.3.3 Shaft

The shaft [2100] furnished is machined from the highest quality material selected with consideration to the service for which the pump is to be applied. The shaft is of sufficient diameter to assure low torsional stresses and is accurately ground and polished throughout its entire length.

3.3.4 Sealing device

Cartridge style mechanical seals [4200] are used at both ends of the pump where the shaft protrudes through the suction casing [1130] and stuffing box housing [4110]. Each mechanical seal has a stationary ring against which a spring-loaded rotating ring seals, to prevent leakage from the pump.

3.3.5 Impellers and wear rings

Individually mounted impellers [2200.1/2/3/8], of one piece construction, are keyed to the shaft with keyways on alternate sides of the shaft. The 1st stage impeller is positioned against a shoulder on the shaft with the remaining impellers stacked hub to hub. During operation, force is transmitted through the impeller hub into the shaft at the shaft shoulder. Renewable casing wear rings [1500.1/2/6/10] are provided to control leakage past the impeller hubs or the renewable impeller wear rings (if supplied).

3.3.6 Discharge casing

A cast steel discharge casing [1140] closes the discharge end of the casing and serves as a mounting surface for the outboard stuffing box housing and thrust bearing housing, and includes drilling for insertion of the tie bolts. The outboard feet are also machined into the sides of the discharge casing.

3.3.7 Balancing device

Flowserve ring section pumps are maintained in complete axial balance during operation by a self compensating flanged balance disc [6210], and counter balance disc [6220]. The normal axial thrust developed by the rotor toward the suction end of the pump is effectively counteracted by the balancing device assembly located at the discharge end. The front end of the balance disc is exposed to full discharge pressure. The chamber at the back of the balance disc is piped to suction pressure, placing this pressure on the outer face. A thrust is therefore developed which is equal in magnitude and opposite in direction to the normal thrust of the pump impellers toward the suction.

3.3.8 Radial bearings

The bearing bushes [3300] are carbon steel backed, babbitt lined, sleeve-type insert bearings. The renewable bearing inserts are mounted in bearing bodies [3200.1/2] which are kept from rotating by means of stop pins.

3.3.9 Thrust bearing

The thrust bearing is of the equalizing type having six shoes on each side of the thrust bearing plate and is consequently capable of transmitting the thrust load in either direction. Thrust is transmitted through the thrust bearing plate [3610] to the shoes, by the shoes to the shoe supporting elements, and thence to the bearing housing and the foundation.

3.3.10 Pump pedestals

The pump should not be removed from the pedestal unless it is going to be disassembled. The pump pedestal help to keep the suction and discharge nozzles aligned while torquing the tie bolts.

3.4 Performance and operating limits

This product has been selected to meet the specifications of your purchase order see Section 1.5.

4 INSTALLATION

Note: It is strongly recommended the installation and commissioning of this equipment be conducted in accordance with API Recommended Practices 686/PIP REIE 686 First Edition. Refer to API 610 Eighth Edition Appendix 'L' for baseplate grouting requirements.

Copies of API Recommended 'Practices 686/PIP REIE 686 First Edition may be obtained from America Petroleum Institute, 1220 L Street, N. W., Washington, D. C. 20005. Phone #: (202) 682 8000.

The following ASTM Specifications are furnished as references for test methods used in conjunction with installation of grouting materials and should be used to obtain proper results.

- ASTM C 78-84: Test Method for Flexural Strength for Concrete
- ASTM C 109-90: Test Method for Compressive Strength of Hydraulic Cement Mortars (Modified)
- ASTM C 469 87a: Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in compression
- ASTM C 496-90: Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
- ASTM C 531-85: Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Grouts and Monolithic Surfacings (Modified)
- ASTM C 666-90: Test Method for Resistance of Concrete to Rapid Freezing and Thawing
- ASTM C 939-87: Test Method for Flow of Grout for Preplaced Aggregate Concrete (Flow Cone Method)
- ASTM C 942-86: Test Method for Compressive Strength of Grouts for Preplaced Aggregate Concrete in the Laboratory
- ASTM C 1090-88: Test Method for Measuring Changes in Height of Cylindrical Specimens from Hydrau-lic Cement Grout
- ASTM C 1107-91: Standard Specification for Packaged Hydraulic Cement Grout (Non shrink)
- (CRD C 621-92) ACI 351 24 Hour Test: Grouting for Support of Equipment and Machinery. MBT Test Method for Grout Performance

Minimum requirements for epoxy grout (typical properties at 23 °C (73 °F)

- ASTM D-635: Fire Resistant
- ASTM C-579B: Minimum Compressive Strength 82.7 N/mm^2 (12000 psi)
- ASTM C-827: Height Change @ 38 °C (90 °F). Positive Effective Bearing Area 95%
- ASTM C-1181: Maximum Creep in 1 Year 1.6X10^{-3} mm/mm (in./in.) at 60 ºC (140 °F), 2.76 N/mm^2 (400 psi)
- ASTM C-307. Minimum Tensile Strength 12.4 N/mm^2 (1800 psi)
- ASTM C-580. Minimum Flexural Strength 26.2 N/mm^2 (3800 psi)
- ASTM C-580. Minimum Flexural Secant Modulus 1.2X10^4 N/mm^2 (1.8X10^6 psi)
- ASTM C-531. Maximum Coefficient of Expansion 17X10^6 mm/mm/ºC (in/in/°F). Maximum Peak Exotherm 1000 gm insulated 35 °C (95 °F). Full Aggregate Must Be Used

Damage resulting from neglect and disregard of the instructions and precautions included in this instruction manual will be the sole responsibility of the purchaser.

CAUTION Poor location and use of inadequate standards for the preparation of the foundation adversely affect pump life. A good foundation is particularly important since it can be a primary factor in preventing vibration, a major cause of wear and failure of the pump.

Ex Equipment operated in hazardous locations must comply with the relevant explosion protection regulations. See Section 1.6.4, *Products used in potentially explosive atmospheres*.

4.1 Location

When selecting pump location, allow adequate space for access, ventilation, operation, maintenance and inspection of the unit. Head room must be an important consideration for maintenance of the unit; lifts will have to be made in order to remove the pump, and when supplied, pump with pump pedestal. An overhead rail or crane, in line with the pump centreline is most desirable. Important data and dimensions can be obtained from the General Arrangement drawing included in this User Instructions book.

4.2 Prior to installation / operation

Please read all notes on General Arrangement drawing.

4.3 Foundation

Note: The following information regarding foundation is only offered as a general guideline to the customer. Flowserve Corp. requires that all foundations be designed/installed in accordance with specifications set forth in Chapter 4 'Foundations' from API Recommended Practices 686/PIP REIE 686, First Edition.

CAUTION The design of foundations is not the responsibility of Flowserve Corp. It is therefore recommended that the customer consult a competent specialist skilled in the field of foundations, to insure proper design and installation of the foundation.

CAUTION There are many methods of installing pump units to their foundations. The correct method depends on the size of the pump unit, its location and noise vibration limitations. Non-compliance with the provision of correct foundation and installation may lead to failure of the pump and, as such, would be outside the terms of the warranty. Ensure the following are met.

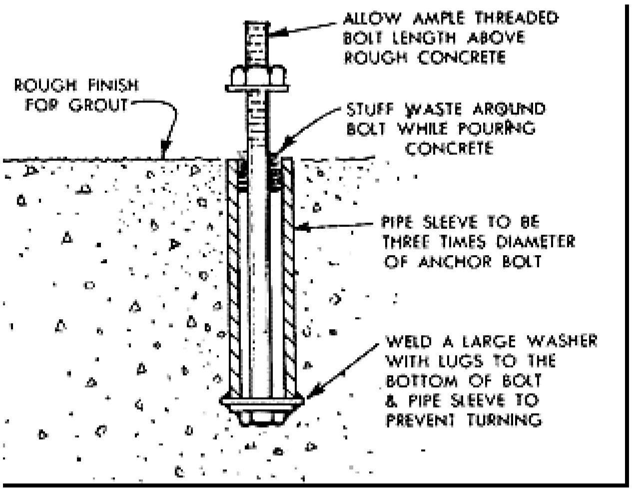
The foundation should be sufficiently rigid and substantial, to prevent any pump vibration and to permanently support the equipment at all points.

The most satisfactory foundations are made of reinforced concrete. These should be poured well in advance of the installation to allow proper time for drying and curing.

The foundation mass ratio should be three to five times the weight of the equipment.

The General Arrangement drawing will furnish anchor bolt locations, size of bolts, etc.

The sketch illustrates a recommended foundation bolt arrangement. Notice the large washer with lugs at the bottom. It should be welded to the bolt and pipe sleeve to prevent turning.

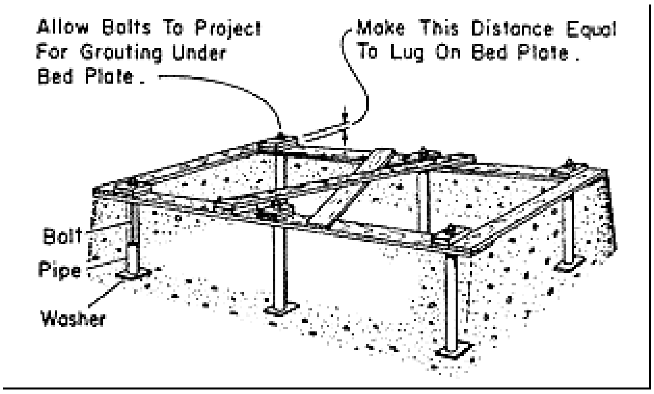


A rough-finish top surface is best when applying grout. It must be clean and dry before pouring any grout.

Note: Recommended ambient temperature should be above 18 ºC (65 °F) during grouting.

4.4 Arrangement of foundation bolt in foundation

Foundation bolts should be located using dimensions as shown on General Arrangement drawing.



The sketch illustrates a template for hanging foundation bolts.

4.5 Bedplate installation

4.5.1 General considerations

The foundation must be sufficiently rigid and must support the unit at all points. Foundation must be designed such that structural resonance is outside of the operating speed range of the pump and motor.

Before putting the unit on the foundation, thoroughly clean the top of the foundation. Break off any loose pieces of cement and roughen the top with a chisel to afford a good hold for grout. Use epoxy type grout.

Refer to General Arrangement drawing for additional bedplate information.

4.5.2 Levelling the bedplate

Note: The following information regarding levelling of equipment is only offered as a general guideline to the customer. Flowserve Corp. requires that all levelling of equipment be performed in accordance with specifications set forth in Chapter 5 'Mounting Plate Grouting' from API Recommended Practices 686/PIP REIE 686, First Edition.

⚠ Make sure that any equipment used to lift the motor or any other components is capable of supporting the total weight encountered. Make sure that all parts are properly rigged before attempting to lift.

CAUTION Place the unit in position on foundation. When lifting baseplate, sling from all lifting eyes provided. Failure to do this may result in permanent deformation of baseplate.

CAUTION Motor (and variable speed coupling, if supplied) must be removed before lifting baseplate.

Establish the equipment elevations as shown on the General Arrangement drawing. The equipment train must be levelled prior to grouting to verify final alignment can be achieved.

For shims and/or fasteners refer to General Arrangement drawing & Notes.

The following tool(s) will be required for use in this procedure:

- A precision (machinist) level, graduated in 0.05 mm/m (or 0.0005 in./ft.) increments.

Note: Do not grout baseplate prior to levelling the bedplate.

CAUTION Baseplate must not be lifted with motor (and variable speed coupling, if supplied) mounted.

CAUTION When lifting, sling bedplate from all lifting eyes provided. Failure to do this may result in permanent deformation of baseplate.

Begin levelling at high end of baseplate. Level crosswise on this end till pads are within 0.16 mm/m (0.002 in./ft.). Adjust the baseplate to achieve this degree of level by using built in levelling screws.

Proceed to the rest of the pads repeating the procedure above until the baseplate is level in the crosswise direction. If possible, span the pads with a flat bar and check level across pads.

Level both sides of the baseplate in the lengthwise direction to 0.16 mm/m (0.002 in./ft.) to a maximum of 0.25 mm (0.010 in.) over the entire length of the baseplate.

Tighten the anchor bolts and check the level in both crosswise and lengthwise direction. If tightening disturbs the level, adjust levelling screws till levelness is achieved when anchor bolts are tight.

If the pads cannot be levelled within this designated tolerance, please contact your Flowserve representative for appropriate corrective action.

Mount all equipment, if necessary, and proceed to alignment.

4.6 Equipment mounting

4.6.1 General considerations

Pump is mounted on bedplate at the factory and shipped to the site on bedplate.

Note: Refer to General Arrangement drawing for additional information on bolting pump to bedplate and bedplate installation.

The driver may already be mounted on the baseplate depending upon the contractual requirements. Refer to the driver (and variable speed coupling, if supplied) IOM and General Arrangement drawing for additional information.

4.6.2 Soft foot check

The pump feet shall be checked for soft feet. The hold down bolts should be torqued to the values listed in the torque tables. Then one foot shall be loosened with an indicator contacting the top of the foot. The maximum allowable foot movement shall be 0.25 mm (0.010 in.). Re-tighten this foot and proceed to the next. If any foot has more than the maximum allowable soft foot movement, please contact your Flowserve representative for appropriate corrective action.

4.7 Vertical thermal rise of equipment

CAUTION The pump and motor (and variable speed coupling, if included) will normally have to be aligned at ambient temperature and should be corrected to allow for thermal expansion at operating temperature.

A hot check can only be made after the unit has been in operation a sufficient length of time to assume its NORMAL operating temperature and conditions. If the unit has been properly cold set, the coupling hub misalignment will be within 0.050 mm total indicator run-out (0.002 in. TIR) and coupling hub faces are parallel within 0.025 mm (0.001 in.) when in operation. If not, make adjustments.

Note: Refer to "RIM AND FACE DATA SHEET".

Note: It is recommended, the completed "RIM AND FACE DATA SHEET" be retained as part of your permanent maintenance file.

⚠ Do not attempt any maintenance, inspection, repair or cleaning in the vicinity of rotating equipment. Such action could result in injury to operating personnel.

⚠ Before attempting any inspection or repair on the pump, the driver controls must be in the "off" position, locked and tagged to prevent restarting equipment and injury to personnel performing service on the pump.

4.8 Initial shaft/coupling alignment

4.8.1 General considerations

Note: The following information regarding shaft alignment is only offered as a general guideline to the customer. Flowserve Corp. requires that all shaft alignment be performed in accordance with specifications set forth in Chapter 7 'Shaft Alignment' from API Recommended Practices 686/PIP REIE 686, First Edition.

CAUTION Shaft alignment must be correct for successful operation. Rapid wear, noise, vibration and actual damage to the equipment may be caused by shaft misalignment. The shafts must be aligned within the limits given within this section.

Note: Adjustment to correct the alignment in one direction may alter the alignment in another direction. Always check in all directions after making any adjustment.

Note: If variable speed coupling is included, it is necessary to align the pump and variable speed coupling shafts, and the variable speed coupling and motor shafts.

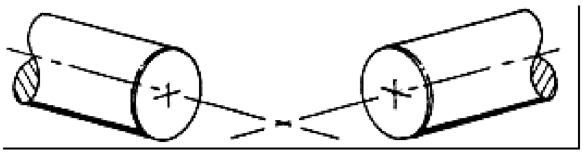
Coupled equipment must be aligned to minimize unnecessary stresses in shafts, bearings and coupling. Flexible couplings will not compensate for appreciable misalignment. Foundation settling, thermal expansion or nozzle loads resulting in foundation deflection and vibration during operation may require the full coupling misalignment capability.

4.8.2 Types of misalignment

There are two types of shaft misalignment: Angular and Offset. Therefore, two sets of measurements and corrections are required. Both types of misalignment can occur in horizontal and vertical planes and are present in most applications.

4.8.2.1 Angular misalignment

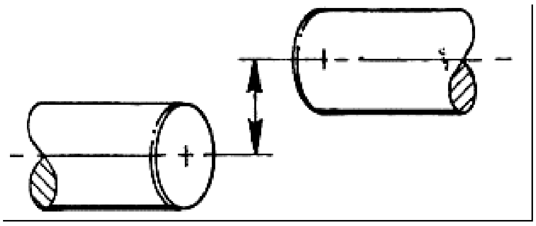
In angular misalignment, the centrelines of the shafts intersect, but are not on the same axis.



Angular misalignment

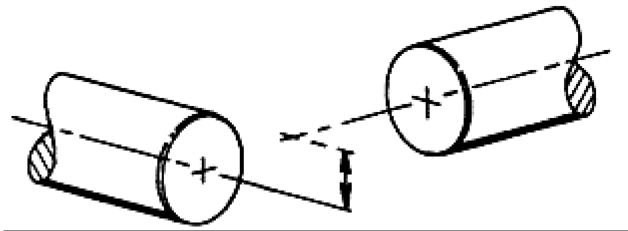
4.8.2.2 Offset misalignment

In offset misalignment, the shaft centrelines are parallel but do not intersect.



Offset misalignment

4.8.2.3 Combination of angular and offset misalignment



Combination of angular and offset misalignment

4.8.3 Alignment

For shim & alignment procedures, refer to General Arrangement drawing notes.

DANGER Ensure pump and driver are isolated electrically and the half couplings are disconnected.

CAUTION The alignment MUST be checked.

4.8.3.1 Measure gap

The first step in shaft/coupling alignment is to bring the pump and driver shafts into their proper axial position. The shaft gap, or distance between coupling hubs, must be in accordance with the certified General Arrangement drawing and must be measured with pump and driver shafts in the centre of their axial end float. Motor with sleeve bearings is to be aligned with rotor at magnetic centre.

Note: Refer to driver instructions.

CAUTION If the driver does not run in its magnetic centre the resultant additional axial force may overload the pump thrust bearing.

Move driver to insure proper gap distance.

4.8.3.2 Before alignment

Note: It is recommended that the pump hold down bolting be torqued and the pump be fixed before taking any alignment measurements. This makes the driver the movable machine. In certain cases, however, it may be impractical to move the driver; therefore, the pump may have to be moved. When this case exists, the pump should not be fixed until after final alignment. (See Section 4.11, *Doweling pump and driver*).

CAUTION If pump shaft must be rotated bearings are to be pre-lubed before aligning starts. Refer to Section 5.2.1, *Lubrication*.

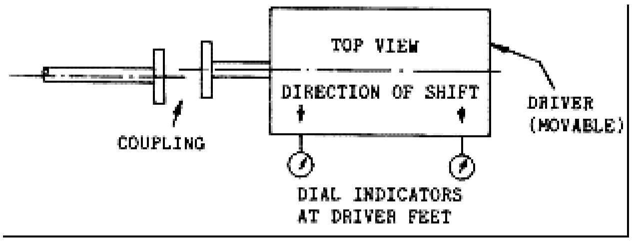
Align pump and driver using the rim and face method, rotating driver only. Align equipment such that coupling hub rims are aligned within 0.050 mm TIR (0.002 in. TIR), and coupling hub faces are parallel within 0.025 mm (0.001 in.).

Note: Refer to "RIM AND FACE DATA SHEET".

Laser alignment, double reverse (dial) alignment, or reverse rim (dial) alignment methods can be used to check alignment when site requirements dictate.

4.8.3.3 Horizontal move

The dial indicators shown below are required to accurately measure the move in the horizontal direction. Move the driver by bumping with soft hammer/mallet or using the alignment screws (if provided).

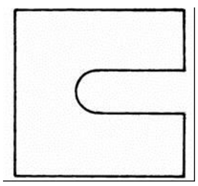


4.8.3.4 Vertical move

Before moving the equipment vertically, it is important that the vertical thermal expansion be taken into consideration. Refer to General Arrangement Notes and/or Driver Instructions for recommended cold vertical setting.

The stainless steel shims between the equipment feet and mounting surface should be clean and dry. This is especially critical for pumps that have been in service for some time and need to be realigned. Water, dirt and rust may change the height of the shim pack over a period of time. Shims should be made large enough to support the weight of the equipment on its mounting foot. Do not use many thin shims, as this may result in a spongy mounting.

Move the equipment vertically by adding or removing the calculated thickness of shims. Torque equipment hold-down bolting to required values.



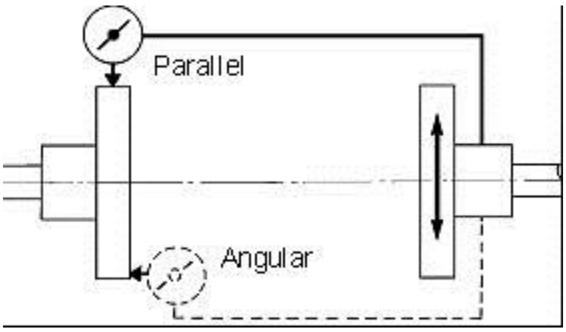
Recommended shim design

4.9 Checking coupling alignment

The angular and offset coupling alignment must now be rechecked:

- Coupling faces are to be parallel within 0.025 mm (0.001 in.)
- Coupling outside diameters are to be aligned within 0.050 mm TIR (0.002 in. TIR)

Use a dial indicator as shown below to check both parallel and angular alignment.



"Bump" the motor and check motor rotation.

4.10 Assembling coupling

Assemble the coupling(s) per the manufacturer's instructions.

Install coupling guard(s).

4.11 Doweling pump and driver

Note: For doweling information, refer to General Arrangement drawing notes.

Pumps handling liquids at temperatures greater than 90 ºC (200 °F) are designed to permit expansion away from the drive or coupling end. This is accomplished by means of a pin and key block located beneath the suction and discharge heads respectively. The pin fixes the suction end while the key allows for expansion in the axial direction with temperature gradients.

The pin and key blocks are not welded at the factory. After installation and final alignment in the facility, customer must weld pin and key block to cross members with a 13 mm (0.5 in.) fillet weld all around.

Note: Refer to the IO&M manual of the motor (and variable speed coupling, if included) for information about doweling.

RIM AND FACE DATA SHEET

Project Number__________

Plant: ________________________ Unit: ________________________

Movable: Item: ________________________ Manufacturer: ________________________

Type: ________________________ Serial No.: ________________________

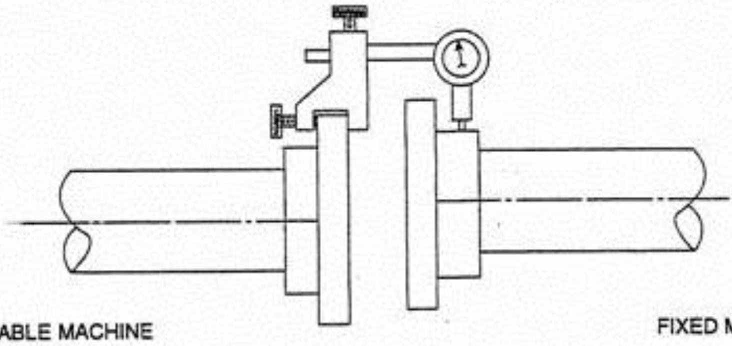
Fixed: Item: ________________________ Manufacturer: ________________________

Type: ________________________ Serial No.: ________________________

Indicator bar sag: ____________ Indicator bar number: ____________

RIM READINGS

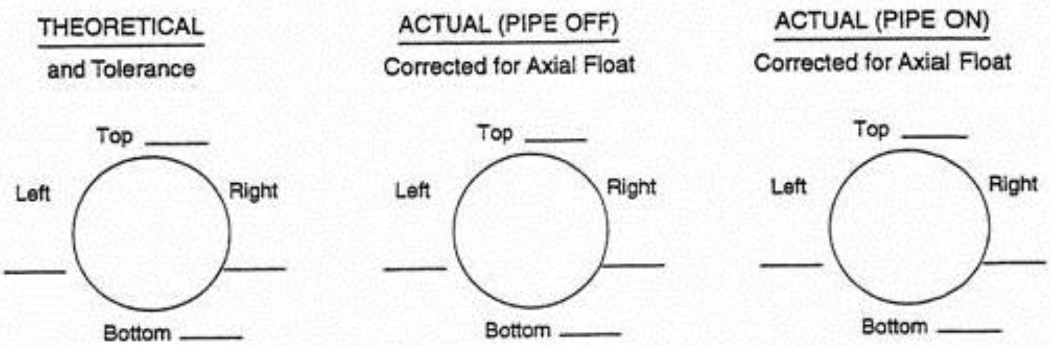
Set proper face readings before taking rim readings



Swept diameter × __________

D = Axial distance between shaft hubs × __________

INDICATOR READINGS: "Left" and "Right" indicator readings are determined by looking from the back of the movable machine toward the fixed machine.



PREPARED BY ________________________ DATE ____________

RIM AND FACE DATA SHEET (CONTINUED)

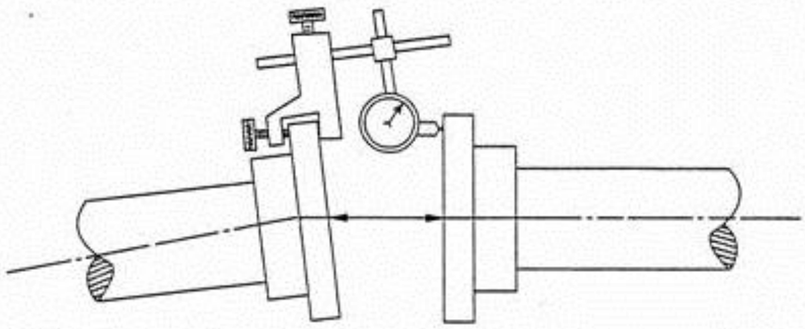
Project Number__________

Movable: Item: ______________________________
Type: ______________________________

Fixed: Item: ______________________________
Type: ______________________________

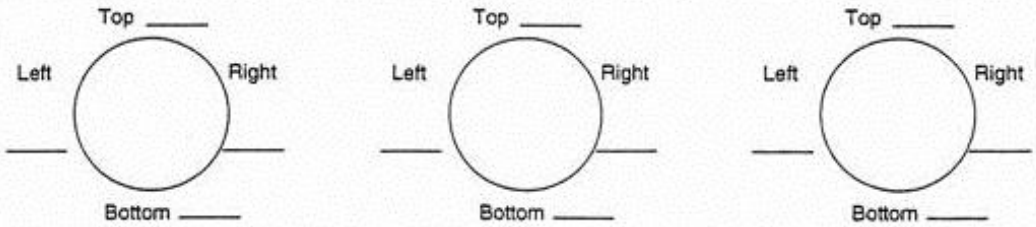
Indicator bar sag: ______________ Indicator bar number: ______________

FACE READINGS



INDICATOR READINGS: "Left" and "Right" indicator readings are determined by looking from the back of the movable machine toward the fixed machine.

THEORETICAL and Tolerance	ACTUAL (PIPE OFF) Corrected for Bar Sag	ACTUAL (PIPE ON) Corrected for Bar Sag



Shims Tabulation

Fixed IB Left	______________	Move. IB Left	______________
Fixed IB Right	______________	Move. IB Right	______________
Fixed OB Left	______________	Move. OB Left	______________
Fixed OB Right	______________	Move. OB Right	______________

Note: All shims are recorded looking to the fixed machine from the movable machine.

WITNESSED BY ____ DATE ______________________

4.12 Grouting

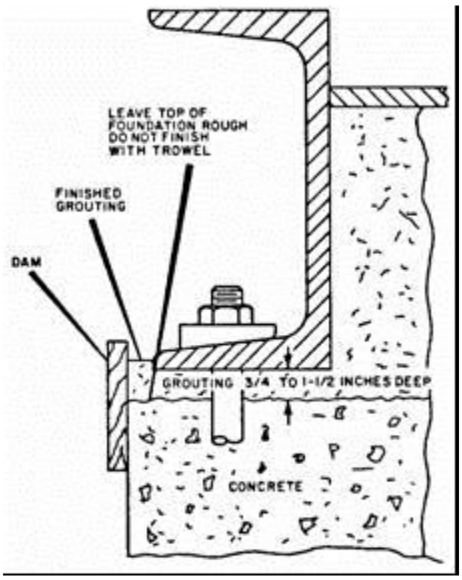
Note: The following information regarding grouting is only offered as a general guideline to the customer. Flowserve Corp. requires that all grouting be installed in accordance with specifications set forth in Chapter 5 'Mounting Plate Grouting' from API Recommended Practices 686/PIP REIE 686, First Edition.

It is recommended that the customer consults a competent specialist skilled in the field of grouting, to insure proper installation of all grouting.

Build a dam around the foundation before pouring grout. It is a matter of personal preference whether the levelling wedges under the bedplate should be removed after grouting. If you do want to remove the wedges, carefully mark their locations before pouring grout.

Use of a quality, high strength, non-shrink epoxy grout is recommended.

Alternatively, a layered sandwich of epoxy grout and cemetitious grout can be used. The first layer is an epoxy grout that ends 25 mm (1 in.) above bottom of the lower baseplate flanges. The second level is a cementitious non-shrink grout poured to approximately 50 mm (2 in.) below the top of the baseplate flanges or topplate. The last layer is another epoxy grout to the top of the baseplate flanges or topplate.



Spaces are provided in the bedplate to permit pouring the grout and stirring. Fill under the bedplate completely, stirring to assure proper distribution of the grout. Check to see that the grout flows under the edges of all the ribs.

Note: Do not vibrate bedplate when grouting; make sure all areas indicated on General Arrangement drawing are thoroughly puddled to prevent any resonant problems.

When the grout is thoroughly hardened, remove the dam and wedges, if desired, filling in the holes they leave with grout.

4.13 Suction strainer

CAUTION In a new installation, great care should be taken to prevent dirt, scale and welding beads from entering the pump. Even when piping has been previously flushed, it is difficult to break loose the oxides and mill scale which will become free when the pipe heats and cools several times. Numerous close running clearances are vulnerable to abrasive matter present in new piping. Foreign material may be large enough, or of sufficient volume, to jam a pump, with probable damage to both pump and drive equipment. Smaller material passing through the pump can cause rapid pump wear and premature pump failure.

The pump is provided with the expectation that it will be pumping clean liquids (unless otherwise stated in the order and addressed in the proposal). If a suction strainer is provided it is not intended to be used for cleaning the entire boiler piping system.

Flowserve ring section pumps are normally provided with running clearances ranging typically from 0.30 mm (0.012 in.) to 0.41 mm (0.016 in.). Particles of this size will normally pass through the pump without causing damage, providing the concentrations are minor.

The possibility exists that, on shutdown of the pump, such particles can become trapped in the close running clearances during coastdown, causing binding. Flowserve cannot recommend a procedure that will totally prevent such binding; however, we strongly suggest that systems be cleaned and thoroughly flushed prior to connecting the pump to the piping to minimize particles entering the pump. Starting and stopping of the pump should be MINIMIZED as pumps are most susceptible to dirt during starts and stops.

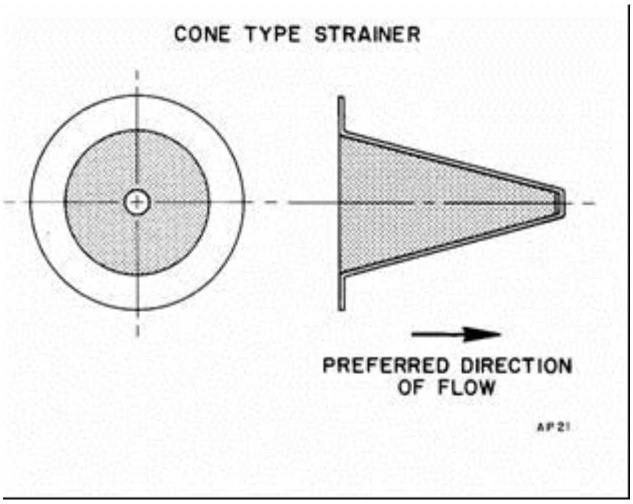
In the event that binding on coastdown occurs, it is unlikely that the binding can be remedied by hand rolling the rotor, and partial disassembly may be required to clean the affected parts. It should be noted that increased particle concentrations increase the probability of coastdown binding and seizures, as well as erosion damage.

CAUTION Excessive force used to try to free a bound rotor may cause damage beyond minor cleanup and repair of rotor parts.

Generally, a pump should not be installed without strainer protection. The suction system should be thoroughly flushed before installing the suction strainer and making up the suction piping to the pump. The strainer should be installed in the inlet piping of the pump, making certain that it is located where it may be readily serviced (clean). Be sure, however, that the installed strainer will not distort the flow to the pump suction.

CAUTION Do not install the strainer directly on the pump suction nozzle. Strainers should be located at least 6 or 10 pipe diameters upstream of the suction nozzle.

The Flowserve standard for suction strainers consists of conical shaped steel plate with 1.6 mm (1/16 in.) perforations. The open area of the strainer should be a minimum of three times the area of the pump suction.



At all times when using suction strainers, it is critical that the pressure drop across the strainer be constantly monitored to ensure that the pump suction pressure does not fall below that required to prevent pump cavitation. Pressure (or vacuum) gauges should be installed on both sides of the strainer so that the pressure drop across the strainer can be monitored. During start-up of the system, the gauges should be monitored continuously. Consult the plant engineer or system designer for the allowable pressure differential across the strainer prior to operating the pump. Pressure differential across the strainer and/or screen is typically no more than 0.2 bar (3 psi). An increase in the differential pressure between the two gauges indicates that the strainer or screen is becoming clogged with dirt and scale. Before the pressure drop becomes so severe that cavitation occurs, the pump should be shut down and the strainer cleaned. Alarm settings to protect the pump from damaging cavitation and loss of suction need to be supplied by the plant engineer or system designer prior to operating the pump. Typically alarm settings to protect the pump from damaging cavitation and loss of suction would be 0.35 bar (5 psi) differential pressure across the strainer (screen). The suction piping should be arranged such that the ultimate strainer configuration (location) allows ready access for cleaning.

The strainer may be fitted with a finer screen to filter the inlet flow. When this is done, 100 mesh screen is typically used for start up operation, at reduced flow rates. For final operation in a closed system, the suction strainers are normally removed after the system is cleaned. For critical pump applications, where continuous screening of suction flow is desirable, and in open systems, 20 mesh screening is typically used for permanent strainers. At all times, when using screens and suction strainers, it is critical that pressure drop across the screen and/or strainer be constantly monitored to ensure that the pump suction pressure does not fall below that required to prevent cavitation.

When dirt and scale have been removed from the system, as indicated by no further change in pressure drop across the strainer with time, the start up strainer may be removed or the screen may be replaced with one having larger openings. If a permanent strainer will be used during normal operation, the pressure differential needs to be monitored on a continuous basis.

CAUTION If a permanent strainer is not used, the start up strainer needs to be temporarily reinstalled whenever the system is opened up for repair or routine maintenance. As long as a suction strainer or screen remains in place, the differential pressure should be monitored on a regular basis.

CAUTION The pressure drop across the strainer is a direct reduction in the NPSH available to the pump. NPSH available must always exceed the NPSH required by the pump. This requirement may limit the pump flow rate, particularly during start-up operation. Alarms or automatic pump shut-down devices should be installed to minimize the possibility of pump damage. It is the responsibility of the pump operator to obtain the allowable pressure drop across the strainer for safe pump operation from the plant engineer or system designer prior to operation of the pump.

4.14 Piping

Note: The following information regarding piping is only offered as a general guideline to the customer. Flowserve Corp. requires that all piping and related systems be designed/installed in accordance with specifications set forth in Chapter 6 'Piping' from API Recommended Practices 686/PIP REIE 686, First Edition.

Note: Don't install piping until preliminary alignment, grouting and final field weldings have been completed.

Note: The design of piping, and related systems, is not the responsibility of Flowserve Corp. It is therefore recommended that the customer consults a competent specialist skilled in the field of piping, to insure proper design/installation of all piping.

CAUTION Protective covers are fitted to the pipe connections to prevent foreign bodies entering during transportation and installation. Ensure that these covers are removed from the pump before connecting any pipes.

CAUTION Never use the pump as a support for piping.

CAUTION Ensure piping and fittings are flushed before use.

⚠ Ensure piping for hazardous liquids is arranged to allow pump flushing before removal of the pump.

4.14.1 Suction and discharge piping

These units are furnished for a particular service condition. Changes in the hydraulic system may affect performance adversely. This is especially true if the changes reduce the pressure at the suction flange. In case of doubt, contact the nearest Flowserve Office.

Suction and discharge piping should be of ample size, be installed in direct runs, and have a minimum of bends.

Install a check valve and a gate valve in the discharge pipe on the pump. When the pump is stopped, the check valve will protect the pump against excessive pressure and will prevent the pump from running backward. The check valve should be installed between the gate valve and the pump nozzle in order to permit its inspection. The gate valve is also useful in priming and starting the pump.

Keep the suction pipe short and direct. Use a suction pipe at least one size larger than the pump suction nozzle. Keep the suction pipe free of all air pockets.

Note: On suction lift the piping should be inclined up towards the pump inlet with eccentric reducers incorporated to prevent air locks.

Note: A spool piece should be installed in suction line so that the suction screen may be installed and removed.

4.14.2 Nozzle loads and piping

Customer to ensure all piping is installed according to design, which should result in nozzle loads below the acceptable limits. All piping supports and hangers must be set properly before operating equipment. Failure to do so may result in damage to pump. When installing suction and discharge nozzle piping, do not force piping to fit up to nozzles. Piping should not be strained in the cold static condition.

CAUTION Maximum forces and moments allowed on the pump flanges vary with the pump size and type. To minimize these forces and moments that may, if excessive, cause misalignment, hot bearings, worn couplings, vibration and the possible failure of the pump casing, the following points should be strictly followed:

- Prevent excessive external pipe load
- Never draw piping into place by applying force to pump flange connections
- Do not mount expansion joints so that their force, due to internal pressure, acts on the pump flange

Note: Piping should be independently supported. When hot liquids will be handled, expansion joints, bends or loops and hangers should be installed to prevent excessive strains on the pump nozzles. Customer should route piping in such a manner that disassembly of pump is not restricted.

4.14.3 Acid wash

CAUTION Pumps that will be subjected to acid wash or flushing of any type intended to clear the piping system of foreign material, must be by-passed to prevent debris from entering the pump. Failure to do so will result in corrosion damage to critical components and deterioration of non metallic parts. In addition, foreign material being flushed through the system may be introduced into the pump.

4.14.4 Bypass line

Customer to provide a suitable minimum flow by-pass system connected to pump discharge prior to first valve. The by-pass flow should be directed to the source of pump suction and designed to handle the minimum flow listed in the General Arrangement Notes. A back pressure device located downstream of the minimum flow valve may be required to suppress valve cavitation or downstream line flashing.

CAUTION Operation at low flow results in pump horsepower heating the liquid. A by-pass may be required to prevent vaporization and subsequent pump damage. Mechanical damage may result from continuous operation at flows less than 25% of design operating point (see General Arrangement drawing & nameplate).

Note: Refer to the General Arrangement drawings & notes for pertinent data, specifically:

- Piping Notes
- Nozzle Forces & Moments
- Balancing Line
- Minimum Flow Bypass
- Warm Up Line

4.15 Final checks

CAUTION Check the tightness of all bolts in the suction and discharge pipework. Check also the tightness of all foundation bolts.

4.16 Final alignment check

CAUTION After grout has completely set, and pipes been connected to the pump, recheck alignment following the procedure performed in the previous sections.

4.17 Electrical connections

DANGER Electrical connections must be made by a qualified Electrician in accordance with relevant local national and international regulations.

It is important to be aware of the EUROPEAN DIRECTIVE on potentially explosive areas where compliance with IEC60079-14 is an additional requirement for making electrical connections.

It is important to be aware of the EUROPEAN DIRECTIVE on electromagnetic compatibility when wiring up and installing equipment on site. Attention must be paid to ensure that the techniques used during wiring/installation do not increase electromagnetic emissions or decrease the electromagnetic immunity of the equipment, wiring or any connected devices.

DANGER The motor must be wired up in accordance with the motor manufacturer's instructions (normally supplied within the terminal box) including any temperature, earth leakage, current and other protective devices as appropriate. The identification nameplate should be checked to ensure the power supply is appropriate.

A device to provide emergency stopping must be fitted.

If not supplied pre-wired to the pump unit, the controller/starter electrical details will also be supplied within the controller/starter.

For electrical details on pump sets with controllers see the separate wiring diagram.

CAUTION See Section 5.3, before connecting the motor to the electrical supply.

4.18 Protection systems

The following protection systems are recommended particularly if the pump is installed in a potentially explosive area or is handling a hazardous liquid. If in doubt consult Flowserve.

If there is any possibility of the system allowing the pump to run against a closed valve or below minimum continuous safe flow a protection device should be installed to ensure the temperature of the liquid does not rise to an unsafe level.

If there are any circumstances in which the system can allow the pump to run dry, or start up empty, a power monitor should be fitted to stop the pump or prevent it from being started. This is particularly relevant if the pump is handling a flammable liquid.

If leakage of product from the pump or its associated sealing system can cause a hazard it is recommended that an appropriate leakage detection system is installed.

To prevent excessive surface temperatures at bearings it is recommended that temperature or vibration monitoring are carried out.

5 COMMISSIONING, START-UP, OPERATION AND SHUTDOWN

CAUTION ***These operations must be carried out by fully qualified personnel.***

CAUTION Do not wipe down in the vicinity of rotating parts. If unusual noise or vibrations occur, secure the pump as soon as possible.

⚠ In the interest of operator safety, the unit must not be operated in excess of the nameplate conditions. Such operation could result in unit failure causing injury to operating personnel.

⚠ The unit must not be operated unless the coupling(s) guard(s) is bolted in place. Failure to observe this could result in injury to operating personnel.

CAUTION Before starting or while operating the pump, the pump and suction line must be completely filled with the liquid being pumped and the line must be properly vented. Rotating parts depend on this liquid for lubrication. The pump may seize if operated without liquid.

CAUTION The pump and suction line must be filled with liquid during start-up, operation, and shutdown periods.

CAUTION Never operate the pump with the suction valve closed, and never throttle the pump on the suction side.

CAUTION To reduce output volume, the discharge-line valve may be throttled – but do not operate the pump against a closed discharge valve for longer than 30 seconds.

CAUTION Operation at low flows results in pump horsepower heating the liquid. A flow bypass is required to prevent vaporization and subsequent pump damage. Mechanical damage may result from continuous operation at less than the minimum continuous stable flow (MCSF)—(see General Arrangement drawing notes).

CAUTION Do not operate the pump unless the mechanical seal receives continuous lubricating flush.

5.1 Commissioning

Commissioning of all equipment must be performed in accordance with specifications set forth in Chapter 9 'Commissioning' from API Recommended Practices 686/PIP REIE 686, First Edition.

5.2 Pre-operational checks

At initial start-up and after the equipment has been installed:

a) Ensure pump and piping are clean. Before putting the pump into operation, it should be thoroughly flushed to remove the rust preventive as well as any foreign matter which may have accumulated during installation. Take all possible care not to contaminate your system.
b) Check that the system and pump casing are vented and completely full of liquid.
c) Vent the mechanical seal system by following venting procedure in Section 5.2.2, *Mechanical seal*, and mechanical seal instructions in Section 10.1 of this User Instructions.
d) Ensure that mechanical seal is properly assembled and tightened.

CAUTION Most mechanical seals are equipped with locating spacers between the gland plate and shaft sleeve. Spacers must be removed before starting unit. Do not discard spacers; they are required to maintain proper seal setting during maintenance.

e) Turn rotor by hand or with strap to make sure it turns freely.
f) Check motor rotation by starting unit momentarily. Verify that the motor rotation matches that of the fluid coupling and pump.

⚠ The driver rotation must be checked before connecting coupling. Actual damage to the equipment and personal injury could result from operating the unit with wrong rotation.

g) Check torque of all bolting and plugs.
h) Ensure coupling is properly aligned and lubricated, and pump, fluid coupling, and driver are properly doweled (refer to Section 4, *Installation*).
i) Ensure all guards are in place.
j) Be sure that the driver has been prepared for operation in accordance with the manufacturer's instructions.

CAUTION If the driver bearings are not connected to the pump lubrication system, check that the driver oil or grease reservoir(s) have been filled to the proper level as described in the driver manufacturer's instructions.

k) Clean and flush bearing housings and lubrication system. Fill reservoir with oil to the proper level (refer to Section 5.2.1, *Lubrication*).
l) Ensure rotor is aligned within casing (refer to Section 6, *Maintenance*).

5.2.1 Lubrication

⚠ Operation of the unit without proper lubrication can result in overheating of the bearings, bearing failures, pump seizures and actual break-up of the equipment, exposing operating personnel to injury.

Remember that oil requires frequent replenishment at normal operating temperatures and very frequent replenishment at elevated operating temperatures. Oil is always subject to gradual deterioration from use and contamination from dirt and moisture. This deterioration and contamination will, in time, be harmful to the bearings and can cause premature wear. For these reasons, oil should be checked for contamination and deterioration regularly.

The frequency of oil change depends on the operating conditions and the quality of the lubricant. Oil should be checked for deterioration and contamination weekly during periods of operation. Mineral oils oxidize and should be replaced at no more than three month intervals. Longer intervals between replacements may be possible if a routine oil sampling program is used to monitor the oil condition.

5.2.1.1 Oil specifications

Straight mineral oils without additives are generally preferred. It should be a turbine type and not contain free acid, chlorine, sulphur or more than a trace of free alkali. Lubricating oils are identified by an ISO Viscosity Grade (VG) Number. The VG Number is the viscosity of the oil at 40 °C (104 °F) in centistokes. In the majority of instances, a turbine oil with a VG Number of 32 will meet the bearing lubrication requirements (see Section 5.2.1.2, *Oil temperature*).

Oil Characteristics	
Recommended ISO Viscosity Grade (VG) Number	**32**
Viscosity Index	**102**
Pour Point	**-7 °C (20 °F)**
Flash Point	**204 °C (400 °F)**

Lubricant must be compatible with all parts requiring lubrication. Refer to lube, seal, and lube oil console piping drawings and notes for information pertaining to your system.

5.2.1.2 Oil temperature

Cooling oil lubricating system is provided to supply cooled oil to the bearing housings reservoirs. If bearing temperature exceeds the above mentioned limits, make sure cooling water system is on and cooling water is being supplied to the heat exchanger on the cooling oil lubricating system.

⚠ CAUTION The minimum bearing oil temperature is 15 ºC (60 °F). The oil lubricating console reservoir is supplied with an immersion heater to maintain the minimum 15 ºC (60 °F) oil temperature. Oil in the reservoir of the oil lubricating system should not be below 15 ºC (60 °F) at pump start up time. If oil temperature is below 15 ºC (60 °F) in pump bearing housings reservoir, oil lubricating console should be started and the warm oil circulated to the pump prior to main pump start up.

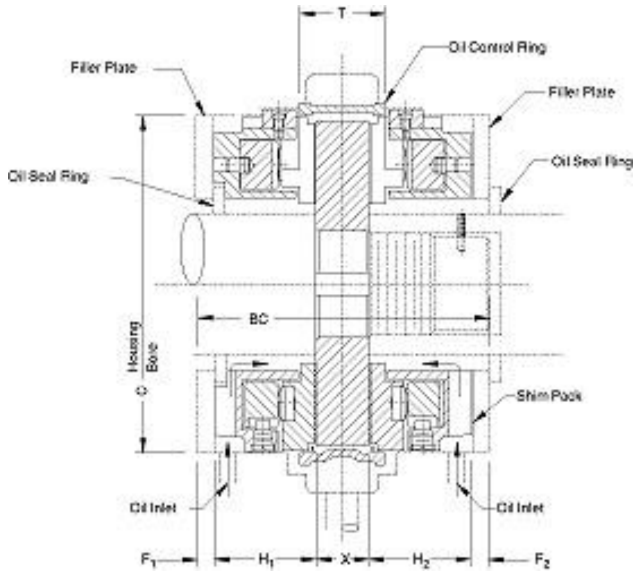
5.2.1.3 Cleaning and filling the lubrication system prior to operation

⚠ CAUTION Before operating the pump, the lubrication system should be cleaned and checked per the following steps.

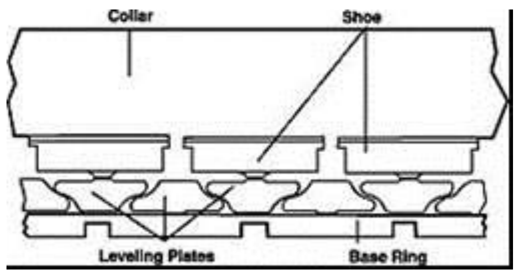
To clean the lubrication system:

a) Remove the radial [3210.1] and thrust [3210.2] upper bearing housings (refer to Section 6, *Maintenance*).
b) Remove bearing bushes from bearing housing. Bearing bushes can be "rolled out". Check for anti rotation pin.

Note: If temperature and/or proximity probes are supplied, remove them prior to removing bearing bushes or thrust shoes.



c) Remove shoes from KTB bearing (see KTB sketches above and below).



Note: Observe position of shoes as they must be reassembled in the same position and orientation.

Typical KTB shoe

d) Flush out the bearing housings with kerosene or other suitable solvent.
e) Wash the bearing linings/thrust shoes with a suitable solvent.
f) Flush the entire lubrication system following the steps below and refer to the lube system manual for additional information.
g) Break open bearing supply pipe flanges and install 100 mesh screens in the supply line.
h) Fill oil reservoir with oil that is proper grade and viscosity in accordance with lubrication recommendations.
i) Flush through lube oil system filters for a period of at least 4 hours. Shut down and inspect temporary strainers and filters.

Note: During flushing operation, examine the piping for leaks and correct as necessary. Also check for any obstructions that will interfere with free flow of oil to bearings.

j) If screens are not clean, replace with new, clean screens and repeat the previous step.
k) If the screens are clean, clean lube oil reservoir tank, install new, clean filter cartridges, and wipe out bearing housings.
l) Replace KTB shoes [3033], bearing linings [3300] and instrumentation (if necessary).
m) Replace drain plugs, piping and close system and refill with oil that is proper grade and viscosity in accordance with lubrication recommendations.
n) Lubrication system is now ready for routine start up operation.

Operation of the unit with incorrect oil level setting can result in overheating of the bearings, lack of lubrication to the bearings, bearing failures, pump seizures and actual break-up of the equipment, exposing operating personnel to injury.

5.2.2 Mechanical seal

Your pump is typically shipped with the mechanical seal already installed. All mechanical seals are of the cartridge type design. The mechanical seal is designed to suit each application. This creates the correct seal loading face when seal gland is bolted in place.

Cartridge type mechanical seals are preset at the seal manufacturer's facility and require no field settings. The seal installation should be checked before start-up.

Note: Refer to the mechanical seal manufacturer drawings and instructions found in Section 10.1 of this manual for detailed information.

To remove mechanical seal from pump:
a) Install setting plates/eccentric washer in place.
b) Loosen drive collar.
c) Remove gland bolting.
d) Slide sleeve with mechanical seal [4200] from shaft.

Seal may be disassembled/inspected/reassembled per seal manufacturer's drawing and instructions in Section 10.1 of this manual.

After reassembly of seal, setting plates/eccentric washers must be removed before start up.

CAUTION Never run a mechanical seal dry, even for a short time.

5.2.3 Pump instrumentation set points

For set points please refer to documents: Instrument List or Logic Diagram.

In specific cases it might be possible to exceed published levels. Should pump operate in excess of shutdown levels, please contact Flowserve.

5.2.4 Motor instrumentation set points

Refer to the Instrumentation List and the vendor's instruction manual for specifics.

5.2.5 Variable speed coupling instrumentation set points

Refer to the Instrumentation List and the vendor's instruction manual for specifics.

5.3 Initial start-up procedure

CAUTION Ensure the pump is given the same rotation as the pump direction arrow cast on the pump casing.

a) Prepare the driver (and variable speed coupling, if included) for start up in accordance with the manufacturer's instructions.
b) Prime pump and ensure pump suction valve is open.

CAUTION Before starting or while operating the pump, the pump and suction line must be completely filled with the liquid being pumped. The rotating parts depend on this liquid for lubrication, and the pump may seize if operated without liquid.

c) Ensure pump recirculating line is open and free of obstructions.

⚠ The unit must not be operated unless all guards are in place. Failure to observe this caution could result in personal injury to operating personnel.

d) Discharge valve should be closed.
e) The suction valve should be WIDE OPEN. (Vent system to release entrapped air; close vent system after venting)
f) Suction strainer should be clean and completely free of debris.
g) Be sure that all valves in the suction and balance leakage lines are open. The minimum flow system must be open during starting and stopping and when discharge flow is less than the minimum flow specified on the General Arrangement drawing notes.
h) Make sure all gages are functioning.
i) Turn on the lubrication system and check for proper flow and supply pressure at the bearing housings.
j) Check for any leaks in the lubrication system.

⚠ Operation of the unit without proper lubrication can result in overheating of the bearings, bearing failures, pump seizures and actual break-up of the equipment exposing operating personnel to personal injury.

k) Make sure balance line valve is in locked open position. See General Arrangement drawing notes for balance line instructions.

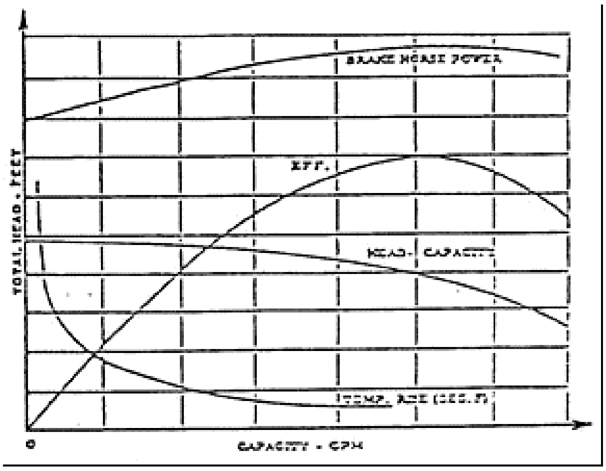
⚠ CAUTION The flow of liquid which passes between the balance disc [6210] face and the counter balance disc [6220] face is reduced from the discharge pressure to slightly above suction pressure. This flow and pressure reduction counteracts the hydraulic thrust created by the impellers. Therefore, if balance disc line is closed when the pump is in operation, this counteraction is eliminated and rapid seizure will occur.

l) Check that cooling water is turned on and the proper flow rate is being circulated to the mechanical seal coolers, the pump stuffing boxes, and, if supplied, the motor and pump bearing housings.
m) Check that seal is vented by observing leakage from seal piping vent. Close vent when liquid is emitted. Ensure that the mechanical seal system piping is clear and free of obstructions. Ensure that the magnetic separator isolation valves are open.
n) Prepare the driver (and variable speed coupling, if included) for start up in accordance with the manufacturer's instructions.
o) Start the driver and bring the unit up to speed.
p) As soon as pump is up to speed, slowly open discharge valve. This will avoid abrupt changes in velocity and prevent surging in the suction line.
q) Perform running checks

5.4 Operating checks

⚠ In the interest of operator safety, the unit must not be operated above the nameplate conditions. Such operation could result in unit failure causing injury to operating personnel.

⚠ CAUTION Operation at low flows results in pump horsepower heating the liquid. A bypass may be required to prevent vaporization and subsequent pump damage. Mechanical damage may result from continuous operation at flows less than min flow value (see General Arrangement drawing notes).



Typical curve showing temperature rise toward shut-off

⚠ Operation of the unit without proper lubrication can result in overheating of the bearings, bearing failures, pump seizures and actual break-up of the equipment exposing operating personnel to injury.

Immediately after start up, and frequently during running, check the following:
a) Check suction pressure and HP and IP discharge pressures.
b) Check differential pressure across the suction strainer.

⚠ CAUTION If pressure differential across suction strainer exceeds 0.35 bar (5 psi), shut down the pump immediately, and clean the suction strainer.

c) Check mechanical seal areas; there should be no visible leakage to the naked eye.

d) Check the mechanical seal water temperature. (Refer to Instrument List and/or mechanical seal drawing).
e) Check for unusual noises.
f) Check for adequate flow of cooling liquids.
g) Check for adequate flow of bearing lubricating oil.
h) Isolate and inspect the magnetic separators located in seal flush piping. (Refer to the seal piping drawing).

CAUTION Mechanical seals are particularly sensitive to impurities in the feed water system. To prevent damage to the mechanical seal faces, daily inspection and cleaning of the magnetic separators is strongly recommended.

CAUTION When disassembling the magnetic separators, make sure that the unit is isolated from the seal flush system using the bypass valves.

i) Check vibration levels are below those indicated on the Instrumentation List.
j) Check the pump and motor bearing temperatures. (Refer to the Instrumentation List).
k) After unit has been operated a sufficient length of time to reach normal operating temperature and condition, the unit is to be shut down and a hot coupling alignment check must be made (refer to Section 4, *Installation*).

Do not attempt any maintenance, inspection, repair or cleaning in the vicinity of rotating equipment. Such action could result in personal injury to operating personnel.

5.5 Normal start-up

The starting procedure to be followed for normal start up is the same as that for initial starting.

5.6 Securing the pump

a) De-energize driver circuit.
b) The pump should be shut down rapidly to protect the internal wearing parts which are lubricated by the liquid being pumped. Lubrication is reduced when a pump is stopped slowly, and seizure could result.

CAUTION If pump stops abruptly when driver is shut down, investigate for rotor binding. Take necessary remedial action before re-starting pump.

c) Close the pump suction and discharge valve, balance line, (and intermediate stage take off line valve if supplied).
d) Close valve in bypass line.
e) Turn off cooling water.
f) Turn off the lubrication system.

CAUTION If pump is subjected to freezing temperatures, the pump must be drained of liquid to prevent damage to pump.

6 MAINTENANCE

6.1 Security

⚠ It is the plant operator's responsibility to ensure that all maintenance, inspection and assembly work is carried out by authorized and qualified personnel who have adequately familiarized themselves with the subject matter by studying this manual in detail. (See also Section 1.6.2, *Personnel qualification and training*).

⚠ Any work on the machine must be performed when it is at a standstill. It is imperative that the procedure for securing the machine is followed, as described in Section 5.6.

⚠ On completion of work all guards and safety devices must be re-installed and made operative again.

Before restarting the machine, the relevant instructions listed in Section 5, *Commissioning, start up, operation and shut down*, must be observed.

⚠ ***Oil and grease leaks may make the ground slippery. Machine maintenance must always begin and finish by cleaning the ground and the exterior of the machine.***

If platforms, stairs and guard rails are required for maintenance, they must be placed for easy access to areas where maintenance and inspection are to be carried out. The positioning of these accessories must not limit access or hinder the lifting of the part to be serviced.

When air or compressed inert gas is used in the maintenance process, the operator and anyone in the vicinity must be careful and have the appropriate protection.

⚠ Do not spray air or compressed inert gas on skin.

⚠ Do not direct an air or gas jet towards other people.

⚠ Never use air or compressed inert gas to clean clothes.

⚠ Before working on the pump, take measures to prevent an uncontrolled start. Put a warning board on the starting device with the words
"Machine under repair: do not start".

⚠ DANGER With electric drive equipment, lock the main switch open and withdraw any fuses. Put a warning board on the fuse box or main switch with the words ***"Machine under repair: do not connect".***

6.2 Preventive maintenance schedule

Although your Flowserve pump has been designed for extended, trouble free service, certain preventive maintenance measures should be performed on a regular basis to ensure optimum performance. A well planned program of routine maintenance is the best assurance of dependable operation. The following preventive maintenance (PM) inspections are suggested as a minimum, and may be supplemental by the experience of the operating personnel.

Preventive maintenance inspections should include the following:

Preventive Maintenance Item	Instructions	Frequency
Suction Strainer	Check pressure differential between the gauges located on each side of the strainer.	Daily
Pump Suction and Discharge Flow Rates	Check suction and discharge pressure gauges for proper pump operation.	Daily
Mechanical Seal	Visually.	Daily
Instrumentation	Check all related pressure gauges, temperature detectors, etc. to detect any abnormalities.	Daily
Bearing Housings	Check sight gauges.	Daily
Auxiliary Piping	Check for leakage around connections, etc.	weekly
Shaft/Casing Vibration	Review all vibration data for any abnormalities and/or sudden changes in levels.	weekly
Bolting Tightness	Check external bolting for proper tightness.	Monthly
Cleanliness	General clean-up soiled areas.	Quarterly

6.3 General

Your Flowserve pump is a precision machine. Take every precaution to avoid damage or even slight burrs to any of the machined surfaces when dismantling the pump.

Before performing any disassembly, maintenance, or inspection on the unit, the following steps should be taken and warnings observed:

a) Lock and tag driver controls in the “off” position.
b) Isolate pump from system.
c) Drain pump of all fluid.

⚠ Do not attempt any maintenance, inspection, repair or cleaning in the vicinity of rotating equipment. Such action could result in injury to operating personnel.

⚠ When pump is handling hot liquid, extreme care must be taken to ensure safety of personnel when attempting to drain pump. Hot pumps must be allowed to cool before draining.

⚠ In the interest of operator safety when handling any heated parts protective gloves or other suitable protection must be worn.

⚠ Before attempting any inspection or repair on the pump, the driver controls must be in the “off“ position, locked, and tagged to prevent injury to personnel performing service on the pump.

⚠ Before attempting to disassemble the unit, the pump must be isolated from the system by closing the suction and discharge valves. The pump should be carefully vented to release casing pressure. Drain all liquid.

⚠ When the pump is handling toxic, flammable, corrosive, or extreme-temperature liquids, extra care must be taken when draining the pump to ensure the safety of personnel. Suitable protective devices must be worn when draining the pump. Liquids at extreme temperatures (hot or cold) must be allowed to reach safe temperature before draining.

6.4 Torque values

For pump hold down torque value (and driver, if Flowserve supplied) see Section 6.8, *Torques and clearances*, of this User Instructions book. Recommended Torque Values are selected to achieve the proper amount of pre stress in the threaded fastener. Maintenance personnel must insure that threads are in good condition (free of burrs, galling, dirt, etc.) and that commercial thread lubricant is used. Torque should be periodically checked to assure that it is at the recommended value.

⚠ When reassembling pump, all fasteners must be tightened to the proper torque value. Failure to observe this warning could result in injury to operating personnel.

6.5 Coupling removal

Remove coupling guard. Refer to coupling drawing and installation instructions for removal. Remove coupling bolting and remove the spacer piece. Loosen setscrews in coupling lock nut and remove coupling lock nut [7411].

The coupling hub has a shrink fit to the pump shaft. The use of a puller and heat will be required to remove it from the shaft.

Note: Remove pump half coupling hub by heating to approximately 149 ºC (300 ºF) in successive stages from periphery of coupling toward center. If equipped with a gear type coupling, NEVER APPLY AN OPEN FLAME TO COUPLING HUB TEETH.

6.6 Dismantling procedure

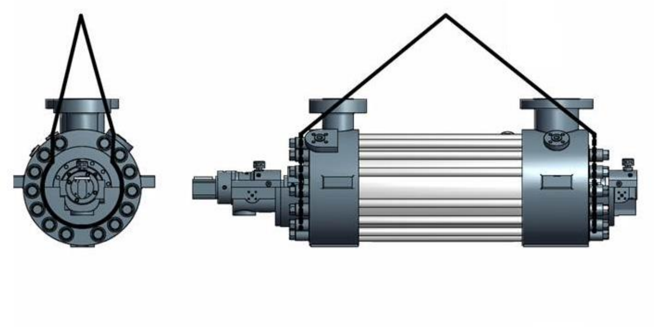
6.6.1 General

a) Remove all auxiliary piping and instrumentation that will interfere with disassembly and drain oil from bearing housings.

⚠ Use extreme caution not to expose maintenance personnel to hot liquids when removing auxiliary piping or draining bearing housings.

b) Remove temperature detectors (if supplied) from bearing housings.
c) Remove shaft vibration probes (if supplied) from bearing housings.
d) Install mechanical seal setting plates/eccentric washer.
e) Loosen mechanical seal gland bolting and drive collar setscrews of mechanical seals.
f) If a removable pedestal has been supplied with the pump as an assembly fixture, when removing the pump from bedplate, it is recommended that the pedestal and pump be removed as single unit. When lifting the pedestal, use (4) lifting lugs located on pedestal.
g) If there is an auxiliary pedestal, when removing the pump from bedplate (if needed), use two slings placed around the bearing brackets located in both suction and discharge heads [1130 & 1140] and support on blocking. Pump is located on assembly fixture by a pin and key block. The pin is under the suction casing and

key under discharge casing; be careful when pulling pump off the pin.



Note: When dismantling the pump, refer to Sectional Assembly drawing, found in Section 8 of this User Instructions book.

6.6.2 Thrust bearing removal

a) Remove capscrews and bearing end cover [3266] from thrust bearing housing [3210.2].
b) Remove shim [3126.3].
c) In case the bearing housing is sealed by flingers, loosen setscrews in pump side flinger and slide it back on the shaft towards the mechanical seal.
d) Remove capscrews holding thrust bearing housing upper [3210.2] to housing [3205.2]. Using eyebolts lift off thrust bearing housing upper [3210.2]. Springs and spring retainers may fall from cap. Do not lose. Place cap on blocking, to prevent damaging machined surfaces.
e) Remove thrust shoes first, then base ring assemblies from KTB assembly [3032]. Tag parts for reassembly.
f) Remove top half of bearing bush [3020].
g) Loosen setscrews and remove bearing nut [3712]. Remove thrust bearing plate [3610] (slight heat may be required) with key [6700.4], sealing ring, and shims [3126.5]. Tag and record thickness of shims for reassembly.

In the interest of operator safety when handling any heated parts, protective gloves or other suitable protection must be worn.

h) Remove bottom half of bearing bush [3020] by carefully raising shaft [2100] and rolling bearing out from under the shaft.
i) Install eyebolts in bearing housing [3210.2] and rig to an overhead hoist.
j) Loosen and remove capscrews and dowel pins. Carefully remove bearing housing [3210.2] from discharge casing [1140], with springs and spring retainers, and place on blocking on floor.
k) Gather together and tag 4 springs and 4 spring retainers.
l) In case the bearing housing is sealed by flingers, remove flinger from the shaft.
m) In case the bearing housing is sealed by labyrinth sleeves, remove labyrinth sleeve [3709] with its pins and circular joint ring [4595.6] from shaft.

6.6.3 Radial bearing removal

a) In case the bearing housing is sealed by flingers, loosen setscrews from coupling side and mechanical seal-side flingers and remove the flinger (coupling side) from end of shaft, and slide the flinger (mechanical seal-side) on the shaft toward the mechanical seal.
b) Remove capscrews and dowel pin from radial bearing housing upper [3210.1]. Rig eyebolt in bearing cap to an overhead hoist and lift bearing cap from bearing housing and place on blocking on the floor.
c) Remove upper half bearing bush [3020] with pin.
d) Remove bottom half of bearing bush [3020] by carefully raising shaft [2100] and rolling bearing out from under the shaft.
e) Install two eyebolts in diagonally opposite corners of bearing housing [3210.1] and rig to an overhead hoist. Remove capscrews and dowel pins from bearing housing. Using the overhead hoist, lower and remove bearing housing from suction casing [1130].
f) In case the bearing housing is sealed by flingers, remove flinger from the shaft.
g) In case the bearing housing is sealed by labyrinth sleeves, remove labyrinth sleeves [3709] with their pins and circular joint rings [4595.6] from shaft.

6.6.4 Mechanical seal removal

Refer to mechanical seal instructions (located in Section 10.1) for detailed information on seals.

a) Loosen capscrews securing the mechanical seal setting plates. Rotate setting plates in the space between the gland and drive collar. Retighten the capscrews. Do this on both ends of pump.
b) At both ends of pump, remove gland hex nuts and washers from mechanical seals [4200]. Loosen setscrews in drive collar that hold seal to pump shaft [2100] and remove seals (intact as units), with sleeve and circular joint rings from pump shaft [2100]. Mark/tag each seal assembly for inboard or outboard location.

6.6.5 Stuffing box housing removal

a) At thrust end of pump, remove capscrews that hold stuffing box housing [4110] in place.
b) Place eyebolts in top of stuffing box housing [4110] and carefully remove housing over the end of pump shaft. Circular joint ring [4595.5] should come off with housing.

6.6.6 Balance disc removal

a) Loosen the setscrews in balance disc retaining ring [2530] and remove ring.
b) Push shaft [2100] towards thrust bearing end to help facilitate the removal of the retaining ring sleeve [2482]. It will be necessary to push the balance disc [6210] inboard so that the retaining ring sleeve [2482] may be easily removed from its groove. Heat should not be applied to the balance disc in order to move inboard (loose fit rotor). Make sure rotor does not move inboard when moving balance disc inboard.

Note: Do not use a pry to facilitate removal of the retaining ring sleeve.

c) Remove retaining washers [3126.1] after retaining ring sleeve [2482] is removed. Record the number and size of retaining washers [3126.1] for use in reassembling the pump. It is recommended the retaining washers be tied together.
d) Two screws may be inserted into the back of the balance disc to facilitate removal. There is a circular joint ring [4595.3] located between the balance disc [6210] and shaft [2100]. Slide the balance disc [6210] out carefully so as not to damage the circular joint rings. Remove key [6700.2] from shaft [2100].

⚠ CAUTION The utmost of care should be taken when removing this balance disc as it may gall and pick up if not removed properly.

6.6.7 Disassembly of pump

Note: When moving pump, the pump should remain bolted to its assembly fixture and be moved with the assembly fixture.

Note: Identify all impellers, keys, stage casings and diffusers by marking them as they are removed with the appropriate stage number so that they are reassembled in the same location.

Note: Impellers are a loose fit on the shaft. All impellers [2200] are removed and installed over the thrust (outboard) end of the pump shaft [2100].

Clean exposed shaft areas of any dirt or burrs. Protect bearing journal areas of shaft by covering with hard sheet packing or similar material.

6.6.7.1 Discharge casing removal

a) Remove the flex lock-nut/studs and cap-screws that hold the discharge casing feet and suction casing to the assembly fixture. Pump is located on assembly fixture by a pin and key block. The pin is under the suction casing and key under discharge casing; be careful when pulling pump off the pin.
b) Loosen the main bolting nuts [6582] at suction casing end of the tie bolts [6571]. Do not remove nuts [6582] at this time.

Note: Loosen by alternating diagonally opposite nuts.

c) Block inboard end of shaft such that the shaft does not slide through the impellers when hoisting the unit into a vertical position. Rig the pump assembly to an overhead crane and remove pump from pedestal, hoisting it into a vertical position. Discharge end of pump should be upward. Stand the pump assembly on blocking over an opening so that the shaft [2100] portion, protruding past the suction casing [1130], does not contact the floor.
d) Remove nuts [6582] and washers [2905.1] from tie bolts at the suction end of pump. Remove the tie bolts [6571] by sliding them through the discharge casing [1140].
e) Sling straps around feet of discharge casing [1140] and lift off of last stage casing/diffuser [1150.29/1410.7]. Counter balance disc [6220] and circular joint ring [4595.3] will come off with discharge casing. Circular joint ring [4595.5] will remain in discharge casing during disassembly.

Note: Use care when sliding assembly off shaft to prevent the counter balance disc from contacting the shaft.

f) Remove capscrews and lockwashers holding counter balance disc to inside of discharge casing [1140]. Remove counter balance disc [6220] and circular joint ring [4595.3] from discharge casing [1140].

6.6.7.2 Rotor disassembly

a) Remove last stage diffuser [1410.7]. Since it is a tight fit on the stage casing [1150.29], slight heat may be required to remove diffuser from stage casing.
b) Remove last stage impeller [2200.8] and key [6700.2] from shaft. If impellers cannot be removed from pump shaft, slight heating may be used to enlarge impeller bore. Apply heat (torch with rosebud tip) to periphery of impeller until temperature reaches 90 ºC (200 °F) minimum to 105 ºC (225 °F) maximum. Use tempilstick to determine temperature.

Note: Impellers have a loose fit onto the shaft.

c) Remove last stage casing [1150.29]. If stage casing is hard to remove, slight heat may be applied at fit. Circular joint ring [4595.9] is located between faces of stage casings. Pry slot has been provided on outer diameter of stage casings.

d) Continue to remove impellers [2200.2/3], keys [6700.2], stage casings [1150.14/3/2], diffuser [1410.2/1], and circular joint rings [4595.4] using same procedure described in b and c.
e) After 2nd stage impeller [2200.2] is removed, remove stage casing [1160], inlet ring [1910], interstage sleeve [2410], first stage diffuser [1410], first stage impeller [2200.1] and key [6700.3] and circular joint rings [4595.14/8].
f) After first stage impeller [2200.1] is removed, casing wear ring [1500.1] will remain in internal suction casing [1130.2].
g) Remove retaining ring [2530] and shaft [2100].
h) Remove internal parts of the internal suction casing, washers and joint rings.

6.7 Inspection & renewal of parts

Note: Wire brush the pump parts thoroughly. Clean off all scale, carbon, etc. Examine parts for wearing, corrosion and erosion.

6.7.1 Shaft

Having completely dismantled the pump, set the bare pump shaft [2100] on rollers or V blocks at the bearing journal areas and check run out. Rollers must be wide enough so as not to cause indentations in journal areas. The maximum run out should not be more than 0.05 mm (0.002 in.) total indicator reading.

Note: Do not use bearing centres to check run out.

6.7.2 Balance disc

Check balance disc [6210] for wear, cracks, and pickup. Check the counter balance disc [6220] and make sure it has not rubbed. If it is worn, replace.

6.7.3 Stage casing wear rings & casing wear rings

The casing wear rings [1500.1/2/6/10] and stage casing wear rings [1500.1/2/6/10] are renewable and should be replaced when badly grooved and/or when performance does not meet system requirements.

Casing wear rings [1500.1/2/6/10] or stage casing wear rings [1500.1/2/6/10] can be drilled at one or more places and split. Rings too hard to drill can be weakened by grinding with a small hand grinder.

To replace casing wear rings [1500.1/2/6/10] or stage casing wear rings [1500.1/2/6/10], it is advisable to shrink them by freezing. Replacement bushings and casing wear rings will be 1/8", undersize. Install rings, then turn to its original running clearance.

6.7.4 Impellers

If the clearances between the impeller wear areas and the stationary wearing areas need to be renewed, undersize stationary wearing parts will be furnished. Impeller wear rings [2300] (if supplied) can be turned to remove light grooving. Do not turn beyond this.

6.7.5 Counter balance disc

The counter balance disc [6220] is bolted to the discharge casing [1140] with circular joint ring [4595.3], socket casing capscrews and washers. Make sure counter balance disc is not cocked during installation.

6.7.6 Mechanical seals

Refer to seal drawing and instructions in this User Instructions book.

6.7.7 Retaining ring

Inspect retaining ring [2530] for grooves, pitting, scoring or worn setscrew threads. Worn retaining ring must be replaced. If threads are not too badly worn, redress threads.

6.7.8 Thrust shoes (KTB)

Inspect shoes for signs of wiping or grooving. Badly wiped shoes must be replaced. Small grooves or light wiping may be removed by careful scraping. When dressing thrust shoes, a uniform thickness must be maintained by use of a micrometer.

Note: Any metal that is removed from the shoes will effect the total endplay of the thrust bearing. When the amount of shims used to establish endplay has been increased 3/32” over the original amount, replacement of the shoes are required. Thrust shoes must be replaced in sets.

6.7.9 Thrust bearing plate

Check thrust bearing plate for scoring or burrs. Small score marks or burrs can be removed by stoning or light filing.

Note: Any metal that is removed from the thrust bearing plate will effect the total endplay of the thrust bearing. When the amount of shims used to establish end play has been increased 3/32” over the original amount, replacement of the bearing plate is required.

6.7.10 Radial bearings

Check running clearances. Check bearing babbit surfaces for signs of wear, cracking, flaking, or grooving. Shallow grooves or worn spots must not be removed by scraping. Any scraping of the bearing may tend to upset the oil wedge that supports the shaft. Badly worn bearings must be replaced.

Note: Journal bearing clearances may be considered excessive when the diametral clearance increases to 0.10 mm (0.004 in.) over the normal maximum clearance. If conditions permit and the unit has exhibited smooth operation, the bearings may be kept in service even if they exceed the recommended maximum clearance. Bearing replacement is left to the discretion of the operating engineer.

6.7.11 Circular joint rings

Renew all circular joint rings [4595].

6.8 Torques and clearances

6.8.1 Clearances

- Shaft [2100] to bearing bush [3020]: 0.100-0.160 mm (0.0039-0.0063 ft)
- Impeller ring 1st stage [2300] to casing wear ring [1500.1]: 0.360-0.420 mm (0.014-0.017 ft)
- Interstage sleeve [2410] to casing wear ring [1500.10]: 0.360-0.420 mm (0.014-0.017 ft)
- Impeller ring 2nd to 11st stage [2300.2] to casing wear ring 2nd to 11st stage [1500.2]: 0.360-0.420 mm(0.014-0.017 ft)
- Impeller bushing 2nd to 10st stage [2300.6] to casing wear ring 2nd to 10st stage [1500.6]: 0.350-0.410 mm (0.014-0.016 ft)
- Balance disc [6210] to counter balance disc [6220]: 0.350-0.410 mm (0.014-0.016 ft)

6.8.2 Torque values

Torque values listed below are selected to achieve the proper amount of pre-stress in the threaded fastener. Maintenance personnel must ensure that threads are in good condition (free of burrs, galling, dirt, etc.) and that commercial thread lubricant is used. Torque should be periodically checked to ensure that it is at the recommended value.

Radial bearing housing [3205.1] to suction casing [1130.1] bolting	685 (505)	N·m (lbf·ft)
Thrust bearing housing [3205.2] to discharge casing [1140] bolting	685 (505)	N·m (lbf·ft)
Radial bearing housing [3205.1] to bearing housing upper [3210.1] bolting	205 (151)	N·m (lbf·ft)
Thrust bearing housing [3205.2] to bearing housing upper [3210.2] bolting	205 (151)	N·m (lbf·ft)
Mechanical seal [4200] to suction casing [1130] and stuffing box housing [4110] bolting	98 (72)	N·m (lbf·ft)
Stuffing box housing [4110] to discharge casing [1140] bolting	417 (308)	N·m (lbf·ft)
Counter balance disc [6220] to discharge casing [1140] bolting	417 (308)	N·m (lbf·ft)
Bearing end cover [3266.1] to thrust bearing housing [3210.2] bolting	115 (85)	N·m (lbf·ft)
Tie bolt nuts [6582]	9305 (6863)	N·m (lbf·ft)
Pump to pedestal (coupling side)	1985 (1464)	N·m (lbf·ft)
Pump to pedestal (thrust bearing side)	1985 (1464)	N·m (lbf·ft)
Pedestal to baseplate	685 (505)	N·m (lbf·ft)

6.9 Rebuilding pump for installation

6.9.1 Rebuilding pump

a) Place pump shaft [2100], first stage impeller key [6700.3] and impeller [2200.1] on horses/V blocks supported at the mechanical seal area of the shaft. Block to prevent rolling.
b) Rig the suction casing [1130] to an overhead hoist and lay it on blocking over an opening so that the shaft can be vertically inserted without contacting the blocking.
c) Place internal suction casing [1130.2] into the suction casing [1130.1] with washers and circular joint rings [4595].

CAUTION Do not damage the circular joint ring [4595.15] during installation process.

Note: In the interest of operator safety when handling any heated parts protective gloves or other suitable protection must be worn.

d) Install shaft [2100] and retaining ring [2530] with the first stage impeller [2200.1], into the suction casing [1130]. Block the shaft.

Note: Impellers have a loose fit onto the shaft.

Note: Stage casing is a loose fit into the suction casing [1130].

e) Install the stage casing [1160]/diffuser [1410.1] assembly, with its casing wear ring [1500] and joint rings already in place, into the suction casing [1130].
f) Install interstage sleeve [2410] and inlet ring [1910].
g) Install stage casing [1160].

h) Install the second stage impeller [2200.2] and its key [6700.2] onto the shaft [2100].
i) Continue to install stage casings [1150.2/3/14] diffuser [1410.1/2] assembly, stage casing wear rings [1500], circular joint rings [4595.9], impellers [2200.2/3], and impeller keys [6700.2] for the remaining stages.
j) Install last stage diffuser [1410.7], onto stage casing [1150.29], impeller [2200.8] and impeller key [6700.2].

Note: Diffusers [1410/.1/.2.7] have a loose/tight fit onto the stage casing [1150.1/2/3/14/29].

k) Install circular joint ring [4595.3] into its groove in the counter balance disc [6220]. Install counter balance disc into discharge casing [1140] using capscrews and lockwashers. Torque to recommended value. (See Section 6.8.2, *Torque values*).

CAUTION Do not damage circular joint ring [4595.3] during installation process.

l) Rig discharge casing to overhead hoist and lower into place over the last stage diffuser [1410.7] and stage casing [1150.29] making sure circular joint ring [4595.2/9] is in the groove on the face of discharge casing.
m) Install all tie bolts [6571.1/2] through holes in discharge casing [1140] and move down through holes in suction casing [1130]. If they were removed previously during dismantling, install washers [2905.1] and nuts [6580] at the discharge end of the tie bolts. Bottom out the tie bolts into the nuts. Use a good thread compound on the studs.
n) Install washers [2905.1] and nuts [6580] at suction casing end of tie bolts. Do not torque at this time, hand tighten only.
o) Lift and manoeuvre assembled pump into a horizontal position and set onto pump assembly fixture. Bottom hole on suction casing [1130] must fit over alignment pin on assembly fixture.

Note: Make sure radial end of shaft is blocked towards the thrust end; otherwise shaft may slide out of the loose fit impellers.

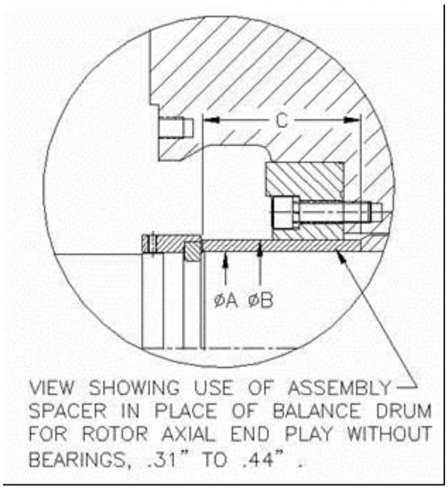
p) Lubrication between pedestal and pump feet may be required to allow pump feet to slide when torquing tie bolts.
q) Studs and locking nuts are provided for the four feet – two in each casing. Tighten the suction feet to the assembly fixtures with studs and locking nuts to a torque value less than ½ the recommended value. (See 6.8.2, *Torque values*). Once the discharge casing feet line up with tapped holes in assembly fixture tighten these bolts in the same manner as the suction casing. Do not torque hold down bolting at this time.
r) Use feeler gage to make sure all feet are contacting assembly fixture pump pads before tightening the tie bolts. After tightening the distance between any foot and a pedestal should be 0.25 mm (0.010 in.) or less.
s) Start torquing nuts [6580] at suction end of pump. Be sure that suction and discharge casings remain parallel while torquing. When tightening nuts, tighten diagonally opposite nuts to ensure casing is pulled into place evenly. Torque to recommended value. (See Section 6.8.2, *Torque values*).

CAUTION No matter how discharge casing is pulled into place, it is vital that it is pulled square. Don't let any part of the casing get out of parallel by more than 1.5 mm (0.06 in.).

t) Check the distance between casings. Using a bolt or bar and feeler gauge, measure all around the pump casing circumference. Adjust torque on nuts [6580] until casings are parallel within 0.25 mm (0.010 in.). Ensure the rotor turns freely.
u) Install alignment key between bottom portion of discharge casing [1140] and key block on pedestal.

6.9.2 Rotor end play / balance disc installation

The total end play will be found to be approximately 8 – 11 mm (5/16 - 7/16 in.). However, the exact dimension for each pump must be determined to be assured of adequate axial clearance between the rotating components and stationary parts.



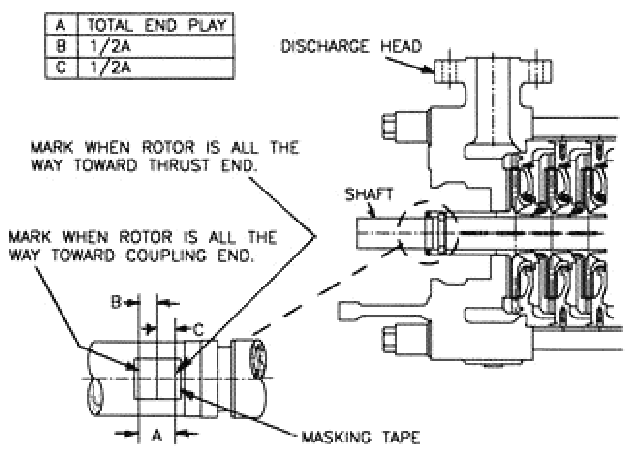
a) Push rotor gently outboard as far as it will go. On outboard end of shaft, install balance disc assembly spacer as shown below, assemble shims [3126.1] as necessary, retaining ring sleeve [2482] and retaining ring [2530]. Tighten setscrews.

Note: Front face portion of the balance disc assembly spacer should butt up against back hub of last stage impeller [2200.8]. (All impellers should be locked together). The amount of shims used will not be the same as during final assembly. The dimensions of the assembly spacer are shown below for reference.

BALANCE DISC ASSEMBLY SPACER DIMENSIONS			
Pump type	**A(ID)**	**B(OD)**	**C(Length)**
3X10WXH	66.5 mm (2.62 in.)	76.2 mm (3.00 in.)	96.8 mm (3.81 in.)
3X11WXH	76.2 mm (3.00 in.)	88.9 mm (3.50 in.)	117.3 mm (4.62 in.)
4X12WXH	91.9 mm (3.62 in.)	114.3 mm (4.50 in.)	128.5 mm (5.06 in.)
6X14WXH	108.0 mm (4.25 in.)	131.8 mm (5.19 in.)	138.2 mm (5.44 in.)

b) Pull the rotor assembly inboard as far as possible. Put masking tape on shaft per following sketch. Place a straight edge across the discharge casing, rest it on the shaft, and mark tape as shown.
c) Push rotor gently outboard as far as it will go. Mark tape again, as above. Block coupling end of shaft to hold it outboard.

CAUTION Do not push rotor back & forth more than once or twice as damage to close running clearances may result.



d) Measure the distance between the two marks. This distance will be divided into half. Mark this line; it represents the desired impeller/diffuser position.
e) Loosen setscrews and remove retaining ring [2530], retaining ring sleeve [2482], shims [3126.1] and assembly spacer.
f) Install balance disc key [6700.2] into shaft [2100].
g) Install circular joint ring [4595.4] into inner diameter groove of balance disc [6210].
h) Balance disc [6210] has a loose fit to the shaft [2100]. Install balance disc [6210] onto shaft. Install shims [3126.1], retaining ring sleeve [2482], and retaining ring [2530], and tighten setscrews.
i) Push rotor gently inboard as far as it will go. Bring balance disc [6210], shims [3126.1] and retaining ring sleeve [2482] metal to metal.
j) Check with straight edge to see if rotor is now in desired position. That is, does the straight edge fall on middle line on masking tape.
k) If the rotor is not properly positioned, add or subtract shims [3126.1] at balance disc [6210] to correct alignment.

6.9.3 Installation of outboard stuffing box housing

a) Renew circular joint ring [4595.5] and assemble to circular joint ring groove on stuffing box housing [4110].
b) Lift and install stuffing box housing [4110] over the outboard end of shaft [2100].
c) Enter stuffing box housing [4110] into its fit of the discharge casing. Install capscrews.
d) Tighten capscrews using utmost care to draw the stuffing box housing [4110] up parallel to its mating face. Torque to recommended value. (See Section 6.8.2, *Torque values*).

6.9.4 Checking rotor vertical lift

It is necessary to check and record the vertical lift of the rotor within the casing.

a) Place a dial indicator on the upper portion of the suction and discharge casings, with the indicator tip resting on the top of the shaft. Zero the indicator.
b) Using a bar and a block of wood under the shaft, lift the shaft and record the movement. Take measurements at both ends of the pump.
c) The minimum acceptable vertical movement is the impeller ring clearance on the suction end of the pump and the minimum counter balance disc/balance disc clearance on the discharge end of the pump.
d) If this minimum movement is not obtained, the cause must be investigated and corrected.

6.9.5 Shaft alignment

a) In case the bearing housings are sealed by labyrinth sleeves, position inboard labyrinth sleeves [3709] with their circular joint rings [4595.6] onto the shaft [2100].
b) In case the bearing housings are sealed by flingers, position inboard flingers [2540] onto the shaft [2100] near mechanical seals [4200].
c) Rig radial bearing housing [3210.1] to suction casing [1130]. (Make sure that labyrinth sleeves are positioned in the correct position onto the

bearing housing, as well as their pins, if applicable). Install dowel pins and snug capscrews.

d) Install both horizontal and vertical adjusting screws in the bearing housing mounting flange. Remove dowel pins.
e) Wipe a film of oil on journal area of shaft. Place lower half of bearing bush [3300] on shaft. Wipe a film of oil on lower half outer diameter of bearing bush. Roll lower half of bearing bush into lower half of bearing housing [3020].
f) Rig the thrust bearing housing [3210.2] to an overhead hoist as done during disassembly. Assemble thrust bearing housing [3210.2] to discharge casing [1140]. Install dowel pins and snug capscrews. (Make sure that labyrinth sleeve is positioned in the correct position onto the bearing housing, as well as its pins, if applicable). Install both the horizontal and vertical adjusting screws in bearing housing mounting flange. Remove dowel pins.
g) Wipe a film of oil on journal area of shaft. Place lower half of bearing bush [3300] on shaft. Wipe a film of oil on lower half outer diameter of bearing bush and roll lower half of bearing bush into lower half of bearing housing [3210.2].
h) Using a set of inside spring callipers and the adjusting screws adjust the horizontal and vertical position of the shaft at the radial bearing end so that the distance between the shaft and the stuffing box bore is the same all the way around.
i) Repeat step *f to* align thrust end within the stuffing box bore then recheck radial end. Pump shaft should turn free with no indication of binding or rubbing. This should be taken into consideration when making adjustments.
j) When vertical and horizontal alignment is obtained, tighten bearing housing bolting except the two top bolts at the adjusting screws. Ream dowel holes and install dowel pins. Loosen adjusting screws and tighten the two top bearing housing bolts.

6.9.6 Balance disc and thrust bearing setting

a) Roll out lower half of both bearing bushes [3300]. Remove both radial/thrust bearing housings [3210.1/2].
b) Install the stuffing box bushings in the bottom of the stuffing boxes followed by the inboard mechanical seals [4200] on both ends of the pump. Make sure circular joint ring(s) are inserted in the seal grooves before installing the mechanical seal. Install gland studs and nuts at this time. Torque to recommended value. (See Section 6.8.2, *Torque values*). Do not tighten the drive collar setscrews at this time.

CAUTION Care must be taken not to damage the shaft sleeve circular joint ring when sliding the seal over the shaft.

c) Re-install the radial bearing housing [3205.1] to the suction casing [1130] as done before. Install dowel pins with nuts and capscrews. Torque capscrews to recommended value. (See Section 6.8.2, *Torque values*).
d) Wipe a film of oil on lower half of bearing bush [3300]. Raise shaft slightly and roll lower half bearing bush into radial bearing housing [3205.1].
e) Install radial bearing housing upper [3210.1]. Install capscrews/lockwashers and tighten.
f) Re-install the thrust bearing housing [3205.2] to the discharge casing [1140] as done before. Install dowel pins with nuts and capscrews. Torque capscrews to recommended value. (See Section 6.8.2, *Torque values*).
g) Wipe a film of oil on lower half of bearing bush [3300]. Raise shaft slightly and roll lower half bearing bush into trust bearing housing [3205.2].
h) Place dial indicator at the inboard coupling end of the pump against the shaft [2100]. Push the shaft toward the coupling end and set the dial indicator to zero.

Note: Do not force, as rotor will stop when balance disc [6210] contacts counter balance disc [6220].

i) Install shim [3126.3] and inboard seal ring into position on shaft [2100].

Note: Do not install springs [4263] and spring retainers at this time.

j) Install shims [3126.3] against shaft shoulder if amount was recorded at disassembly. If this is an initial assembly, start with a total shim thickness of approximately 1.5 mm (0.060 in.).
k) Install thrust bearing plate key [6700.2]. Install “dummy” thrust bearing plate on shaft [2100]. Install bearing nut [3712] but do not tighten.

Note: The “Dummy” thrust bearing plate is identical to the thrust bearing plate [3610] supplied but the fit on the shaft is loose instead of tight.

l) Install lower and upper halves of KTB thrust bearing [3033] base and thrust shoes.

Note: Wipe a thin film of oil on KTB parts [3033] before installing.

m) Tighten bearing nut [3712] to force “dummy” thrust bearing plate against KTB thrust shoes [3033]. Check indicator reading at coupling end. Indicator should show a 0.025 to 0.076 mm (0.001 to 0.003 in.) reading. This reading is the clearance required between the face of the balance disc [6210] and counter balance disc [6220]. If adjustment is necessary add or subtract shims [3126.3] as required to obtain required clearance of a 0.025 to 0.076 mm (0.001 to 0.003 in.).

n) Pull rotor toward outboard end and install thrust bearing housing upper [3210.2] with dowel pins and 4 bolts. Tighten bolts.

o) Push rotor toward coupling end and verify the indicator again reads a 0.025 to 0.076 mm (0.001 to 0.003 in.). Adjust shims [3126.3] if necessary.

Note: It is essential that the setup is done correctly and accurately. Repeat the steps above.

Note: Record shim thickness after final set up is completed.

p) After balance disc clearance has been established and checked, push shaft towards the coupling end. Set indicator to zero.

q) Install the outboard shim [3126.3] and the support casing or bearing end cover [3266].

r) Push the rotor outboard. The indicator should read 0.46 to 0.61 mm (0.018 to 0.024 in.). This is the bearing clearance. If indicator shows less than 0.46 mm (0.018 in.) the shim [3126.3] will have to be made thinner. If the indicator shows greater than 0.61 mm (0.024 in.), a shim will have to be added.

s) After proper clearance is obtained, remove the bearing end cover [3266], shim [3126.3], outboard base ring, thrust bearing cap [3210.2] bearing nut [3712], “dummy” thrust bearing plate, and KTB assembly [3033].

6.9.10 Final thrust bearing assembly

a) Make sure shims [3126.3] and inboard base ring are in place.

b) Install regular thrust bearing plate [3610] which has an interference fit with the shaft [2100]. Regular thrust bearing plate must be heated to 175 ºC (350 ºF) before installing.

⚠ In the interest of operator safety when handling any heated parts, protective gloves or other suitable protection must be worn.

c) Install bearing nut [3712] and tighten. After allowing thrust bearing plate [3610] to cool ambient temperature. Re-tighten nut. Tighten setscrews in bearing nut to set.

d) Install the KTB assembly [3032]. Install thrust bearing cover [3210.2]. Install dowel pins and 4 capscrews and tighten.

e) Push rotor inboard toward coupling end. Re-check indicator reading. Indicator should still show a 0.025 to 0.076 mm (0.001 to 0.003 in.) reading.

f) Remove thrust bearing cover [3210.2].

g) Remove KTB assembly [3032].

h) Slide shim [3126.3] and base ring up against bearing housing. Install KTB assembly [3032]. Install shim [3126.3].

i) Ensure bearing housing [3205.2] and bearing housing upper [3210.2] parting flange surfaces are clean. Coat flange with new gasket eliminator (Permatex).

j) In case bearing housings are sealed by labyrinth sleeves, install labyrinth sleeve [3709] with its circular joint ring [4595.6] into its position in thrust bearing housing.

k) Install the remaining 2 sets of Belleville springs [4263] and spring retainers into the thrust bearing housing upper [3210.2].

l) Carefully install the bearing housing upper [3210.2] onto the housing [3205.2]. Install capscrews to bolt bearing housing and bearing cap together. Torque to recommended value. (See Section 6.8.2, *Torque values*).

Note: Be sure springs [4263] and retainers do not fall out of the cover during assembly.

m) Install the outboard seal ring and shim [3126.5]

n) Ensure bearing housing [3205.2], bearing housing upper [3210.2] and bearing end cover [3266] surfaces are clean. Coat surfaces with new gasket eliminator (Permatex).

o) Install bearing end cover [3266]. Install capscrews and torque to recommended value. (See Section 6.8.2, *Torque values*).

p) Tighten outboard mechanical seal drive collar setscrews. Loosen setting plate bolting and remove seal spacers.

q) In case bearing housing is sealed by flingers, position flinger [2540] to bearing housing [3210.2]. Maintain a 0.76 mm (0.030 in.) gap between housing and flinger. Tighten setscrews.

⚠ **CAUTION** Mechanical seal spacer must be removed before start-up.

6.9.11 Final radial bearing assembly

a) Remove radial bearing cap [3210.1].

b) Ensure bearing housing [3205.1] and bearing cap [3210.1] parting flange surfaces are clean. Install labyrinth sleeves [3709] with their circular joint rings [4595.1] into their position in radial bearing housing [3210.1]. Coat flange with new gasket eliminator (Permatex). Assemble bearing cap [3210.1] to bearing housing [3205.1]. Install capscrews to bolt bearing housing and bearing cap together. Torque to recommended value. (See Section 6.8.2, *Torque values*).

c) In case bearing housings are sealed by flingers, position inboard flinger [2540] to bearing housing [3205.1]. Maintain a 0.76 mm (0.030 in.) gap between housing and flinger. Tighten setscrews.

d) Tighten inboard mechanical seal drive collar setscrews. Loosen setting plate bolting and remove seal spacers.

CAUTION Mechanical seal spacer must be removed before start-up.

6.10 Final pump assembly

a) Move pump and pedestal (assembly fixture) as a unit to the bedplate using the four lifting lugs located on pedestal (do not lift unit by the pump or nozzles).
b) Align pedestal onto bedplate.
c) Install the taper dowel pins in the four pedestal corner feet. Bolt all six pedestal feet to bedplate.
d) Replace all auxiliary piping, and probes, detectors, and electrical leads (bearing housings) that were removed for dismantling purposes.

6.11 Coupling reassembly

a) Mount pump half coupling hub on pump shaft, draw up coupling lock nut [7411] and accurately mark its axial position on shaft, to establish its cold position. Then remove coupling hub from shaft [2100].
b) Accurately measure and mark the axial shift on shaft, for hot position. See chart below for axial shift dimension.

COUPLING AXIAL SHIFT DIMENSIONS

Pump type	Shift
3X10WXH	0.45 mm (0.018 in.)
3X11WXH	0.48 mm (0.019 in.)
4X12WXH	0.61 mm (0.024 in.)
6X14WXH	0.83 mm (0.033 in.)

c) Heat pump half coupling hub uniformly to a temperature of 90 to 105 ºC (200 to 220 ºF), by immersing in rapidly boiling water, by furnace or by heating coil.

CAUTION Do not heat in oil or do not use a torch.

d) Mount pump half coupling hub on pump shaft before it has cooled more than 5 °C (10 ºF), pulling up to hot position marked on shaft [2100] by tightening coupling lock nut [7411]. Tighten setscrews in coupling lock nut.
e) Install spacer coupling.
f) Check coupling/shaft alignment as described in Section 4.
g) Install coupling guard and tighten bolting.

Fill lube system oil reservoir (refer to Section 5.2.1, *Lubrication*).

Refer to Sections 5.3, *Initial start-up procedure*, and Section 5.4, *Operating checks*.

7 FAULTS; CAUSES AND REMEDIES

FAULT SYMPTOM

Failure to deliver head and/or flow at start-up or during operation	Insufficient capacity and/or pressure	Pump loses prime after starting	Excessive vibration	Noise/Cavitation	Excessive discharge pressure pulsations	Driver overloaded	Pump stops abruptly	Mechanical seal leakage	Mechanical seal overheats or excessive	Pump overloads driver	High balance drum leakoff line pressure	PROBABLE CAUSES	POSSIBLE REMEDIES
●												Pump not completely filled with liquid	For low-temperature applications allow more cooling time for pump to reach fluid temperature. (At start-up only, see Start-Up procedures in Section 5, *Commissioning, start-up, operation and shutdown*).
●			●	●	●							Actual NPSH available is lower than specified NPSH requirement.	Check suction piping configuration. Minimum recommended length of straight piping before suction flange is 5 times the diameter of the suction piping. (Refer to Section 4, *Installation*).
●			●	●	●							Air leaks in suction line when operating under vacuum	Secure all vent connections. Check flanges for leakage.
●			●	●	●							Air/vapor pocket in suction line	Bleed line through vent connections.
●	●			●								Foreign material in suction line	Dismantle suction line and clear it of all foreign material, including suction strainer and isolation valve.
●	●											Reverse direction of rotation	Correct rotation is counter-clockwise when looking from coupling end of pump. Switch any two motor leads to change rotation. If turbine, contact turbine manufacturer.
●												Driver speed too low	Check power supply for correct frequency to motor.
													Check actual speed against rated speed listed on Pump Data Sheet (Section 10.1). If necessary, contact Flowserve office or driver manufacturer (and, if included, variable speed coupling manufacturer) for maintenance instructions.
●												Flow too low, causing overheating of the fluid and loss of NPSH after a short period of satisfactory operation	Check Pump Data Sheet (Section 10.1) or performance curve and adjust the system to the rated head-flow levels.
													If necessary, increase flow by installing a bypass line to a supply tank. Do not bypass directly to suction line.
													Increase NPSH available or reduce NPSH required.
●	●									●		Flow too high	Check Pump Data Sheet (Section 10.1) or performance curve and adjust the system to the rated head-flow levels
													Reduce flow
	●											Suction pressure less than required or speed too low	Open suction valve wide. Check power supply to motor for correct voltage.
●												Excessive recirculation from discharge to inlet	Check flow through bypass line. Adjust valves if necessary.

FAULT SYMPTOM

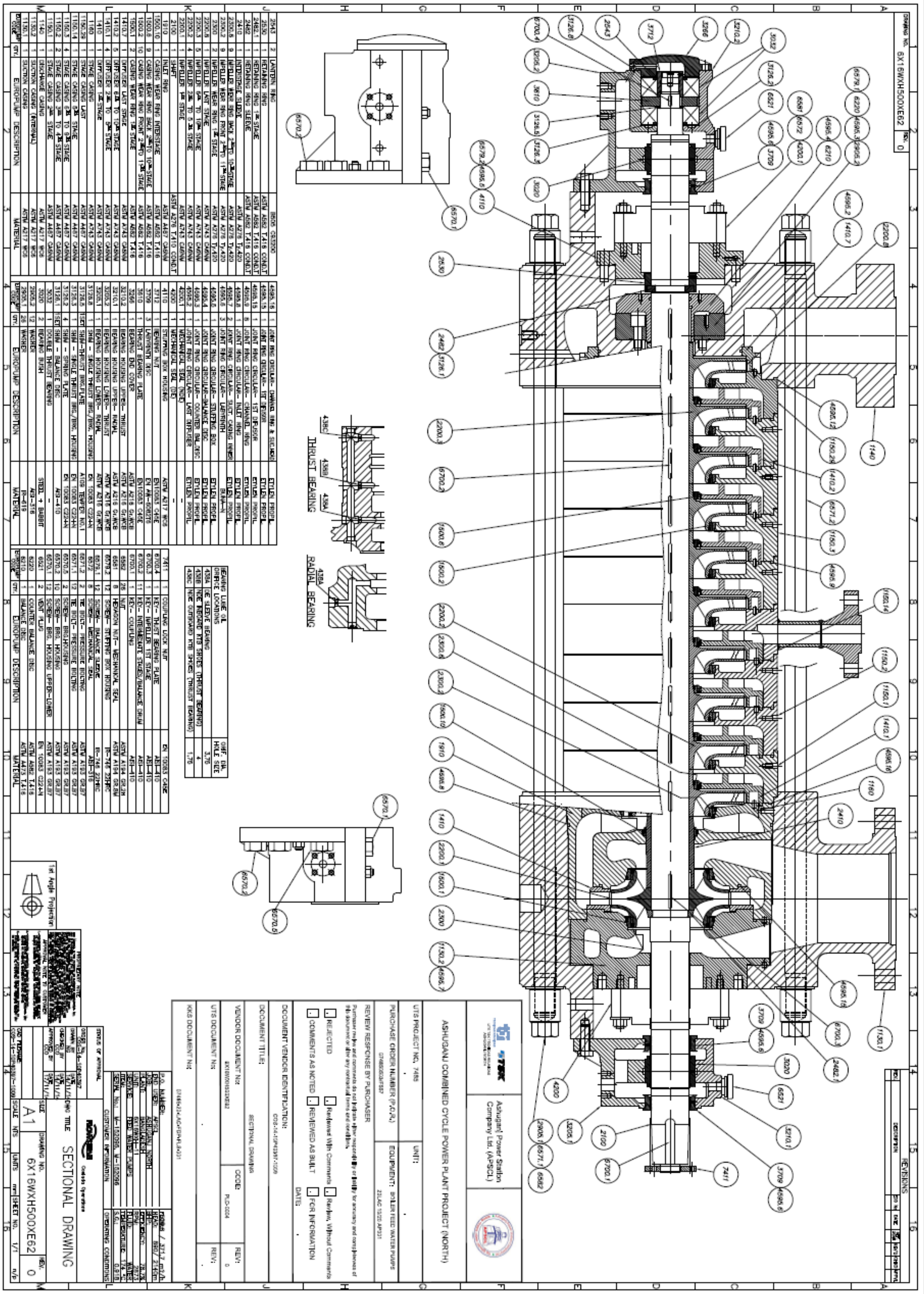
Failure to deliver head and/or flow at start-up or during operation	Insufficient capacity and/or pressure	Pump loses prime after starting	Excessive vibration	Noise/Cavitation	Excessive discharge pressure pulsations	Driver overloaded	Pump stops abruptly	Mechanical seal leakage	Mechanical seal overheats or excessive	Pump overloads driver	High balance drum leakoff line pressure	PROBABLE CAUSES	POSSIBLE REMEDIES
●						●						Viscosity and/or specific gravity of liquid higher than rated value	Check actual viscosity and/or specific gravity against the rated values listed on the Pump Data Sheet (Section 10.1). Adjust system if necessary.
●												Material buildup and/or clogged passageways and/or corrosion on surfaces adjacent to the impeller	Clear areas near impeller of all foreign material. Restore surfaces to smooth finish using emery cloth. Replace parts that cannot be restored (either due to severe corrosion or mechanical damage).
	●											Incorrect direction of rotation	Reconnect motor leads. If turbine-contact turbine manufacturer.
	●	●										Excessive amount of air or vapors in the fluid	Check suction system for air leakage and correct. Vent air. Tighten flange bolts.
	●	●										Foreign material in impeller(s)	Dismantle pump and remove any foreign material
	●	●										Foreign material in suction line	Dismantle suction line and remove foreign material
	●											Excessive high flow operation	Reduce flow.
		●										Insufficient water supply	Ensure that suction valve is wide open. Check for proper liquid level.
		●										Suction pipe clogged	Remove foreign material.
				●		●				●		Driver speed too high	Check power supply for correct frequency to motor. If turbine-check steam pressure to turbine. If necessary, contact Flowserve office or driver manufacturer (and, if included, variable speed coupling manufacturer) for maintenance instructions.
				●								Incorrect suction piping configuration creating undesirable flow patterns	Check suction piping configuration. Minimum recommended length of straight piping before suction flange is 5 times the diameter of the suction piping. (Refer to Section 4, *Installation*).
			●	●	●							Flow rate below recommended Minimum Continuous Stable Flow (MCSF)	Check Pump Data Sheet for recommended MCSF and adjust the system conditions to the rated head-flow levels.
													If necessary, increase pump discharge flow by installing a bypass line from discharge to a supply tank. Do not bypass directly to the suction line.
							●					Electrical failure in motor	Check power supply for correct frequency to motor. If necessary, contact Flowserve office or driver manufacturer (and, if included, variable speed coupling manufacturer) for maintenance instructions.
									●			Insufficient cooling water seal	Obstruction in seal water piping. Remove and clean.

FAULT SYMPTOM

Failure to deliver head and/or flow at start-up or during operation	Insufficient capacity and/or pressure	Pump loses prime after starting	Excessive vibration	Noise/Cavitation	Excessive discharge pressure pulsations	Driver overloaded	Pump stops abruptly	Mechanical seal leakage	Mechanical seal overheats or excessive	Pump overloads driver	High balance drum leakoff line pressure	PROBABLE CAUSES	POSSIBLE REMEDIES
									●		●	Worn balance drum	Dismantle and replace
										●		Pump bearings seize or rotating element binds	Dismantle pump and replace part or parts causing seizure or binding
●												Impeller damage	Remove and replace impeller.
●												Impeller or diffuser throat clogged with foreign material	Clear impeller or diffuser throat of all foreign material.
●												Impeller key sheared or missing from assembly	Disassemble and check impeller key. Remove and replace if damaged.
	●											Mechanical defects: wearing ring worn. Impeller damaged sheared impeller key	Dismantle pump and correct
		●										Broken or damaged coupling	Inspect and replace same.
						●	●					Rotor binds	Dismantle pump; inspect for mechanical damage; remove any foreign material from impeller/diffusor area. Restore surfaces to smooth condition. Use emery cloth.) Replace any damaged or severely corroded parts. Ensure that the rotor turns freely. Examine areas where rotating contact may occur, such as the impeller.
		●										Impeller unbalanced	Clear impeller. If problem persists, remove and rebalance.
		●				●						Driver shaft bent	Inspect the driver shaft as described in Section 6.7, *Inspection and renewal of parts*. If necessary, contact FLOWSERVE office or driver manufacturer for maintenance instructions.
						●						Mechanical/cavitation damage to the diffuser throat area causing excessive flow rates	Inspect diffuser throat area; cutwater must be radiused. Replace diffuser if the diffuser throat edge cannot be restored to original condition.
								●				Seal setting lost or incorrect	Refer to seal drawing or contact FLOWSERVE office for proper seal setting instructions.
								●				Worn or damaged seal	Disassemble seal and inspect for wear or damage. Check for the following: -Solid particles/dirt in seal -Rough, sticky, or irregular spring action of the seal faces. -Non-uniform wear patterns or cracks on seal faces. -Worn or damaged O-rings / gaskets.
								●				O-ring/gasket missing. Damaged, and/or incorrectly seated	Remove gland and properly install O-ring or gasket. Replace if damaged. Check chemical and temperature limits of the material.
								●				Gland studs incorrectly tightened, or gland not properly seated	Check studs for damage and tighten to proper torque value.
											●	Restriction in balancing line	Remove restriction.

8 PARTS LIST AND DRAWINGS

8.1 Sectional drawing



9 CERTIFICATION

Certificates, determined from the contract requirements will be provided with the quality dossier.

10 OTHER RELEVANT DOCUMENTATION AND MANUALS

10.1 Supplementary User Instruction manuals

Supplementary instruction determined from the contract requirements for inclusion into User Instructions such as for a driver, instrumentation, controller, sub-driver, seals, sealant system, mounting component, etc. are included under this section. If further copies of these are required they should be obtained from the purchaser for retention with these User Instructions.

10.2 Change notes

If any changes, agreed with Flowserve Pump Division, are made to the product after its supply, a record of the details should be maintained with these User Instructions.

10.3 Additional sources of information

Reference 1:
NPSH for Rotordynamic Pumps: a reference guide, Europump Guide No. 1, Europump & World Pumps, Elsevier Science, United Kingdom, 1999.

Reference 2:
Pumping Manual, 9th edition, T.C. Dickenson, Elsevier Advanced Technology, United Kingdom, 1995.

Reference 3:
Pump Handbook, 2nd edition, Igor J. Karassik et al, McGraw-Hill Inc., New York, 1993.

Reference 4:
ANSI/HI 1.1-1.5
Centrifugal Pumps - Nomenclature, Definitions, Application and Operation.

Reference 5:
ANSI B31.3 - Process Piping.

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To find your local Flowserve representative, please use the Sales Support Locator System found at www.flowserve.com

FLOWSERVE®

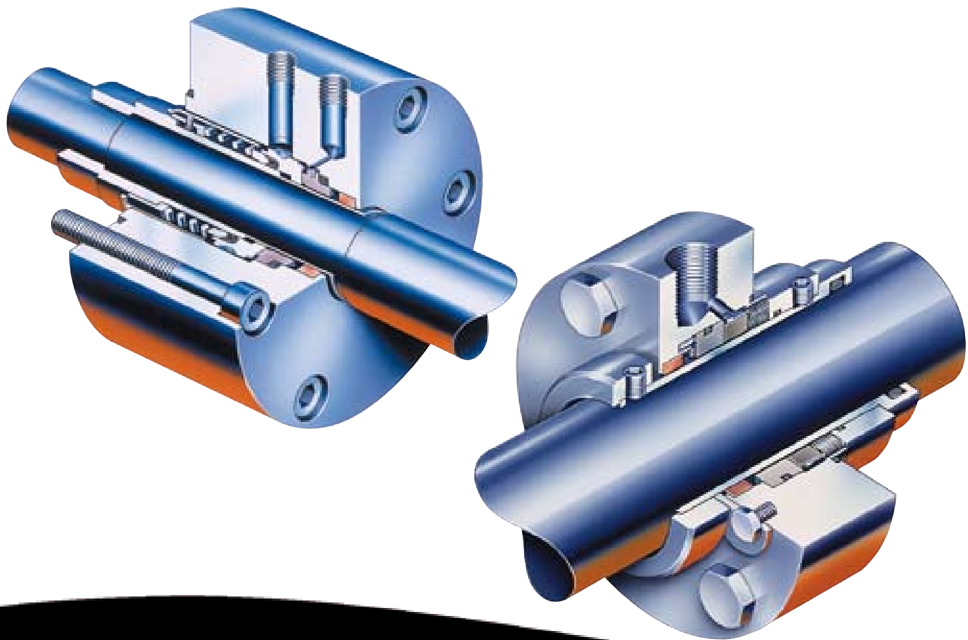
USER INSTRUCTIONS
-Original Instruction-

General Installation and Maintenance Instructions for Machinery Components

These installation instructions can be used for the following seal types:

Pusher seals: Allpac 4 series, Allpac N series, Centipac 1 series, CRO, D series, DHT series, Europac 306, Europac 6 series, FRO, GSD, GSL, HD series, HSC, HSH, LD, P series, Q series, RO, Simpac 3 series, SRO, U series, UHT series.

Bellows seals: BRC series, BX series, BXH series, BXLS series, BXRH, CBR series, CBS, GSDH, PBR, PBS, X series.



Experience In Motion

1. Drawing, Brief Description, Explosion Protection, Functional Requirements

! This mechanical seal is designed to provide reliable performance under a wide range of operating conditions. The information and specifications presented in this product brochure are believed to be accurate, but are supplied for information purposes only and should not be considered certified or as a guarantee of satisfactory results by reliance thereon. Nothing contained herein is to be construed as a warranty or guarantee, express or implied, with respect to the product.
Although Flowserve Corporation can provide general application guidelines, it cannot provide specific information for all possible applications.
The purchaser/user must therefore assume the ultimate responsibility for the proper selection, installation, operation and maintenance of Flowserve products. Because Flowserve Corporation is continually improving and upgrading its product design, the specifications, dimensions and information contained herein are subject to change without notice.

1.1 Assembly Drawing

The assembly drawing is included in the shipping box with the mechanical seal.

1.2 Brief Description

A mechanical seal is a device designed to seal a rotating shaft against a stationary housing, e.g. a pump shaft against a pump casing. The stationary components will consist of a seal ring and (depending on the design) a springloaded element. The spring-loaded element can be a spring or a bellows. The seal ring is sealed against the housing with a secondary gasket, e.g. an O-ring. The rotating components will consist of a seal ring and (depending on the design) a spring-loaded element.
The spring-loaded element can be a spring or a bellows. The seal ring is sealed against the shaft with a secondary gasket, e.g. an O-ring.

A mechanical seal can be supplied as a pre-assembled cartridge or in separate components. Assembly is done in accordance with the assembly drawing. A mechanical seal will run in the pumped product or external source fluid. Liquid seals must always have a film of liquid present between the seal faces. Gas seals must always have a film of gas present between the seal faces. The sealing surfaces are separated from each other by a fluid film (liquid or gas) during shaft rotation and in principle run without contact and thus minimal wear under these conditions.

1.3 Explosion Protection

The mechanical seal is regarded as a machine element. Machine elements do not need to comply with Directive 94/9/EC (ATEX 95 product guide) as these are regarded as an integral part of a larger piece of machinery (pump, agitator). This has been confirmed by both the EC ATEX standing committee as well as the European Sealing Association (ESA). Reference is made to following web-sites:

EC ATEX standing committee: http://ec.europa.eu/enterprise/atex/rotating.htm

ESA position statement: http://www.europeansealing.com/statements.html

For applications which require information on expected surface temperatures of the mechanical seal faces, Flowserve document “ATEX 137 information declaration” is available upon request. This document allows users to determine typical surface temperatures based upon seal design, operating conditions and face materials and may be used by the users to comply with ATEX 1999/92/EC (ATEX 137).

1.4 Functional requirements

The proper functioning of a mechanical seal is only achieved once the following conditions have been met:

- The sealing surfaces are lapped within specification.
- Perpendicularity and concentricity between the shaft and the seal chamber face and bore respectively
- Freedom of movement of the spring loaded components in axial direction
- Axial and radial shaft movements within Flowserve or OEM tolerances whichever is the tightest.
- The seal is used under the conditions for which it was selected.
- The equipment in which the seal(s) is (are) installed is operated within normal parameters (no cavitation, excess vibration etc.)
- Prevention of sedimentation on shaft or sleeve surfaces caused by for instance crystallisation or polymerisation
- Permanent liquid or gas film between the sealing surfaces, depending on seal type.

Failure to meet these requirements will result in excessive leakage and / or shortened seal life and may result in high component and surface temperatures (see the directive 94/9/EC, 1999/92/EC and EN 13463-5).

2. Safety

DANGER:

This means that personal danger or major material damage can occur when no attention is paid to this.

! ATTENTION:

This means that important information is pointed out that may also be overlooked by skilled personnel. The information can be important to avoid personal injury or material damage.

Please read these instructions carefully. Installation in accordance with the following instructions will contribute to long and trouble free running of the mechanical seal. For related mechanical seal auxiliary equipment (reservoirs, coolers, etc.), separate instructions will be provided.

The ultimate user must ensure that personnel assigned to handle, install and run the mechanical seal and related equipment is well acquainted with the design and operating requirements of such equipment.

! For this personnel it may be required to wear protective clothing as per the plant's safety regulations.

Damage to any of the seal components and in particular the faces may cause (excessive) leakage in liquid or gas form. The degree of hazard depends on the sealed product and may have an effect on people and / or the environment. Components coming into contact with leakage must be corrosion resistant or suitably protected. Normal seal leakage should not result in the formation of an explosive mixture. Plant regulations concerning work safety, accident prevention and pollution must be strictly adhered to.

This mechanical seal has been designed and built to seal rotating equipment. Damages resulting from use in other applications are the responsibility of the user.

Failure, recovery or fluctuation in power supply to the machine and/or supply system may not expose persons or environment to dangerous situations or harm the functionality of the mechanical seal.

Guards that are provided by the equipment manufacturer have to be in accordance with plant regulations, but should not create additional danger. These guards have to ensure proper access to the working area required for maintenance to the mechanical seal.

The electricity supply of the equipment must be in accordance with directive 2006/95/EC. When machinery is powered by a source of energy other than electricity this may not cause dangerous situations for persons and environment.

3. General

All illustrations and details in these installation and maintenance instructions are subject to changes that are necessary to improve product performance without prior notice.

The copyright of these instructions is the property of Flowserve. These instructions are intended for Maintenance, Operating and Supervisory personnel and contain regulations and drawings of a technical character that may not, in full or in part, be copied, distributed, or used without authorisation for competitive purposes, or given to others.

! It should be understood that Flowserve does not accept any liability for instances of damage and/or malfunctioning incurred through non-adherence to these installation instructions.

4. Transport, Storage

The mechanical seal and related equipment must be transported and stored in the unopened, original shipping box. The warehouse in which the mechanical seals and related equipment are stored must be dry and free of dust.
Avoid exposing equipment to large temperature fluctuations and radiation.

Parts or complete mechanical seals that have been dropped or otherwise have been subjected to heavy impacts during transport must not be installed.
An inspection by Flowserve or its appointed representative is strongly advised.

After a storage period of 3 years the mechanical seal must be inspected for its “as new” properties. This applies in particular to the seal faces and secondary sealing elements. An inspection by Flowserve becomes necessary.

! If the equipment is to be preserved with the mechanical seal(s) installed, the preserving medium must not impair the function of the mechanical seal by e.g. fouling of the seal faces and/or attack the secondary seals.

! The mechanical seal can in principle be transported with suitable means like lifting accessories.

5. Equipment Check

! 5.1 Follow plant safety regulations prior to equipment disassembly:

- 5.1.1 Wear designated personal safety equipment
- 5.1.2 Isolate equipment and relieve any pressure in the system
- 5.1.3 Lock out equipment driver and valves
- 5.1.4 Consult plant Material Safety Data Sheet (MSDS) files for hazardous material regulations

5.2 Disassemble equipment in accordance with the equipment manufacturer’s instructions to allow access to seal installation area.

5.3 Remove existing sealing arrangement (mechanical seal or otherwise).
Clean seal chamber and shaft thoroughly.

! 5.4 Verify the shaft dimensions as shown on the seal assembly drawing. Inspect surfaces under gaskets to ensure they are free from pits or scratches. Break all sharp corners on shaft steps, threads, reliefs, shoulders, key ways, etc. over which gasket(s) must pass and/or seal against.

! 5.5 Verify the seal chamber bore or OD pilot fit as shown on the seal assembly drawing.

! 5.6 Check seal assembly drawings for any modifications (reworks) to be made to the equipment for mechanical seal installation and act accordingly.

! 5.7 The equipment must be earthed to prevent sparks due to static electricity discharge.

! <u>Shaft runout</u> should not exceed 0,05 mm (.002”) TIR (Total Indicator Reading) at any point along the shaft for ball or roller type bearings. For sleeve type bearings, refer to manufacturer instructions. If the equipment is not completely dismantled, verify runout near seal location.

The above values apply to shaft speeds in the range from 1000 to 3600 RPM. For values above and below, consult your Flowserve representative.

See figure 1.

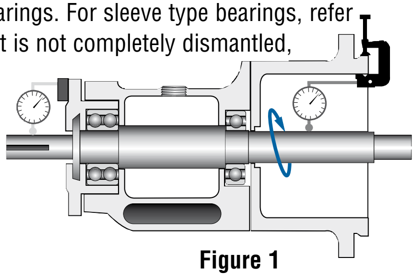


Figure 1

! <u>Shaft endplay</u> should not exceed 0,25 mm (.010”) TIR, regardless of thrust bearing type.

See figure 2.

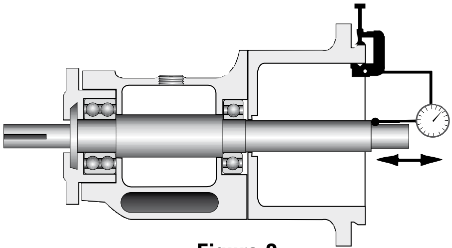


Figure 2

! <u>Radial shaft movement</u> should be checked against the equipment manufacturer's specifications. Generally 0,05 - 0,10 mm (.002” -.004”) will be applicable for ball or roller type bearings. For sleeve or journal type bearings, values will generally be in the order of 0,10 - 0,15 mm (.004” - .006”).

See figure 3.

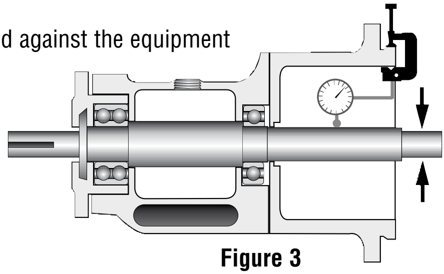


Figure 3

! <u>Seal chamber squareness</u> to the shaft centreline should be within 0,015 mm per 25 mm seal chamber bore (.0005" per 1" seal chamber bore).
Note: make sure that shaft endplay does not affect the reading.
Verify the smoothness of the seal chamber face for a good gasket joint.

See figure 4.

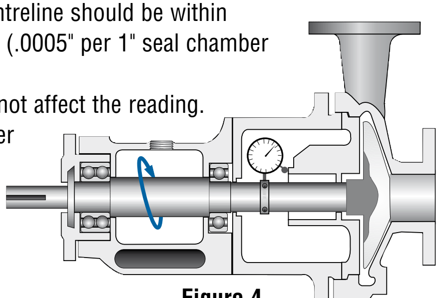


Figure 4

! Concentricity of the shaft to the seal chamber bore should be within 0,025 mm per 25 mm shaft diameter (.001" per 1" shaft diameter) to a maximum of 0,125 mm (.005") TIR.

See figure 5.

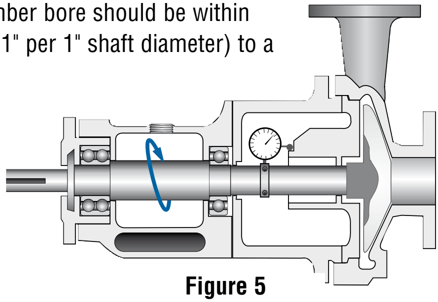


Figure 5

6. Mechanical Seal Installation

Verify that the mechanical seal is in accordance with the order documents, to ensure that the correct seal is being installed.

Take care that seal cartridge or components of the seal are handled and carried safely during installation of mechanical seal and that the ergonomic principles are followed. In order to prevent personal injuries the operator should also wear protective clothing as per the plant's safety regulations.

Correct seal setting is important for running a mechanical seal successfully.

! Incorrect seal setting can lead to malfunction of the mechanical seal and consequent leakage of sealed product into the environment.

Cartridge seals unitize the complete seal assembly on a sleeve such that the entire seal is installed simultaneously. Component seals are assembled sequentially on the equipment and require careful measurements to properly locate and lock the rotating components relative to the stationary components. When measuring the setting or securing cartridge seals, always make sure the shaft is in the same position as when the equipment is operating (e.g. including the effects of thermal growth or contraction of the shaft relative to the casing).

To ease installation, gaskets may be lightly lubricated. Lubricant must be compatible with both handled product and gasket material. Generally, silicon grease is suitable but this should be verified before applying.

! Caution: avoid over compressing a bellows. This could result in reduced spring force and length.

Some mechanical seals are sensitive to direction of rotation. Verify that the direction of rotation of the shaft corresponds to that of the mechanical seal before installation.

Precautions must be taken for parts of the mechanical seal that will be used as support to step on during assembly operations. These parts must be protected against slipping, stumbling or falling (for example by using a strut).

6.1 Installation of Cartridge Type Seal with Setting Plates

See figure 6.

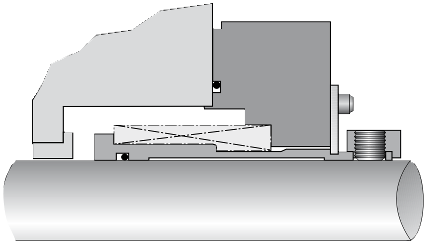


Figure 6

6.1.1 Check assembly drawing, bill of material and seal assembly prior to installation.

6.1.2 Install the seal onto the shaft and locate the gland against the face of the seal chamber.

6.1.3 Orient the ports on the seal gland(s) as indicated by the seal assembly drawing and connecting piping.

6.1.4 Evenly torque gland bolts/nuts to prevent cocking of the gland or uneven gland pressure against the seal chamber.

Do not tighten drive arrangement screws.

6.1.5 Complete the remaining equipment assembly including thrust bearings, if applicable.

6.1.6 Ensure the setting plates are correctly located and engaged.

! Incorrect position of the setting plates can lead to malfunction of the mechanical seal and consequent leakage of sealed product into the environment.

6.1.7 Tighten drive arrangement screws to the torque values shown on the seal assembly drawing.

Inaccurate tightening of these screws can lead to unsafe situation as mechanical seal may move out of the seal chamber when pressure is applied.

6.1.8 Assemble interconnecting piping as per API-plan and piping instructions as given in paragraph 7. See also (if applicable) auxiliary system installation and maintenance manual.

6.1.9 Disengage setting plates from the sleeve and secure tightly in disengaged position.

! Ensure that plates cannot fall back onto the sleeve as to prevent risk of contact between rotating and static parts.

6.1.10 Inspect equipment and driver alignment in accordance with coupling and / or equipment manufacturer's instructions.

6.1.11 After bringing the unit up to operating conditions (pressure and temperature), recheck pump to driver alignment. Make adjustments as necessary.

6.2 Installation of a Cartridge Type Seal with Centring Tabs.

See figure 7

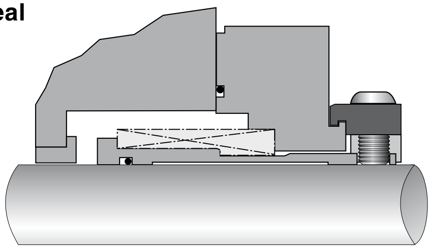


Figure 7

6.2.1 Check assembly drawing, bill of material and seal assembly prior to installation.

6.2.2 Install the seal onto the shaft and locate the gland against the face of the seal chamber.

6.2.3 Orient the connections on the seal gland(s) as indicated by the seal assembly drawing and connecting piping.

6.2.4 Install gland bolts/nuts, but do not tighten. The gland must be free to move radially.

6.2.5 Complete the remaining equipment assembly including thrust bearings, if applicable.

6.2.6 Ensure the centring tabs are correctly located and engaged.

! Incorrect position of the setting plates can lead to malfunction of the mechanical seal and consequent leakage of sealed product into the environment.

6.2.7 Evenly torque gland bolts/nuts to prevent cocking of the gland or uneven gland pressure against the seal chamber.

6.2.8 Tighten drive arrangement screws to the torque values shown on the seal assembly drawing.

Inaccurate tightening of these screws can lead to unsafe situation as mechanical seal may move out of the seal chamber when pressure is applied.

6.2.9 Assemble interconnecting piping as per API-plan and piping instructions as given in paragraph 7. See also (if applicable) auxiliary system installation and maintenance manual.

6.2.10 Remove centring tabs and store them in a known place.

6.2.11 Inspect equipment and driver alignment in accordance with coupling and / or equipment manufacturer's instructions.

6.2.12 After bringing the unit up to operating conditions (pressure and temperature), recheck pump to driver alignment. Make adjustments as necessary.

6.3 Installation of a Component Type Seal

See figure 8.

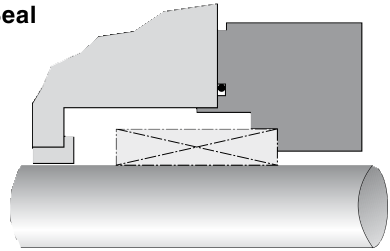


Figure 8

6.3.1 Check assembly drawing, bill of material and seal components prior to installation. Ensure seal faces and joints are free of scratches, contamination and other damage. Prior to installation, wipe lapped surfaces clean with a lint free cloth and quick drying solvent. Lubrication of seal faces is not recommended unless specified on the seal assembly drawing.

6.3.2 Assemble seal chamber and shaft (including thrust bearings, if applicable) and verify/ scribe the seal setting distance as shown on the assembly drawing. Other setting aids such as spacer rings may be indicated on the assembly drawing.

! Please note that incorrect seal setting can lead to malfunction of the mechanical seal and consequent leakage of sealed product into the environment.

6.3.3 When applicable, pre-assemble the rotating and stationary components or sub-components of the seal in accordance with the assembly drawing.

6.3.4 Assemble the seal components sequentially onto the equipment, fastening the rotating components. Locate the gland(s) against the face of the seal chamber.

6.3.5 Orient the connections on the seal gland(s) as indicated by the seal assembly drawing.

6.3.6 Evenly torque gland bolts/nuts to prevent cocking of the gland or uneven gland pressure against the seal chamber.

6.3.7 Complete the remaining equipment assembly including thrust bearings, if applicable.

6.3.8 Assemble interconnecting piping as per API-plan and piping instructions as given in paragraph 7. See also (if applicable) auxiliary system installation and maintenance manual.

6.3.9 Inspect equipment and driver alignment in accordance with coupling and / or equipment manufacturer's instructions.

6.3.10 After bringing the unit up to operating conditions (pressure and temperature), recheck pump to driver alignment. Make adjustments as necessary.

6.4 Installation of Seals with Hooked Sleeves (overhung pumps)

See figure 9.

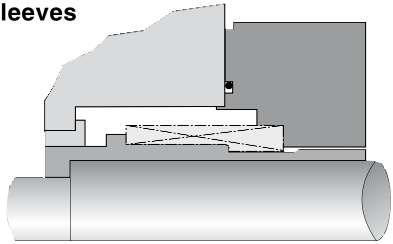


Figure 9

6.4.1 Check assembly drawing, bill of material and seal components prior to installation. Ensure seal faces and joints are free of scratches, contamination and other damage.

Prior to installation, wipe lapped surfaces clean with a lint free cloth and quick drying solvent. Lubrication of seal faces is not recommended unless specified on the seal assembly drawing.

6.4.2 Assemble seal chamber and shaft (including thrust bearings, if applicable) and verify the distance from the seal chamber face to the end of the shaft as shown on the assembly drawing.

! If this distance is not in accordance with dimension on assembly drawing the setting of the mechanical seal will be incorrect and this can lead to malfunction of the mechanical seal and consequent leakage of sealed product into the environment.

6.4.3 When applicable, pre-assemble the rotating and stationary components or sub-components of the seal in accordance with the assembly drawing.

6.4.4 Assemble the seal components sequentially onto the equipment. Locate the gland(s) against the face of the seal chamber. If applicable, install drive keys as indicated on the seal and/or pump assembly drawing.

6.4.5 Orient the connections on the seal gland(s) as indicated by the seal assembly drawing and connecting piping.

6.4.6 Evenly torque gland bolts/nuts to prevent cocking of the gland or uneven gland pressure against the seal chamber.

6.4.7 After the impeller nut is properly torqued, check that the sleeve is completely seated

6.4.8 Complete the remaining equipment assembly including thrust bearings, if applicable.

6.4.9 Assemble interconnecting piping as per API-plan and piping instructions as given in paragraph 7. See also (if applicable) auxiliary system installation and maintenance manual.

6.4.10 Inspect equipment and driver alignment in accordance with coupling and / or equipment manufacturer's instructions.

6.4.11 After bringing the unit up to operating conditions (pressure and temperature), recheck pump to driver alignment. Make adjustments as necessary.

Parts of the mechanical seal that are moving during operation of the machine (for example drive collar) have to be protected against contact with guards that are in accordance with specifications of manufacturer from the machine.

7. Piping Instructions

Piping instructions are detailed on the mechanical seal assembly drawing.

These instructions must be followed precisely to ensure correct seal operation. Ensure that piping is connected to the correct pipe ports to prevent unsafe situations.
For auxiliary systems: carefully read the maintenance instructions provided with the system.

The connections on the mechanical seal are properly marked.

Minimize restrictions, especially in closed loop piping arrangements.
Unless otherwise specified, the minimum internal diameter for pipe, tubing and connecting hardware should be 12,7 mm (.500”).

Total pipe length and number of bends should be kept to a minimum.
Use smooth, large radius bends; do not use elbows, tees, etc. Orifices should be installed as far away from the seal gland as possible. An exception to this rule should be made for orifices fitted to drain piping. To avoid clogging of the orifice it is advisable to install it in the seal gland so that the generated heat will serve to keep the leaked product fluid.

For “loop type” systems (API-plan 23, 52 and 53 A, B, C)

Pipe runs should be sloped continuously up or down to allow adequate circulation, proper venting and draining. Make sure that the loop, including seal gland, does not include vapor traps. Unless otherwise specified, reservoirs and coolers must be mounted 40 to 60 cm (15” to 24”) above the seal inlet or outlet connection, whichever is the highest, to promote thermosyphoning in standby condition.

Seals equipped with excess leakage detection

Excess leakage detection, often used with single or non-pressurized dual seals, is commonly achieved by monitoring liquid level or pressure increases. With such an arrangement, the drain line for normal leakage must slope downward continuously to the point of exit (e.g. sump).
Refer to the seal assembly drawing for additional piping requirements including the proper location of the restriction orifice and instrumentation.

8. Performance Testing of Pumps

Pump manufacturers will often perform pump performance tests on water with the mechanical seal installed. If the pump product used during field operation is not equal to water, seal designs and face materials require special precautions to prevent damage to the seals during these tests. For example, on seals with two hard faces, the seals may be provided with faces in alternate materials more suitable for the pump test medium. These faces are to be replaced with faces in the selected materials at the conclusion of the testing. A mechanical seal equipped with a hard face comination can be safely operated on water provided the pressure does not exceed 5 bar and the speed does not exceed 10 m/s.

When high temperature seals with graphoil gaskets are tested on water during a pump performance test, the seals must be carefully dried after the test to prevent vaporization of water absorbed by the gaskets when the pump is brought to its (high) operating temperature.

Contact your Flowserve representative for additional information.

9. Functional Recommendations

! 9.1 The pressure and temperature in the seal chamber or of the barrier fluid must not exceed the recommended maximum seal limits. The shaft speed must also not exceed the seal’s limits.

! 9.2 For seals using external cooling and/or an external flush, apply cooling and / or flush prior to seal start-up. Avoid inadvertent operation of valves located in the cooling system that might result in shutting off the cooling flow.

9.3 Single and dual non-pressurized (tandem) seals require adequate vapor pressure margin in the seal chamber to prevent flashing of the product at the seal faces.

9.4 Dual non-pressurized (tandem) seals require the buffer fluid pressure to be maintained at a value lower than the seal chamber pressure. Buffer fluid pressure is usually equal to atmospheric or vapor recovery system pressure, unless otherwise specified.

9.5 Dual pressurized (double) seals require the barrier fluid pressure to be maintained at least 2 bar (30 psi) above the seal chamber pressure, unless otherwise specified. It is imperative to pressurize the barrier prior to pressurizing the equipment. Likewise, do not de-pressurize the barrier system until the equipment has been fully isolated, depressurized and vented.

9.6 Flowserve can supply information on barrier fluid temperature and flow requirements based on product type, seal size, product temperature, barrier fluid characteristics and shaft speed. The buffer/barrier fluid must contain little or no additives for anti-wear/oxidation. Automotive antifreeze should never be used. Ensure that the barrier fluid is clean and compatible with the product.

9.7 This seal is designed to resist corrosion by the product(s) listed on the assembly drawing. Do not expose the seal materials to products other than those shown on the assembly drawing. The seal assembly drawing lists the materials of construction. Consult your Flowserve representative when in doubt or when using the seal for another application than for which it was selected.

9.8 Liquid seal requirements: Do not start the equipment dry. Open valves to flood equipment with product. Vent all air and/or product vapor from the equipment casing and the seal chamber before start up. Vent casing and tubing of heat exchange (if applicable). Process fluid must flood and pressurize the seal chamber at all times for single seal and non-pressurized dual seals. Barrier fluid must flood dual seals at all times during equipment operation.
Gas seal requirements: Do not apply liquids to gas seal designs. Non-pressurized dual seals with the outboard seal designed to work in gas must be connected only to a gas purge, if applicable.

9.9 When required, dry steam should be applied to the quench connection.
Use a needle valve (or other flow restriction) to provide 0.1 bar (1 to 1.5 psi) steam to the quench connection on the seal gland.

⚠ Take care to apply steam pressure gradually to prevent an unsafe situation due to an excessive flow of hot steam being blown into the operator's working area.

This should result in wisps of steam exiting the seal gland area. Ensure that all condensate is drained from the supply line and open the steam quench slowly before the pump is preheated to prevent thermal shock.

9.10 Start up equipment in accordance with normal maintenance procedures unless specifically requested otherwise by Flowserve.
If the equipment is not operating properly (e.g. seals and / or bearings running hot, cavitation, heavy vibration, etc.), shut down the equipment, investigate and remove the cause.

⚠ The temperature of the external of the mechanical seal depends from the operating temperature of the product and/or barrier fluid.
Proper precautions need to be taken to prevent contact with hot parts

⚠ Points 9.1 to 9.10 must be taken into account during the first start up as well as during restarts after machine was stopped.

10. Shut Down, Disassembly

The equipment can be shut down at any time. Before the mechanical seal can be removed the equipment must be de-pressurized and drained.

! Operator must persuade himself before starting disassembling of mechanical seal that the external of the equipment is cool enough to be handled without risk.

Barrier pressure (if applicable) must be relieved after the equipment has been de-pressurized.

⚠ Dismantling of the mechanical seal is only allowed after machine has been stopped.

Product may be released during removal of the mechanical seal. Safety measures and protective clothing may be required as per the plant's safety regulations.

Further disassembly of the mechanical seal must be done according to the supplier's specifications.

11. System Check

Checking of the system, limits itself to monitoring pressure, temperature, leakage and consumption of barrier (buffer) fluid, when applicable.

Maintenance to the mechanical seal is only allowed after machine has been stopped.

The required area for operating the machine or doing maintenance to the mechanical seal must be easy accessible.

12. Spare Parts, Repairs

Repairs will be necessary when the seal reaches the end of its normal life expectancy or when it has been running outside of its design capabilities.

This product is a precision sealing device. The design and dimensional tolerances are critical to seal performance. Only parts supplied by Flowserve should be used to repair this seal. These are available from the numerous Flowserve stocking locations.

To order replacement parts, refer to the part code, order number or B / M number, which can be found on the assembly drawing. It is recommended to keep a spare seal on stock to reduce equipment downtime.

All liabilities and warranties to Flowserve for damage incurred through the use of non-original replacement parts and accessories will be rendered null and void.

Please note that special manufacturing and delivery specifications exist for all parts of our products manufactured or produced by ourselves and the replacement parts are always offered in accordance with the latest technology and with the most current regulations and laws.

Flowserve seals can normally be reconditioned. When repair is necessary, the seal should be carefully removed from the equipment (reinstall the centring tabs or setting plates if applicable).

! Decontaminate the seal assembly and return it to a Flowserve authorized repair facility with an order marked "Repair or Replace". A signed certificate of decontamination must be attached.

A Material Safety Data Sheet (MSDS) must be enclosed for any product that came in contact with the seal. The seal assembly will be inspected and, if repairable, a quotation will be made for restoring it to its original condition. Upon acceptance of the quotation, the parts will be rebuilt, tested, and returned to sender.

TO REORDER REFER TO
B/M # ________________
Order #__________________

FIS144eng REV 12/2009 Printed in Europe

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and find more about Flowserve Corporation,
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Building a better future
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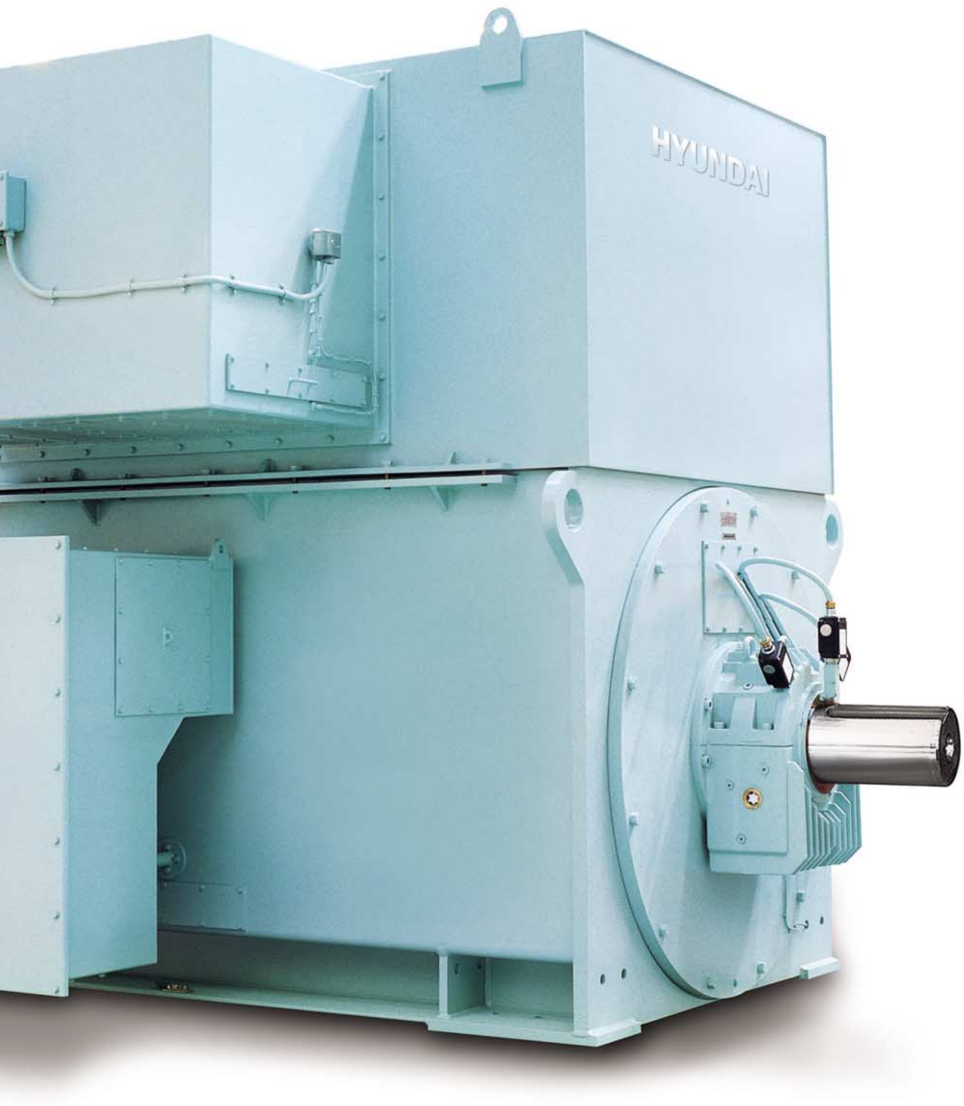
Instructions for

Three-phase Induction Motor

Common Items | Instruction Manual



Notice

- The information contained in this book is intended to assist operating personnel by providing information on the general characteristics of the purchased equipment.
- It does not relieve the user of the responsibility of using accepted engineering practices in the installation, operation and maintenance of this equipment.

HYUNDAI
HEAVY INDUSTRIES CO.,LTD.

Safety Procedures

This equipment contains hazardous voltages. Death, serious personal injury or property damage can result if safety instructions are not followed.

The successful and safe operation of motors is dependent upon proper handling, installation, operation and maintenance, as well as upon proper design and manufacture. Failure to follow certain fundamental installation and maintenance requirements may lead to personal injury and the failure or loss of the motor as well as damage to other property.

Only qualified personnel should work on or around this equipment after becoming thoroughly familiar with all warnings, safety notices and maintenance procedures contained herein. Only qualified personnel should be involved in inspection, maintenance and repair procedures and all plant safety procedures must be observed.

Qualified Person: For the purpose of this manual and product labels, a Qualified Person is one who is familiar with the installation, construction and operation of the equipment, and the hazards involved. In addition, he or she:

a. is trained and authorized to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety procedures.
b. is trained in the proper care and use of protective equipment, such as rubber gloves, hard hat, safety glasses, face shields, flash clothing, etc., in accordance with established safety procedures.
c. is trained in rendering first aid.

⚠ DANGER	For the purpose of this manual and product labels, Danger indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING	For the purpose of this manual and product label, Warning indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION	For the purpose of this manual and product label, Caution indicates a potentially hazardous situation which, if not avoided, may result in property damage or minor or moderate injury. It is also used to alert against unsafe practices.

Motors should be installed and grounded per local and national codes.
Do not operate this equipment in excess of the values given on the nameplate or contrary to the instructions contained in this manual. The equipment (or a prototype) has been factory tested and found satisfactory for the conditions on which it was sold. Operation in excess of these conditions can cause stresses and strains beyond design limitations. **Failure to heed this warning may result in equipment damage and possible personal injury.**

⚠ DANGER 	**Hazardous Voltage.** Will cause death, serious injury, electrocution or property damage. Disconnect all power before working on this equipment.

NOTE: Many squirrel cage induction machines are driven by various types of prime movers as induction generators. This instruction manual applies to both motors and induction generators. However, for reasons of clarification, the machine will be referred to as a "motor."

Contents

01 Foreword

This instruction manual describes and provides instructions for installation, operation and maintenance of induction motors.

These instructions do not support to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently, the matter should be referred to the nearest HYUNDAI HEAVY INDUSTRIES business office.

NOTE

For service shop requirements, refer to

ROTATING MACHINERY MANUFACTURE DEPT.
ELECTRO & ELECTRIC SYSTEMS DIVISION
HYUNDAI HEAVY INDUSTRIES CO., LTD.

Address:	1000, Bangeojinsunhwan-doro Dong-gu, Ulsan, Korea
Telephone:	82-52-202-6671, 6672
Fax:	82-52-202-6996

02 Receiving, Handling and Storage

2.1 Receiving

Each shipment should be carefully examined upon arrival. If the packing is damaged, unpacking should be made immediately to check whether or not the motor and its fitting are in good condition, and any damage to contents should be photographed and reported to the carrier and to the nearest HYUNDAI HEAVY INDUSTRIES business office.

All large motors are equipped with a locking device, which protects the bearing from damage due to the movement of the rotor in transit. Do not remove this device until transport is complete and coupling is ready to be fitted.

WARNING

Heavy Equipment
Improper lifting can cause death, severe injury, or damage. Check eyebolts, lifting lug and eyenuts before lifting. Use proper slings and spreaders.

2.2 Handling

To ensure proper handling after unpacking, the motors require the chain hoist, wire ropes and other handling equipment. When hoisting the motor, wire ropes should be attached to the lifting holes on the side of the motor frame, and should be put in hard rubber, thick cloth, etc. between the external covers for protective purposes. Then the motor is slowly and carefully raised and moved to the intended position.

CAUTION

When unpacking and handling the motor, attention should be given to the following points:
- Anticorrosive agent which is applied to the coupling shaft ends should be removed right before starting the motor. The coupling or shaft ends should be checked to ascertain whether or not they are in abnormal condition.

2.3 Storage

If the motors are not put into service at the time of delivery, they should be stored according to the following conditions.

⚠ WARNING	**Top Heavy.** Can cause severe injury or property damage. When lifting motor, 1. Lift only at designated locations. 2. Use spreader for lifting. 3. Apply tension gradually to cables. 4. Do not jerk or attempt to move unit suddenly. 5. Do not use cover lugs when lifting.

Outdoor Storage is Not Recommended.

Variations in temperature and humidity can cause condensation, resulting in corrosion of metal parts and possibly in insulation failure. Therefore, the following cover the minimum acceptable storage arrangements in an unheated but protected environment:
It is preferable to use a heated facility, which would simplify meeting these conditions.
When outdoor storage cannot be avoided, contact HYUNDAI HEAVY INDUSTRIES for specific instructions on minimizing damage, giving full particulars of the circumstance.

Storage Facility Requirements

⚠ CAUTION	**Damp Location.** Can cause property damage if equipment is operated intermittently. Use space heaters to prevent dampness. Grease machine fits when unit is reassembled to prevent corrosion.

The storage facility must provide protection from contact with rain, hail, snow, blowing sand or dirt, accumulations of groundwater, corrosive fumes and infestation by vermin or insects.
There should be no continuous or severe intermittent floor vibration. Power for the space heaters and illumination should be available. There should be fire detection and a fire-fighting plan. The motors must not be stored where it is liable to be accidentally damaged or exposed to weld spatter, exhaust fumes or dirt and stones kicked up by passing vehicles.

If necessary, use guards or separating walls to provide adequate protection. Avoid storage in an atmosphere containing corrosive gases, particularly chlorine, sulfur dioxide and nitrous oxides.

Protecting the Cooling-water System

When the motors are delivered, the cooling water system is not filled with cooling water.

- When you place the motor in storage after use, drain the cooling water systems and purge them with air so that they are completely empty.
- The detail instructions are as follows and the caution name plates are installed on the motor

1) Air-to-Water Coolers

While a motor is not in its operation, and if the ambient temperature goes below the water freezing point, please drain the cooling water completely to prevent cooler pipe damage from water freezing.
The temperature of the cooling water must be over 5°C (41°F).

2) Water Cooled Type Ball or Roller Bearings

While a motor is not in its operation, and if the ambient temperature goes below the water freezing point, please drain the cooling water completely to prevent cooler pipe damage from water freezing.
The temperature of the cooling water must be over 5°C (41°F)

3) Water Cooled Type Thrust and Guide Pad Bearings

While a motor is not in its operation, and if the ambient temperature goes below the water freezing point, please make the cooling water flow continuously to prevent cooler pipe damage from water freezing.
The temperature of the cooling water must be over 5°C (41°F)

⚠ CAUTION	**Frost Damage to the Cooling Circuit.** The cooling circuit can be damaged if the cooling water freezes. If the ambient temperature falls below 0°C during operation, add anti-freeze to the cooling water.

Temperature Control.

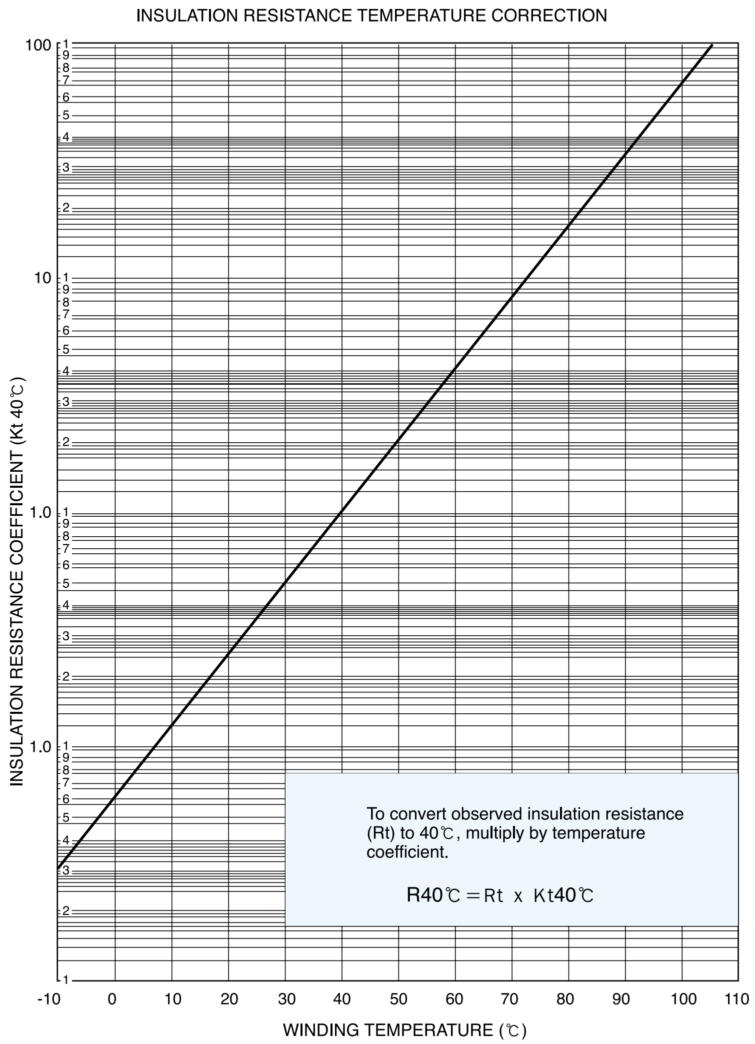
Hazardous Voltage.
Will cause death, serious injury, electrocution or property damage.
Disconnect all power before working on this equipment.

Whenever the motor temperature is equal to and below ambient temperature, water vapor can condense on and within it, promoting rapid deterioration.
Prevent this by energizing the space heaters to keep the motor temperature above ambient temperature by at least 3°C However, during periods of extreme cold or rapid temperature drops, the space heaters may not be adequate to maintain this differential and supplementary heating may be required.

CAUTION

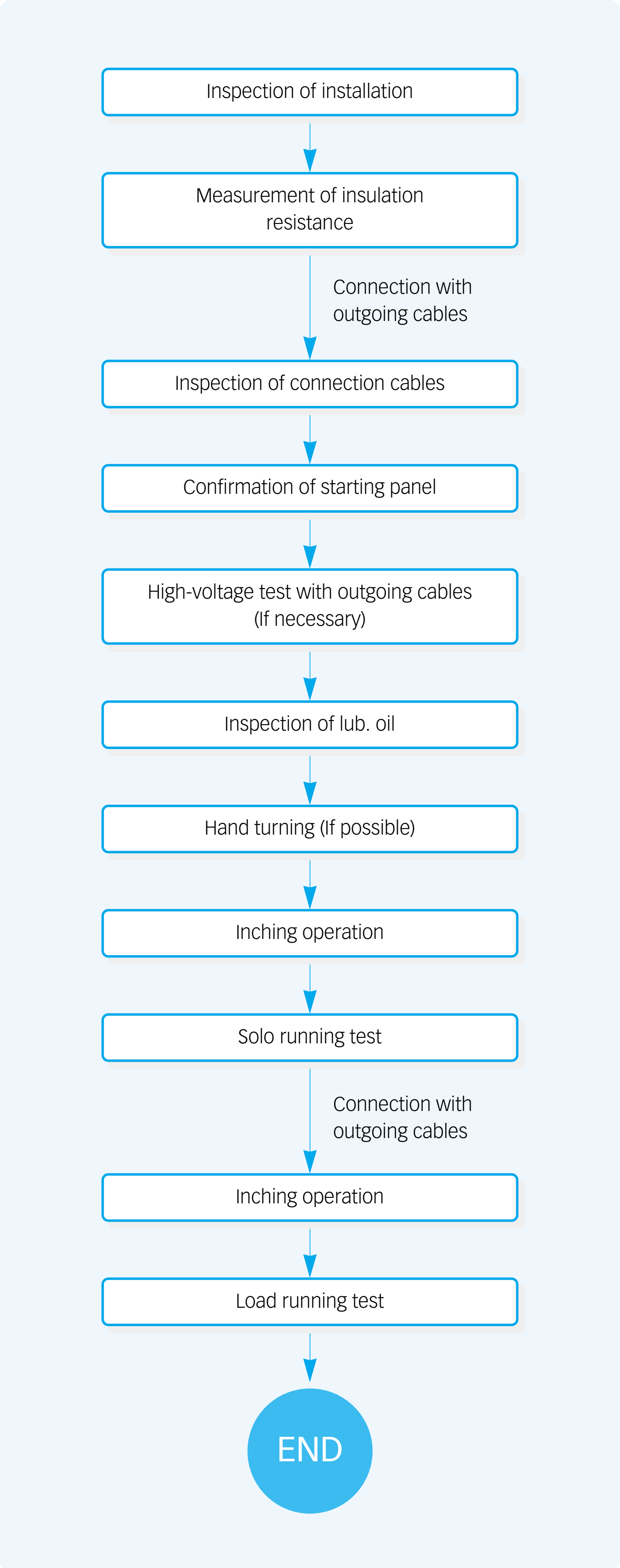
If the motor is boxed or covered in any way when the space heaters are energized, there should be thermostatic control and sufficient surveillance to detect an over-temperature condition quickly. Ensure that temporary packaging does not contact the space heaters.
When windings of motor are uninjured and their insulation resistance to ground is well above the minimum of rated voltage (kV) plus 1 megohm when corrected to 40°C according to IEEE 43 or as below in Fig. 1, low temperature is not a problem.
However, if the resistance drops, the windings can be permanently damaged by freezing. Therefore, the motor temperature should be kept above freezing point.

➡ Fig. 1 Insulation Resistance Temperature Correction



03 Inspection and Test for Initial Start-up on Site

Generally, inspection and text of motors are performed as in the following chart for initial start-up on site.



3.1 Installation

General

Ensure that the motor enclosure is suitable for its environment, that the ambient temperature is less than specifications for operating the motor at all times and that all bearings are lubricated before operating the motor.

Foundation

Motors should be mounted on solid and rigid foundations to ensure proper vibration and free operation. The desirable foundation and anchor bolt design will

– accommodate at least the maximum static and dynamic foundation loads indicated on the motor outline dimension drawings.
– have sufficient rigidity to maintain acceptable alignment after the application of load.
– be free of natural frequencies, which are likely to be excited during normal operation (this could result in vibration problems on the motor).

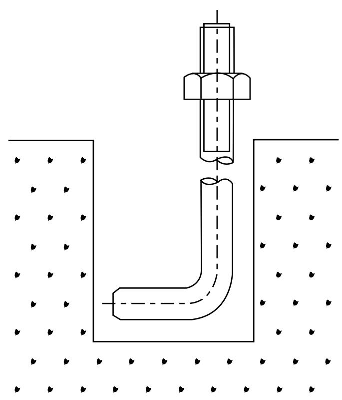
In some cases where precision is required, a study of these factors should be conducted to determine the natural frequencies of the motor support.

NOTE: If normal vibration or noise will be objectionable (as in office buildings), it may be advisable to use vibration dampeners between the machine or driven/drive unit and the foundation.

Foundation Bolt

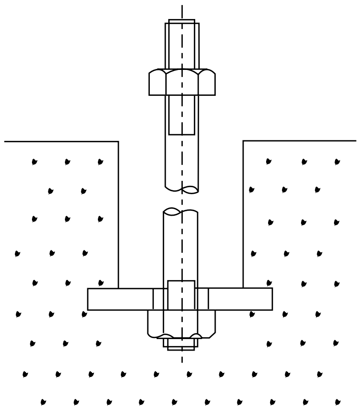
There are some different methods of installing the foundation bolt as shown in Fig. 2. The methods depend on the capacity and construction of the motor.

Fig. 2 Type of Foundation Bolt



< J-Type >

Fig. 2 Type of Foundation Bolt



< Plate-Type >

Mounting

After removing the package from the skid of the motor, remove the polyethylene shroud. Remove the motor from the skidding. The motors should be mounted on a flat surface and packed about with shims (shim allowance is generally 2-3 mm thick).
The shims should support the maximum length of each motor foot. It is preferable to use corrosion-resistant shims such as brass or stainless steel; otherwise “shim swell” due to corrosion resistance may be detrimental to good alignment. Care should be taken not to distort the frame during “bolting down”.

CAUTION A basic rule is to not have more than 5 shims in a shim pack under any one machine foot. Thick shim packs consisting of many thin shims will cause a soft foot and cause vibration or twisted frame (machine foot out of plane).

NOTE: Experience has shown that any base-mounted assemblies of motor and driven units temporarily aligned at the factory, no matter how rugged or deep, may twist during shipment. Therefore, alignment must be checked after mounting.

Remove the Locking Device of Large Motors

All large motors are equipped with a device for preventing the shaft from movement in order to protect the rolling face of bearing from damages due to vibration in transit.

This locking device is fitted on the drive side or on the non-drive side. Before connecting a motor to a machine, the fitting bolts should be loosened, and the fitting device should be taken off.

CAUTION The rotor is locked by a rotor locking device for the purpose of protection during transportation. These are normally locked on the drive end shaft, but sometimes locked on the non-drive end shaft. The locking device shall be taken off by simply loosening the screw bolt. As the locking device is generally painted in yellow-brown, it can be easily visible.

Bolt Tightening Torque

The following table provides the general guidance of Max. bolt tightening torque, especially mounting bolt tightening situation. The values are maximum for each case, thus care should be taken not to exceed the values.

Material / Thread Size	Tightening Torque(kgf • m)	
	SS400 (For anchor bolt)	S45C (Strength grade: 8.8)
M6 X 1	0.4	1.1
M8 X 1.25	0.8	2.1
M10 X 1.5	1.6	4.3
M12 X 1.75	2.8	7.5
M14 X 2	4.6	12.1
M16 X 2	6.7	18
M20 X 2.5	13.3	35
M22 X 2.5	18.3	49
M24 X 3	22.4	60
M30 X 3.5	46.9	124
M36 X 4	80.5	215
M42 X 4.5	128	343
M48 X 5	194	518
M56 X 5.5	310	822
M64 X 6	463	1233
M72 X 6	667	1776
M80 X 6	922	2454
M90 X 6	1325	3540
M100 X 6	1855	4929

CAUTION For the maximum tightening torque for main power cable connection bolt, please refer to ‘7.4 Operation, 3) Tightening Torque’, page 24.

3.2 Inspection of Installation

After installation, check for looseness of bolts and nuts on the terminal boxes, cooler boxes and so on. Then, the foundation and centering of the motors should be checked. These items are normally checked and reviewed on the erection records.

Checklist for inspection of installation

1. Outside view of machine
   - No rusted portions.
   - No damaged portions/parts.
   - Confirmation of caution, nameplate.

↓

2. Removal of rotor locking device
   (If necessary)

↓

3. Check for no looseness
   - End covers.
   - Terminal boxes.
   - Cooler boxes.

↓

4. Check around foundation
   - Motor levelling.
   - Tightness of foundation bolts.

↓

5. Inspection of accessories
   - Thermometers
     (indication checks at amb. temp.).
   - Temperature detectors
     (indication checks at amb. temp.).

↓

6. Confirmation of centering

3.3 Measurement of Insulation Resistance and Polarization Index

Hazardous Voltage.
Will cause death, serious injury, electrocution or property damage. Disconnect all power before working on this equipment.

The insulation resistance of stator, rotor and auxiliaries shall be measured before the initial start-up of the machine or after a long period of standstill. The insulation resistance testing is available method for determining the extent of moisture absorption and dirtiness of the insulation. The insulation resistance of new machines with dry windings is very high. If the machine has been subjected to incorrect transportation and bad storage environment such as high humidity, salty and dirty, the insulation resistance can be extremely low. Based on the result of insulation measurement, correct cleaning and drying action shall be determined and conducted.

3.3.1 Procedures for insulation resistance test

The insulation resistance is measured by using an insulation resistance meter (Megger). Guidelines for test voltage are presented in the following table.

Winding rated voltage (V)*	Insulation resistance test direct voltage (V)
< 1000	500
1000 - 2500	500 - 1000
2501 - 5000	1000 - 2500
5001- 12000	2500 - 5000
> 12000	5000 - 10000

* - Rated line-to-line voltage for three-phase AC machines, that is the rated voltage of machines.
  - The test voltage guidelines were quoted from IEEE 43-2000.

The test voltage is applied between the winding and the frame for 1 minute. The test is usually performed to the whole windings as a group. In case that the test is conducted to each phase winding, the frame and other windings not under test shall be earthed. Before the insulation resistance test is conducted, the following actions shall be taken.

– Verify that all power supply cables are disconnected.
– The winding temperature is measured.
– All resistance temperature detectors are earthed.
– All other external equipment such as surge capacitors, lightening arrestors, current transformers and etc are disconnected and earthed.

3.3.2 Correction to temperature of insulation resistance

The insulation resistance value varies inversely, on an exponential base, with the winding temperature. In order to be able to compare measured insulation resistance values, it is recommended that all insulation test values be corrected to a common base temperature of 40°C.
The correction is made by using the following equation :

$\mathbf{R_C = K_T R_T}$, $\mathbf{K_T = (0.5)^{(40-T)/10}}$

Where:

R_C is insulation resistance (in MΩ) corrected to 40°C

K_T is insulation resistance temperature coefficient at temperature T°C

R_T is measured insulation resistance (in MΩ) at temperature T°C

Example:

R_T = 3000 MΩ at 35°C

$K_T = (0.5)^{(40-35)/10} = (0.5)^{5/10} = (0.5)^{1/2} = 0.707$

R_C = 0.707 x 3000 MΩ = 2121 MΩ

3.3.3 Polarization Index (PI)

The measured insulation resistance will usually rapidly increase when the voltage is first applied, and then gradually approach a relatively constant value as time elapses. The insulation resistance of a dry winding in good condition may approach a constant value of insulation resistance in 4 min or less. If the winding is wet or dirty, a low steady value will usually be reached 1 min or 2 min after the test voltage is applied.
The polarization index is normally defined as the ratio of the 10 min resistance value (IR_{10}) to the 1 min resistance value (IR_1). The polarization index test is less dependent on the temperature than the insulation resistance. So, it is not necessary to make a temperature correction to the PI. If the 1 min insulation resistance is above 5000 MΩ, the polarization index is not an indication of the insulation condition and is therefore not recommended as an assessment tool.

3.3.4 Recommended minimum values for insulation resistance and polarization index

The actual winding insulation resistance to be used for comparison with IR_{1min} is the observed insulation resistance, corrected to 40°C, obtained by applying a constant direct voltage to the entire winding for 1 min. Generally, the insulation resistance value for dry windings exceeds the minimum values significantly. It is impossible to give definite values, because resistance is affected by the machine type, humidity, temperature, aging, operation period and etc. Therefore, the following values can only be considered as guidelines.

• Recommended value for Insulation Resistance (IR)

New stator windings	Used stator windings	Wound rotor windings
IR_{1min} > 1000 MΩ	IR_{1min} > 100 MΩ	IR_{1min} > 5 MΩ

※ If the measuring conditions are extremely warm and humid, IR_{1min} value of stator windings above 100 MΩ may be accepted.

• Recommended value for Polarization Index (PI)
The minimum PI value for class F insulated windings is more than 2.

3.3.5 Suitability for operation

Recommended minimum values of the IR or PI may be used to estimate the suitability of the winding for operation. If the IR or PI is low because of dirt or excessive moisture, it may be improved to an acceptable value by cleaning and drying. It may be possible to operate machines with PI and IR values lower than the recommended minimum values; however, it is not recommended. In all cases where the test values fall below the recommended minimum values, investigations should be undertaken to determine the cause to such low readings.

3.3.6 Insulation resistance measurement for auxiliaries

To ensure correct operation of the machines protections and other auxiliaries, their condition can be determined by an insulation resistance test. The test voltage for the space heater shall be 500 VDC and for other auxiliaries 100 VDC. The recommended minimum value of the space heater is over than 1MΩ. The insulation resistance measurement for temperature sensors is not recommended.

3.4 Inspection of Lubrication Oil

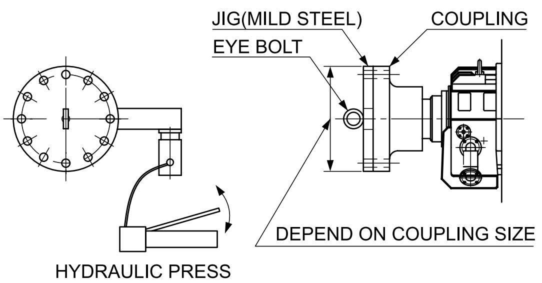
Before the initial running test, inspection of lubrication oil is very important, that is, confirmation of no oil leakage and proper oil level.
Refer to bearing maintenance manual.

CAUTION	Before starting the machine, fill the bearing chamber to the center of the oil gauge. Always fill through the pipe or plug at the side of the motor. Do not overfill, as the oil may then escape along the shaft and enter the unit. Avoid adding oil while unit is running.

3.5 Manual Rotation

If possible, rotate the rotor manually to ensure that it is free to move without rubbing or scraping and to lubricate the bearing surfaces. A minimum of 10 revolutions is recommended. If start of turning is very difficult by hand. The JIG for starting as per the below sketch is requested depend on actual coupling size. Couple the JIG with coupling and push or pull the handle using hydraulic jacking or chain block. Once Shaft is moving, turn is using pipe to eye bolt. It is easy to turn continuously once the shaft is moving.

Manual Rotation



3.6 Connection to Power and Grounding

Examine the nameplate data to know the correct power supply. Also check heater power where applicable. Check all connections to ensure that they have not come loose during transport. Make certain that the correct cable size has been selected and connected to phase rotation as shown in motor terminal box. The motor and control wiring, overload protection and grounding should be done in accordance with the National Electrical Code and local requirements.
In case of the wound rotor, check to see that brushes are "free" in the holder and the pressure of the brushes is applied correctly. Ensure that the slip ring surface is clean and free from contamination. Avoid "fingerprint" marks on ring surface. To maintain the proper degree of protection, make sure all gaskets and cover plates are properly fixed and sealed. Any unused entry holes should be plugged.

WARNING	- Ensure that the motor starter (supplied by others) is open. - Make the connections as in the required rotation. - Drill the cable entry plate (at bottom of box) to suit your power cable and its fitting. - Connect the station ground to one of the ground pads provided on the stator frame.

3.7 Solo Run Test

CAUTION	**Do not exceed number of HYUNDAI-specified hot and cold starts per hour.** Will cause overheating. Allow time between starts to permit stator windings and rotor cage to cool.

Before coupling with the load machine, the motor is normally run through a solo running test.
At the initial start, the motor is inching operated for approx. 1-2 sec.
At that time, inspection of rotation, abnormal noises, and lubrication conditions are checked during the idling. If these items have any problems, the supplied power shall be taken off, checked and reported in detail.

The motor is then restarted. The motor is run during 1-2 hrs. and vibration amplitude on the bearing housing and bearing temperature are measured and recorded.

WARNING	**Do not operate equipment beyond design limitations.** Can cause personal injury or damage to equipment. Operate in accordance with instructions in the manual and nameplate ratings.

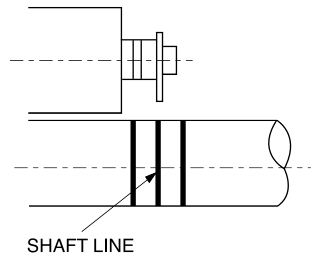
3.8 Alignment

The correct alignment of machinery is very important for reducing the stress and vibration of the shaft and the wear of the bearing and coupling. In case a coupling maker gives those instructions, it is recommended that the instructions be followed.

Flexible Coupling

The flexible coupling set forth herein means the one driven through the rubber brush or the leather brush including the gear coupling. In aligning the motor equipped with the sleeve bearing, attention is to be paid to the endplay of the motor bearing and to the position of the coupling. The center of the motor bearing endplay is indicated by the endplay indicator.
The bearing endplay can be equally divided by setting the endplay indicator to the standard line of the shaft as shown in Fig. 3.

Fig. 3 Endplay Indicator



CAUTION

In case the coupling is used, it may be considered that the rotor can be easily moved in the axial direction. In fact, however, it hardly slides in the axial direction at the coupling as the torque grows greater. When by some reason the rotor has undergone some axial movement, and the coupling does not provide enough slip to allow the rotor to return to the magnetic center of the motor, it will continue to operate with the bearing end in contact with the shoulder of the journal.

Rigid Coupling

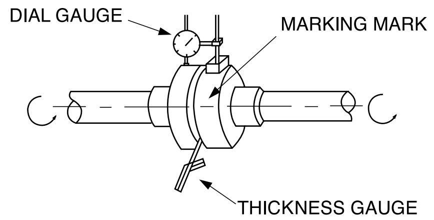
In case of the sleeve bearing, when both flanges are connected to each other, the endplay indicator is referred to install the flexible coupling in order to determine the position of the motor.

Alignment

NOTE: The foot plane is of concern for each unit of rotating equipment. Check driven equipment if necessary.

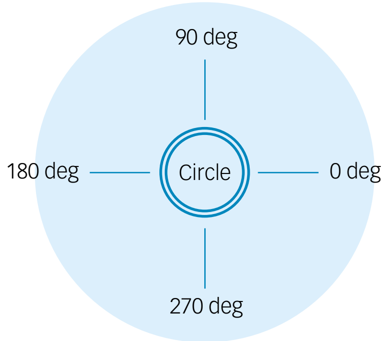
Alignment is made to bring the shaft centers of the motor and machine combined with it into the same line; the parallel and eccentricity are measured through the coupling. Generally a thickness gauge or a taper gauge is used in measuring the parallel, and in measuring the eccentricity, a dial gauge is to be fitted to the coupling on one side; the both shafts are to be turned by 0 deg, 90 deg, 180 deg and 270 deg; and the dial gauge reading is to be taken at the four points as shown in Fig. 4. The alignment accuracy is to be generally 0.025 mm or less (both plate and circle).

Fig. 4 Procedure for Alignment

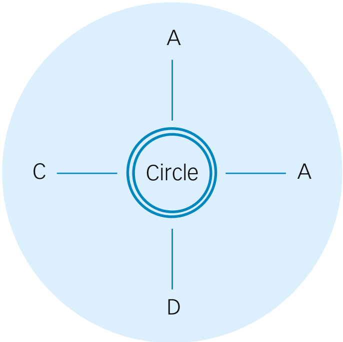


Measurement of Eccentricity

The both shafts are to be simultaneously turned; the values shall be obtained from the measurement made at four points by means of a dial gauge and are to be recorded; and the corrected value is to be obtained in the following manners.



(Measured Value)



(Measured Value)

$$\text{Corrected value of left and right} = \frac{A - C}{2}$$

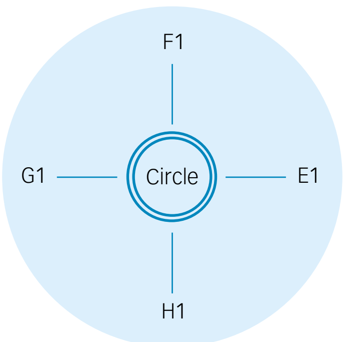
$$\text{Corrected value of left and right} = \frac{A - C}{2}$$

(Corrected Value)

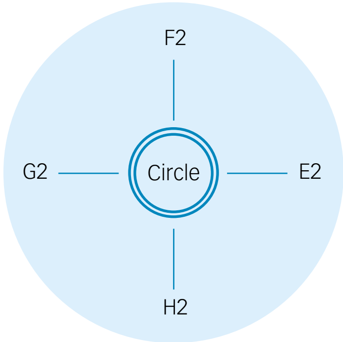
⚠ CAUTION	The difference between the total of the measured values at the left and right points (A-C) and the total of the measured values at the top and bottom points (B- D) should not exceed 0.03 mm. The improper fitting of the dial gauge and the erection of the fitting arm, if any, may cause greater difference.

Measurement of Parallelism

The values at the four points of E1, F1, G1 and H1 are to be corrected after measurement made by means of a thickness gauge at the position where both shafts were connected to each other at the time of eccentricity measurement; and measurements are to be made again at the points of E2, F2, G2 and H2 after turning both shafts.



(Measured Value)



(Measured Value)

Corrected value of left and right

$$= \frac{(F1 + F2) - (H1 + H2)}{2}$$

Corrected value of left and right

$$= \frac{(E1 + E2) - (G1 + G2)}{2}$$

(Corrected Value)

Belt Connection

If it is intended that the motor will be directly coupled through a flexible coupling to a machine, no check for the minimum sprocket diameter will be necessary. However, if a chain, gear, V-belt, or flat belt drive is used on the output shaft a check should be made.

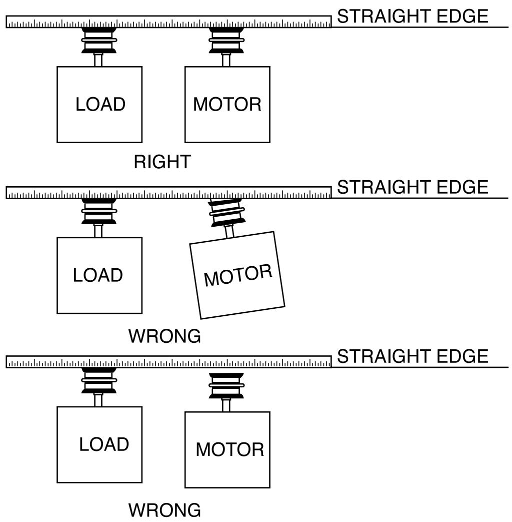
Direction of Belt Tension

In the case of the motor with roller bearing, belt tension may be applied in the horizontal or the vertical direction. In case of the motor with the sleeve bearing, the belt tension should be applied in the horizontal direction only.

Alignment of Belted Drives

Aligning a belted drive is much simpler than aligning a direct coupling drive. To check alignment, place a straight edge across the faces of the drive and driven sheaves. If properly aligned, the straight edge will contact both sheave faces squarely.

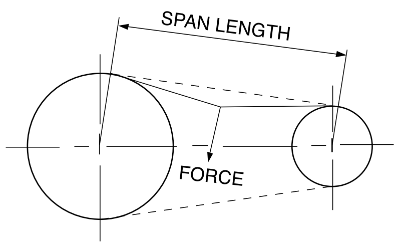
Fig. 5 Alignment of Belt Drive



Belt Tension

The V-belt is to be stretched in the following way. There is calculated deflection force to be applied perpendicular to the belt at the center of the belt span as shown in Fig. 6.

Fig. 6 Belt Tension

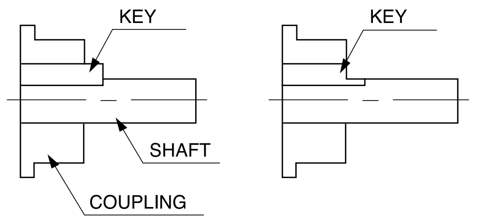


The drive is properly tensioned when the deflection of the belt caused by the deflection force is equal to 1.6 mm for span length of 100 mm. If the deflection force is higher than normal values, this will result in reduced belt life, reduced bearing life and could cause shaft failure.

Coupling Balance

The coupling should be dynamically balanced to G2.5 or better. The motor is dynamically balanced with a half key fitted; therefore, the proposed coupling should be balanced accordingly, and the correct key profile fitted.

Fig. 7 Coupling Balance



Frame Distortion Check

In addition to ensure the proper alignment of the coupling, care should be taken to ensure that the motor frame is not distorted during alignment.

To confirm that distortion has not occurred, we recommend the following procedure be adopted:

1) Align the motor within tolerances as required by section “alignment.”
2) Apply a dial gauge between the motor frame adjacent to one mounting foot and the foundation and set indicator to zero.
3) Loosen hold down bolt and record movement of dial gauge measurement.
4) Re-torque hold down bolt.
5) Repeat steps 1-4 for all hold down bolts, one at a time.

3.9 Test Run of Motor

⚠ CAUTION	Carry out the initial operation in accordance with contractual agreements. The initial operation may only be carried out by trained personnel who have been assigned to do this by the person responsible for the plant.

After coupling with the load machine, the motor is inching operated at first.
When both motor and load machine show no abnormality, the motor is restarted with a minimum load. At that time, the current, supplied voltage is checked and recorded.
While the motor is running continuously, the motor vibrations on the bearing housing are controlled by Fig. 8.

⚠ CAUTION	**Do not exceed number of HYUNDAI-specified hot and cold starts per hour.** Will cause overheating. Allow time between starts to permit stator windings and rotor cage to cool.

04 Inspection and Maintenance Schedule

The following maintenance and inspection schedules cover the necessary steps for inspection of the motors. Since the conditions under which the motors are required to operate may differ considerably, the maintenance and inspection schedules can only be recommended for the intervals at which at least first inspection should be carried out if operating conditions are normal. On the basis of the experience gained with the plant, the inspection intervals should therefore be selected to meet such conditions as contamination, frequency of start-ups, load, etc.

Interval			Inspection and Maintenance Work	Machine Part
A	B	C		
A: Daily Inspection B: First Inspection, no later than 6 months. C: Following Inspection, no later than two (2) years (when required, dismantle the machine).				
○			Check the machine for irregular noise and excessive vibration (Fig. 8).	
○			Where possible, measure and record the bearing temperature.	
			Relubricate the grease lub. Bearing oil-lub bearing: Change the oil. Clean and inspect the bearings. For the intervals of maintenance work, see the lubrication instruction plate on the machine.	
	○	○	Check the shaft sealing rubber ring for deterioration.	
○			Where possible, measure the bearing temperature, oil pressure and flow rate.	Sleeve (white metal) bearing
○			Check that the oil-rings are operating correctly.	
○			Check the oil flow, oil level and any oil leaks.	
	○	○	Check the contamination of lub. oil and change the lub. oil.	
	○	○	Carry out the following oil changes with normal amb. temp. Self oil lub.: 5000-8000 operating hours Forced feed oil lub.: 15,000-20,000 operating hours	
		○	Check the axial play.	
	○	○	Check the shaft sealing for deterioration.	
		○	Inspect the bearing surface.	
	○	○	Clean and inspect the bearing insulation and insulation of the pipe.	
	○	○	Check the system, connections and piping for leaks.	Forced feed oil lub. system
	○	○	Check the oil level.	
	○	○	Clean and inspect the oil filters and oil coolers.	
	○	○	Check to see that the enclosure is not clogging (blocking) the machine ventilation.	Enclosure
	○	○	Check the gaskets for deterioration.	
	○	○	Check the enclosure for any deformities or damage.	
	○	○	Check the noise-suppression material for damage.	

Inspection and Maintenance Schedule

Interval			Inspection and Maintenance Work	Machine Part
A	B	C		
	○	○	Check and clean the external cooling air paths.	Enclosure
		○	Drain the drain plug, when provided.	
	○	○	Replace and clean the air filter, when provided.	
	○	○	Check the clearances to rotating parts.	
	○	○	Check the enclosure for corrosion.	
		○	Check earthing (grounding) terminals.	
	○	○	Check the enclosure including external cabling conduit connection for ingress of water or dust.	Junction (terminal) box, terminals
		○	With loose leads: Check to see that the cable connections are properly insulated.	
		○	Check connection for good contact.	
		○	Check terminal insulators for damage.	
○			Measure and record the winding temperature detectors, when provided.	Stator winding
	○	○	Check and record the insulation resistance of windings.	
	○	○	Clean the windings, as far as possible.	
		○	For totally enclosed machines, clean the winding if required.	
		○	For the wound rotor machine with continuous sliding brushes and open enclosure machine, clean the entire winding and cooling air paths, including the core packs-air duct.	
		○	Check the slot wedge for tight fit.	
		○	Check condition of winding insulation, including end connections.	
		○	Check winding and bracing for tightness.	
	○	○	Clean the winding, as far as possible.	Squirrel-cage rotor
		○	For totally enclosed machine, clean entire winding if required.	
		○	For the open enclosed machine: Clean entire winding and cooling air paths including the core packs-air duct.	
		○	Check cage bars and end rings for fractures and loosely soldered connection.	
		○	Check cage for axial displacement.	
		○	Check end rings and support rings and the associated locking elements for tight fit.	
	○	○	Check and record the insulation resistance of windings.	Wound rotor winding
	○	○	Clean the winding, as far as possible.	
		○	For totally enclosed machines, clean the winding if required.	

Interval A	Interval B	Interval C	Inspection and Maintenance Work	Machine Part
		○	For the machine with continuous sliding brushes or open enclosure machines, clean entire winding and cooling air paths including the core packs-air duct.	Enclosure
		○	Check the slot wedge for tight fits.	
	○	○	Check the winding-end for deposits of oil and carbon dust.	
		○	Check the banding for tightness, and check for any loosely soldered joints.	
		○	Check bracings and wedges of winding end and ring circuits for tightness.	
		○	Check leads of stator winding, slip ring leads of wound rotor machine and their locking elements for tightness.	Water air cooler (heat exchanger)
○			Vent the cooler while in operation.	
○			Where possible, measure and record the water temperature. (Caution that cooling pipes are not damaged by freezing when the operation is stopped).	
	○	○	Check the cooler, connection and piping for leaks.	
	○	○	Check and clean the cooler.	
	○	○	Inspect the corrosion protection (when provided).	
○			Compare brush noise, sparking and contact marking with conditions found in previous inspection.	Slip ring, brushes
	○	○	Check to see that the brushes can move freely in the brush holders.	
	○	○	Check the pigtail (connection) leads for discoloration and damage.	
	○	○	Take out and clean the air filter.	
A or at least within 1 month			Check the brush length and replace as necessary.	Slip ring, brushes (cont'd)
			Inspect contact surfaces; they should be bright, free from rubbing or threading and have a uniform skin.	
1 week			Remove deposits of carbon dust from the slip ring chamber, slip ring and brush holders.	
3 or 6 months			Check the holder for damage.	
			Check the tightness of slip ring, including separators and fixing studs.	
	○	○	For arm type brush holder, check brushes for screw tightness.	
○			Avoid continuously sliding the brushes.	Brush lifting mechanism
○			Avoid continuously rotating the thrust roller.	
	○	○	Check to see that the mechanism, including the sliding surface of the shaft to the short-circuit ring, is free form dust.	
	○	○	Check the abnormality of thrust roller and limit switch.	
	○	○	Check the sliding surface of short-circuit ring for corrosion.	
		○	Check setting of short-circuit ring to shaft.	
	○	○	For arm type brush holders, check brushes for screw tightness.	
	○	○	Re-lub. the reduction gear assembly.	
	○	○	Check the manually operated gear unit for damage.	

04 Inspection and Maintenance Schedule

Interval			Inspection and Maintenance Work	Machine Part
A	B	C		
○			Axial rotor placement should be kept by indication of the shaft on its magnetic center.	Shaft and coupling
	○	○	Check and adjust the belt tension.	
	○	○	Check the external and internal fan for damage or corrosion.	
		○	Check rotor alignment.	
		○	Check the balancing weight for tightness.	
		○	Check all coupling bolts and locking elements for tightness.	
		○	Check the oil leakage of gear coupling.	
		○	Check the shaft keys for tightness.	
		○	Check the monitoring instruments and contact device for proper function.	Monitoring instruments
	○	○	Check the brush length and replace as necessary.	Ground brush
		○	Check the holder for damage.	

Fig. 8 Values of Vibration

Speed, rpm	Rotational Frequency, Hz	Velocity, in/s (mm/s) peak
3600	60	0.15(3.8)
1800	30	0.15(3.8)
1200	20	0.15(3.8)
900	15	0.12(3.0)
720	12	0.09(2.3)
600	10	0.08(2.0)

05 Maintenance of Windings

5.1 General

It is important to keep the machines in good condition by performing periodical maintenance to prevent the insulation from being damaged by moisture, dirt and other foreign matter.

If the machines have been operated under high humidity conditions, not been used for a long time, or been subjected to sudden changes in ambient temperature, the insulation may have absorbed considerable moisture, causing deterioration of the insulation.

Other causes of insulation breakdown include operation of the machines at an overcurrent exceeding the rated current, use under an ambient temperature exceeding the specified values as may be possible with a heated air blower which directly radiates heat over the machines, and overheated windings resulting from dust accumulating on the core packs and coil ends. All of the above items impair insulation and reduce the life of the machine.

5.2 Cleaning of Coils

The method selected will depend on the type of machines, type of insulation, kind of dirt, and other conditions and circumstances.

Cleaning by Wiping with Cloth

Wiping cloths can be used for cleaning when the machine

is small, the surfaces to be cleaned accessible, and the dirt to be removed dry.
Waste should not be used, as lint will adhere to the insulation and increase the collection of dirt, moisture, and oil. This is particularly objectionable on high-voltage insulation, as it tends to cause concentration of Corona.

Cleaning by Means of Compressed Air

Compressed air, used to blow out dirt with a jet of air, is usually effective especially where dirt has collected in places that cannot be reached with a wiping cloth.
Cleaning can be done more quickly with compressed air than with wiping cloth especially on the large machines. If blowing with compressed air results in simply transferring dirt from one place to another on the machine, little is accomplished.

There are a number of precautions to be observed when using compressed air: Air being blown should be dry, especially if blowing against insulation. Moisture condenses and accumulates in air lines and hoses.
Care should be taken to assure this has been completely dried out before using the compressed air on insulation.
Compressed air should never be more than 3~4 kg/cm^2 pressure. Higher pressures can damage insulation and force dirt under loosened tape.
Care should be taken not to blow loosened dirt into inner recesses where it will be difficult to remove and where it might obstruct ventilating ducts.

⚠ WARNING	Wear goggles when blowing dirt out with compressed air and be careful not to direct the air jet toward others. Failure to heed this warning can result in injury to the eyes.

Cleaning by Means of Solvents

Solvents are usually required to remove grease and oil dirt. A lint-free cloth wet with solvent may be dipped in the fluid.
Petroleum distillates are the only solvents recommended for cleaning electrical apparatuses. These solvents, classed as Safety-Type Solvents, have a flash point of above 37.8 deg and are available from most oil companies and other supply sources under various trade names:
- Mineral spirits, cleaner's naphtha, and similar products with a flash point above 37.8 deg.
- Gasoline, naphtha, and similar grades must not be used for cleaning. They are highly volatile and present a great fire hazard.

⚠ WARNING	Avoid prolonged or repeated contact with petroleum distillates or breathing their vapors. These solvents can cause severe skin irritation, are toxic, and are readily absorbed into the system. Failure to heed this warning can cause severe personal injury or death. Do not use carbon tetrachloride or mixtures containing carbon tetrachloride for cleaning purposes. Carbon tetrachloride and its fumes are highly toxic. Failure to heed this warning can result in serious illness or death. Avoid excessive contact with cleaning solvents and breathing their vapors. Some solvents are extremely toxic and readily absorbed into the system.

5.3 Use of Space Heaters

When the motor is operating, its interior is not humid and in a dry condition. But it absorbs humidity at rest.
In order to prevent absorption of humidity, the space heater installed inside the frame should be immediately energized after the motor comes to a stop, and the temperature inside of the motor should be controlled 3 to 5 deg higher than the ambient temperature.
If there is no space heater, a 100-150-W incandescent lamp may be used.

⚠ CAUTION	Connect this heating system according to its output and reference voltage. Arrange the control so that the heating system - switches on after the electrical machine switches off. - switches off before the electrical machine switches on.

5.4 Drying Insulation

Should the insulation resistance for the winding have poor insulation resistance due to the ingress of moisture, then the windings must be dried to improve the insulation resistance to the minimum specified value before the application of insulation resistance. The preferred method of drying windings is the external heat method. The alternative is the internal heat method.

1) The External Heat Method.

* Temperature-controlled oven
The best method is to dismantle the motor (including

bearings) and place the motor in a temperature-controlled oven at between 110°C max. for 8-10 hours depending on oven efficiency to remove moisture.

* The alternative external heat method is to remove end shields and covers, connect the anti-condensation heaters, and fit additional “black heat” resistance in and around the motor.

A temperature controller should control additional resistance heaters with a probe adjacent to the winding at the top of the motor. The temperature should be set for 100°C to 120°C. The drying process will take approximately 10-16 hours once the correct temperature is achieved.

< Key Points to Remember >

1) Heaters must be the “black heat” types otherwise the insulation might be burnt.
2) The motor may need to be covered by some thermal insulation to retain the heat.
3) A vent opening should be placed in the tip of the thermal insulation tent for the evaporated moisture to escape.
4) Sufficient space should be allowed between the heaters and any winding insulation so as not to generate local excess heating of the winding insulation.

2) The Internal Heat Method

With this method, the heat is applied by passing current through the windings to generate heat. Extreme caution should be exercised using this method so that you do not damage the internal insulation before the windings are up to optimal temperature.

WARNING	This method should only be used if all winding resistance is greater than 1 megohm.

< Key Points to Remember >

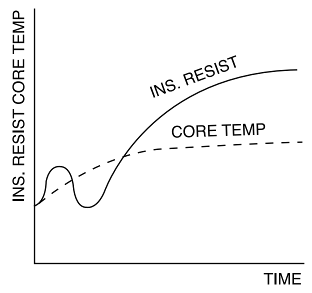
1) Remove brushes and short the ring together with a copper link in case of a slip ring motor (wound rotor).
2) Connect an AC supply voltage to the stator windings. The applied voltage should be approximately 12%. In this case the stator nominal voltage is 3,300 V and since 415 V AC represents 415/3,300 x 100 = 12.5%, this will be a convenient supply voltage. In case the current is taken from the supply, it would be typically 70% of the full load rated current.
3) The power supply should be controlled with a temperature controller operating from the internally connected RTDs supplied by the motor manufacturer.
4) The shaft should be locked to prevent rotation.
5) Set the temperature controller to 110°C maximum.
6) Drying will take approx. 8-12 hours once the windings have reached 100°C. The windings should take 6-8 hours to heat up to 110°C.

Determination of Dried Insulation

During the drying process the insulation resistance should be checked with a 500-V (low-voltage machine) or 1,000-V (only high-voltage machine) DC low-energy source meter (e.g. megger) and then recorded after 1 minute.
This process should be repeated every hour until the results show the winding is dry.

Once the winding is completely dry, the insulation resistance will stabilize. After the windings cool down, the insulation value should increase.

Fig. 9 Change in Insulation Resistance



Notes on Drying Insulation

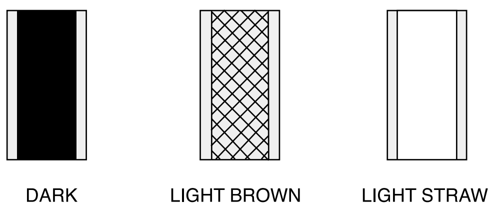
1) A temperature-controlled oven should be used if the windings have been completely immersed in water.
2) Should the windings contain contamination, the windings should be properly cleaned before attempting to dry windings. Contact your factory representative for further advice.
3) All processes for drying insulation should be performed under the supervision of qualified personnel. Failure to observe proper procedures may result in permanent damage to the insulation or winding system. For further advice contact your factory representative.

6.1 Slip Rings

Good Conditions

The slip ring must run true to the center of rotation. The maximum permissible TIR (Total Indicator Runout) must be no greater than 0.2 mm. If the TIR is greater than this, the slip rings must be machined true. The surface of the slip rings must be a smooth finish. The slip ring will normally show a running band under the brush contact area. This can be from light straw in colour to dark brown (almost black). The most normal colour is “light brown”. The surface should be consistent in colour around the periphery and across the brush track. Sparking should not be evident during operation and the rings should be dry with no signs of contamination.

Fig. 10 Examples of Good Condition



The Brush Running Band is a film on the ring basically consisting of copper oxide and carbon. This film occurs naturally during normal operating and it is essential for good brush and ring condition. Do not try to remove it. The film is easily maintained by ensuring the area is free from contamination and the machine is properly loaded.

Poor Conditions

Poor ring conditions can be caused by several conditions. The common causes of poor ring conditions are:

1) ***Brush loading is not optimum correction***:
See Section “Optimizing Brush Wear”.

2) ***Contamination***:
Such as oil, salt air, H_2S or silicone vapours (even from Silastic) may destroy the film built up on the rings.
Correction : The contamination should be removed and a new set of brushes fitted and bedded in. It is preferred that slip rings be cleaned with a dry lint-free cloth. If required, some “non-residue/noncorrosive” electrical cleaning solvent could be used.

WARNING	Electrical solvent, if inhaled or absorbed through the skin, can be dangerous to your health. Please refer to the manufacturer safety information for proper advice

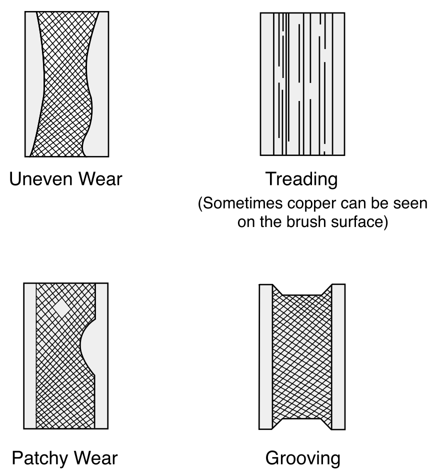
3) ***Corrosion of Brush Rings***
This condition may occur if the motor has been at standstill for a long time (e.g. after extended storage).
Correction : This should be removed by using a fine “grinding stone” stone available from most service shops or brush suppliers. Rotate the motor either with a small pony motor or run the motor on no load and uncoupled with the slip rings short-circuited after accelerating to full speed (do not start without rotor resistance starter).

WARNING	Although no voltage is present across the rings during this operation you should - ensure the rings cannot open circuit, otherwise high voltages could be present. - follow electrical safety rules. This procedure should only be performed by qualified and experienced personnel.

4) ***Threading***
If threading occurs, brush optimization should be corrected first.
(1) Light threading can be corrected the same way as “corrosion”.
(2) Heavy threading should be corrected by machining the slip rings.

5) ***Out of Round Rings***
This must be corrected by machining the slip rings.

Fig. 11 Examples of Poor Conditions



Machining Slip Rings

Method 1 - Preferred:
Dismantle the motor and remove bearings. Place the rotor in a lathe, centre bearing journals true and machine slip rings.

Method 2 - Alternative:

The rings are removed from the shaft with a puller which can be attached to the hub of the slip ring assembly. Access to the rings can be gained by removing the drive end endshield and carefully disconnecting the rotor leads. After the rings have been removed they can be machined in a lathe.

Method 3 - Alternative:

Some motor repair shops offer on-site machining. This is not a preferred method, but may be required for emergency repair. If on-site machining is performed, the following precautions should be adhered to

- replace brushes after machining operation is complete.
- all ring scrap to be removed from slip ring enclosure.
- this operation should only be performed by experienced personnel.

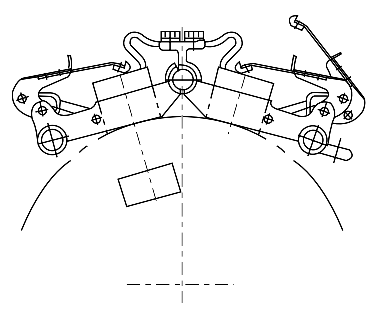
After machining, the rings should be kept clean and free from fingerprints until ring film has developed during operation.

6.2 Brushes and Brush Holders

General

The brushes must make good contact with the slip ring surface. To ensure this, they must move freely within the brush holder and pressure lever must apply the correct pressure. The brush holder assembly is fixed. To replace brushes, unclip the pressure level and undo the "pigtail" from the holder assembly.

Fig. 12 Brush Holder Assembly



If satisfactory brush life has been obtained, replace the brushes with the same grade as the original. Always make sure brushes are bedded in after replacement.

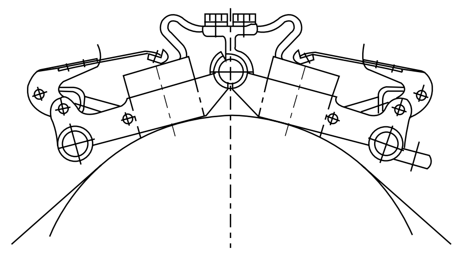
It may be possible that brushes wear out quickly. A common cause for this is a light load or brushes not making proper contact with the rings. In this case consult Section "Brush Optimization" or your carbon brush supplier. If brush holders need replacing, the brush assembly may be removed by taking off the drive end endshield. The brushes are to be changed when they have worked down to about 1/3 of their original length. The wear is not the same for all brushes. It is important to keep the brush housing clean and grease from excess carbon dust. Clean out housing periodically, using vacuum cleaner and clean, dry compressed air (max. 4 bars) where possible.

WARNING	Cleaning while operating is not recommended, except in case of experienced operators. High velocity compressed air can lift brushes or short pigtails together.

Bedding Brushes

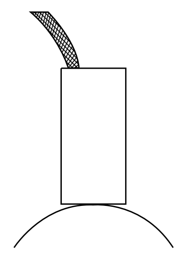
When new brushes are fitted they should be bedded in. If the slip rings wear, the diameter can vary, so the diameters of the brush face and the diameter of the rings may not be exactly the same. So, in all cases, brushes should be bedded in.

Fig. 13 "Bedding" Brushes In



Some abrasive sandpaper should be placed around the slip ring and the brush fitted in the holder with the tensator in place. The abrasive is drawn back and forth until all of the brush is in contact with the ring.

Fig. 14 Example of Poor Surface Profile



The brush surface contact area must not be less than 80% of the surface of each individual brush.
During the initial run, if possible, it is desirable to apply some bedding chalk to the rings before entering under the brush surface, this will promote the final bedding in of the brush.

NOTE: Bedding chalk is usually available from most service shops or carbon brush suppliers.

7.1 General

Transport, Storage

Always keep the cover and the cable entries tightly closed.

7.2 Description

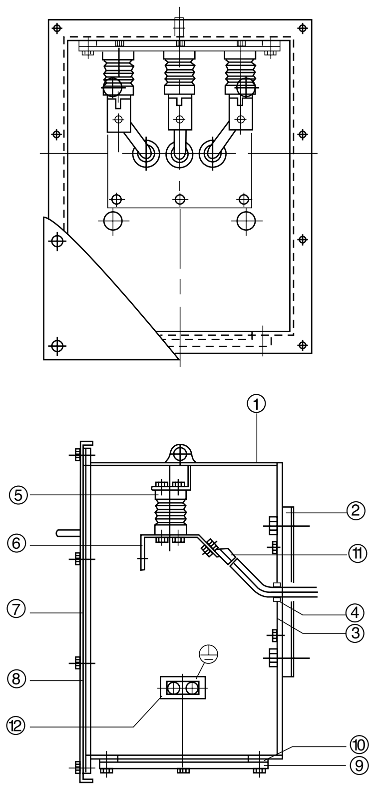
1) Application

In the terminal box, the connection is made between the stator winding and the supply cable from the system. The terminal box is mounted on the machine frame at an easily accessible location.

2) Construction

A typical construction is shown in Fig. 15

Fig. 15 Construction of Terminal Box
(Example, delivered design may deviate in details)



① Terminal box body	⑦ Packing
② Packing	⑧ Terminal box cover
③ Cable holder	⑨ Gland plate
④ Cable grommet	⑩ Packing
⑤ Insulator	⑪ Terminal lug
⑥ Connector	⑫ Earthing terminal

3) Degrees of Protection

The terminal boxes comply at least with degree of protection IP55 as per IEC 34-5.

4) Connection Part for Main Terminals

The connection part is suitable for connection with cable lug depending on the equipment complement.

7.3 Installation

1) Termination

General

Ensure that the power supply agrees with the rating plate data. The supply cables should be matched to the rated current and plant-specific conditions (e.g. ambient temperature, method of cable installation, etc.). Connect the supply-cable conductors.

CAUTION	Connection cables and cable ends must not exert any bending or torsion forces on the connection bolts!

Connection by Means of Cable Lugs

The size of cable lugs must be matched to the size of the supply cable. Use appropriate units with sufficient current-carrying capacity.

Direction of Rotation

When the power supply phase conductors L1, L2, L3 are connected to terminals U, V, W respectively, the motor will rotate in a correct direction. If the connections to any two terminals are reversed, i.e. if lines L1, L2, L3 are connected to terminals V, U, W (or U, W, V or W, V, U) respectively, the motor will rotate in a reverse direction.

Installing and Entering the Cable

The following steps are recommended for split entry:

- Cut the sealing insert so that its opening is some millimeters smaller than the cable diameter.
- Introduce the cable into the cable gland. In the case of a very small cable diameter, the cable diameter should be increased by applying insulation tape at the securing point to ensure concentric positioning of the cable in the sealing insert.
- Provisionally attach the terminal box cover in order to check whether perfect sealing is achieved both at the flange surfaces and at the entry point with sufficient prestressing. If this is not the case enlarge the sealing insert cut out or adjust the cable diameter by means of insulation tape. The securing bolts should then be tightened alternately in steps.
- Unused entry openings always must be closed off by suitable plugs.

These must

- be of permissible resistant material,
- conform to degree of protection IP55,

- be tightened so that they can be removed only by means of a tool.

Earth Connection

An earth terminal for connecting the cable earth conductor is provided in the terminal box.

The minimum connection cross-section of earth connections should be selected according to IEC 34-1 with reference to live conductors.
Make sure in any case of installation and maintenance work that the equipotential bonding is maintained.

Final Checks

Before closing the terminal box, check the following:
- Conductor connections and, if applicable, the circuit connections have been made correctly.
- Interior of the terminal box is clean and free from remainders of cable material.
- All terminal screws and the appropriate cable entry parts are firmly tightened.
- Clearance in air of ≥8 mm at 500 V, ≥10 mm at 660 V, ≥14 mm at 1 kV, ≥60 mm at 6 kV, ≥100 mm at 10 kV are maintained. Remove any projecting wire ends!
- Connection leads are not subject to strain and the insulation cannot be damaged.
- Unused entry openings are closed off by suitable plugs.
- All seals and sealing surfaces are in perfect condition. If sealing of the joints is effected by metal-to-metal joints only, the surfaces should be cleaned and thinly regreased.
- Entry glands fulfill all requirements concerning degree of protection, conditions of installation, permissible lead diameter.

7.4 Operation

Safety Advice

Covers to prevent accidental contact with live or rotating parts and those required for proper air guidance and thus effective cooling should not be opened during operation. During maintenance or inspection work in the immediate vicinity of the terminal box or of the rotating machine suitable measures should be taken to protect personnel against hot gases escaping under short-circuit conditions.

> ⚠ CAUTION
>
> Only switch off the electrical machine during the main running period in an emergency, in order to protect the switchgear and electrical machine.

7.5 Maintenance

> ⚠ DANGER
>
> 
>
> High-voltage power source must be disconnected before working on equipment.
> Failure to disconnect power source could Result in injury or death.
> Terminal box only to be opened by skilled personnel.

1) Safety Advice

Before any work is started on the machines, particularly before covers are removed from live parts, make sure that the machine/plant has been correctly disconnected from the power supply.
Please adhere to the general "5 safety rules"
- Isolate the equipment from the power supply,
- Provide a safeguard to prevent unintentional reclosing,
- Verify safe isolation from the supply,
- Earth and short-circuit,
- Provide barriers or covers for adjacent live parts.

2) Tightness, High-current Loading

The terminal boxes should be inspected regularly to ensure that they are tight, that the insulation is undamaged and that the connections are firmly attached. If the terminal box is subject to extremely high current loading it is recommended that the insulators, connecting parts and cable connectors be checked.
If any dust or moisture has penetrated the terminal box, clean and dry out the terminal box. The seals and sealing surfaces should also be checked and the cause of faulty sealing should be remedied.

3) Tightening Torque

Max. tightening torque for current-carrying bolted joints is given in below table.

Screw Strength class	Tightening Torque (Nm)	
	Steel (8.8)	Brass
M5	-	2.9
M6	10.8	4.9
M8	20.7	9.8
M10	42.4	19.7
M12	73.9	34.5
M16	177.4	82.8

※ The tolerance of tightening torques is ± 10%

> **NOTE:** Replace the cover and tighten up the screws (taking safety elements into consideration).

08 Terminal Box for Auxiliary Circuits

8.1 General

Transport, storage

Always keep the cover and the cable entries tightly closed.

8.2 Description

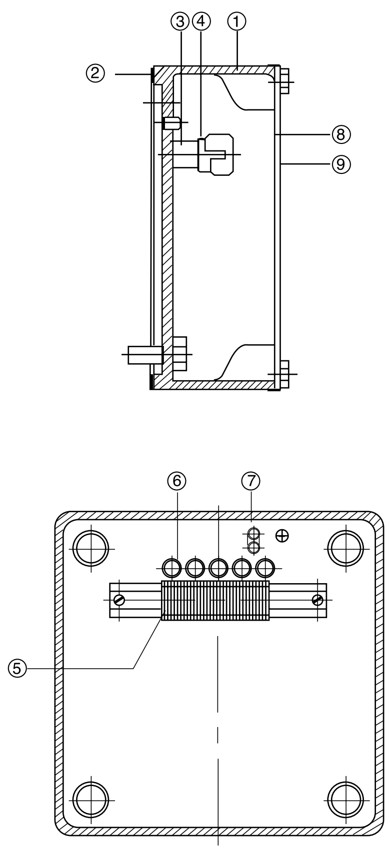
1) Application

The terminal boxes are employed for connection of auxiliary circuits.
If specially ordered for anti-condensation heater, an auxiliary terminal box for anti-condensation heater may be supplied.

2) Construction

The typical construction is shown in Fig. 16.

Fig. 16 Construction of Terminal Box
(Example, delivered design may deviate in details)



① Terminal box body
② Packing
③ Support ring
④ Rail
⑤ Terminal block.
⑥ Cable grommet
⑦ Earthing terminal
⑧ Packing
⑨ Terminal box cover

3) Degrees of Protection

The terminal boxes comply at least with degree of protection IP55 as per IEC 34-5.

8.3 Installation

1) Termination

When making the connections of auxiliary circuits note wiring diagram for auxiliary circuits documented in the approval specification.
The cross-section of a supply cable should be selected on the basis of the rated current and plant-specific conditions.
The connection terminals for auxiliary circuits are suitable for conductor cross-sections of at least 2.5mm².
The ends of the conductors should be stripped in such a way that the remaining insulation reaches almost up to the terminal.

2) Installing and Entering the Cable

Hazardous Voltage.
Will cause death, serious injury, electrocution or property damage.
Disconnect all power before working on this equipment.

In addition to the information given for cable selection and preparation, the following specific notes apply, depending on the type of entry fitting used :
To maintain the degree of protection IP all screwed-in glands must be firmly tightened and sealed by suitable measure, e.g. by means of an adhesive or by fitting sealing ring. The same measures are required when fitting screwed-in plugs.

The center rings of screw glands included in the scope of supply are always screwed in place, fixed in position and sealed in accordance with degree of protection IP55 by use of LOCTITE. These glands also are fitted with blind washers for transport protection.

For adapting the cable diameter to the gland conditions it may be necessary to apply a layer of insulation tape to the leads to enlarge its overall diameter or to cut out some rings of the sealing insert.
With extreme lead diameter it may be necessary to replace the glands by those of appropriate dimensions.
Entry plates of terminal boxes may be supplied undrilled in order to allow selection of cable entry screw glands, whose design, number and size are suitable for the cables employed.

Terminal Box for Auxiliary Circuits

The entry elements should be selected so that
- they are suitable for the cable diameter,
- they conform to the degree of protection,
- they are suitable for the installation conditions.

The supply leads-particularly the protective conductor- should be laid loosely in the terminal box with an extra length to protect the cable insulation against splitting. Unused entry openings always must be closed off by suitable plugs.

These must
- be of permissible resistant material,
- conform to degree of protection IP55,
- be tightened so that they can be removed only by means of a tool.

3) Earth Connection

An earth terminal for connecting the cable earth conductor is provided in the terminal box.

09

Anti-condensation Heating with Heating Tube

9.1 Description

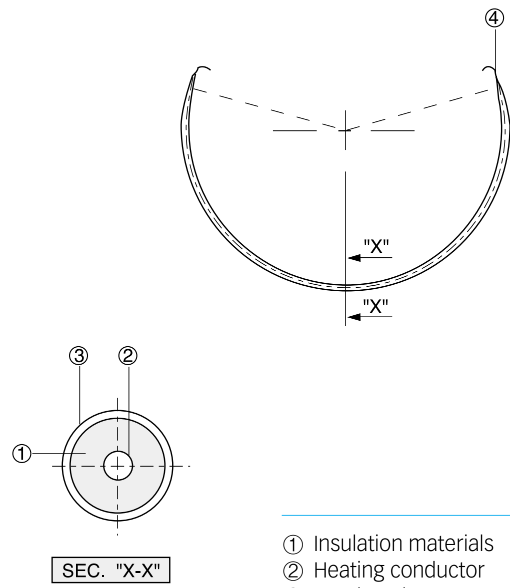
1) Application

Anti-condensation heaters fitted in electrical machines warm the air inside the stationary machine to a temperature above that of the surroundings, thus effectively preventing moisture condensation.

2) Construction

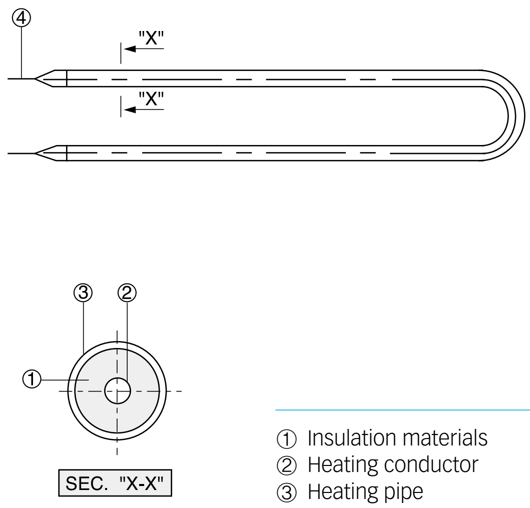
The typical constructions are shown in Fig. 17, 18 and 19.

Fig. 17 O Type Anti-condensation Heater
(Example, delivered design may deviate in details)



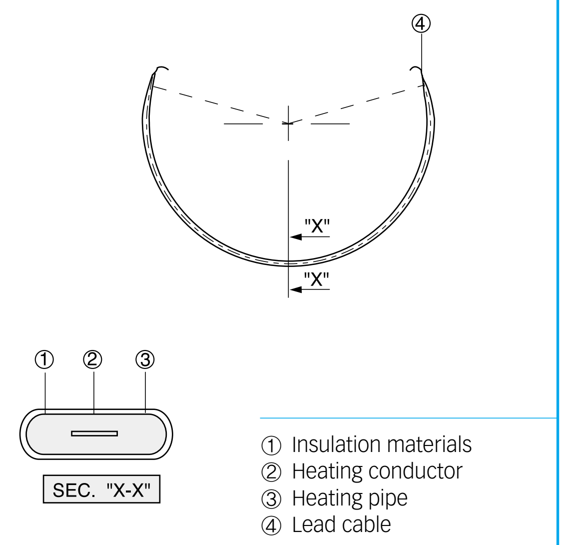
① Insulation materials
② Heating conductor
③ Heating pipe
④ Lead cable

Fig. 18 U Type Anti-condensation Heater
(Example, delivered design may deviate in details)



① Insulation materials
② Heating conductor
③ Heating pipe
④ Lead cable

Fig. 19 Strip Type Anti-condensation Heater for Explosion-proof Machines with “increased safety” (Example, delivered design may deviate in details)



The heating tube has a heating conductor which is embedded in insulating material and arranged inside a corrosion-resistant metal tube. The tube ends are sealed to prevent the ingress of moisture.

3) Installation

The anti-condensation heater consists of one or more tubular heating elements connected together. These heating tubes are combined to form units and are installed in the stator frame. The arrangement constitutes the so-called “stabilized design”, i.e. the heating temperature stabilizes itself at the rated voltage thanks to the optimum balance of heater rating and heat dissipation. Special temperature monitoring devices are therefore not necessary. This applies to explosion-proof versions as well.

9.2 Installation

1) Connecting the Supply Cable

The heater connections are brought to terminals which are located in a separate terminal box and may be made without cable lugs.
Connection must be made in accordance with wiring diagram documented in the approval specification.
Examine the data plate to see that the voltage and the power of the heating agree with the main supply. The supply connection of the heaters must be interlocked with the main breaker of the machine to ensure that the heaters are switched off when the machine is running and switched on once the machine has come to a standstill.

Through appropriate series connection of the heating tubes, even the temperature of explosion

– proof machines can be limited such that these machines meet the requirements of “stabilized design” and do not require any additional temperature monitoring measures. For this reason, no changes may be made in the original heating-tube connection!

2) Insulation Testing

The heater may only be put into operation if the specified minimum insulation value of 0.5 Mega-ohm is obtained from measurement of the insulation resistance with the heater connected.
For the period after commissioning of machines equipped for anti-condensation heating, it is assumed that either the machine itself is in operation or the anti-condensation heater is heating the stationary machine.

9.3 Maintenance

Hazardous Voltage.
Will cause death, serious injury, electrocution or property damage.
Disconnect all power before working on this equipment.

1) Safety Advice

The anti-condensation heater is switched on when the machine has come to a standstill. Therefore, it must be switched off before any protecting cover is opened for maintenance work.

2) Cleaning

With respect to maintenance, occasional cleaning performed during routine maintenance of the machine and the replacement of any damaged parts is sufficient.

3) Repairs

Should replacement of the heating tubes become necessary use the same type of heaters. Install the new tubes securely and lock the fixing elements.
The heating tube units in explosion-proof machines may only be replaced as a whole and must be purchased as whole preformed units to suit the particular application.
If repairs and modifications to models covered by the certificate for these machines are not performed in a HYUNDAI workshop, an acceptance inspection by an authorized engineer is necessary. If modifications not covered by the certificate are made, the machine must be newly certified.

10.1 Flange-type Sleeve Bearings (Ring Lubrication System)

1) Mounting

The flange-type sleeve bearings of electrical machines are of the split type. They are ring-lubricated and are subject to the following instructions supplementing and modifying the operating instructions of the machine:
Corresponding to the operating conditions the sleeve bearings of new machines have a favorable bearing clearance which should not be changed. Also scraping (spot grinding) is not allowed as it could worsen the antifriction qualities.
It is possible to remove the upper part of the bearing housing for maintenance without removing the coupling. And using the crane or chain block is good method in dismantling.
Before the machines are aligned and commissioned, the bearings should be filled with lubricating oil, because the machines are delivered without oil in the bearings (Oil type is indicated on the nameplate for bearing).

2) Oil Change

⚠ CAUTION	**Maintain Proper Oil Level.** May cause damage to equipment due to improper lubrication. Follow lubricating instructions carefully. Avoid adding oil while unit is running.

Check the bearing temperature regularly. The governing factor is not the temperature rise itself, but the temperature variations over a period of time. If abrupt variations without apparent cause are noticed, shut down the machine and renew the oil.
The lubrication oil indicated on the data plate is used for starting up the machines at an ambient temperature of above +5°C At lower temperatures (to about -20°C), it is sufficient to preheat the oil. If the ambient temperature is below -20°C another type of oil according to the special conditions is used. Do not mix oils of different grades.
Recommended oil changing intervals are about one operating year in the case of intermittent and continuous duty. When cleaning, first flush the bearings with kerosene and then with oil. Pour in the kerosene and oil through the top sightglass hole. Leave the drain open until all the kerosene has been removed and clean oil runs out. Now plug the drain and fill the bearing with oil up to the centre of the lateral inspection glass.
When the machine has run up to speed, check the oil ring through the top inspection glass to see that it rotates correctly, and check the bearing temperature, Should the bearing temperature not drop to the normal value after the oil change, it recommended that the surfaces of the bearing shells be inspected.
If the bearings are fitted with thermometers for checking the bearing temperature, fill the thermometer well in the upper bearing shell for thermofeeler with oil to improve heat transfer and top up with oil every time the lubricating oil is changed.

3) Dismantling, Assembling

When dismantling the machine the lower part of the bearing housing need not be unscrewed from the end shield, When opening the bearing housing, determine, if on which side of the machine the adjusting shims.(upper and lower parts)are installed. These shims must be installed at the same place when assembling the machine. Exceptions are possible if the stator core was changed.
Drain the oil, take off the upper part of the bearing housing and the upper bearing shell, lift the shaft very slightly and turn out the lower bearing shell and the sealing rings in peripheral direction. The oil ring can be withdrawn by holding it at an inclined position to the shaft.
If only slight damage has occurred to the bearing surface, it may be re-conditioned by scraping as long as the cylindrical shape of the bore is maintained, so that a good oil film can form. The lining must be renewed if more serious damage is found. The oil pockets and grooves of the new lining or scraped shell should be cleaned and finished with particular care

The replacement bearing shells are delivered by the works with a finished inner diameter. Only if the bearing shells were delivered unfinished, the inner diameter is 1mm smaller than the finished diameter. Oil rings which have become bent through careless handling will not turn evenly. Straighten or replace such rings. Replace any damaged sealing rings.

Fig. 20 Oil Pockets and Oil Grooves

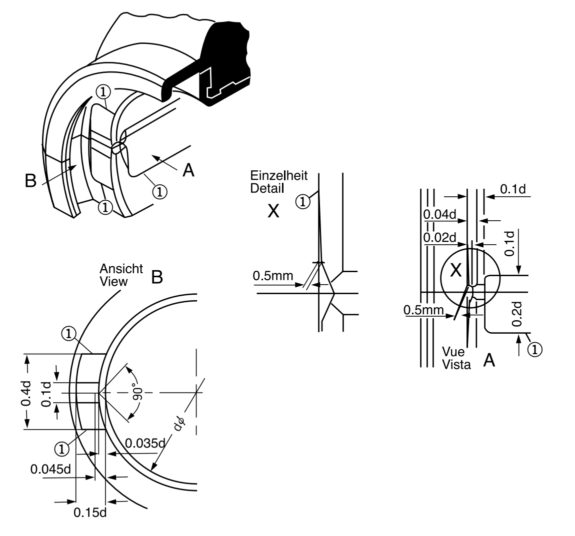
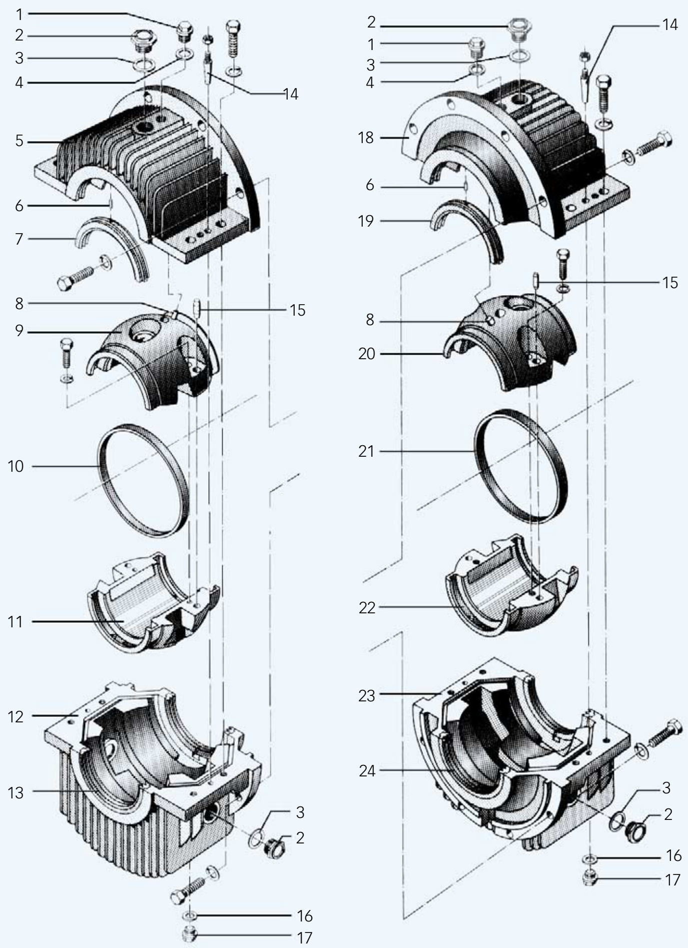
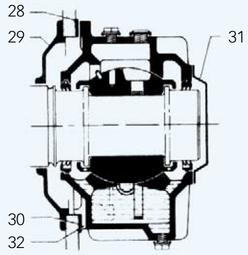
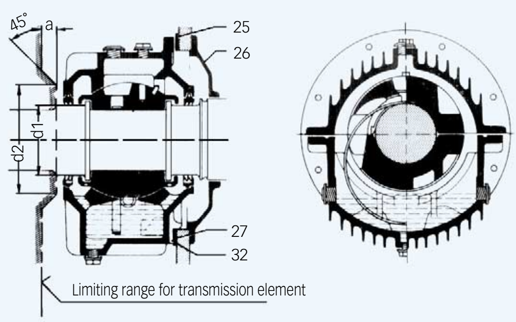


Fig. 21 Ring-lubricated Flange-type Sleeve Bearings (Example, delivered design may deviate in details)







1. Screw plug(thermometer mounting)
2. Inspection glass
3. Sealing ring for 2
4. Sealing ring for 1
5. Bearing housing, upper part drive end
6. Cylindrical pin
7. Sealing ring, upper half, drive end
8. Guide pin to prevent twisting
9. Upper bearing shell, drive end
10. Oil ring, drive end
11. Lower bearing shell, drive end
12. Bearing ring, lower half, drive end
13. Sealing ring, lower half, drive end
14. Taper pin
15. Guide pin to fix bolted parts
16. Sealing ring for 17
17. Drain plug
18. Bearing housing, upper part, non-drive end
19. Sealing ring, upper half, non-drive end
20. Upper bearing shell, non-drive end
21. Oil ring, non-drive end
22. Lower bearing shell, non-drive end
23. Bearing housing, lower part, non-drive end
24. Sealing ring, lower half non-drive end
25. Upper adjusting shim, drive end
26. Sealing cover drive end
27. Lower adjusting shim, drive end
28. Upper adjusting shim, non-drive end
29. Sealing cover, non-drive end
30. Lower adjusting shim, non-drive end
31. Protective cap
32. Pressure compensation opening

10.2 Flange-type Sleeve Bearings (Forced Lubrication System)

1) Mounting

These flange bearings of electrical machines are of the split type. They are lubricated and oil rings and are provided for additional forced lubrication. They are subject to the following instructions supplementing and modifying the operation instructions of the machine: Corresponding to the operating conditions the sleeve bearings of new machines have a favorable bearing clearance which should not be allowed to worsen the antifriction qualities. It is possible to remove the upper part of the bearing housing for maintenance without removing the coupling. And using the crane or chain block is a good method in dismantling.

Before the machines are aligned, the bearings should be filled with lubricating oil (oil type is indicated on the nameplate for bearing), because the machines are delivered without oil in the bearings.

Check the oil piping to the bearings, oil pump, oil tank, and cooler before commissioning the machines. No reducers must be fitted in the piping. Install a regulating orifice on the oil supply line to protect the bearing from flooding. If the oil pump fails, the lubrication maintained by the oil ring is effective for about 15 to 30 minutes, provided the oil contained in the bearing does not drain away. As the oil is discharged to the atmospheric pressure, the discharge-end of oil piping shall be positioned at the lower level about over 500mm than the level of oil suface. And the diameter of piping shall be sufficient enough so as not to be clogged during the oil discharging to raise the level of the oil in the bearing. Oil discharge tubes must terminate flush with the inside surface of the bearing housing to prevent the oil rings from rubbing against the tubes.

Fill the oil tank with lubricating oil indicated on the data plate. This oil is used for starting up the machine at an ambient temperature of above +5°C At lower temperatures preheat the oil. It is recommended to use a control system adjusted in such a manner to have an oil temperature of 15 to 20°C in the tank and to have a preheated oil flow through the cold bearings for 5 to 10 minutes before starting up the machine. Do not mix oils of different grades.

The necessary pressure of the oil entering the bearings and the oil flow rates are indicated on the data plate. Adjust to these values when starting up the machine for the first time and correct them when the bearing has attained its normal running temperature. The oil in the bearing housing must not rise above the center of the lateral inspection glass.

If the bearings are fitted with thermometers for checking the bearing temperature, Install the thermometer in the upper bearing shell for the thermofeeler with oil to improve heat transfer and top up with oil every time the lubricating oil is changed.

In the case of insulated bearings, make sure that the insulation is not bridged by the tubes; interrupt the electrical conductivity of the tubes near the bearings, e.g. by installing oil-resistant fittings of plastic material or hoses of rubber or plastic material.

Switch on the oil pump before starting up the machine. The use of a pump driven from the shaft of the main machine is permitted only in special cases, i. e. when the acceleration and coasting times are short.

2) Oil Change

⚠ CAUTION	**Maintain Proper Oil Level.** May cause damage to equipment due to improper lubrication. Follow lubricating instructions carefully. Avoid adding oil while unit is running.

Check the bearing temperature regularly. The governing factor is not the temperature rise itself, but the temperature variations over a period of time, if abrupt variations without apparent cause are noticed, shut down the machine and renew the oil.

Recommended oil changing intervals are about 20,000 operating hours. After the machine has come to a standstill and the old oil is drained out of the bearings and oil tank operate the oil pump with kerosene for a short time and then use oil to clean the bearings, the oil pump, the oil tank, the cooler and the pipe lines. Pour in the kerosene and then the oil through the filling opening of the oil tank. Leave the drains open from time to time until all the kerosene has been removed and clean oil runs out of the bearings and the oil tank. Then, plug the drains and fill the tank with oil. Should the bearing temperature not return to the normal value after the oil change, it is recommended that the surfaces of the bearing shells be inspected.

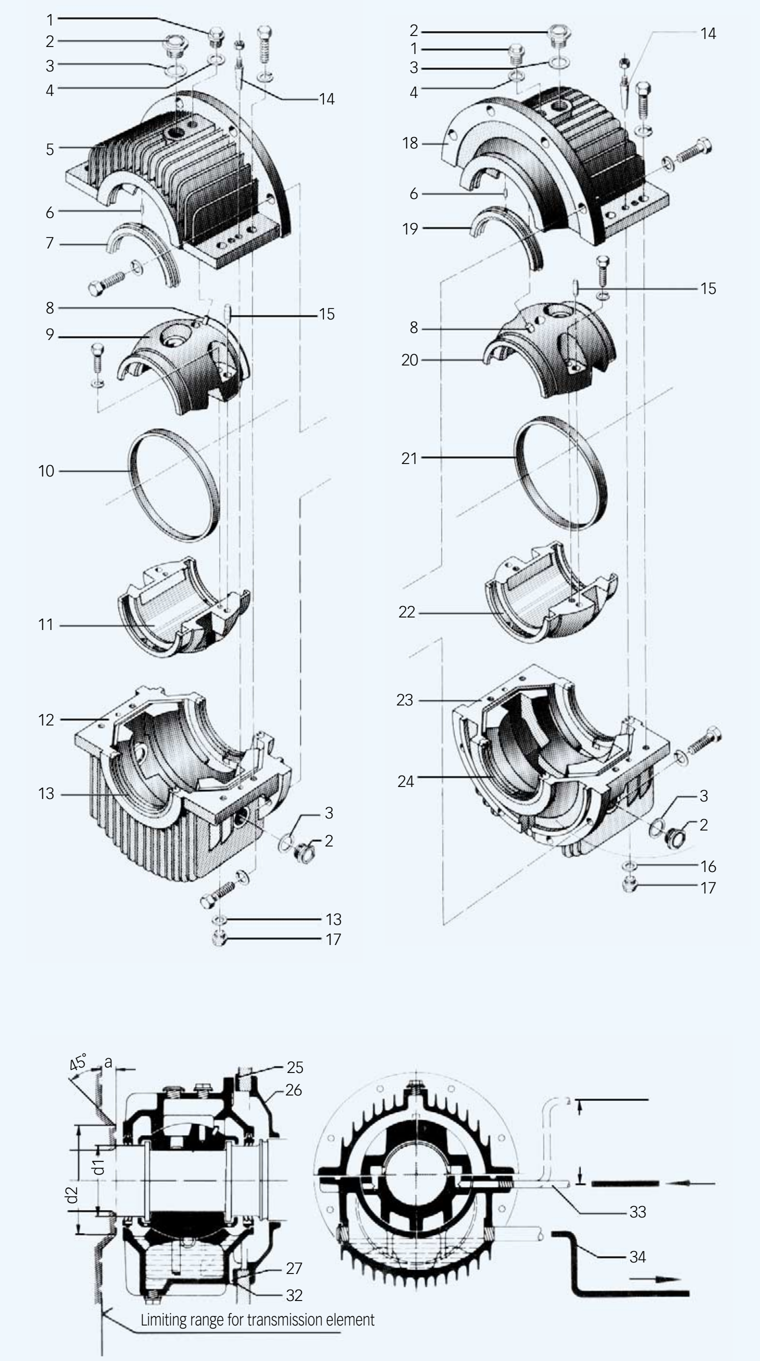
3) Dismantling, Assembling

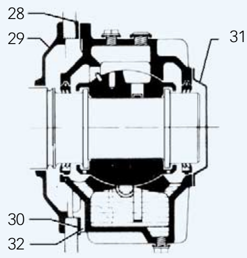
When dismantling the machine the lower part of the bearing housing need not be unscrewed from the end shield. When opening the bearing housing, determine on which side of the machine the adjusting shims (upper and lower parts) are installed. These shims must be installed at the same place when assembling the machine. Exceptions are possible, if the stator core was changed. Drain the oil, take off the upper part of the bearing housing and the upper bearing shell, lift the shaft very slightly and turn out the lower bearing shell and the sealing rings in peripheral direction. The oil ring can be withdrawn by holding it at an inclined position to the shaft.

If only slight damage has occurred to the bearing surface, it may be re-conditioned by scraping as long as the cylindrical shape of the bore is maintained, so that a good oil film can form.
The lining must be renewed if more serious damage is found. The oil pockets and grooves of the new lining or scraped shell should be cleaned and finished with particular care.

The replacement bearing shells are delivered by the works with a finished inner diameter. Only the bearing shells were delivered unfinished, the inner diameter is 1mm smaller than the finished diameter. Oil rings that have become bent through careless handling will not turn evenly. Straighten or replace such rings. Replace any damaged sealing rings.

➡ Fig. 22 Flange-type Sleeve Bearing for Forced-oil Lubrication (Example, delivered design may deviate in details)





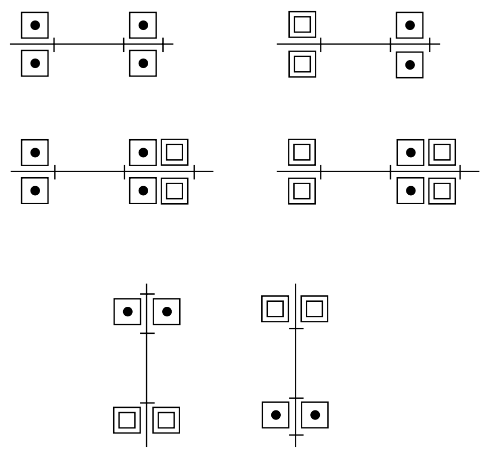
1. Screw plug(thermometer mounting)
2. Inspection glass
3. Sealing ring for 2
4. Sealing ring for 1
5. Bearing housing, upper part drive end
6. Cylindrical pin
7. Sealing ring, upper half, drive end
8. Guide pin to prevent twisting
9. Upper bearing shell, drive end
10. Oil ring, drive end
11. Lower bearing shell, drive end
12. Bearing ring, lower half, drive end
13. Sealing ring, lower half, drive end
14. Taper pin
15. Guide pin to fix bolted parts
16. Sealing ring for 17
17. Drain plug
18. Bearing housing, upper part, non-drive end
19. Sealing ring, upper half, non-drive end
20. Upper bearing shell, non-drive end
21. Oil ring, non-drive end
22. Lower bearing shell, non-drive end
23. Bearing housing, lower part, non-drive end
24. Sealing ring, lower half non-drive end
25. Upper adjusting shim, drive end
26. Sealing cover drive end
27. Lower adjusting shim, drive end
28. Upper adjusting shim, non-drive end
29. Sealing cover, non-drive end
30. Lower adjusting shim, non-drive end
31. Protective cap
32. Pressure compensation opening
33. Oil supply tube with orifice
34. Oil discharge tube with sight glass

10.3 Rolling-contact Bearings

1) Mounting

Electrical machines fitted with rolling-contact bearings mentioned above are subject to the following instructions supplementing and modifying the operating instructions of the machine:
The locating bearings are deep-groove ball bearings for horizontally mounted machines. These bearings may also be in pairs with cylindrical roller bearings in the case of bearings is not guide radially and is prevented from rotating by compression springs.
The locating bearings for vertically mounted machines are angular-contact ball bearings of type range 72 or 73 (angular-contact ball bearings with increased axial fixation see supplementary operating instructions).
The floating bearings are deep-groove ball bearings or cylindrical roller bearings. In case of deep-groove ball bearings as floating bearings, the axial play is compensated by means of compression springs.

Fig. 23 Examples for Bearing Combination



- Deep-groove ball bearing
- Cylindrical roller bearing
- Angular contact ball bearing

2) Regreasing

NOTE: A common mistake is over-lubrication of bearings. When grease is added without removing the drain plug, the excess grease must go somewhere and usually it is forced into and through the inner bearing cap and is then thrown into the windings. Excess grease in the bearing can cause bearings to run hot and could lead to bearing failure.

Initial lubrication of the bearings is normally carried out in the works with grease satisfying the conditions of running test at a test temperature of 120°C to DIN 51 806. If a different type of grease is required, this is indicated on the data plate, provided that the particular operating conditions were given in the order.
Keep the new grease meticulously clean. Greases having a different soap base should not be mixed since this would reduce the grease quality.
For regreasing, clean the lubricating nipple and press in the grease quantity indicated on the data plate, using a grease gun. The shaft should rotate during regreasing; hence, the machines need not be stopped. After regreasing, the bearing temperature will rise by a few degrees and will drop to the normal value when the grease has reached its normal service viscosity and the excess grease has been forced out of the bearing.
It is recommended that the lubricating instructions be strictly followed. Special cases may require lubrication to special instructions, e.g. where there is an extreme coolant temperature or aggressive vapours. The old grease from several regreasing operations gathers in the space inside the outer bearings caps. Remove the old grease when overhauling the machines.
The model of bearing is favorably chosen as for direction and size of load (type of construction, forces acting on the shaft) and therefore it should not be changed.
The permissible values of axial and radial forces may be taken from the list of machine.
The machines should operate in only one type of construction as shown on the rating plate, because another type of construction required perhaps further measures in addition to a modification of the model of bearing. Always in this case an inquiry is necessary.

3) Lubrication

In case the machines are stored at warehouse or storage area for longer than 6 months, the existing lubricant shall be poured out and be replaced with new one.
The regrease interval for grease is 3 months, and the replacement interval for oil is 6 months. In case of 2 pole motor, refer to the lubrication name plate.

4) Dismantling, Assembling

CAUTION	**May cause bearing damage(brinelling) if outer race of bearing is struck.** BECAREFUL When replacing bearing. Avoid subjecting bearing to impact.

For working on the locating bearing in the vertical position of the machine, support or discharge the rotor.

It is recommended that new roller bearings be installed as follows: Heat the ball bearings or the inner ring of the roller bearings in oil or air to a temperature of approx. 80°C and slip them onto the shaft. Heavy blows may damage the bearings and must be avoided.
When installing single angular-contact ball bearings, make sure that the broad shoulder of the inner ring (and the narrow shoulder of the outer ring) in operating position points upwards, i.e. in a direction opposite to that of the axial thrust.
When assembling the machines, avoid damage to the sealing rings. Rubber sealing rings (V-rings) should be carefully fitted over the shaft as shown Fig. 28. New felt sealing rings should be so dimensioned that the shaft can run easily while proper sealing is still effected. Before fitting new rings, soak them thoroughly in highly viscous oil (normal lubricating oil N68 to DIN 51 501) having a temperature of approx. 80°C.

5) Locating Faults

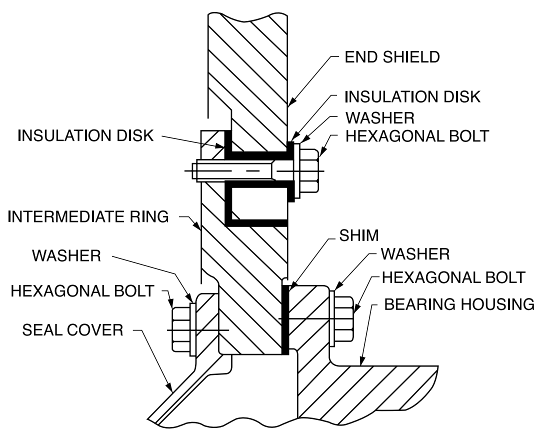
The troubleshooting table helps to trace and remove the causes of faults. It is partly difficult to be found the damages of bearings. In case of doubt, it is recommended to renew the bearings.

10.4 Insulation to Prevent Shaft Current (High-voltage and Large Machines)

NOTE: Not all machines are equipped with insulated bearings.

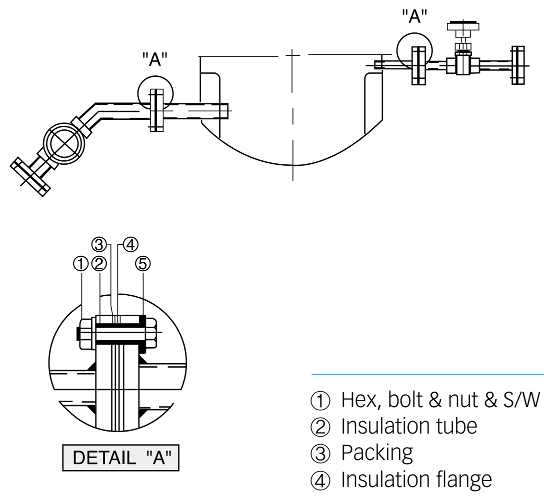
To prevent the risk of bearing damages due to the circulating shaft current, which is induced by shaft voltage, the insulation disk is provided at the end shield as shown in Fig. 24.

Fig. 24 Bearing Insulation



With motors having single shaft extension, the bearing at non-drive end is insulated. In case of motors with double shaft extension, both bearings are insulated. When the motors with the double shaft are coupled with the driven load, one of the couplings must be insulated to prevent the damage of other shaft connected equipments.

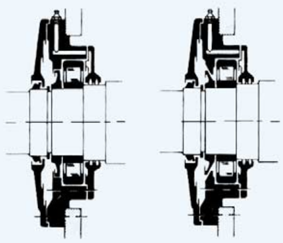
Fig. 25 Bearing Cooling Pipe System for Forced-oil Lubrication



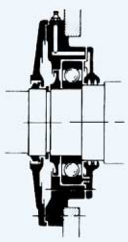
① Hex, bolt & nut & S/W
② Insulation tube
③ Packing
④ Insulation flange
⑤ Insulation washer

Care should be taken to prevent shorting out this insulation. All lines (lubrication oil pipes, V.T.D., vibration sensors, etc) fitted at the workshop are insulated from the end shield, but it is necessary to ascertain whether or not the insulation is required for all lines which are connected at the time of the motor installation at the site.
The bearing cooling pipe for forced-oil lubrication is insulated as shown in Fig. 25. The shaft voltage (peak to peak) is usually high frequency voltage of 1 volt or les and rarely several volts. When a shaft current by this voltage flows, the shaft and journal part are tarnished and in the worst case sparking can make minute black spots on shaft and journal parts. There is a possibility that the oil film will be locally broken by electrical spark.
When disassembling or assembling, be sure to measure the insulation resistance. Measure the insulation resistance between the shaft and the earth using no more than 100 VDC. The insulation resistance is acceptable if the resistance value is more than 10㏀.

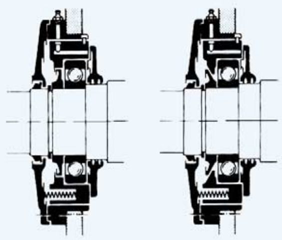
Fig. 26 Floating Bearings (Example, delivered design may deviate in details)



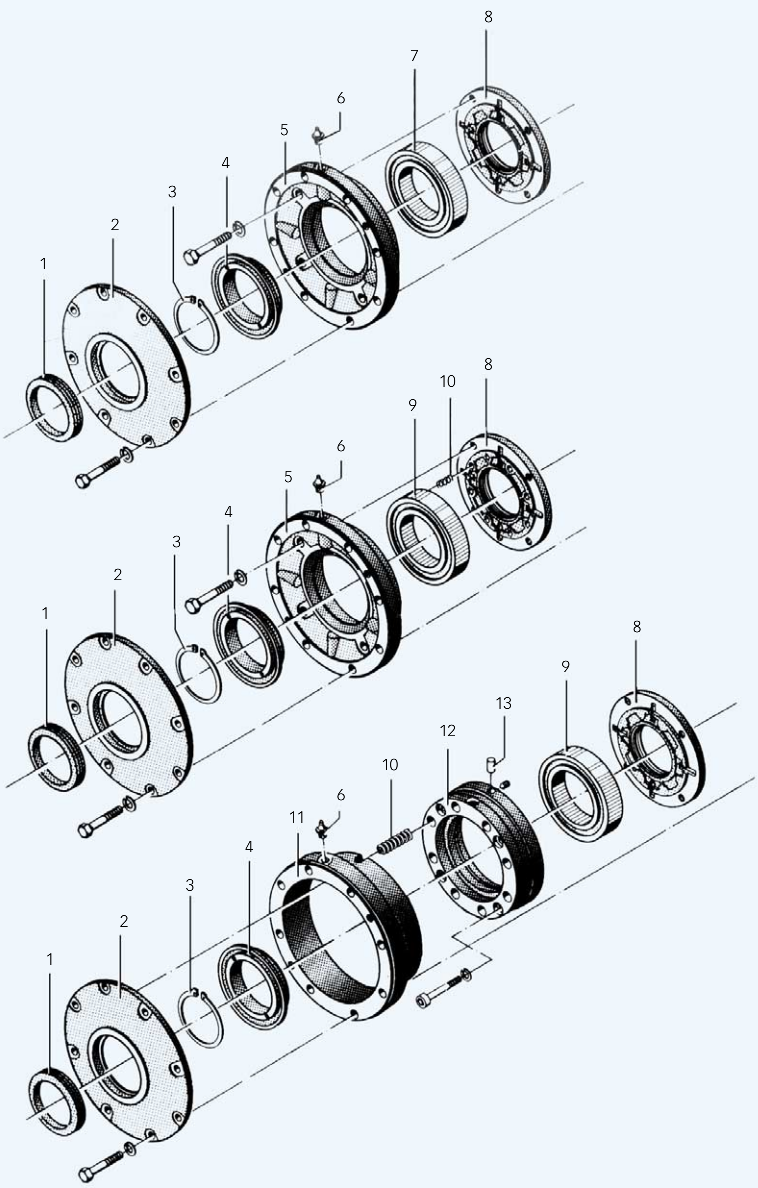
Cylindrical roller bearing



Deep-groove ball bearing
with compensation of axial play



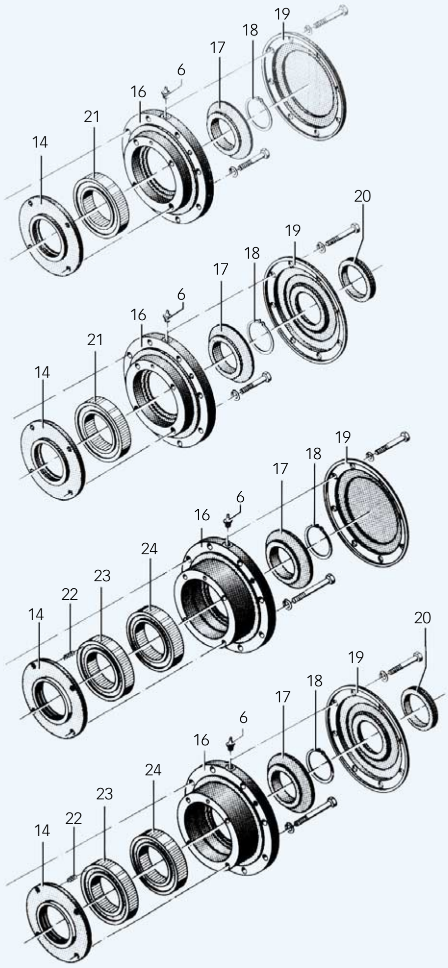
Deep-groove ball bearing with compensation of axial play, with bearing housing bush and intermediate ring

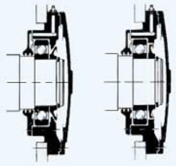


1. V-ring [1)]
2. Outer bearing cap [1)]
3. Circlip [1)]
4. Grease slinger [1)]
5. Bearing housing [1)]
6. Lubricating nipple
7. Cylindrical roller bearing [1)]
8. Inner bearing cap with felt sealing rings [1)]
9. Deep groove ball bearing (floating-bearing)
10. Compression spring [1)]
11. Bearing housing ring
12. Bearing housing bush
13. Cylindrical pin

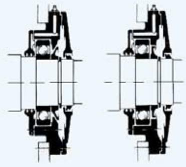
[1)] Floating bearing side

Fig. 27 Locating Bearings (Example, delivered design may deviate in details)

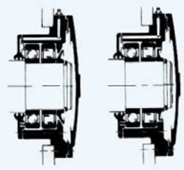




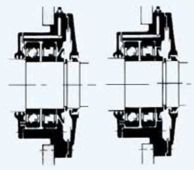
Single bearing, shaft does not pass through the outer bearing cap



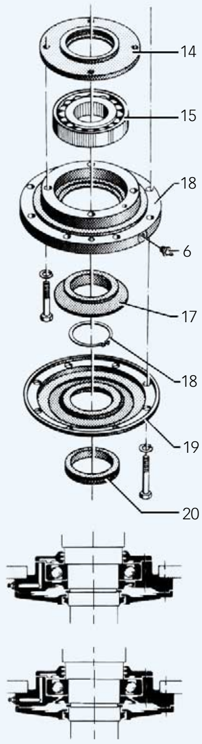
Single bearing, shaft passes through the outer bearing cap



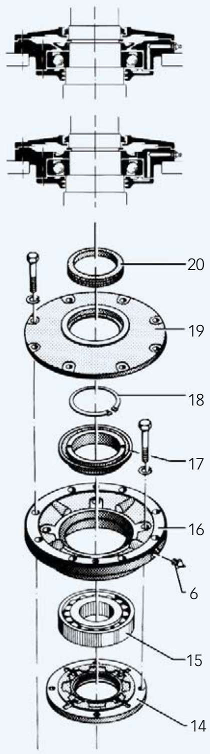
Duplex bearing, shaft does not pass through the outer bearing cap



Duplex bearing, shaft passes through the outer bearing cap

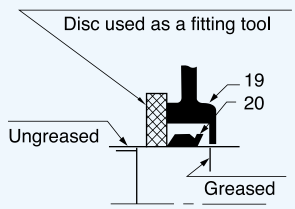


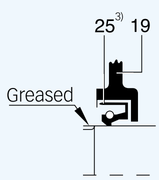
Angular-contact ball bearing placed below



Angular-contact ball bearing placed above

Fig. 28 Fitting Instructions for V-ring and Oil Seal for Shaft



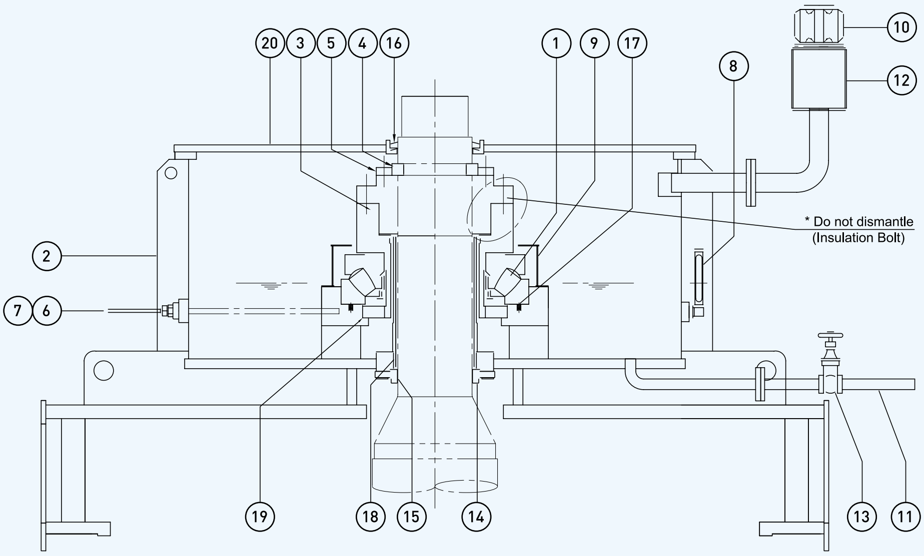


Single bearing, shaft does not pass through the outer bearing cap.

14. Inner bearing cap with felt sealing rings [2]
15. Angular-contact ball bearing
16. Bearing slinger [2]
17. Grease slinger [2]
18. Circlip [2]
19. Outer bearing cap [2]
20. V-ring [2]
21. Deep-groove ball bearing(Locating bearing) or angular-contact ball bearing
22. Compression spring [2]
23. Deep-groove ball bearing [2]
24. Cylindrical roller bearing [2]
25. Oil seal for shaft [1)2)3)]

[1)] Floating bearing side
[2)] Locating bearing side
[3)] Special operating conditions only

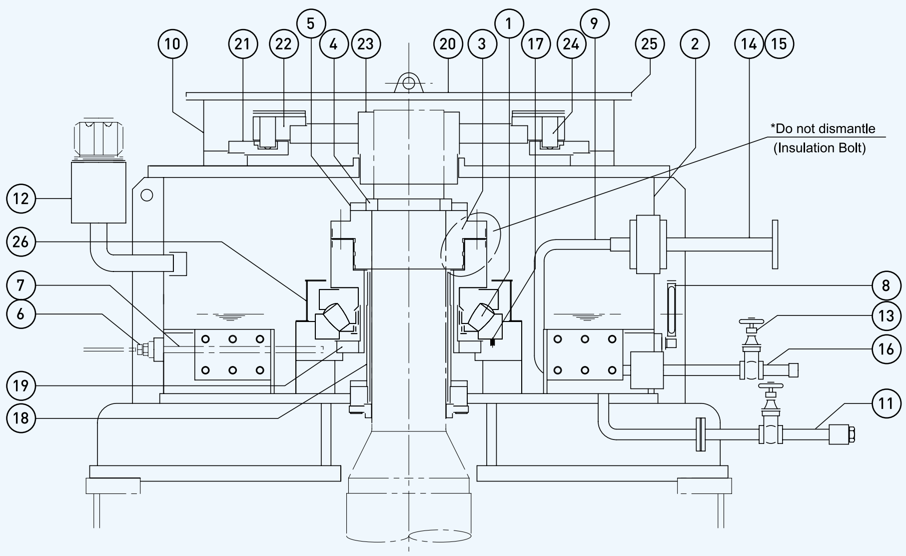
Fig. 29 Replacement Procedure for Upper Bearing(Upper Bearing Assembly Drawing)



NO.	Description	NO.	Description	NO.	Description
1	Bearing	8	Oil Level Gauge	15	Bearing Inner Cap Packing
2	Upper Bearing Support	9	Oil Cover	16	V-ring
3	Bearing Runner	10	Air Breather	17	Spring
4	Ring Key	11	Oil Drain Pipe	18	Guide Pipe
5	Ring	12	Oil Cup	19	Guide Bushing
6	Bearing Temp. sensor	13	Globe Valve	20	Top Cover
7	Thermo well	14	Bearing Inner Cap0		

1. It is requested to check and confirm an availability to lift up pump shaft coupled with motor about 1.0 to 1.5 mm. If not available, motor shall be disconnected with pump and proper measure to lift up rotor shall be established depend on uncoupled status.
2. Dismantle V-ring (Item No. 16 shown on above drawing).
3. Dismantle Top Cover (Item No. 20 shown on above drawing).
4. Fully drain out bearing oil.
5. Dismantle coupling cover to install hydraulic jack.
6. Install hydraulic jack (3 point) on lower of pump coupling. If three (3) points of jack are not available due to space problem, two (2) points are acceptable.
7. To check lift up of shaft, install two (2) points of dial gauge on motor bottom bracket. Dial gauges (1/100 mm) are used for checking.
8. Jacking up to lift 0.5 mm.
9. Dismantle ring (Item No. 5).
10. Dismantle ring key (Item No. 4). If ring key cannot be dismantled, jacking up 0.5 mm additionally and try to dismantle again.
11. Set special JIG using crane and install stud bolts and nuts between top of bearing runner (Item No. 3) and JIG.
12. Install hydraulic jack between JIG and shaft top.
13. Jacking up JIG and dismantle bearing runner.
14. Dismantle bearing from bearing runner after heating by gas torch.
15. Dismantle racer & pressure spring (Item No. 17).
16. Dismantle guide bushing (Item No. 19) and cleaning inside of bearing support.
17. Assemble new bearing to bearing runner after heating by electric heater. If heater is not available, oil heating is acceptable.
18. Start reassembly in accordance with reverse sequence of above.
19. After completion of assemble, try hand turning to confirm condition.

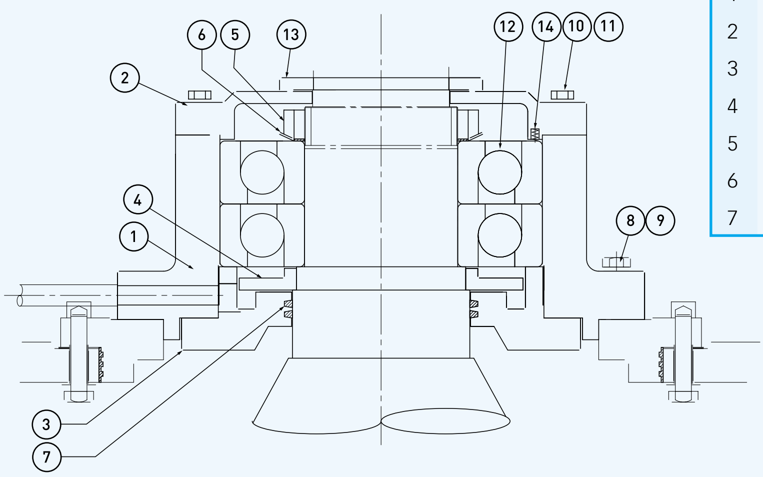
Fig. 30 Replacement Procedure for Upper Bearing(Upper Bearing Assembly Drawing)



NO.	Description	NO.	Description	NO.	DESCRIPTION
1	Bearing	10	Ratchet Housing	19	Guide Bushing
2	Upper Bearing Support	11	Oil Drain Pipe	20	Support Cover
3	Bearing Runner	12	Oil Cup	21	Non-Reverse Ratchet
4	Ring Key	13	Globe Valve	22	Pin Housing
5	Ring	14	Water Inlet Pipe	23	Ratchet Runner
6	Bearing Temp. sensor	15	Water Outlet Pipe	24	Ratchet Pin
7	Thermo well	16	Water Drain Pipe	25	Ratchet Pin Cover
8	Oil Level Gauge	17	Spring	26	Oil Cover
9	Heat Exchanger	18	Guide Pipe		

1. It is requested to check and confirm an availability to lift up pump shaft coupled with motor about 1.0 to 1.5 mm. If not available, motor shall be disconnected with pump and proper measure to lift up rotor shall be established depend on uncoupled status.
2. Dismantle Ratchet housing cover (Item No. 20 shown on above drawing).
3. Dismantle Pin housing, ratchet wheel (Item No.22 and 21)
4. Dismantle Ratchet Runner (Item No.23) and Ratchet housing(Item No.10)
5. Fully drain out bearing oil.
6. Dismantle coupling cover to install hydraulic jack.
7. Install hydraulic jack (3 point) on lower of pump coupling. If three (3) points of jack are not available due to space problem, two (2) points are acceptable.
8. To check lift up of shaft, install two (2) points of dial gauge on motor bottom bracket. Dial gauges (1/100 mm) are used for checking.
9. Jacking up to lift 0.5 mm.
10. Dismantle ring (Item No. 5).
11. Dismantle ring key (Item No. 4). If ring key cannot be dismantled, jacking up 0.5 mm additionally and try to dismantle again.
12. Set special JIG using crane and install stud bolts and nuts between top of bearing runner (Item No. 3) and JIG.
13. Install hydraulic jack between JIG and shaft top.
14. Jacking up JIG and dismantle bearing runner.
15. Dismantle bearing from bearing runner after heating by gas torch.
16. Dismantle racer & pressure spring (Item No. 17).
17. Dismantle guide bushing (Item No. 19) and cleaning inside of bearing support.
18. Assemble new bearing to bearing runner after heating by electric heater. If heater is not available, oil heating is acceptable.
19. Start reassembly in accordance with reverse sequence of above.
20. After completion of assemble, try hand turning to confirm condition.

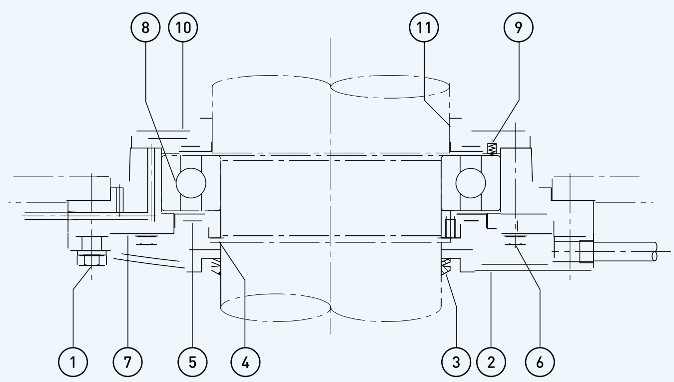
Fig. 31 Replacement Procedure for Upper Bearing(Upper Side Bearing Assembly Drawing)



NO.	Description	NO.	Description
1	Bearing Housing	8	Hex Bolt
2	Outer Bearing Cap	9	Spring Washer
3	Inner Bearing Cap	10	Hex Bolt
4	Slinger	11	Spring Washer
5	Lock Nut	12	Ball Bearing
6	Lock Washer	13	Sealing Disk
7	Inner Cap Packing	14	Compression Spring

1. It is requested to check and confirm an availability to lift up pump shaft coupled with motor about 1.0 to 1.5 mm. If not available, motor shall be disconnected with pump and proper measure to lift up rotor shall be established depend on uncoupled status.
2. Dismantle Grease pipes and Sealing disk (Item No. 13 shown on above drawing).
3. Dismantle Outer bearing cap (Item No. 02).
4. Install hydraulic jack (3 point) on lower of pump coupling. If three (3) points of jack are not available due to space problem, two (2) points are acceptable.
5. To check lift up of shaft, install two (2) points of dial gauge on motor bottom bracket. Dial gauges (1/100 mm) are used for checking.
6. Jacking up to lift 0.5 mm.
7. Dismantle Lock Nut and Washer (Item No.05 and 06)
8. Dismantle Bearing Housing (Item No.01).
9. Heating the bearing(Item No. 12) by gas torch.
10. Dismantle bearing from shaft. Be careful of shaft damage.
11. Dismantle grease slinger after heating by gas torch (Item No.04).
12. Dismantle Inner bearing cap (Item No.03).
13. Cleaning all items
14. Assemble new bearing to shaft after heating by electric heater. If heater is not available, oil heating is acceptable.
15. Start reassembly in accordance with reverse sequence of above.
16. After completion of assemble, try hand turning to confirm condition.

Fig. 32 Replacement Procedure for Lower Bearing(Bottom Side Bearing Assembly Drawing)



1. Dismantle Outer bearing cap and seal ring (Item No. 02 and 03 shown on above drawing).
2. Dismantle Circlip (Item No.04).
3. Dismantle grease slinger after heating by gas torch (Item No.05).
4. Dismantle Bearing Housing (Item No.07).
5. Heating the bearing (Item No. 08) by gas torch..
6. Dismantle bearing from shaft. Be careful of shaft damage.
7. Dismantle Inner bearing cap and Compression spring (Item No.09 and 10).
8. Cleaning all items
9. Assemble new bearing to shaft after heating by electric heater. If heater is not available, oil heating is acceptable.
10. Start reassembly in accordance with reverse sequence of above.
11. After completion of assemble, try hand turning to confirm condition.

11 Air Filter and Cooler

11.1 Air Filter

Air Filter Cleaning Period

The cleaning period depends on the site conditions and can change. The cleaning of the filter is required if the record of the stator winding temperature (using the stator winding sensors) indicates an abnormal increase in temperature.

Air Filter Cleaning Procedure

The filter element (flat or cylindrical) is immersed in a tank of cold or warm water (temperature less than 50°C). Use water with detergent added.
Shake the filter gently to ensure that the water flows through the filter in both directions.
When the filter is clean, rinse it with clear water.
Drain the filter properly (there must be no formation of droplets).
Refit the filter on the machine.

CAUTION	Do not clean the filter using compressed air. This procedure would reduce filter efficiency.

11.2 Cooler

1) General Points

The purpose of the cooler is to remove machine heat losses (mechanical, ohmic, etc). The exchanger is located on the top of the machine.

Normal Operation

The air is pulsed by a fan fixed to the machine shaft.

Description of Air-Water Double Tube Exchanger

The double-tube technique keeps the cooling circuit from being affected by possible water leakage. The double tube provides a high safety level. In case of leakage, the water goes from the inside of the internal tube to the coaxial space between the two tubes. The water is drained axially to a leakage chamber where it may activate a sensor. An exchanger comprises a fin-tube block containing :
- a steel frame
- a fin-tube block expanded mechanically to the tubes.

The tube bundle is roll-expanded in the end plates. The water distribution in the tubes is provided by two removable water boxes. A water box is equipped with collars for fitting the inlet and outlet lines. Neoprene seals ensure the water box and the end plate joints.

2) Cleaning

The frequency of cleaning operations depends essentially on the purity of the water used. We recommend a minimum of one inspection per year. The life of zinc block for anticorrosion is about a year. Therefore, replace it with a new one every year.
Cut off the water supply by isolating the inlet and outlet lines and drain the water. Disconnect the leak sensor (option with double-tube cooler) and make sure that there are no leaks. Remove the water boxes on each side of the machine. Rinse and brush each water box.

NOTE: Do not use a hard wire brush, as this will remove the protective tar-epoxy layer formed on the surface of the water boxes. Clean each tube with a metal scraper. Rinse in soft water. Keep the leakage chamber dry (double-tube water-cooler only).

3) Stop the Machine

Leak detection for a double-tube exchanger. If a leak is detected, cut off the power supply of the water in/outlet lines and change to emergency operations, it is necessary to ascertain and repair it. Remove the two water boxes, apply a slight positive pressure in the leakage chamber and thus between the two tubes (only concerns double-tube coolers). If a tube is damaged, plug it at both ends. Use a tapered plug. The plug should preferably be made of saltwater-resistant aluminum bronze or of a synthetic material.

4) Leak Detection (Float System)

A magnet float activates a switch located in the float-guiding rod.

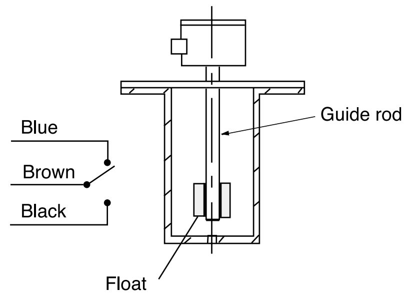


Fig. 33 Leakage Detector

5) Cooler Removal

The cooler unit is slid into its housing. It is possible to remove the cooler from the housing without removing the water boxes. The cooler is fastened to the housing via a series of screws on the housing. Remove the supply and return pipes. Provide two supports to hold the cooler when it comes out of its housing. Remove the cooler using slings that can be attached to the connecting flanges.

6) Cooler Reassembly

Carry out the operations of the “Cooler Removal” in the reverse order. Be careful to push the cooler completely into its housing before tightening the fastening screws of the cooler to the casing.

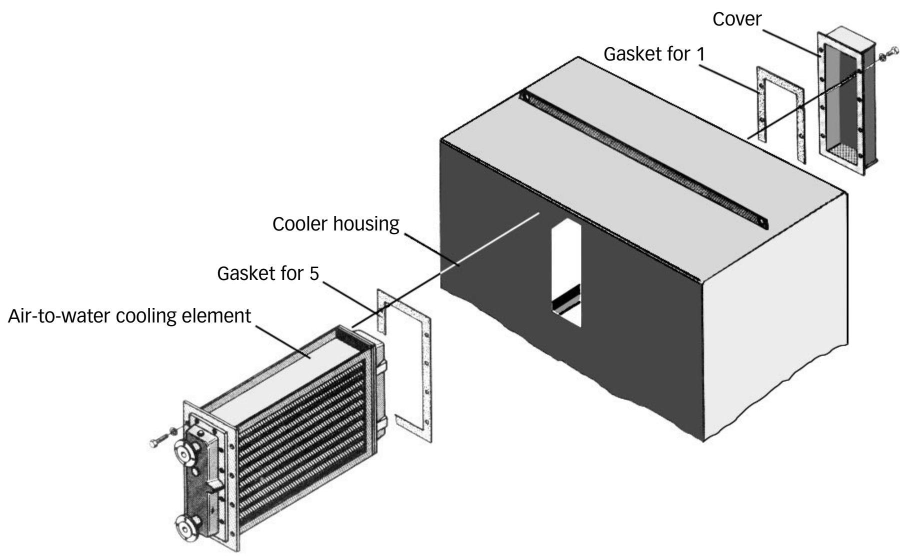


Fig. 34 Cooler Removal

12 Protection

General

It is our recommendation that all electric motors are fitted with motor protection. The preferred type of motor protection should provide the following protection features:

1) Current limit by a programmable thermal limit curve with thermal modeling based on winding temperature.
2) If RTD is installed for winding temperature detector, winding temperature detection by RTDs should have separated alarm and trip set points.
3) Ambient temperature RTD located in the motor ambient air stream.
4) If a bearing temperature indicator is installed, alarm and trip set points should be separated.
5) Calculation of motor thermal capacity available.
6) Ground fault detection.
7) Current unbalance detection.
8) Capacity for the protection system to learn motor cooling times.

A motor protection system with these features should reward you with better reliability and will allow you to optimize the motor to its maximum performance.

Protection Setting Recommended

Guide values for adjustment of tripping temperature.

Description	Temperature Rise 'B'			Temperature Rise 'F'		
	Permissible Max. Temperature	Alarm	Trip	Permissible Max. Temperature	Alarm	Trip
Winding Temperature	Max. 130 °C	130 °C	135 °C	Max. 155 °C	155 °C	160 °C
Bearing Temperature (Anti-friction*)	Max. 100 °C	100 °C	105 °C	Max. 100 °C	100 °C	105 °C
Bearing Temperature (Sleeve)	Max. 95 °C	95 °C	100 °C	Max. 95 °C	95 °C	100 °C
Current unbalance	Max. 10%	6% (10-sec delay)	10% (Inst.)	Max. 10%	6% (10-sec delay)	10% (Inst.)

- T means operation temperature including ambient temperature.
- Max. permissible temp. rise includes ambient temperature.

* When a suitable heatproof lubricant is used or a greasing interval is changed, the limit of temperature rise shall be determined by agreement between manufacturer and purchaser.

Induction Motor Troubleshooting

Hazardous Voltage.
Will cause death, serious injury, electrocution or property damage. Disconnect all power before working on this equipment.

Abnormality		Probable Cause	Remedy
Motor fails to start	Power source & line	1. Drop in line voltage	A check is to be made with a voltmeter.
		2. Great drop in voltage due to inadequate line capacity and impedance drop	a. A check is to be made on voltage at motor terminal before and at time of starting. b. Similar change in voltage is to be checked at motor terminal.
		3. Cut line or unbalanced	Defective parts are to be repaired.
	Starter	4. Erroneous wire connection	To be repaired
		5. Cut line or unbalanced voltage	To be reconditioned
		6. Drop in line voltage	Compensator tap connection is to be raised.
		7. Cut line or unbalance in starting resistor	Resistance is to be measured; repairs are to be made.
	Motor	8. Cutting of stator coil or of rotor coil	Resistance and current are to be measured, and repairs are to be made.
		9. Erroneous connection of stator coil	To be reconditioned
		10. Defect of rotor	a. Squirrel cage motor, rotor conductor is to be checked for disconnection. b. Wound motor, a check is to be made for line cutting and unbalance. c. Repairs or renewal is to be made.
		11. Stator core is in contact with rotor.	a. A check is to be made by turning by hand.
		12. Defective bearing	b. Bearing is to be disassembled and examined.
		13. Insufficient starting torque	a. Squirrel cage motor, motor is to be replaced with the one having larger capacity and of the wound type. b. Wound motor, tap for starting resistor is to be replaced.
	Load	14	Load is to be reduced.
Length of time required for acceleration after starting		1. Inadequately low voltage.	A check is to be made on voltage drop of power source and line.
		2. Defective rotor.	a. Squirrel cage rotor, rotor bar and end ring are to be checked for contact. b, Wound motor, a check is to be made on coil for unbalance and on brush for imperfect contact.
		3. Overload or inadequate torque	Load is to be checked, if load is normal, motor capacity is to be changed.

Abnormality	Probable Cause	Remedy
Rotation in reversal direction	Phase reversal	Two phases of U.V.W.(or R.S.T.) at starter or motor terminal are to be changed.
Motor body overheated	1. Overload	Load is to be reduced (to rated current)
	2. Overcurrent due to voltage drop	a. A check is to be made with a voltmeter power source. Voltage is to be raised. b. Load is to be reduced.
	3. Excessive iron loss due to overvoltage.	A check is to be made with a voltmeter power source. Voltage is to be reduced.
	4. Cut line or imperfect contact in one phase	To be reconditioned
	5. Short-circuiting and grounding of coil	Resistance and current are to be checked and reconditioned.
	6. Contact between stator and rotor	Judgment can be made according to noise; bent shaft, bearing, etc., are to be corrected.
	7. Inadequate ventilation due to dust.	Cleaning is to be carried out.
Vibration	1. Unbalance of rotor a. Bending of shaft b. Loose joint c. Residual unbalance d. Critical speed of shafting e. Dust attached to rotor f. Imperfect connection between coupling and shaft	 To be repaired To be tightened by bolts securely To be readjusted To be cleaned To be reconditioned
	2. Improper magnetic center	To be reconditioned
	3. Defective bearing	Refer to the "Bearing" section
	4. Coupling deflection	To be reconditioned
	5. Abnormal contact between shaft and stationary part, such as end cover, etc.	a. To be checked by turning manually b. To be disassembled for detecting defects
	6. Unsatisfactory contact of brush	Brush is to be checked for contact.
	7. Improper alignment	To be reconditioned
	8. Sinking of foundation	To be reconditioned
	9. Transmission of vibration from combined machine	Insulation for vibration
	10. Unequal pitch of claw coupling	Reconditioning of pitch
	11. Improper bush of flexible coupling	Reconditioning of pitch

Induction Motor Troubleshooting

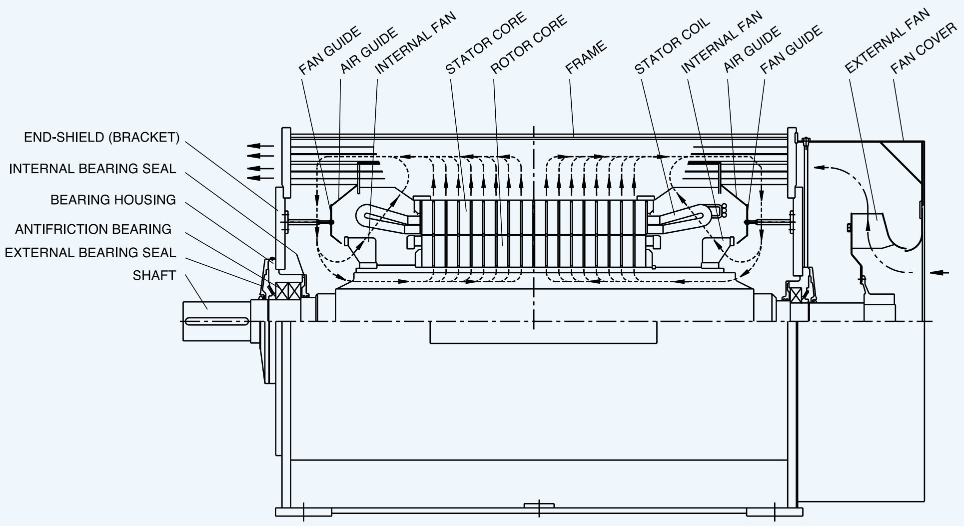
Abnormality	Probable Cause	Remedy
Noise	1. Disagreement of air gap	Causes are to be detected; repairs are to be made.
	2. Single-phase operation	Causes of single-phase operation such as line cutting and imperfect contact are to be detected; repairs are to be made.
	3. Short-circuits of layer and phase of stator coil and rotor coil	To be reconditioned
	4. Abnormal contact between shaft and stationary part such as end cover	1. A check is to be made by turning manually. 2. To be disassembled for inspection
	5. Unsatisfactory foundation and installation	Readjustment of installation
	6. Loose bolts for foundation	Foundation bolts are to be tightened.
	7. Gap between foundation and base	Reconditioning of installation
	8. Resonance with foundation	Readjustment of foundation
	9. Crackings at brazed joint rotor bar and end ring	To be disassembled and defective parts are to be repaired.
Unbalance of phase current	1. Voltage unbalance	Power source and lines are to be checked and balanced.
	2. Single-phase operation	Line cutting and improper contact are to be reconditioned.
	3. Secondary circuit	1. Rotor shaft coil resistance is to be measured and reconditioned. 2. Contact of brush or short-circuit ring is to be checked. 3. A check is to be made on endring contact of a squirrel cage motor.
Flaking (a) Flaking of rolling elements	1. Excess of tightening allowance	1. Care should be taken on shaft at time of assembling and on bearing box at time of matching.
	2. Erroneous selection of clearance	2. Clearance is to be reinspected.
	3. Minus operating clearance	3. Care should be taken at time of assembly.
	4. Thermal expansion	4. Examination of working condition
(b) Local flaking of a race	1. Inclusion of dust and other foreign substances or rust, bruises	
(c) Flaking all over a race (d) Flaking on component parts opposite to a race	1. Shaft or bearing box is distorted elliptically.	Machining accuracy and tightening of bearing box are to be checked.
	2. Improper tightening	
	3. Inaccuracy due to improper matching	
	4. Deterioration with time	

Abnormality	Probable Cause	Remedy
(e) Flaking all over around track center (f) Flaking across a race	Abnormal thrust load	Design of bearing system is to be checked.
	1. Shaft bending	
	2. Oblique fitting of outer and inner rings	
(g) Flaking similar to pitting on a race	1. Vibration during stoppage	Examination of working condition
	2. Rust	
Seizing (a) Race ring and rolling discolored and turned soft (b) Damage	1. Inadequate clearance	Proper clearance is to be provided.
	2. Inadequate lubrication	Oil amount of lubricant is to be checked.
	3. Improper overload of lubricant	Reconsideration of working condition and handling
Breakage (total or partial) (a) Fracture (b) Cutting	1. Advancement of flaking caused by shock and below. 2. Great tightening allowance & large round corner of fitted part	Careful handling Examination of tightening Examination of machining accuracy of shaft & bearing housing
Breakage of retainer (a) Fracture (b) Nonuniform abrasion (c) Wear of pocket section (d) Biting-off	1. Moment load 2. Rotation at shift speed 3. Inadequate lubrication 4. Inclusion of foreign substances	Careful handling and reconsideration of working condition Examination of oil supply and lubricant
Rust (a) Rust formed all over surface (b) Rust on local place (c) Contact erosion on joint surface	1. Unsatisfactory condition of storage 2. Left alone 3. Inadequate cleaning 4. Rust-preventive reagent 1. Unsatisfactory packing 2. Sweet 1. Inadequate allowance of tightening 2. Change in load	Inspection of storage room Careful handling Examination of rust-preventive reagent Reexamination of machining of shaft & bearing housing Reexamination of working condition
Wear (a) Abnormal wear of race and rolling element (b) Abnormal wear of retainer	1. Inclusion of foreign substances 2. Occurrences of wear Inadequate lubrication	Examination of lubrication and oil supply
Electrode (a) Crater-shaped depression and corrugated scars	Passage of current	Examination of design of bearing system

Abnormality	Probable Cause	Remedy
Dent and scratch (a) Indentation (on a race, etc.) (b) Aventurine hardening (c) Dents given during handling (d) Scratches during assembly	Dust and foreign substances pressed between race and body Careless handling (dropping, etc.)	Examination of handling and assembling conditions Careful handling Careful assembling
Smearing biting-off on a race and rolling element	1. Inadequate lubrication 2. Skewing of rolling element 3. Selection of lubricant	Examination of lubricant and lubricating condition
Creep wear of outer and inner surface, sliking and discoloring	1. Inadequate tightening allowance 2. Inadequate tightening of sleeve	1. Examination of tightening 2. Examination of machining accuracy of shaft and bearing box 3. Examination of design

14.1 HLA7 Horizontal-type Motor Construction

Fig. 1 HLA7 Horizontal-type Motor Construction (SQUIRREL CAGE)



*Disassembly and reassembly of HLA7 Type induction motor with antifriction bearing

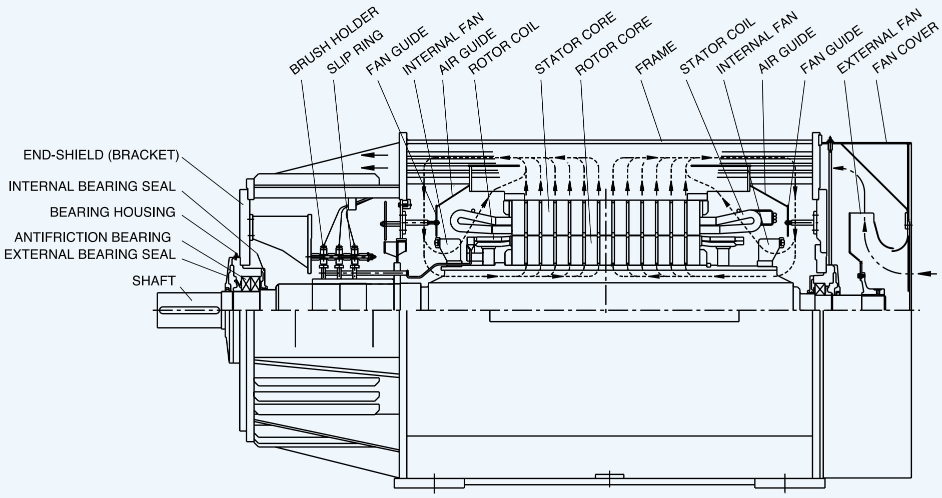
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 7 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, etc.)	
5.	Remove the fan cover	
6.	Remove the external fan	*Heat the fan hub to approx. 80~100°C both for easy assembly and for removal.
7.	Remove the external bearing seal and slinger installed on the bearing housing	
8.	Remove the bearing housing	
9.	Remove the antifriction bearing	
10.	Remove the end shield (bracket) with fan guide	
11.	Remove the air guide	
12.	Remove the rotor from the stator	

14.2 HLS7 Horizontal-type Motor Construction

Fig. 2 HLS7 Horizontal-type Motor Construction (WOUND ROTOR)



*Disassembly and reassembly of HLS7 Type induction motor with antifriction bearing

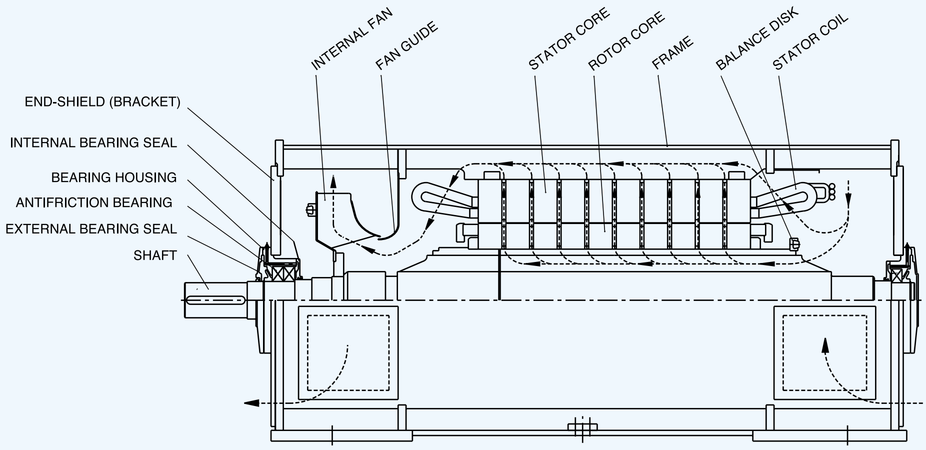
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 7 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, secondary t/box cable, etc.)	
5.	Remove the fan cover	
6.	Remove the external fan	*Heat the fan hub to approx. 80~100°C both for easy assembly and for removal.
7.	Remove the external bearing seal and slinger installed on the bearing housing	
8.	Remove the bearing housing	
9.	Remove the antifriction bearing	
10.	Remove the end-shield with brush holder	
11.	Remove the end-shield with fan guide	
12.	Remove the air guide	
13.	Remove the rotor from the stator	

14.3 HRA3 Horizontal-type Motor Construction

Fig. 3 HRA3 Horizontal-type Motor Construction (SQUIRREL CAGE)



*Disassembly and reassembly of HRA3 Type induction motor with antifriction bearing

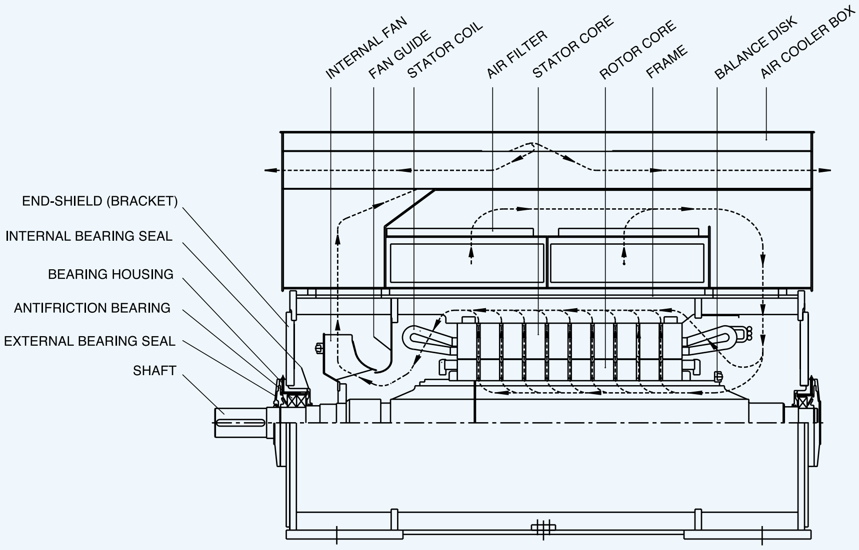
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 5 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, etc.)	
5.	Remove the external bearing seal and slinger installed on the bearing housing	
6.	Remove the bearing housing	
7.	Remove the antifriction bearing	
8.	Remove the internal bearing seal	
9.	Remove the end shield (bracket)	
10.	Remove the internal fan	*Heat the fan hub to approx. 80~100°C both for easy assembly and for removal.
11.	Remove the fan guide	
12.	Remove the rotor from the stator	

14.4 HRP3(4P~) Horizontal-type Motor Construction

Fig. 4 HRP3 (500 Fr.-2P & More Than 4P) Horizontal-type Motor Construction (SQUIRREL CAGE)



*Disassembly and reassembly of HRP3 Type induction motor with antifriction bearing

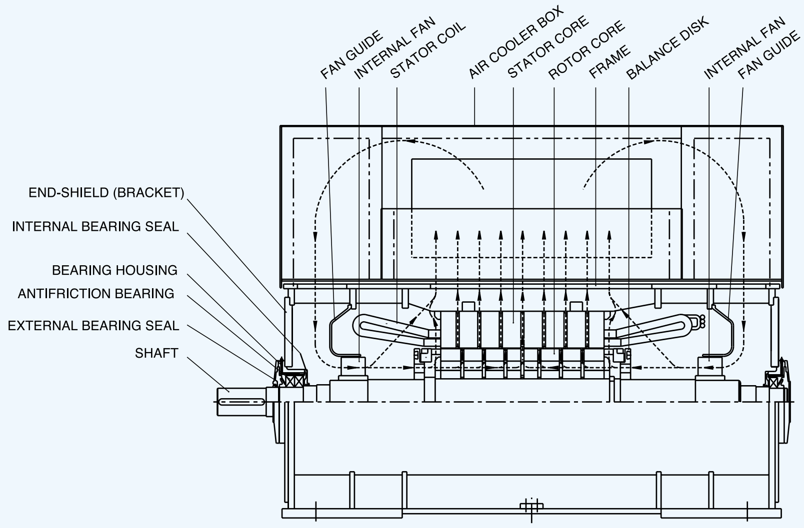
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 5 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, etc.)	
5.	Remove the external bearing seal and slinger installed on the bearing housing	
6.	Remove the bearing housing	
7.	Remove the antifriction bearing	
8.	Remove the internal bearing seal	
9.	Remove the end shield (bracket)	
10.	Remove the internal fan	*Heat the fan hub to approx. 80~100°C both for easy assembly and for removal.
11.	Remove the fan guide	
12.	Remove the rotor from the stator	
13.	Dismantle the air cooler box, if necessary	

14.5 HRP3(2P) Horizontal-type Motor Construction

Fig. 5 HRP3 (355 Fr.~450 Fr.-2P) Horizontal-type Motor Construction (SQUIRREL CAGE)



*Disassembly and reassembly of HRP3 Type induction motor with antifriction bearing

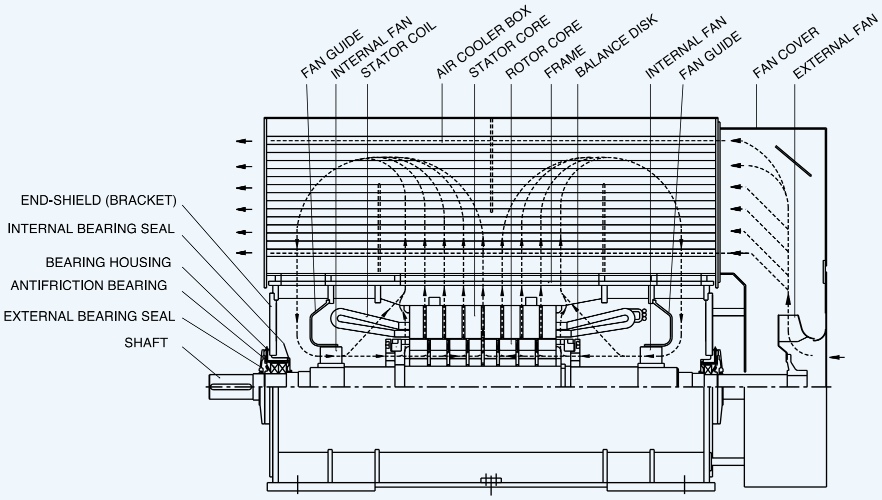
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 5 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, etc.)	
5.	Remove the external bearing seal and slinger installed on the bearing housing	
6.	Remove the bearing housing	
7.	Remove the antifriction bearing housing	
8.	Remove the internal bearing seal	
9.	Remove the end shield (bracket)	
10.	Remove the fan guide	
11.	Remove the rotor from the stator	
12.	Dismantle the air cooler box, if necessary	

14.6 HRQ3 Horizontal-type Motor Construction

Fig. 6 HRQ3 (355 Fr.~450 Fr.-2P) Horizontal-type Motor Construction (SQUIRREL CAGE)



*Disassembly and reassembly of HRQ3 Type induction motor with antifriction bearing

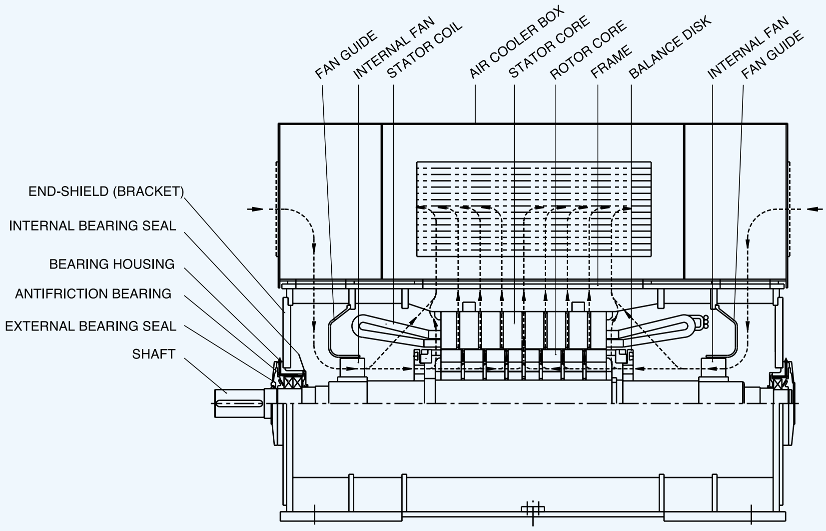
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 5 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, etc.)	
5.	Remove the fan cover	
6.	Remove the external fan	*Heat the fan hub to approx. 80~100°C both for easy assembly and for removal.
7.	Remove the external bearing seal and slinger installed on the bearing housing	
8.	Remove the bearing housing	
9.	Remove the antifriction bearing	
10.	Remove the intermal bearing seal	
11.	Remove the end shield (bracket)	
12.	Remove the fan guide	
13.	Remove the rotor from the stator	
14.	Dismantle the air cooler box, if necessary	

14.7 HRP3(2P) Horizontal-type Motor Construction

Fig. 7 HRP3 (355 Fr.~450 Fr.-2P) Horizontal-type Motor Construction (SQUIRREL CAGE)



*Disassembly and reassembly of HRP3 Type induction motor with antifriction bearing

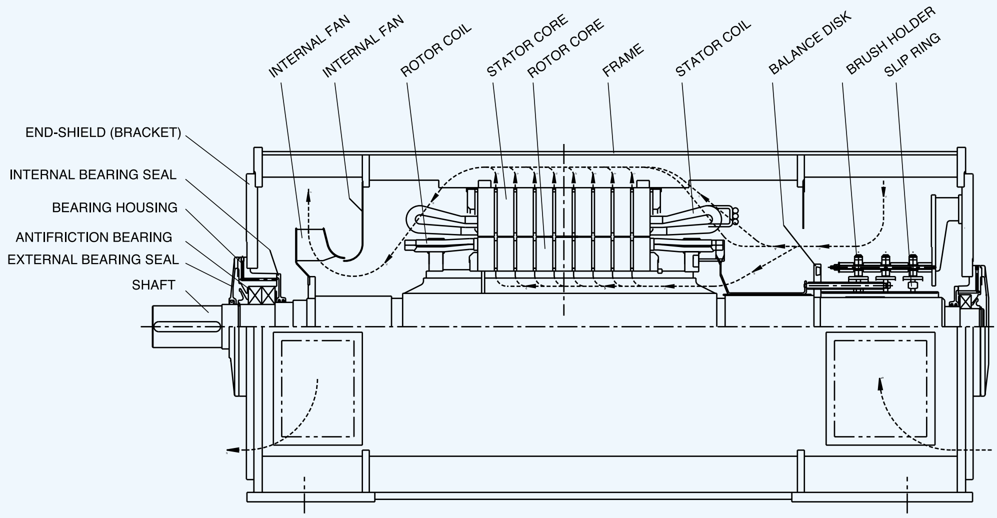
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 5 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, etc.)	
5.	Remove the external bearing seal and slinger installed on the bearing housing	
6.	Remove the bearing housing	
7.	Remove the antifriction bearing	
8.	Remove the internal bearing seal	
9.	Remove the end shield (bracket)	
10.	Remove the fan guide	
11.	Remove the rotor from the stator	
12.	Dismantle the air cooler box, if necessary	

14.8 HRS7 Horizontal-type Motor Construction

Fig. 8 HRS7 Horizontal-type Motor Construction (WOUND ROTOR)



*Disassembly and reassembly of HRS7 Type induction motor with antifriction bearing

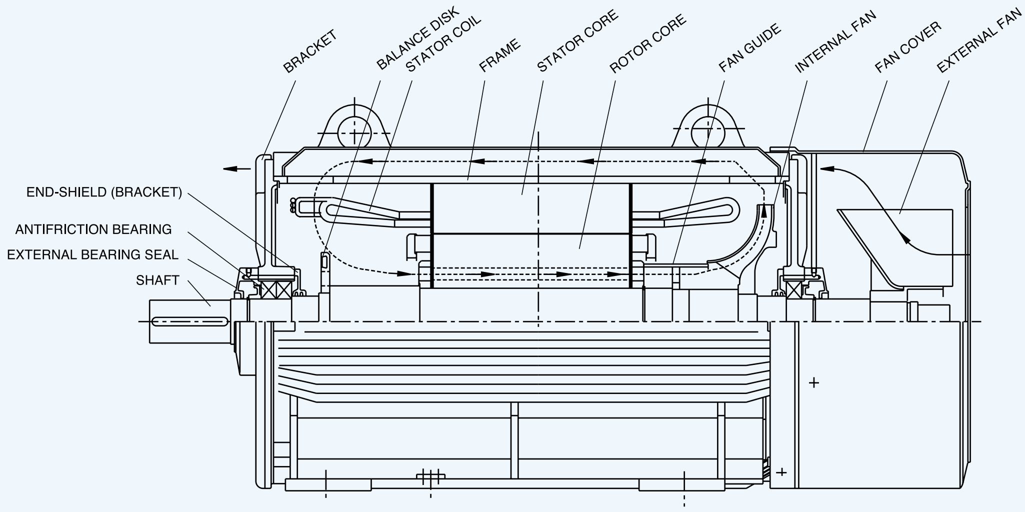
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 7 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, secondary t/box cable, etc.)	
5.	Remove the external bearing seal and slinger installed on the bearing housing	
6.	Remove the bearing housing	
7.	Remove the antifriction bearing	
8.	Remove the end-shield with brush holder	
9.	Remove the end-shield with fan guide	
10.	Remove the internal fan	*Heat the fan hub to approx. 80~100°C both for easy assembly and for removal.
11.	Remove the fan guide	
12.	Remove the rotor from the stator	

14.9 HLE5 Horizontal-type Motor Construction

Fig. 9 HLE5 Horizontal-type Motor Construction (SQUIRREL CAGE)



*Disassembly and reassembly of HLE5 Type induction motor with antifriction bearing

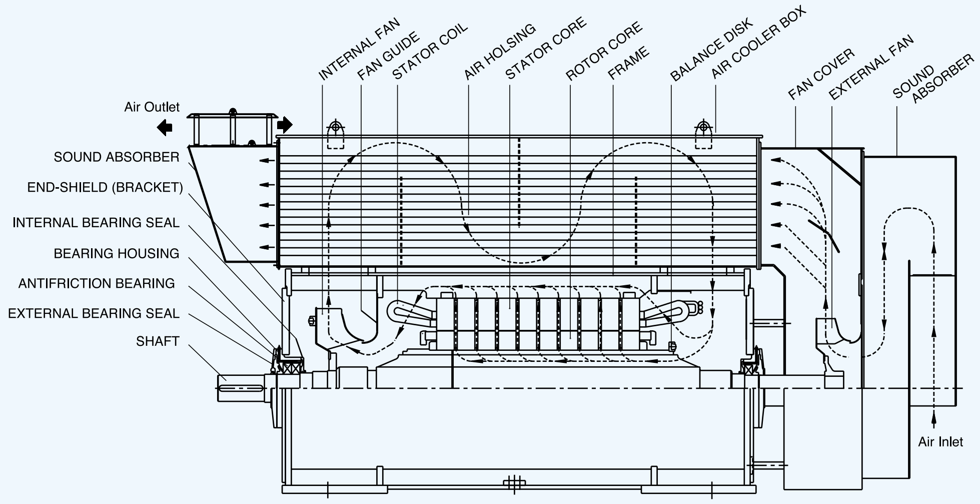
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 7 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, etc.)	
5.	Remove the fan cover	
6.	Remove the external fan	
7.	Remove the external bearing seal and slinger installed on the bearing housing	
8.	Remove the bracket	
9.	Remove the antifriction bearing	
10.	Remove the internal bearing seal	*Heat the fan hub to approx. 80~100°C both for easy assembly and for removal.
11.	Remove the rotor from the stator	

14.10 HRQ3 Horizontal-type Motor Construction

Fig. 10 HRQ3 Horizontal-type Motor Construction (SQUIRREL CAGE)



*Disassembly and reassembly of HRQ3 Type induction motor with antifriction bearing

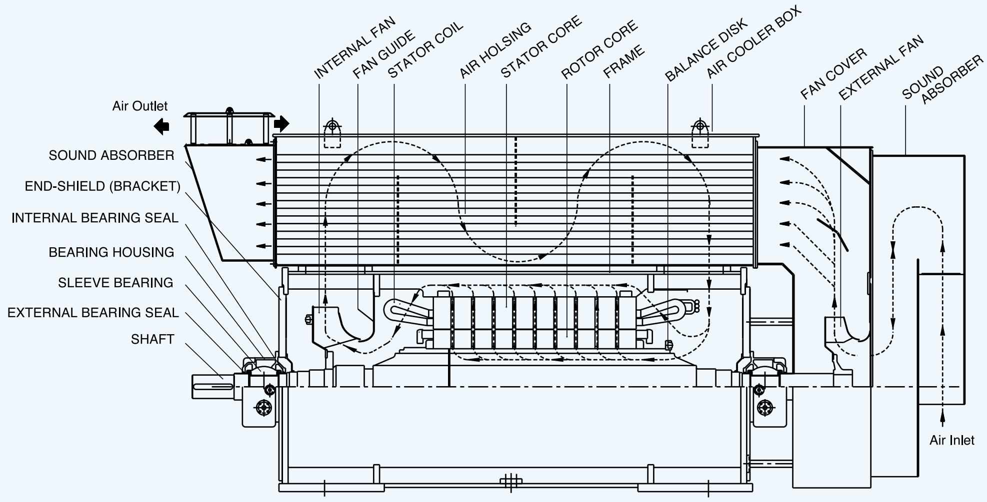
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 5 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, etc.)	
5.	Remove the fan cover	
6.	Remove the external fan	*Heat the fan hub to approx. 80~100°C both for easy assembly and for removal.
7.	Remove the external bearing seal and slinger installed on the bearing housing	
8.	Remove the bearing housing	
9.	Remove the antifriction bearing	
10.	Remove the intermal bearing seal	
11.	Remove the end shield (bracket)	
12.	Remove the fan guide	
13.	Remove the rotor from the stator	
14.	Dismantle the air cooler box, if necessary	

14.11 HRQ3 (Sleeve Bearing) Horizontal-type Motor Construction

Fig. 11 HRQ3 (Sleeve Bearing) Horizontal-type Motor Construction (SQUIRREL CAGE)



*Disassembly and reassembly of HRQ3 Type induction motor with antifriction bearing

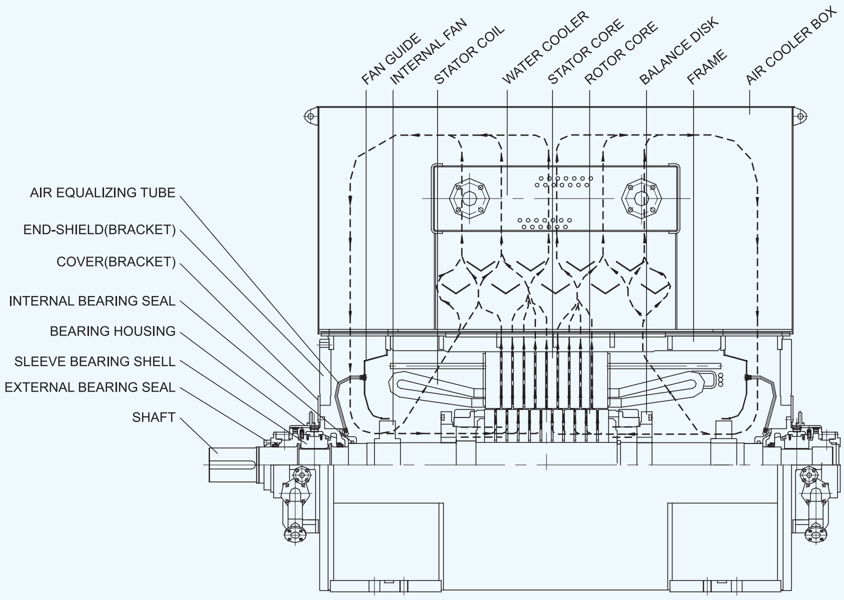
Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 5 to 11 are applied to both the Drive end and Non-drive end of the motors.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perfom an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	*A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, etc.)	
5.	Remove the fan cover	
6.	Remove the external fan	*Heat the fan hub to approx. 80~100°C both for easy assembly and for removal.
7.	Remove the external bearing seal and slinger installed on the bearing housing	
8.	Remove the bearing housing	
9.	Remove the antifriction bearing	
10.	Remove the internal bearing seal	
11.	Remove the end shield (bracket)	
12.	Remove the fan guide	
13.	Remove the rotor from the stator	
14.	Dismantle the air cooler box, if necessary	

14.12 HIN1 (Sleeve Bearing) Horizontal-type Motor Construction

Fig.12 HRN3 horizontal-type motor construction(SQUIRREL CAGE)



*Disassembly and reassembly of HRN 3 Type induction motor with sleeve bearing.

Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing the disassembly steps.
2. Steps 5 to 12 are applied to both the Drive end and Non-drive end the of the motors.

FLOW CHART

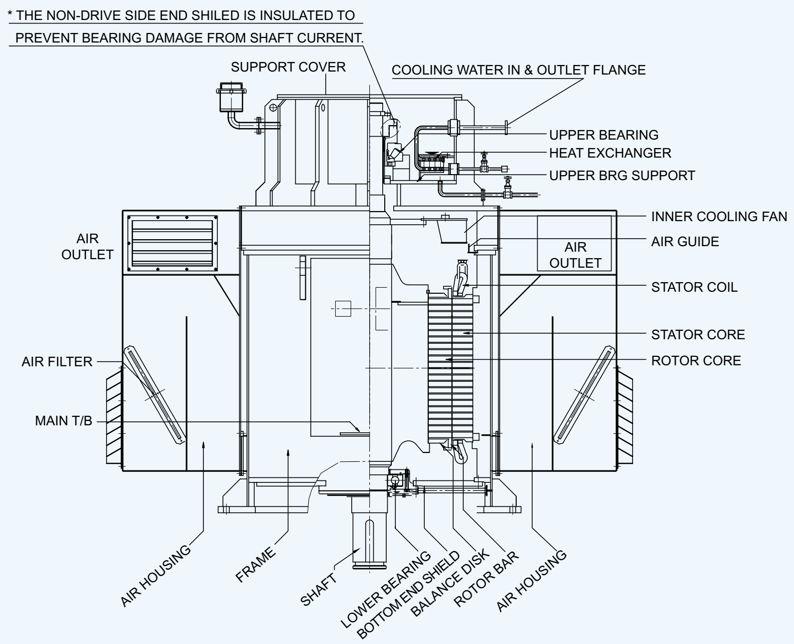
STEP	
1.	Uncouple, and perform an alignment check at the motor and the drive machine
2.	Lift the motor off and shift it to make enough room to move the rotor
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, oil pipe, etc)
5.	Remove the blacket cover
6.	Remove the external seal for sleeve bearing
7.	Remove the air equalizing tube
8.	Remove the sleeve bearing cover
9.	Remove the labyrinth seal & spring
10.	Remove the sleeve bearing shell
11.	Remove the end sheild(bracket)
12.	Remove the fan guide
13.	Remove the rotor from the stator
14.	Dismantle the air cooler box, if necessary

Remarks

* A distance equal to the rotor's length may be required at both end's of the motor drive end and Non drive end

14.13 HRP3 Vertical-type Motor Construction

Fig. 13 HRP3 Vertical-type Motor Construction



*Disassembly and reassembly procedure for Vertical Motor

Notes: 1. Unless otherwise specified, reassembly of motors may be accomplished by reversing disassembly steps.

FLOW CHART

STEP		Remarks
1.	Uncouple, and perform an alignment check at the motor and the drive machine	
2.	Lift the motor off and shift it to make enough room to move the rotor	* A distance equal to the rotor's length may be required at both ends of the motor drive end and Non drive end.
3.	Remove the bolts securing the air seal and rest each part on the rotor shaft	
4.	Dismantle the connection box of the frame, if acc'y attached (BTD, grease pipe, etc.)	
5.	Remove the the air housing	
6.	Remove the bottom bearing. Refer to bottom bearing disassembly procedure.	
7.	Remove the bottom end shield.	
8.	Remove the upper bearing support cover	
9.	Remove the upper bearing. Refer to upper bearing disassembly procedure.	* Before disassemble the upper bearing, install the hydraulic jack at the bottom surface of shaft.
10.	Remove the upper bearing support	
11.	Remove the rotor from stator(From DE side to N-DE side	
12.	Remove the inner cooling fan from rotor if necessary	* Heat the fan hub to approx. 80~100°C both for easy assembly and for removal.

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INDEX

0. TARGET AND SCOPE

This instruction is valid for all standard gear couplings according to the standard catalogue. This instruction substitutes the former 1610 and 1611 instructions.
In case the drawing of the coupling that you are working with; indicates a different instruction than IMO000678, then pay attention only to that instruction on the drawing.

☞ **A T T E N T I O N!**

Make sure that this is the latest version of instruction, by checking it at JAURE’s website WWW.JAURE.COM.

1. PREPARATION PRIOR TO INSTALLATION

The gear couplings should be kept in a non corrosive atmosphere. Machined surfaces, especially bores, should always have an anticorrosive protection from bores. Adequate corrosive protection has to be provided if the coupling has to be kept in stock.

⚠ **C A U T I O N!**

If the coupling has to be in stock for more than 6 months it is advised to dismount the O-rings for the coupling and keep them in ozone free area.

☞ **A T T E N T I O N!**

When installing the hubs on the shafts, remove any anticorrosive protection from bores.

☞ **A T T E N T I O N!**

Gear couplings are potentially dangerous rotating parts. Always use proper guards to prevent accidents and comply with existing safety regulations.

☞ **A T T E N T I O N!**

Before installing the couplings and when handling them, always avoid any damage to the coupling and especially in the gear mesh.

2. INSTALLATION OF KEYED HUBS AND GREASING OF COUPLINGS

2.1 Ensure that all the parts are clean.

2.2 Apply a light coat of grease to the O-rings (6) and install them in the sleeves (2, 3 or 4, 5) grooves. It is necessary to apply some sealant at the keyway area so that the grease leakage is avoided during operation. We recommend to apply Rhodorseal 5661.

2.3 Apply the said grease on the sleeves (2, 3 or 4, 5) teeth. Place the sleeves on the shafts; avoid damage of the O-rings (6).

2.4 For sizes larger than MT Marine 260 or MT-275 place only the cover (7), once the O-rings (6) have been placed in the cover grooves.

2.5 Heat the hubs (1) to 110-130ºC prior to installing onto the shafts. Do not use an open flame burner. Protect the O-rings against temperature (max. O-ring temperature 80ºC)

2.6 Install hubs (1) on their respective shafts. Hub faces have to be flush shaft end. In case of doubt, please contact JAURE.

2.7 Install units to be connected in place and check the spacing "a" between hubs. See tables1 or approved drawing for correct hub spacing "a", according to coupling type. In case of doubt, please contact us.

2.8 Align the two shafts, check alignment using a dial indicator or laser alignment. Alignment precision depends on running speed. (See point 8).

2.9 Allow the hubs (1) to cool before installing the sleeves (2, 3 or 4, 5) over the hubs. Apply grease on coupling hub (1) teeth before installing the sleeves (2, 3 or 4, 5).

2.10 Bolt up the sleeves with the recommended tightening torque (see tables 1) (the use of Loctite 243 is highly recommended), after installing the sealing paper (sizes smaller than MT-275) or O-ring (10) (MT-280 and bigger sizes) in place. Using grease on the O-ring is recommended. Make sure that flange lubrication holes, after mounting, are 90° angle to each other as shown in fig. 1.

2.11 Remove both plugs (9) on the sleeve (2,3 or 4,5). As an approximate method proceed as follows: Turn the coupling so that the flange lubrication holes are in 1^{30}, 4^{30}, 7^{30}, 10^{30} watch position. Take away the 1^{30} and 7^{30} plugs (9) and pump grease into the 1^{30} holes, until grease leaks out from the lower 7^{30} (see fig. 1). During the process it is recommended to remove the 10^{30} plug to vent the interior. For grease quality and more accurate quantity see points 5 and 6. If running conditions are different than the ones given in tables 3 and 4, consult JAURE. For types MTD, MTGD, MTX, MTGX, MTCL, MTB, it is necessary to lubricate each half coupling separately. Introduce the oil plugs (9).

2.12 In order to periodically inspect the gear mesh, there should be enough space to withdraw the sleeves from the hub gear mesh, distance "s" on the catalogue, If this is not the case, it is advised to install a coupling with side covers as the MTN type.

2.13 For assembly balanced couplings respect the matching marks between components at installation.

For installation by cylindrical (IMO000917) or conical (IMO000918) hydraulic Extraction please consult Jaure

3. MAINTENANCE INTERVALS

Coupling should be disassembled and inspected (see point 4), and grease should be changed every 8000 working hours or maximum 2 years, whichever is earlier.

If the working temperature has been high (about more than 60ºC), then change the grease every 4000 hours or maximum 1 year, whichever is earlier.

If longer periods are needed, contact JAURE. Proceed as mentioned in point 2.11. Refill the coupling with grease. It is recommended to use oil (compatible with the used grease), for a correct cleaning of the grease.

4. DISASSEMBLY AND INSPECTION

- Before moving the sleeves, clean the hub surfaces near the O-rings (6) of dust or dirt.
- Remove bolts (11) and the O-ring (10).
- Inspect gearing and sealing.
- Maintain alignment.
- Use new grease. It is recommended to use Low viscosity oil to clean the coupling from old grease.

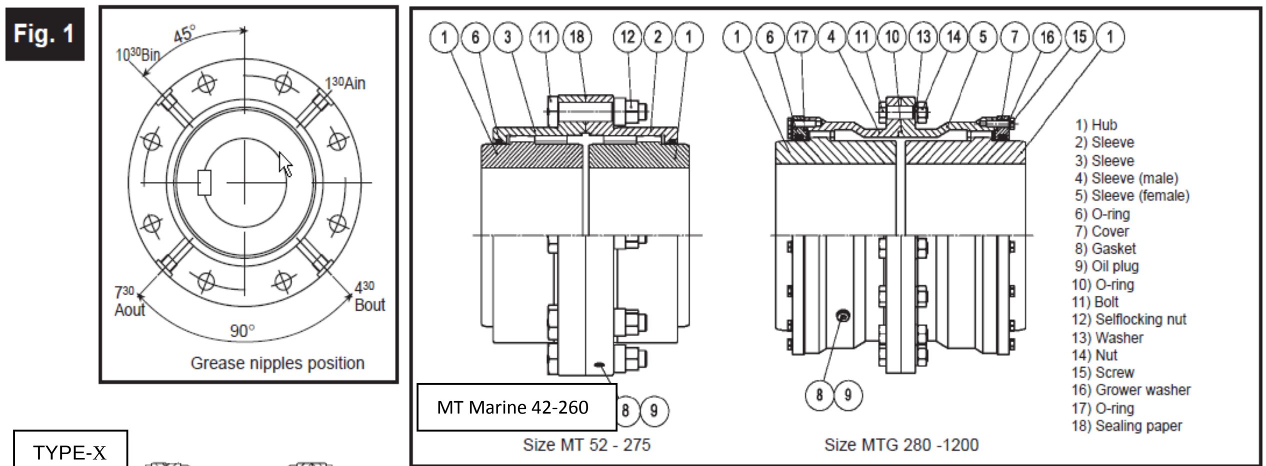
☞ **A T T E N T I O N !**

Take care, oil must be compatible with the grease that is inside the coupling. Once oil and grease are mixed inside the coupling, it will be easier to make that grease go out.

When the hub and the shaft are coupled by means of a keyway and the disassembly of the coupling hubs is required to be done, first the sleeve and the coupling cover will have to be removed. The hub can be removed from the shaft by heating the hub with a flare (80℃ approximately) and making use of the extraction holes.
A more detailed information of this process is given in IMO000060. Coupling to shafts using keyways B01-B04.

☞ **A T T E N T I O N !**

Try not to use the sleeves to remove the hubs. Make use of the extraction holes.



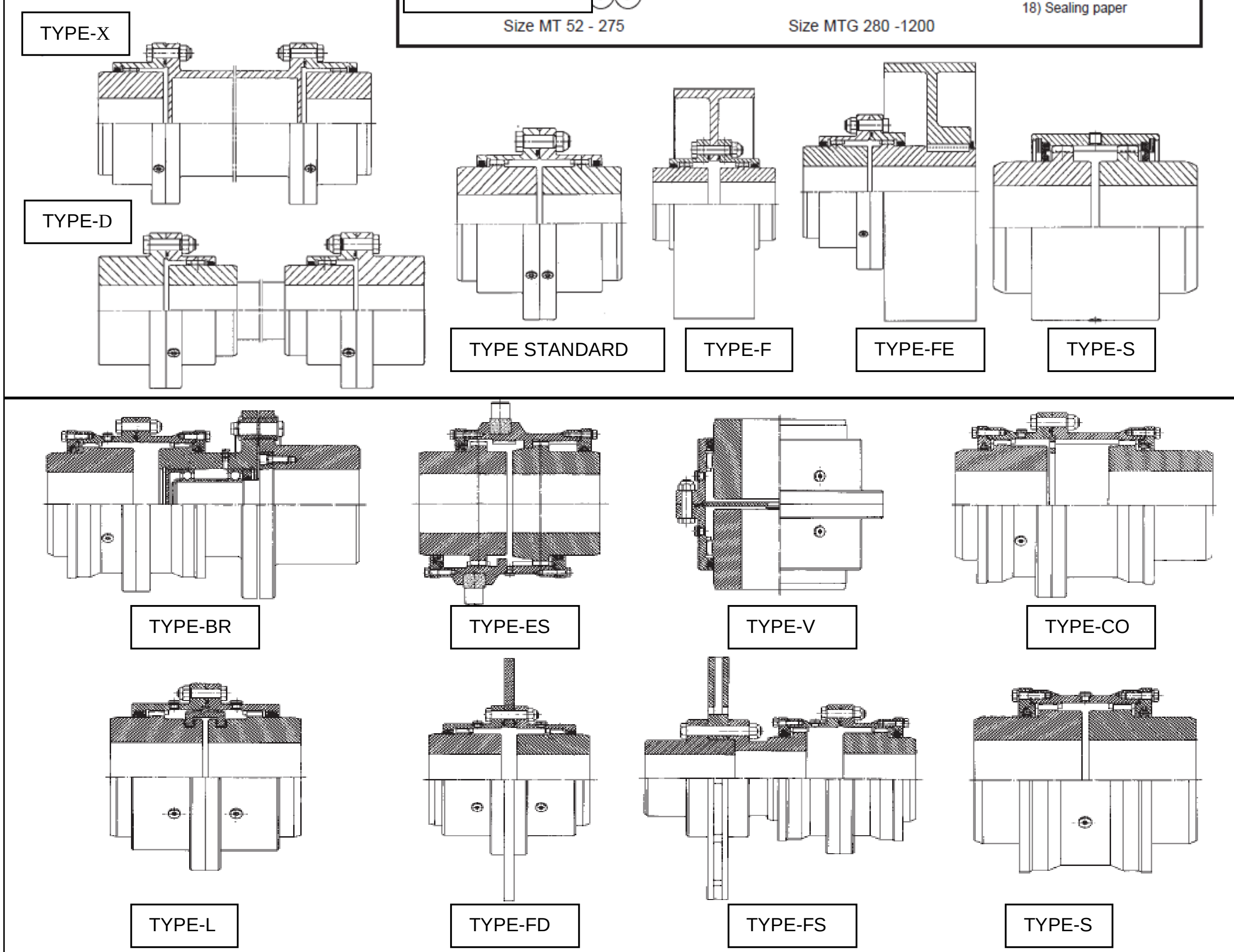


Fig.2: Types of couplings

CouplingsType MT Marine, MT, MTF, MTFE, MTS, MTV, MTCO, MTFD, MTFS, MTG			
Size	**“a” (mm.)**	**Size**	**“a” (mm.)**
MT-42	6±1	**MTG-280**	16±3
MT-52	3±1	**MTG-310**	16±3
MT-55	6±1	**MTG-345**	16±3
MT-62	3±1	**MTG-370**	20±4
MT-70	6±2	**MTG-390**	20±4
MT-78	3±2	**MTG-420**	20±4
MT-90	8±2	**MTG-460**	20±4
MT-98	5±2	**MTG-500**	25±4
MT-100	8±2	**MTG-550**	25±4
MT-112	5±2	**MTG-590**	25±4
MT-125	8±2	**MTG-620**	30±6
MT-132	6±2	**MTG-650**	30±6
MT-145	10±2	**MTG-680**	30±6
MT-156	6±2	**MTG-730**	30±6
MT-165	10±3	**MTG-800**	30±6
MT-174	8±3	**MTG-900**	35±7
MT-185	10±3	**MTG-1000**	35±7
MT-190	8±3	**MTG-1100**	35±7
MT-205	12±3	**MTG-1200**	35±7
MT-210	8±3		
MT-230	12±3		
MT-233	8±3		
MT-260	12±3		
MT-275	10±3		

CouplingsType MT Marine, MT, MTF, MTFE, MTS, MTV, MTCO, MTFD, MTFS, MTG				
Size	**Tightening torque (Nm)**	**Size**	**Tightening torque coupling screws (Nm) (See Fig. 2.1)**	**Tightening torque cap screw (Nm) (See Fig. 2.1)**
MT-42	6	**MTG-280**	375	73
MT-52	8	**MTG-310**	375	73
MT-55	15	**MTG-345**	660	73
MT-62	20	**MTG-370**	660	73
MT-70	52	**MTG-390**	760	178
MT-78	42	**MTG-420**	760	178
MT-90	82	**MTG-460**	760	178
MT-98	73	**MTG-500**	1.140	178
MT-100	82	**MTG-550**	1.140	328
MT-112	73	**MTG-590**	1.140	328
MT-125	174	**MTG-620**	1.800	328
MT-132	178	**MTG-650**	1.800	328
MT-145	174	**MTG-680**	1.800	328
MT-156	178	**MTG-730**	1.800	328
MT-165	174	**MTG-800**	1.800	328
MT-174	178	**MTG-900**	2.300	328
MT-185	247	**MTG-1000**	2.300	570
MT-190	245	**MTG-1100**	2.300	570
MT-205	247	**MTG-1200**	2.300	570
MT-210	245			
MT-230	247			
MT-233	245			
MT-260	428			
MT-275	470			

Table 1: Gap spacing “a” and flange bolt tightening torque for MT Marine, MT, MTG, MTCL, MTX, MTF, MTFE, MTS, MTV,MTCO,MTFD and MTFS

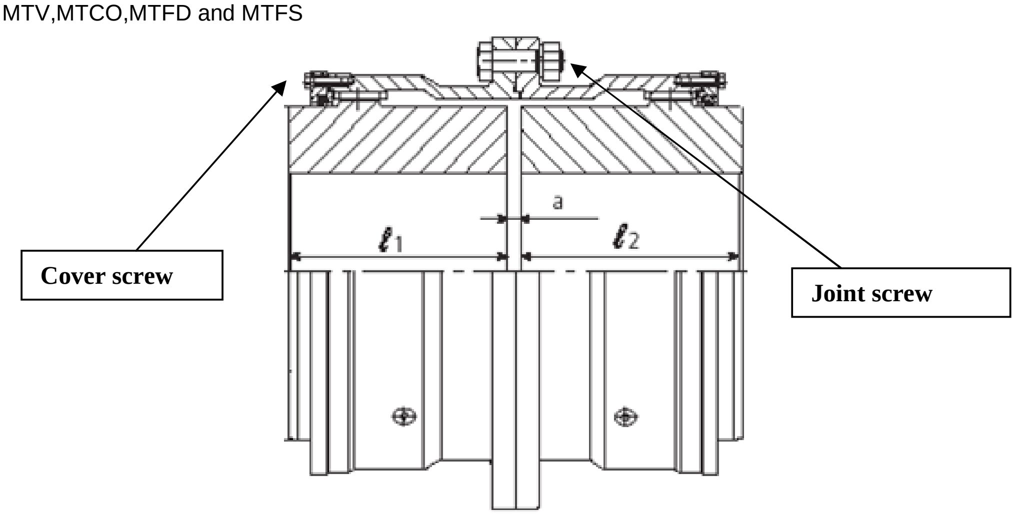


Fig.2.1: Different MTG coupling screws

MTN Type Couplings	
Size	**“a” (mm)**
MTN-42	6±1
MTN-55	6±1
MTN-70	6±2
MTN-90	8±2
MTN-100	8±2
MTN-125	8±2
MTN-145	10±2
MTN-165	10±3
MTN-185	10±3
MTN-205	12±3
MTN-230	12±3
MTN-260	12±3

MTN Type Couplings		
Size	**Tightening torque (Nm)**	**Tightening torque in covers (Nm)**
MTN-42	20	8
MTN-55	39	8
MTN-70	39	8
MTN-90	68	20
MTN-100	68	20
MTN-125	68	20
MTN-145	108	40
MTN-165	108	40
MTN-185	325	40
MTN-205	325	40
MTN-230	325	40
MTN-260	375	70

Table 1.1: Gap spacing “a” and flange bolt tightening torque for MTN.

☞ **A T T E N T I O N!**

If the bolts are oiled, these tightening torque values have to be 20% lower.

5. RECOMMENDED LUBRICANTS:

The lubricants shown at tables 2 are recommended based on JAURES’s experience. In case the final user wants to use a different lubricant, please check the data given at the end of this point in this document.

MEDIUM SPEED, NORMAL or HEAVY DUTY see tables 3 and 4)		
GREASE MANUFACTURER	**GREASE NAME**	**OPERATING TEMP (ºC)**
Emerson	KSG	-40 to +88
Castrol	Tribol 3020/1000-1	-30 to +120
Total Fina Elf	Ceran GEP-0	-25 to +180
Total	Ceran MS	-20 to + 180
Klüber	Klüberplex GE 11-461	-40 to +180
Esso-Exxon-Mobil	Mobilgrease XTC	-30 to +120
Esso-Exxon-Mobil	Mobilith SHC 460	-50 to +150
Molyduval	Molyduval coupling grease	-30 to +150
Shell	Gadus S3 HSCG	-10 to +120
Shell	Gadus S3 V770D1	-20 to +150
Verkol	Verkol 320-1 Grado 1	-15 to +150

Table 2.1

HIGH SPEED, NORMAL DUTY see tables 3 and 4)		
GREASE MANUFACTURER	**GREASE NAME**	**OPERATING TEMP (ºC)**
Emerson	KHP	-40 to +88
Klüber	Kluebersynth GE 14-151	-35 to +140
Shell	Gradus S2 HSCG	-30 to + 120
Esso-Exxon-Mobil	Mogilgrease XTC	-30 to +120

Table 2.2

SPEED LESS THAN 500 rpm, VERY HEAVY DUTY see tables 3 and 4)		
GREASE MANUFACTURER	**GREASE NAME**	**OPERATING TEMP (ºC)**
Emerson	Waverly Torque Lube A	-18 to +100
Esso-Exxon-Mobil	Mobilith SHC 1000 Spec	-20 to +150
Klüber	Klüberlub BE 41-1501	-10 to +150
Castrol	Mollub Alloy 870	-10 to + 130

Table 2.3

LOW SPEED, NORMAL or HEAVY DUTY see tables 3 and 4)		
GREASE MANUFACTURER	**GREASE NAME**	**OPERATING TEMP (ºC)**
Mobil	Mobilith SHC 007	-50 a +150
Klüber	Klueberplex 11-680	-10 to +130

Table 2.4

MEDIUM or HIGH SPEED, HEAVY or VERY HEAVY DUTY see tables 3 and 4)		
GREASE MANUFACTURER	**GREASE NAME**	**OPERATING TEMP (ºC)**
Emerson	Syn-tech 3913G	-55 to +120
Mobil	Mobilith SHC 1500	-20 to +150
Mobil	Mobilux EP 111	-10 to +120
BP	BP Energrease SY 1501	-20 to + 180

Table 2.5

Duty level	Duty
Normal	When teeth material is standard (see catalogue)
Heavy	When teeth material is HD (see catalogue)
Very Heavy	When Teeth Material is hardened by any surface heat-treatment

Table 3: Clarification about levels of duty

Speed level	Peripherical Speed (*)
Low	< 2 m/sec
Medium	>2 m/sc and <60 m/sec
High	>60 m/sec

Table 4: Clarification about levels of speed

For calculating the pheriperical speed, use this formula

(*) $$\frac{\prod \times D1 \times n}{60000}(m/s)$$

Where,

D1 (mm) = External diameter of the sleeve body at the MT catalogue (see catalogue)
n(rpm) = Maximum Operating speed

6. RECOMENDED GREASE QUANTITY

Couplings are supplied with protective grease but not with working grease. The teeth mesh has to be cleaned from any protective oil or grease prior to mounting.

Before mounting, approx. 50 to 70 % of total grease quantity shall be hand packed between hub and sleeve teeth and surrounding area. After mounting, the remaining (30 to 50%) of the grease shall be pumped into the flange lubrication holes.

At high temperature, low speed and reversing drive, more frequent lubrication is needed than the one recommended in these instructions.

For MTV case, fill of grease the upper side half coupling, and introduce the 50% of the indicated quantity at table 5 at lower side half coupling.

⚠ **C A U T I O N!**
Overfilling the coupling with grease may result in equipment damage.

☞ **A T T E N T I O N!**
In case of special couplings, the quantity of grease with which the coupling is to be lubricated will be indicated in the plan.

MT Marine, MT, MTF, MTFE, MTS, MTV, MTCO, MTFD, MTFS, MTG Type Couplings			
Size	**[2] Qty. (kg)**	**Size**	**[2] Qty. (kg)**
MT-42	0.04	**MTG-280**	3
MT-52	0.03	**MTG-310**	3.6
MT-55	0.06	**MTG-345**	4.8
MT-62	0.06	**MTG-370**	5
MT-70	0.17	**MTG-390**	9
MT-78	0.09	**MTG-420**	9.8
MT-90	0.24	**MTG-460**	11.5
MT-98	0.12	**MTG-500**	11.5
MT-100	0.36	**MTG-550**	14.5
MT-112	0.3	**MTG-590**	23
MT-125	0.5	**MTG-620**	23
MT-132	0.4	**MTG-650**	30
MT-145	0.7	**MTG-680**	36
MT-156	0.6	**MTG-730**	38
MT-165	1.3	**MTG-800**	46
MT-174	0.8	**MTG-900**	57
MT-185	1.75	**MTG-1000**	75
MT-190	1.4	**MTG-1100**	115
MT-205	2.2	**MTG-1200**	125
MT-210	2.5		
MT-230	2.8		
MT-233	3		
MT-260	4.5		
MT-275	4.5		

MTN Type Couplings	
Size	**[2] Qty. (kg)**
MTN-42	0.07
MTN-55	0.1
MTN-70	0.12
MTN-90	0.22
MTN-100	0.3
MTN-125	0.4
MTN-145	0.6
MTN-165	1
MTN-185	1.1
MTN-205	1.6
MTN-230	2
MTN-260	1.3

Coupling type MTGX and MTGD			
Size	**[2] Qty. (kg)**	**Size**	**[2] Qty. (kg)**
MTGX-MTGD-190	1.4	**MTGX-MTGD-460**	10
MTGX-MTGD-210	2.5	**MTGX-MTGD-500**	14
MTGX-MTGD-233	3	**MTGX-MTGD-550**	16
MTGX-MTGD-275	4.5	**MTGX-MTGD-590**	19
MTGX-MTGD-280	3.5	**MTGX-MTGD-620**	24
MTGX-MTGD-310	4	**MTGX-MTGD-650**	28
MTGX-MTGD-345	5	**MTGX-MTGD-680**	36
MTGX-MTGD-370	6	**MTGX-MTGD-730**	40
MTGX-MTGD-390	8	**MTGX-MTGD-800**	50
MTGX-MTGD-420	9	**MTGX-MTGD-900**	70

Tables 5: Recommended grease quantity

2) Quantity per complete coupling for MT Marine, MT, MTG, MTG-HD, MTCL, MTS, MTFD, MTFS, MTF, MTFE, MTB, MTBX, MTN, MTNBR.

☞ **A T T E N T I O N!**

For types MTX, MTGX, MTD, and MTGD add the specific quantity shown in the corresponding catalog sheet divided by 2 at each half. Ex. MTX-112: 0,15 kg at each half.

☞ **A T T E N T I O N!**

For types MTS, MTCO, vertical couplings and disengaging couplings consult JAURE.

☞ **A T T E N T I O N!**

For MTGX, MTGD sizes above 1000, please consult JAURE

7. TEETH WEAR CHECK

In order to be able to do a preventive maintenance on gear couplings, it is very recommendable to to check teeth wear level. There are different options. All of them are based on measuring the backlash (B) (tangencial clearance between gear teeth, see image), which must be lower than the values given at table 6. The two most practical methods to do this are:

- By marking both hub and sleeve. By this method, the Backlash is measured by marking the hub and sleeve at the same diameter as figure 3 shows. As the backlash is a tangential dimension, that value is almost the same as the one shown at figure 4, which is the real backlash. This method can be used in theory for all standard couplings that appear on the standard catalogue, but due to the low number of the maximum values, it is especially complex for the smallest sizes (approximately up to size MT 233 or MT Marine 230). Follow these steps:

    - Turn the hub until the sleeve and hub’s teeth are in contact.
    - At that position, mark sleeve and hub (see Fig 3).
    - Turn now the hub to the other side until it is in contact with the sleeve again.
    - Measure the dimension B. Check if this value is higher than the maximum admissible Backlash value for that size.

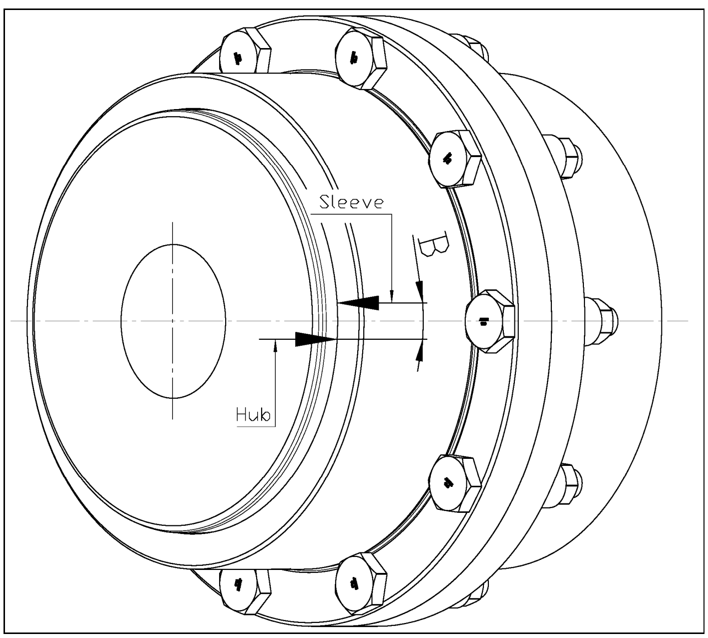


Fig 3: Backlash using marking method

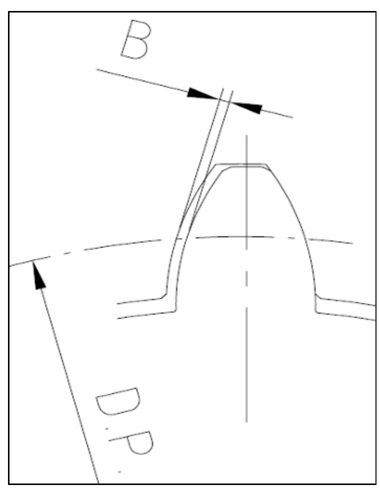


Fig 4: Backlash

- By using measuring gauges. This method is only valid when this fact has been previewed during design process. The reason is that it is necessary to make some holes for this (so, the customer must require this when he orders the coupling). This method is easier to practice, but correct size gauges must be used (Jaure does not supply them). Also the target is to measure the B value.

- Turn the hub until the sleeve and hub's teeth are in contact.
- Insert the gauges through the hole in the way that it may be seen on figure 5. This must be done through the side that has no in contact between hub and sleeve.

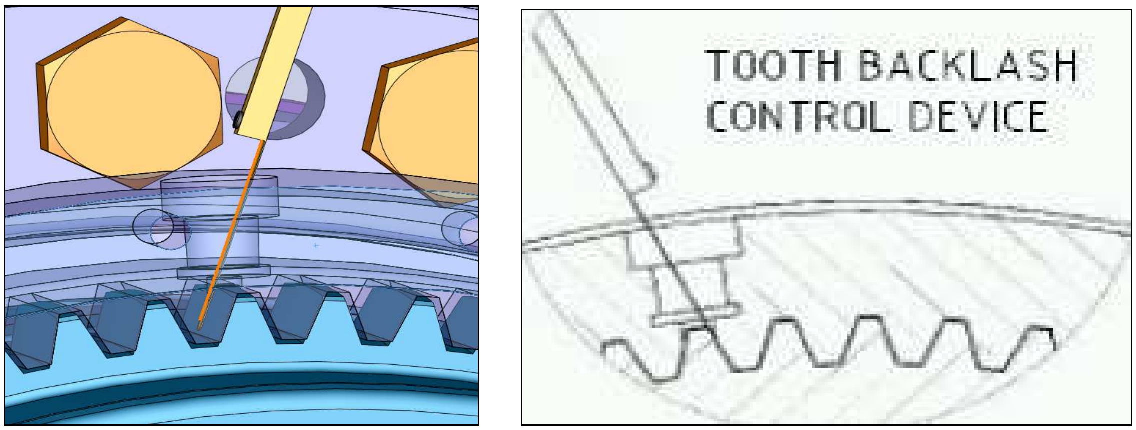


Fig 5: Two sights of gauge method for backlash measurement

☞ **A T T E N T I O N!**

Make sure that you have located the plug in place after measuring the backlash. In case this is not done, the grease will leak through that hole.

- **Other methods:** There are other two methods that can also be used, but they require more disassembly work.
  - By disassembling into two half couplings which are still mounted on their corresponding shafts. Gauges must be inserted through the teeth, but it must be made sure that they reach the middle of the total teeth length.
  - By measuring both teeth span for hub, and distance between pins for sleeve. Through these two dimensions, it is possible to calculate the corresponding backlash. This method is very used by coupling manufacturers, but it is more difficult for final users. The reason is that some experience on this is needed.

COUPLING	B* (admissible backlash, wear limit for gear teeth with standard or HD material) (mm)	COUPLING	B* (admissible backlash, wear limit for gear teeth with standard or HD material) (mm)
MT-42	0.8	MTN-42	1
MT-52	0.8	MTN-55	1
MT-55	0.8	MTN-70	1
MT-62	0.8	MTN-90	1.5
MT-70	1	MTN-100	1.5
MT-78	1	MTN-125	1.5
MT-90	1	MTN-145	2
MT-98	1	MTN-165	2
MT-100	1.3	MTN-185	2
MT-112	1.3	MTN-205	2.5
MT-125	1.3	MTN-230	2.5
MT-132	1.5	MTN-260	2.5
MT-145	1.5	MTG-280	3
MT-156	1.8	MTG-310	3
MT-165	1.8	MTG-345	3.5
MT-174	1.8	MTG-370	3.5
MT-185	2	MTG-390	4
MT-190	2	MTG-420	4.5
MT-205	2	MTG-460	4.5
MT-210	2	MTG-500	5
MT-230	2.5	MTG-550	5
MT-233	2.5	MTG-590	5.5
MT-260	2.5	MTG-620	5.5
MT-275	2.5		

Table 6: Admissible backlash (Only valid for couplings that have not the surface hardened by heat treatment)

8. ALIGNMENT PRECISION

In operation, each half coupling may work at maximum 0,5º misalignment, but the lower the working misalignment is, the longer the lifetime. So, in order to get to an optimized lifetime of the coupling, it is very important to align the coupling properly during assembly. The following must be followed when a JAURE gear coupling is assembled on site in standard conditions. Looking at figures 6 and 7, and tables 7, 8, 9, and following the next formula:

$$\left[\left(\frac{X}{DCD}\right)+\left(\frac{1}{2}x\frac{(Y-Z)}{D2}\right)\right]x\left(\frac{180}{PI}\right)\leq \text{MAMDAº}$$

MAMDA= Maximum Accepted Misalignment During Assembly
PI= 3,1415
X= Offset (half of the TIR measurement)
During alignment, the following values must be respected:

MT, MT Marine, MTG and MTN	Speed (rpm)		
	0 – 500	500 - 1500	1500 – 4000
	MAMDAº	MAMDAº	MAMDAº
All sizes	0,1º	0,075º	0,05º

Table 7: Alignment precision

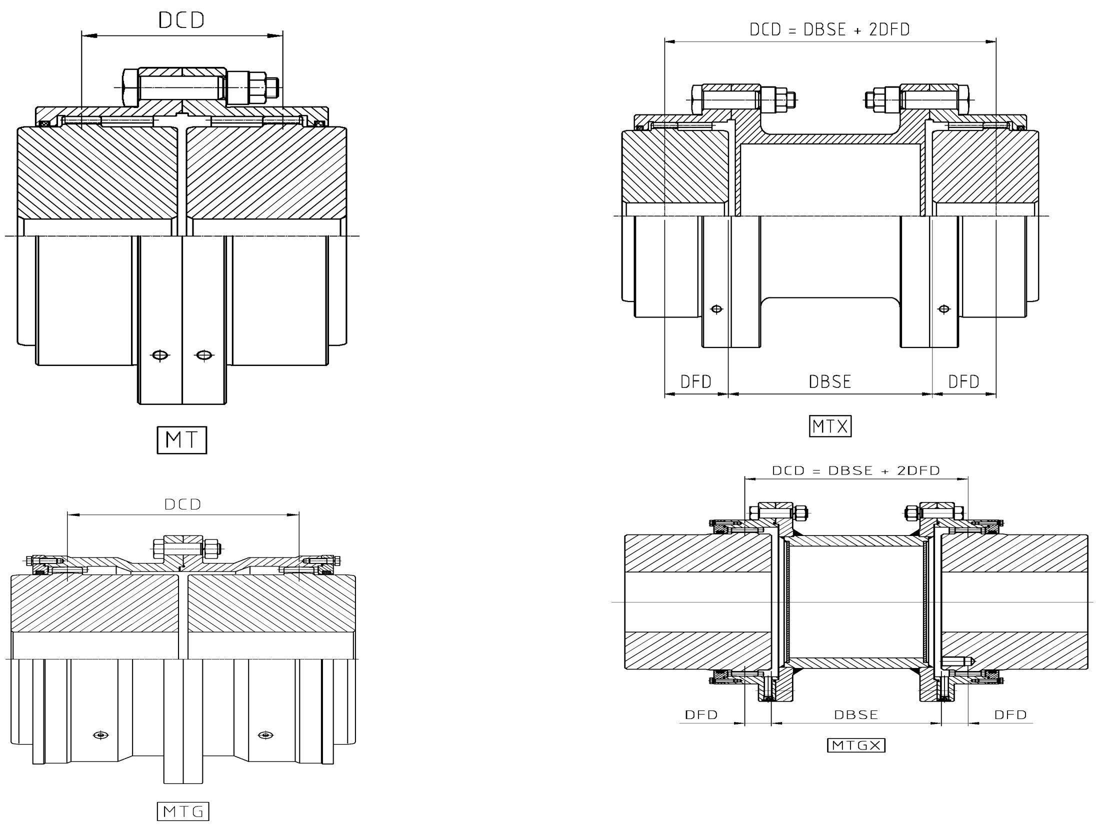


Fig. 6 : Representation of the DCD distances for MT, MTX, MTG and MTGX couplings

MT	DCD (mm)	MTX	DFD (mm)	MTG	DCD (mm)	MTGX	DFD (mm)
42	46	**46**	20	**280**	332	**280**	48
52	48	**52**	22,5	**310**	366	**310**	50
55	56	**55**	25	**345**	401	**345**	57,5
62	58	**62**	27,5	**370**	460	**370**	60
70	75	**70**	34,5	**390**	478	**390**	63
78	76	**78**	36,5	**420**	515	**420**	66,5
90	88	**90**	40	**460**	558	**460**	69
98	88	**98**	41,5	**500**	581	**500**	79
100	113	**100**	52,5	**550**	607	**550**	84
112	114	**112**	54,5	**590**	641	**590**	89
125	131	**125**	61,5	**620**	712	**620**	104
132	132	**132**	63	**650**	720	**650**	111
145	151	**145**	70,5	**680**	730	**680**	117
156	152	**156**	73	**730**	760	**730**	122
165	170	**165**	80	**800**	804	**800**	127
174	172	**174**	82	**900**	855	**900**	146,5
185	202	**185**	96	**1.000**	916	**1.000**	152,5
190	200	**190**	96	**1.100**	990	**1.100**	157,5
205	225	**205**	106,5	**1.200**	1090	**1.200**	162,5
210	227	**210**	109,5				
230	244	**230**	116				
233	248	**233**	120				
260	284	**260**	136				
275	292	**275**	141				

MT and MTX	D2 (mm)	MTG and MTGX	D2 (mm)
42	60	**280**	370
52	69	**310**	410
55	79	**345**	450
62	85	**370**	490
70	101	**390**	520
78	107	**420**	560
90	124	**460**	600
98	133	**500**	650
100	143	**550**	710
112	152	**590**	760
125	170	**620**	810
132	178	**650**	840
145	205	**680**	890
156	209	**730**	950
165	216	**800**	1050
174	234	**900**	1180
185	250	**1000**	1320
190	254	**1100**	1450
205	275	**1200**	1580
210	279		
230	300		
233	305		
260	340		
275	355		

Table 8: DCD, DFD and D2 distances for MT, MTX, MTG and MTGX couplings

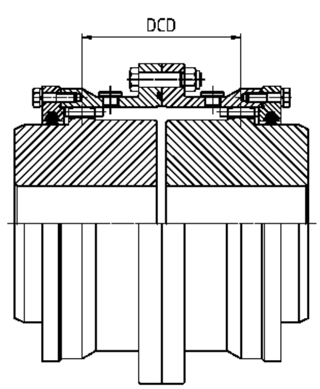


Fig 7: Representation of DCD distances for MTN couplings

DCD: distance between centre of the teething DCD = 2*DFD + DBSE

DFD: distance from the centre of the teething to the end of the hub

MTN	DCD (mm)	D2 (mm)
42	61	71
55	76	86
70	86	105
90	101	124
100	120	148
125	128	174
145	149	198
165	168	220
185	190	244
205	220	270
230	242	304
260	294	320

Table 9: DCD, DFD and D2 distances for MTN couplings.

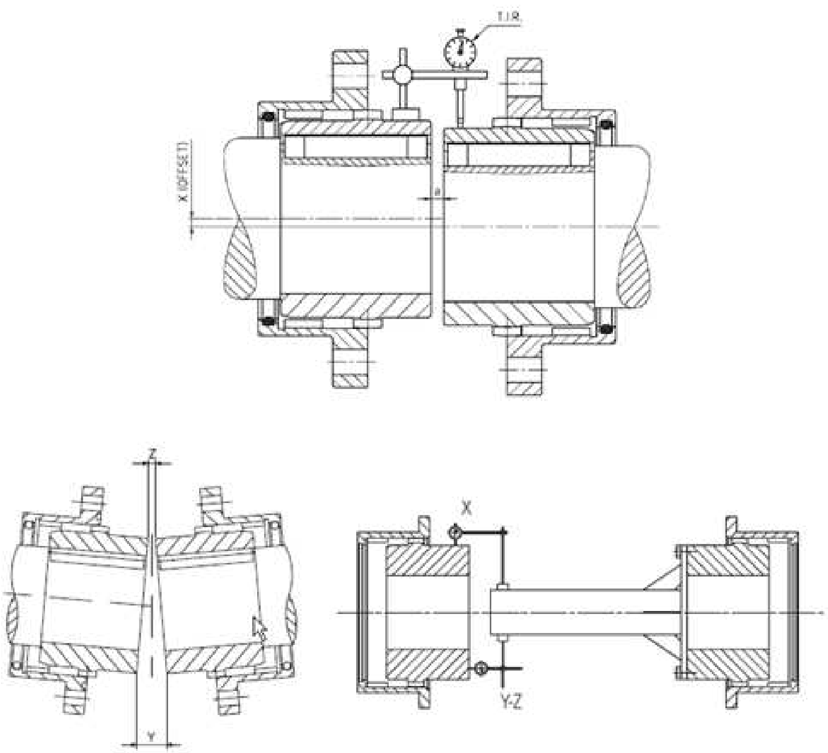


Fig.8: Alignment detail

☞ **A T T E N T I O N !**

A better alignment than the one given in this table will increase coupling life and reduce the reaction forces in shafts and bearings.

☞ **A T T E N T I O N!**

For Y-Z dimension, measure as close as possible to the D2 diameter as it can be seen at the right side of Fig. 7.

Nevertheless the minimum value (Y-Z) should not give an angular misalignment lower than 0.005º degrees in order to provide good teeth penetration between the Gears in the sleeve and hub

9. TRANSPORTATION AND STORAGE

The volume of the supply is indicated in the dispatch documentation. The condition of the goods supplied should be checked at the time of receipt. If there are any damages due to transportation or parts that are missing, these should be notified.

The coupling is packed differently depending on the transportation route and the size. Unless agreed upon otherwise in the contract, the packaging shall be the standard packaging of Jaure.

The pictograms affixed to the packaging should be kept in mind during handling.

☞ **A T T E N T I O N !**

Ensure the use of a suitable elevation device.

The coupling is supplied duly prepared with storage products and can be stored for 6 months in a dry, dust-free place, suitable for the same. If storage for a longer period is planned, we recommend that you must consult Jaure.

☞ **A T T E N T I O N !**

If the coupling is to be stored for more than 6 months, it is recommended that the housing rings are dismantled in the coupling and kept in an ozone-free area.

☞ **A T T E N T I O N !**

Humid stores (with humidity greater than 65%) are not suitable. It must be kept in mind that there should be no condensation.

CHANGE HISTORY

Rev.	Author	Date	Reviewed	Date	Approved	Date
05	XVL	14/09/2011	OGU	14/09/2011	IGM	14/09/2011
Rev.05: Changes made according to ANP000989						

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ÍNDICE

0. OBJETO Y ÁMBITO

Esta instrucción es válida para todos los acoplamientos de dientes estándar conforme al catálogo estándar. La presente instrucción sustituye a las anteriores instrucciones 1610 y 1611.
En caso de que el plano del acoplamiento que utiliza haga referencia a una instrucción que no sea IMO000678, preste atención exclusivamente a la instrucción del plano.

☞ **A T E N C I Ó N!**

Asegúrese de que la presente versión de las instrucciones sea la más reciente. Para ello, compruebe la página web de JAURE: WWW.JAURE.COM.

1. PREPARACIÓN PREVIA A LA INSTALACIÓN

Los acoplamientos de dientes deben ser almacenados en ambientes no corrosivos. Las superficies mecanizadas, especialmente los agujeros, deben tener siempre una protección contra la corrosión.

⚠ **P R E C A U C I Ó N!**

Si el acoplamiento se debe almacenar más de 6 meses, se recomienda desmontar las juntas tóricas de los alojamientos en el acoplamiento y se deberán mantener en una zona exenta de ozono.

☞ **A T E N C I Ó N!**

Cuando se instale el cubo en el eje, se deberá quitar toda protección anticorrosiva de los agujeros.

☞ **A T E N C I Ó N!**

Los acoplamientos de engranajes están compuestos de piezas giratorias potencialmente peligrosas. Use siempre protectores adecuados para evitar accidentes y cumplir con las regulaciones de seguridad existentes.

☞ **A T E N C I Ó N!**

Antes de instalar el acoplamiento, y durante su manipulación, evite en todo momento cualquier daño en el acoplamiento y, sobre todo, en el dentado.

2. INSTALACIÓN DE CUBOS CON CHAVETERO Y ENGRASADO DE ACOPLAMIENTOS

2.1 Asegurarse de que todas las piezas están limpias.

2.2 Untar ligeramente con grasa las juntas tóricas (6) e introducirlas en las ranuras de las camisas (2,3 ó 4,5).Se debe aplicar sellador en la zona del chavetero para evitar fugas de grasa durante la operación. Recomendamos aplicar Rhodorseal 5661.

2.3 Aplicar la grasa indicada a los dientes de las camisas (2, 3 ó 4, 5). Colocar las camisas sobre los ejes, evitando dañar las juntas tóricas (6).

2.4 Para tamaños superiores al MT Marino 260 ó MT-275, colocar antes las tapas (7), una vez que las juntas tóricas (6) hayan sido colocadas en las ranuras de la tapa.

2.5 Calentar los cubos (1) a 110℃-130℃ antes de i nstalarlos sobre los ejes. No utilizar un soplete. Protéjanse las juntas de calor (Temperatura máxima de las juntas= 80ºC)

2.6 Instalar los cubos (1) en sus respectivos ejes. La extremidad de los cubos debe enrasar con las extremidades de los ejes. En caso de duda, consúltenos.

2.7 Posicionar las máquinas a acoplar y comprobar la distancia “a” entre cubos. Verifique para ello las tablas 1, o el correspondiente plano aprobado si lo hubiera. En caso de duda, consúltenos.

2.8 Alinear los dos ejes, controlar la alineación con un reloj comparador o mediante un alineador laser. La tolerancia de la alineación dependerá de la velocidad de rotación. (Ver punto 8).

2.9 Dejar que los cubos (1) se enfríen antes de montar las camisas (2,3 ó 4,5). Aplicar grasa sobre los dientes de los cubos (1) antes de instalar las camisas (2,3 ó 4,5).

2.10 Introducir la junta de papel aceitado o tórica (10) según corresponda y atornillar las camisas según el par de apriete (ver tablas 1) (se recomienda el uso de Loctite 243). Es recomendable aplicar grasa en la junta y un poco de grasa al papel aceitado para fijarlo a la camisa durante el montaje. Asegurarse de que los agujeros de engrase, una vez montado el acoplamiento, están a 90° entre sí, tal y como se muestra en fig. 1.

2.11 Engrasar el acoplamiento. Soltar los 2 tapones de engrase (9) de las camisas (2,3 ó 4,5). A modo orientativo se puede proceder de la siguiente manera: Girar el acoplamiento de modo que los agujeros de engrase están en posición horaria 1^{30}, 4^{30}, 7^{30}, 10^{30}. Soltar los tapones de engrase (9) de las posiciones 1^{30} y 7^{30} e introducir la grasa en el 1^{30} hasta que salga por el inferior 7^{30} (ver fig.1) Es aconsejable soltar el tapón en posición 10^{30} para facilitar la salida del aire. Para la calidad de grasa, así como cantidad más exacta, ver secciones 5 y 6. Para condiciones de funcionamiento diferentes a las dadas en las tablas 3 y 4, consulte a JAURE. Para los tipos MTD, MTGD, MTX, MTGX, MTXCL, MTB, es necesario lubricar cada medio acoplamiento por separado. No olvidar introducir los tapones (9).

2.12 De cara a inspeccionar periódicamente el dentado, deberá existir suficiente espacio para alejar la camisa del dentado del cubo, distancia “S” en el catálogo. Si no es el caso se recomienda instalar un acoplamiento tipo MTN.

2.13 Para acoplamientos equilibrados en conjunto se deberán alinear las marcas de las partes durante el montaje.

Para la instalación mediante extracción hidráulica cilíndrica (IMO000917) o cónica (IMO000918), por favor, consulten con Jaure

3. INTERVALOS DE MANTENIMIENTO

Se debe desmontar e inspeccionar (ver sección 4) el acoplamiento, y cambiar la grasa cada 8000 horas de trabajo o máximo 2 años si durante este periodo de tiempo no se ha alcanzado el tiempo de funcionamiento de 8000 horas.

Si la temperatura de trabajo ha sido alta (más de 60ºC), se deberá cambiar la grasa cada 4000 horas de trabajo o máximo 1 año si durante este periodo de tiempo no se ha alcanzado el tiempo de funcionamiento de 4000 horas.

Si se requieren periodos más amplios, consúltenos. Actuar como se indica en la sección 2.11. Rellenar el acoplamiento con grasa. Se recomienda usar aceite (compatible con la grasa usada), para limpiar correctamente la grasa.

4. DESMONTAJE E INSPECCIÓN

- Antes de mover las camisas, limpiar la superficie próxima a las juntas tóricas (6).
- Soltar los tornillos (11) y la junta tórica (10) ó junta de papel (8).
- Controlar el estado del dentado y de las juntas.
- Comprobar la alineación.
- Utilizar nueva grasa. Se recomienda emplear aceite de poca viscosidad para limpiar el acoplamiento de la grasa antigua.

☞ **A T E N C I Ó N!**

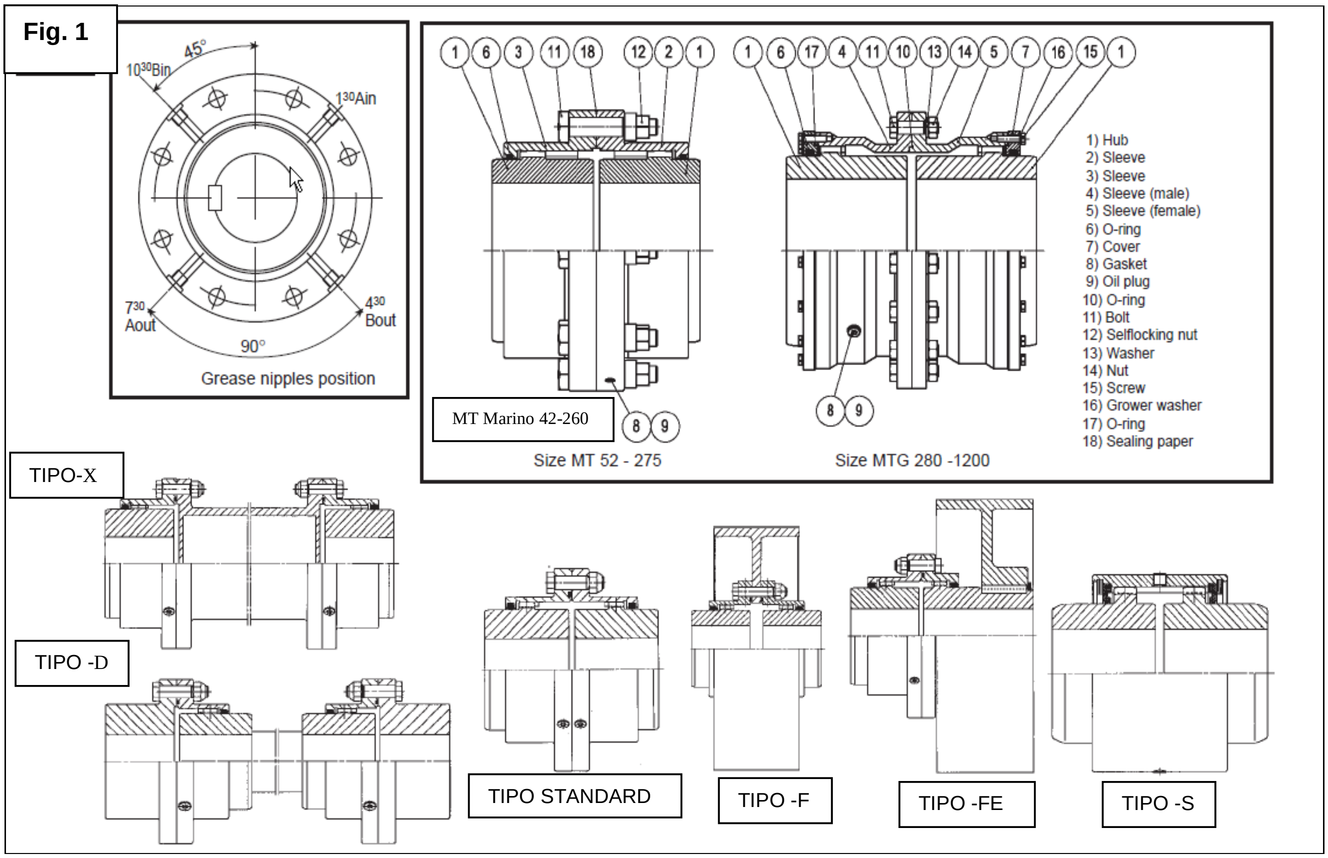
Asegurarse de que este aceite sea compatible con la grasa que está dentro del acoplamiento. Una vez mezclados el aceite y la grasa dentro del acoplamiento, resultará más fácil eliminar la grasa.

Para cuando la unión del cubo y eje sea mediante chavetero, y sea necesario el desmontaje de los cubos del acoplamiento, en primer lugar habrá que retirar la camisa y tapa del acoplamiento. Calentando el cubo mediante una antorcha (80ºC aproximadamente) y haciendo uso de los agujeros de extracción, el cubo puede retirarse del eje.
Una información más detallada de este proceso se encuentra en la IMO000060, Uniones a ejes mediante chavetas B01-B04.

☞ **A T E N C I Ó N!**

Intentar no usar las camisas para retirar los cubos. Hacer uso de los agujeros de extracción.

Fig. 1



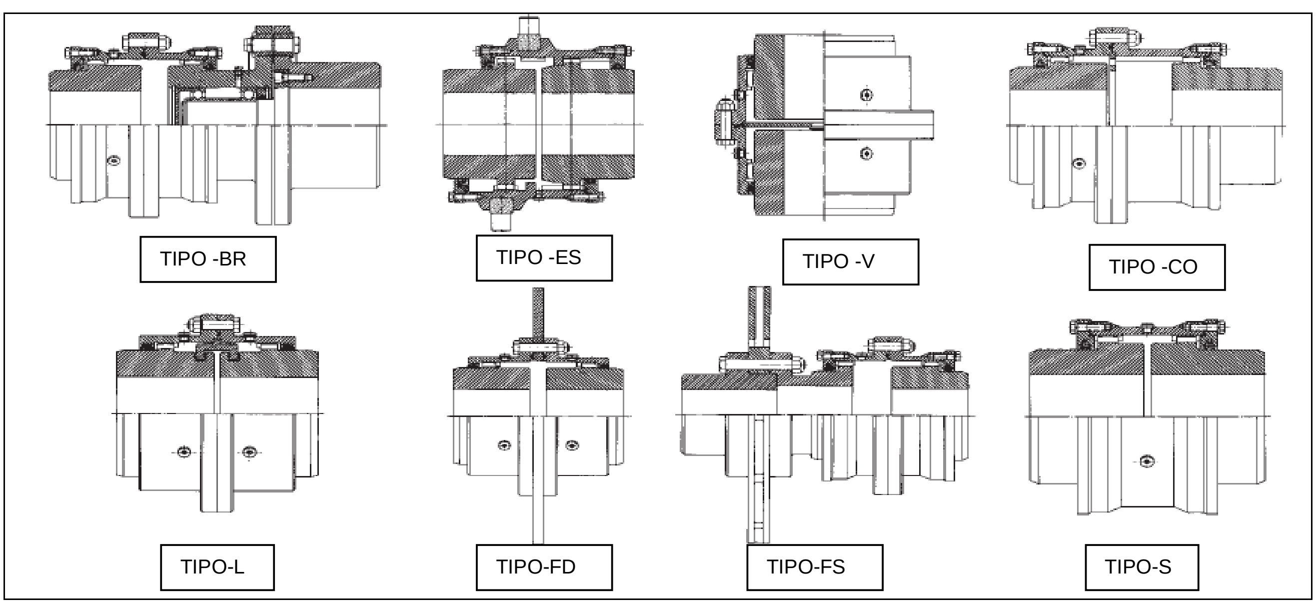


Fig. 2: Tipos de acoplamientos

Acoplamientos tipo MT Marino, MT, MTF, MTFE, MTS, MTV, MTCO, MTFD, MTFS, MTG			
Tamaño	**“a” (mm.)**	**Tamaño**	**“a” (mm.)**
MT-42	6±1	**MTG-280**	16±3
MT-52	3±1	**MTG-310**	16±3
MT-55	6±1	**MTG-345**	16±3
MT-62	3±1	**MTG-370**	20±4
MT-70	6±2	**MTG-390**	20±4
MT-78	3±2	**MTG-420**	20±4
MT-90	8±2	**MTG-460**	20±4
MT-98	5±2	**MTG-500**	25±4
MT-100	8±2	**MTG-550**	25±4
MT-112	5±2	**MTG-590**	25±4
MT-125	8±2	**MTG-620**	30±6
MT-132	6±2	**MTG-650**	30±6
MT-145	10±2	**MTG-680**	30±6
MT-156	6±2	**MTG-730**	30±6
MT-165	10±3	**MTG-800**	30±6
MT-174	8±3	**MTG-900**	35±7
MT-185	10±3	**MTG-1000**	35±7
MT-190	8±3	**MTG-1100**	35±7
MT-205	12±3	**MTG-1200**	35±7
MT-210	8±3		
MT-230	12±3		
MT-233	8±3		
MT-260	12±3		
MT-275	10±3		

Acoplamientos tipo MT Marino, MT, MTF, MTFE, MTS, MTV, MTCO, MTFD, MTFS, MTG				
Tamaño	**Par de apriete (Nm)**	**Tamaño**	**Par de apriete tornillos unión (Nm)** (Ver Fig. 2.1)	**Par de apriete tornillos tapa (Nm)** (Ver Fig. 2.1)
MT-42	6	**MTG-280**	375	73
MT-52	8	**MTG-310**	375	73
MT-55	15	**MTG-345**	660	73
MT-62	20	**MTG-370**	660	73
MT-70	52	**MTG-390**	760	178
MT-78	42	**MTG-420**	760	178
MT-90	82	**MTG-460**	760	178
MT-98	73	**MTG-500**	1.140	178
MT-100	82	**MTG-550**	1.140	328
MT-112	73	**MTG-590**	1.140	328
MT-125	174	**MTG-620**	1.800	328
MT-132	178	**MTG-650**	1.800	328
MT-145	174	**MTG-680**	1.800	328
MT-156	178	**MTG-730**	1.800	328
MT-165	174	**MTG-800**	1.800	328
MT-174	178	**MTG-900**	2.300	328
MT-185	247	**MTG-1000**	2.300	570
MT-190	245	**MTG-1100**	2.300	570
MT-205	247	**MTG-1200**	2.300	570
MT-210	245			
MT-230	247			
MT-233	245			
MT-260	428			
MT-275	470			

Tabla 1: Distancia “a” y pares de apriete de los tornillos de las bridas para MT Marino, MT, MTG, MTCL, MTX, MTF, MTFE, MTS, MTV, MTCO, MTFD y MTFS.

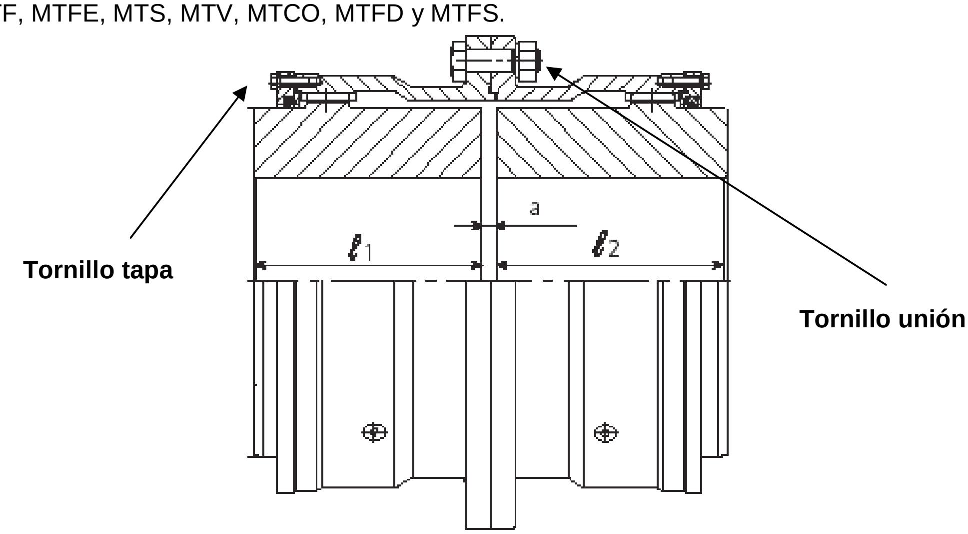


Fig. 2.1: Diferente tornillos acoplamiento MTG

Acoplamientos tipo MTN	
Tamaño	**“a” (mm.)**
MTN-42	6±1
MTN-55	6±1
MTN-70	6±2
MTN-90	8±2
MTN-100	8±2
MTN-125	8±2
MTN-145	10±2
MTN-165	10±3
MTN-185	10±3
MTN-205	12±3
MTN-230	12±3
MTN-260	12±3

Acoplamientos tipo MTN		
Tamaño	**Par de apriete (Nm)**	**Par de apriete en tapas (Nm)**
MTN-42	20	8
MTN-55	39	8
MTN-70	39	8
MTN-90	68	20
MTN-100	68	20
MTN-125	68	20
MTN-145	108	40
MTN-165	108	40
MTN-185	325	40
MTN-205	325	40
MTN-230	325	40
MTN-260	375	70

Tabla 1.1: Distancia “a” y pares de apriete de los tornillos de las bridas para MTN.

☞ **A T E N C I Ó N!**

Si los tornillos están lubricados con aceite, los valores de par de apriete deben ser un 20% menores.

5. LUBRICANTES RECOMENDADOS

Recomendamos los lubricantes mostrados en las tablas 2, en base a nuestra experiencia. Si el usuario desea usar un lubricante distinto, leer con atención los datos expuestos al final de esta sección del presente documento.

VELOCIDAD MEDIA, APLICACIÓN NORMAL O PESADA ver tablas 3 y 4)		
FABRICANTE DE GRASA	**NOMBRE DE GRASA**	**TEMP (ºC) OPERATIVA**
Emerson	KSG	-40 a +88
Castrol	Tribol 3020/1000-1	-30 a +120
Total Fina Elf	Ceran GEP-0	-25 a +180
Total	Ceran MS	-20 a +180
Klüber	Klüberplex AG 11-461	-40 a +180
Esso-Exxon-Mobil	Mobilgrease XTC	-30 a +120
Esso-Exxon-Mobil	Mobilith SHC 460	-50 a +150
Molyduval	Molyduval coupling grease	-30 a +150
Shell	Gadus S3 HSCG	-10 a +120
Shell	Gadus S3 V770D1	-20 a +150
Verkol	Verkol 320-1 Grado 1	-15 a +150

Tabla 2.1

VELOCIDAD ALTA, APLICACIÓN NORMAL ver tablas 3 y 4)		
FABRICANTE DE GRASA	**NOMBRE DE GRASA**	**TEMP (ºC) OPERATIVA**
Emerson	KHP	-40 a +88
Klüber	Kluebersynth GE 14-151	-35 a +140
Shell	Gadus S2 HSCG	-30 a +120
Esso-Exxon-Mobil	Mobilgrease XTC	-30 a +120

Tabla 2.2

VELOCIDAD MENOR DE 500 rpm, APLICACIÓN MUY PESADA ver tablas 3 y 4)		
FABRICANTE DE GRASA	**NOMBRE DE GRASA**	**TEMP (ºC) OPERATIVA**
Emerson	Waverly Torque Lube A	-18 a +100
Esso-Exxon-Mobil	Mobilith SHC 1000 Spec	-20 a +150
Klüber	Klüberlub BE 41-1501	-10 a +150
Castrol	Mollub Alloy 870	-10 a +130

Tabla 2.3

VELOCIDAD BAJA, APLICACIÓN NORMAL o PESADA ver tablas 3 y 4)		
FABRICANTE DE GRASA	**NOMBRE DE GRASA**	**TEMP (ºC) OPERATIVA**
Mobil	Mobilith SHC 007	-50 a +150
Klüber	Klueberplex 11-680	-10 a +130

Tabla 2.4

VELOCIDAD MEDIA, APLICACIÓN MUY PESADA ver tablas 3 y 4)		
FABRICANTE DE GRASA	**NOMBRE DE GRASA**	**TEMP (ºC) OPERATIVA**
Emerson	Syn-tech 3913G	-55 a +120
Mobil	Mobilith SHC 1500	-20 a +150
Mobil	Mobilux EP 111	-10 a +120
BP	BP Energrease SY 1501	-20 a +180

Tabla 2.5

Nivel de aplicación	***Aplicación***
Normal	Cuando el material de los dientes es estándar (ver catálogo)
Pesada	Cuando el material de los dientes es HD (ver catálogo)
Muy pesada	Cuando el material de los dientes está endurecido mediante tratamiento térmico superficial

Tabla 3: Clarificación acerca de los niveles de aplicación

Nivel de velocidad	***Velocidad periférica (*)***
Bajo	< 2 m/seg
Medio	>2 m/seg y <60 m/ seg
Alto	> 60 m/ segundo

Tabla 4: Clarificación acerca de los niveles de velocidad

Para calcular la velocidad periférica, usar esta fórmula :

(*) $\frac{\prod \times D1 \times n}{60000}(m/s)$ donde,

D1 (mm)= Diámetro externo del cuerpo de la camisa en el catálogo MT (ver catálogo)
n(rpm)= Máxima velocidad operativa

6. CANTIDAD DE GRASA RECOMENDADA

Los acoplamientos se suministran con una grasa de protección, pero dicha grasa no debe utilizarse en trabajo. Los dentados del acoplamiento deben limpiarse de cualquier aceite protector previo al montaje.

Antes de atar las camisas se deberá aplicar a mano el 50 -70% de la grasa sobre el dentado de la camisa y cubo. El 30%-50% restante se introducirá a través de los orificios de engrase.

A altas temperaturas, bajas velocidades ó accionamientos reversibles, se recomienda una lubricación más frecuente que la especificada en estas instrucciones. Un llenado excesivo de grasa del acoplamiento puede originar daños en los equipos acoplados.

Para el tipo MTV estándar, llenar de grasa el medio acoplamiento superior e introducir en el medio acoplamiento inferior el 50% de la cantidad indicada en la Tabla 5.

⚠ **P R E C A U C I Ó N!**
Un llenado excesivo del acoplamiento con grasa puede causar daño al equipo.

☞ **A T E N C I Ó N!**
En caso de acoplamientos especiales, la cantidad de grasa con la que tiene que lubricarse el acoplamiento estará indicada en el plano.

Acoplamientos tipo MT Marino, MT, MTF, MTFE, MTS, MTV, MTCO, MTFD, MTFS, MTG			
Tamaño	**2)Cant. (kg)**	**Tamaño**	**2)Cant. (kg)**
MT-42	0,04	**MTG-280**	3
MT-52	0,03	**MTG-310**	3,6
MT-55	0,06	**MTG-345**	4,8
MT-62	0,06	**MTG-370**	5
MT-70	0,17	**MTG-390**	9
MT-78	0,09	**MTG-420**	9,8
MT-90	0,24	**MTG-460**	11,5
MT-98	0,12	**MTG-500**	11,5
MT-100	0,36	**MTG-550**	14,5
MT-112	0,3	**MTG-590**	23
MT-125	0,5	**MTG-620**	23
MT-132	0,4	**MTG-650**	30
MT-145	0,7	**MTG-680**	36
MT-156	0,6	**MTG-730**	38
MT-165	1,3	**MTG-800**	46
MT-174	0,8	**MTG-900**	57
MT-185	1,75	**MTG-1000**	75
MT-190	1,4	**MTG-1100**	115
MT-205	2,2	**MTG-1200**	125
MT-210	2,5		
MT-230	2,8		
MT-233	3		
MT-260	4,5		
MT-275	4,5		

Acoplamientos tipo MTN	
Tamaño	**2)Cant.(kg)**
MTN-42	0,07
MTN-55	0,1
MTN-70	0,12
MTN-90	0,22
MTN-100	0,3
MTN-125	0,4
MTN-145	0,6
MTN-165	1
MTN-185	1,1
MTN-205	1,6
MTN-230	2
MTN-260	1,3

Acoplamientos tipo MTGX y MTGD			
Tamaño	**2)Cant. (kg)**	**Tamaño**	**2)Cant. (kg)**
MTGX-MTGD-190	1,4	**MTGX-MTGD-460**	10
MTGX-MTGD-210	2,5	**MTGX-MTGD-500**	14
MTGX-MTGD-233	3	**MTGX-MTGD-550**	16
MTGX-MTGD-275	4,5	**MTGX-MTGD-590**	19
MTGX-MTGD-280	3,5	**MTGX-MTGD-620**	24
MTGX-MTGD-310	4	**MTGX-MTGD-650**	28
MTGX-MTGD-345	5	**MTGX-MTGD-680**	36
MTGX-MTGD-370	6	**MTGX-MTGD-730**	40
MTGX-MTGD-390	8	**MTGX-MTGD-800**	50
MTGX-MTGD-420	9	**MTGX-MTGD-900**	70

Tablas 5: Cantidad de grasa recomendada

2) Cantidad correspondiente a un acoplamiento completo para el MT Marino**,** MT, MTG, MTG-HD, MTCL, MTS, MTFD, MTFS, MTF, MTFE, MTB, MTBX, MTN, MTNBR.

☞ **A T E N C I Ó N!**

Para las series MTX, MTGX, MTD y MTGD, utilizar la cantidad específica que aparece en hoja dimensional particular dividida entre 2 para cada mitad.
Ej. MTX-112: 0,15 kg a cada lado.

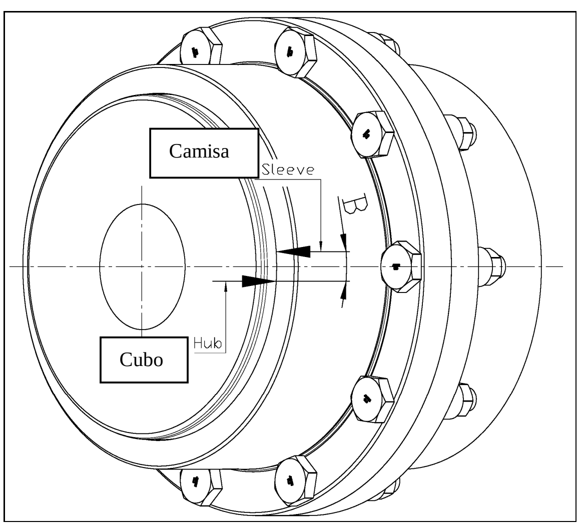
☞ **A T E N C I Ó N!**

Para los tipos MTGX, MTGD, acoplamientos por encima de 1000, consulte a JAURE

7. COMPROBACIÓN DE DESGASTE DE DIENTES

Con el fin de realizar un mantenimiento preventivo de los acoplamientos de dientes, se recomienda encarecidamente comprobar el grado de desgaste de los dientes. Existen diferentes opciones. Todas ellas se basan en la medición de la holgura (B) (espacio tangencial entre los dientes, ver imagen), la cual debe ser inferior a los valores expuestos en la tabla 6. Los dos métodos más prácticos para realizar esta medición son:

- Marcar el cubo y la camisa. Con este método para medir la holgura, se marcan el cubo y la camisa en el mismo diámetro que indica la figura 3. Debido a que la holgura es una dimensión tangencial, el valor es prácticamente el mismo que el mostrado en la figura 4, que es la holgura real. En teoría, se puede usar este método con todos los acoples estándar que aparecen en el catálogo estándar pero, debido al bajo número de los valores máximos, resulta muy complejo de usar con las piezas más pequeñas (aproximadamente hasta el tamaño MT 233 ó MT Marino 230). Seguir los siguientes pasos:
    - Girar el cubo hasta que la camisa y los dientes del cubo entren en contacto.
    - En esta posición, marcar la camisa y el cubo (ver Fig. 3).
    - A continuación, girar el cubo en la dirección contraria hasta que vuelva a entrar en contacto con la camisa.
    - Medir la dimensión B. Comprobar si el valor es mayor que el valor de holgura máximo permisible para dicho tamaño.



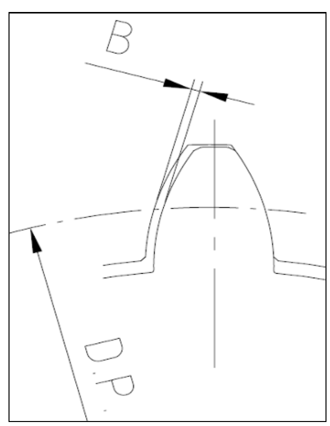


Fig 3: Holgura mediante el método de marcado

Fig 4: Holgura

- Usar calibres de medición. Este método sólo es válido cuando ha sido previsto en el proceso de diseño del acoplamiento. Esto se debe a que es necesario realizar algunos agujeros para poder implementar este método (por ello, el cliente debe solicitarlo cuando encarga los acoplamientos). Este método se realiza más fácilmente, pero requiere el uso de calibres del tamaño adecuado (Jaure no los suministra). El objetivo también consiste en medir el valor B.

- o Girar el cubo hasta que la camisa y los dientes del cubo entren en contacto.
- o Insertar los calibres a través del agujero como se muestra en la figura 5. Se debe insertar por el lado que no está en contacto entre el cubo y la camisa.

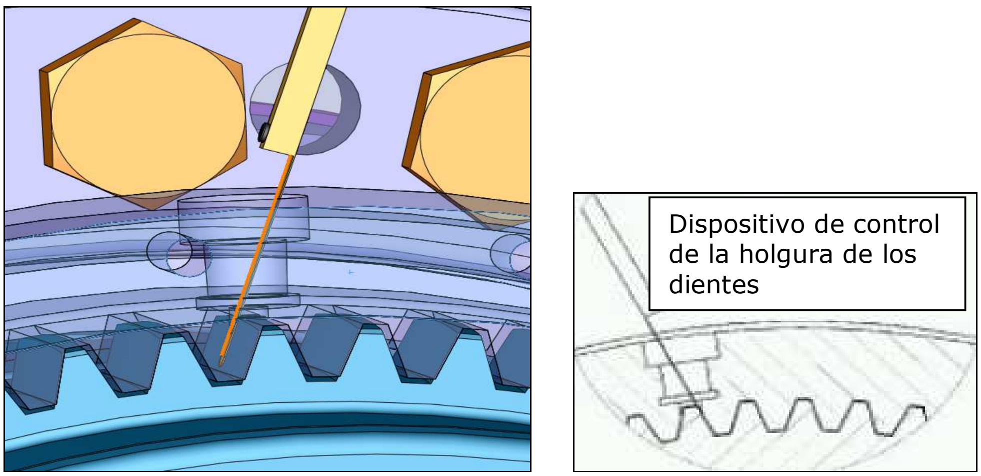


Fig 5: Dos imágenes del método de calibración para medir la holgura

☞ **A T E N C I Ó N!**

Asegúrese de haber colocado el tapón en su lugar después de medir la holgura. De lo contrario, la grasa saldrá por el agujero

- **Otros métodos**: Existen otros dos métodos que pueden utilizarse, aunque requieren un mayor trabajo de desmontaje.

  - o Desmontar los dos medios acoplamientos sin quitarlos de sus correspondientes ejes. Se deben insertar los calibres a través de los dientes, pero hay que asegurarse de que alcancen la mitad de la longitud total de los dientes.
  - o Medir tanto el intervalo entre dientes del cubo como la distancia entre bulones de la camisa. Mediante estas dos dimensiones, es posible calcular la holgura correspondiente. Este método es muy utilizado por los fabricantes de acoplamientos, pero es más difícil de realizar para los usuarios finales. El motivo es que se necesitar tener cierto grado de experiencia para poder llevarlo a cabo.

ACOPLAMIENTO	B*(holgura permisible, límite de desgaste de los dientes con material estándar o HD) (mm)	ACOPLAMIENTO	B* (holgura permisible, límite de desgaste de los dientes con material estándar o HD) (mm)
MT-42	0,8	**MTN-42**	1
MT-52	0,8	**MTN-55**	1
MT-55	0,8	**MTN-70**	1
MT-62	0,8	**MTN-90**	1,5
MT-70	1	**MTN-100**	1,5
MT-78	1	**MTN-125**	1,5
MT-90	1	**MTN-145**	2
MT-98	1	**MTN-165**	2
MT-100	1,3	**MTN-185**	2
MT-112	1,3	**MTN-205**	2,5
MT-125	1,3	**MTN-230**	2,5
MT-132	1,5	**MTN-260**	2,5
MT-145	1,5	**MTG-280**	3
MT-156	1,8	**MTG-310**	3
MT-165	1,8	**MTG-345**	3,5
MT-174	1,8	**MTG-370**	3,5
MT-185	2	**MTG-390**	4
MT-190	2	**MTG-420**	4,5
MT-205	2	**MTG-460**	4,5
MT-210	2	**MTG-500**	5
MT-230	2,5	**MTG-550**	5
MT-233	2,5	**MTG-590**	5,5
MT-260	2,5	**MTG-620**	5,5
MT-275	2,5		

Tabla 6: Holgura permisible (solo válido para acoplamientos que no hayan recibido un tratamiento térmico superficial)

8. PRECISIÓN DE ALINEACIÓN

Durante el funcionamiento, los medios acoplamientos pueden operar con una desalineación máxima de 0,5º. No obstante, cuanto menor sea la desalineación durante operación, mayor será la vida útil. Así pues, para optimizar la vida útil de los acoplamientos, es muy importante alinearlos correctamente durante el montaje. Se debe cumplir con lo siguiente cuando se realice el montaje en sitio de un acoplamiento de dientes de JAURE en condiciones estándar. Observar las figuras 6 y 7, y las tablas 8 y 9; y seguir la siguiente fórmula:

$$\left[\left(\frac{X}{DCD}\right)+\left(\frac{1}{2}x\frac{(Y-Z)}{D2}\right)\right]x\left(\frac{180}{PI}\right)\leq \text{MAMDAº}$$

MAMDA= Desalineación máxima permitida en Montaje (Maximum Accepted Misalignment During Assembly)
PI= 3,1415
X= Offset (la mitad de la medida del TIR)

Durante la alineación, se deben respetar los siguientes valores:

MT, MT Marino MTG y MTN	Speed (rpm)		
	0 – 500	500 - 1500	1500 – 4000
	MAMDAº	MAMDAº	MAMDAº
Todos los tamaños	0,1º	0,075º	0,05º

Tabla 7: Precisión de la alineación para MT, MTG y MTN

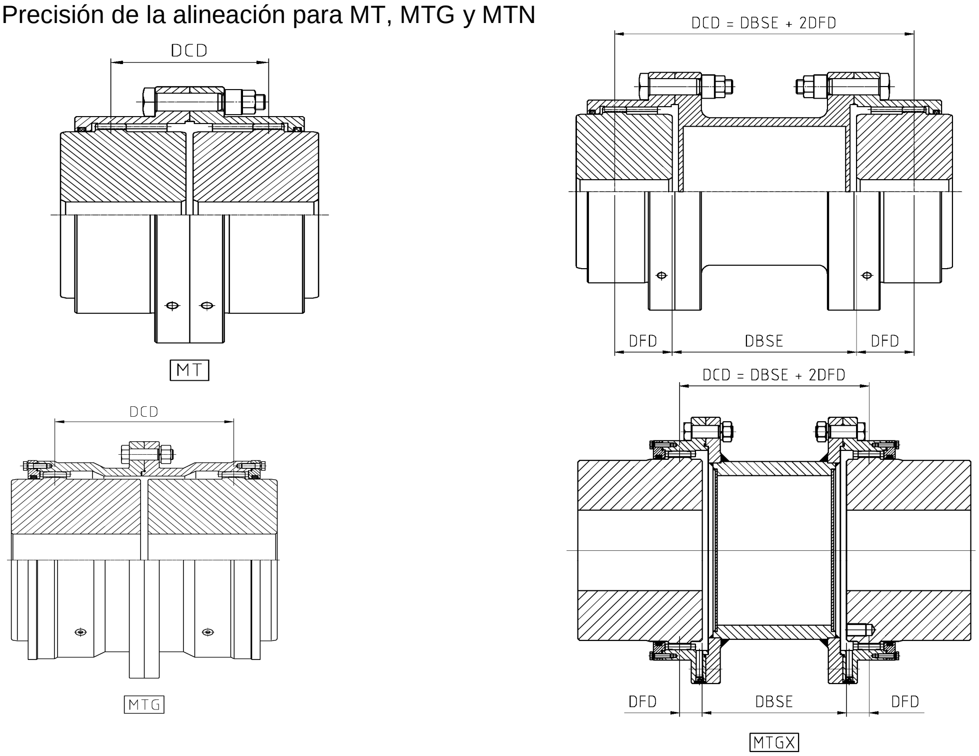


Fig 6: Representación distancias DCD para acoplamientos MT, MTX, MTG y MTGX

MT	DCD (mm)	MTX	DFD (mm)	MTG	DCD (mm)	MTGX	DFD (mm)
42	46	**46**	20	**280**	332	**280**	48
52	48	**52**	22,5	**310**	366	**310**	50
55	56	**55**	25	**345**	401	**345**	57,5
62	58	**62**	27,5	**370**	460	**370**	60
70	75	**70**	34,5	**390**	478	**390**	63
78	76	**78**	36,5	**420**	515	**420**	66,5
90	88	**90**	40	**460**	558	**460**	69
98	88	**98**	41,5	**500**	581	**500**	79
100	113	**100**	52,5	**550**	607	**550**	84
112	114	**112**	54,5	**590**	641	**590**	89
125	131	**125**	61,5	**620**	712	**620**	104
132	132	**132**	63	**650**	720	**650**	111
145	151	**145**	70,5	**680**	730	**680**	117
156	152	**156**	73	**730**	760	**730**	122
165	170	**165**	80	**800**	804	**800**	127
174	172	**174**	82	**900**	855	**900**	146,5
185	202	**185**	96	**1.000**	916	**1.000**	152,5
190	200	**190**	96	**1.100**	990	**1.100**	157,5
205	225	**205**	106,5	**1.200**	1090	**1.200**	162,5
210	227	**210**	109,5				
230	244	**230**	116				
233	248	**233**	120				
260	284	**260**	136				
275	292	**275**	141				

MT y MTX	D2 (mm)	MTG y MTGX	D2 (mm)
42	60	**280**	370
52	69	**310**	410
55	79	**345**	450
62	85	**370**	490
70	101	**390**	520
78	107	**420**	560
90	124	**460**	600
98	133	**500**	650
100	143	**550**	710
112	152	**590**	760
125	170	**620**	810
132	178	**650**	840
145	205	**680**	890
156	209	**730**	950
165	216	**800**	1050
174	234	**900**	1180
185	250	**1000**	1320
190	254	**1100**	1450
205	275	**1200**	1580
210	279		
230	300		
233	305		
260	340		
275	355		

Tabla 8: Distancias DCD, DFD y D2 para acoplamientos MT, MTX, MTG y MTGX.

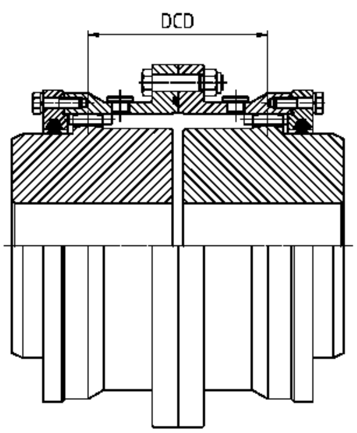


Fig 7: Representación distancias DCD para acoplamientos MTN

DCD: distancia entre centros del dentado. DCD=2*DFD + DBSE
DFD: distancia del centro del dentado hasta el extremo del cubo

MTN	DCD (mm)	D2 (mm)
42	61	71
55	76	86
70	86	105
90	101	124
100	120	148
125	128	174
145	149	198
165	168	220
185	190	244
205	220	270
230	242	304
260	294	320

Tabla 9: Distancias DCD, DFD y D2 para acoplamientos MTN.

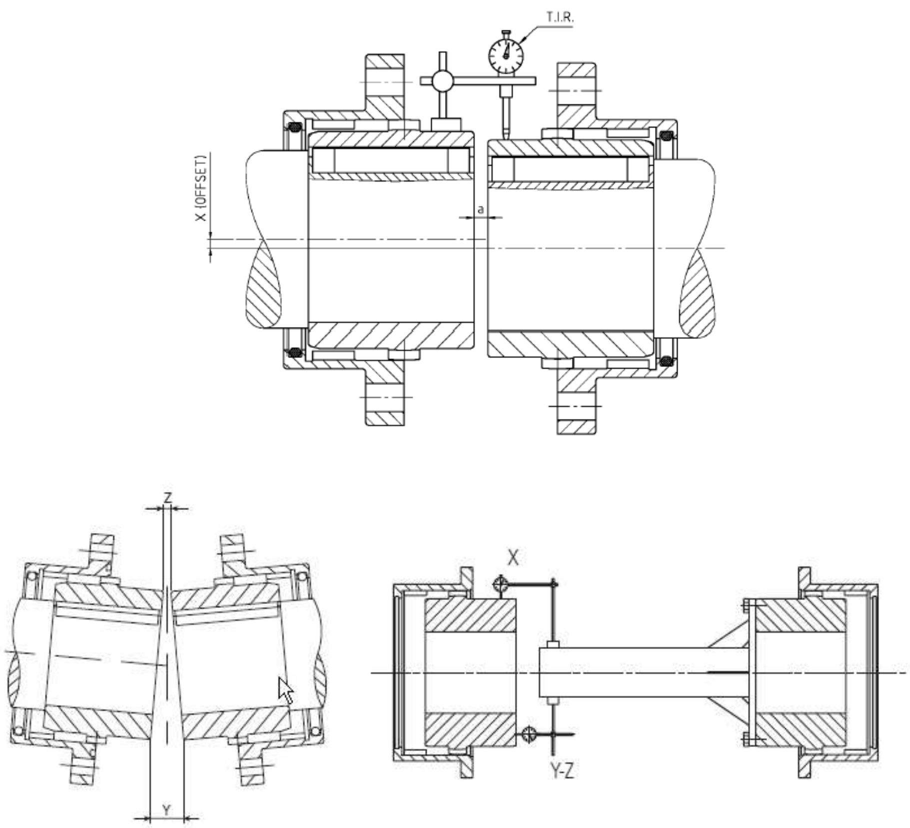


Fig 8: Detalle de alineación

☞ **A T E N C I Ó N!**

Una mejor alineación que la que figura en estas tablas prolongará la vida del acoplamiento y reducirá las fuerzas de reacción en los ejes y cojinetes.

☞ **A T E N C I Ó N!**

En el caso de la dimensión Y-Z, medir lo más cerca posible del diámetro D2 (como se observa en la parte derecha de la Figura 8).

Una mejor alineación que la mostrada en estas tablas incrementará la vida y reducirá las fuerzas de reacción en los ejes y rodamientos. Sin embargo el mínimo valor (Y-Z) no debe ser inferior a 0,005° de cara a permitir la en trada y reparto de la grasa entre el dentado del cubo y camisa.

9. TRANSPORTE Y ALMACENAMIENTO

El volumen del suministro se indica en la documentación de envío. Habrá que comprobar el estado del suministro a su recepción. Se notificarán en caso de que hubiera los eventuales daños de transporte y/o piezas que falten.

El acoplamiento se embala de manera distinta en función del recorrido de transporte y de su tamaño. En caso de que no se haya acordado contractualmente algo diferente, el embalaje será el estándar de Jaure.

Se han de tomar en cuenta los pictogramas adosados al embalaje para una correcta manipulación.

Una vez el acoplamiento esté montado, se recomienda la aplicación de un antioxidante o protector acorde al ambiente donde el acoplamiento vaya a trabajar.

☞ **A T E N C I Ó N!**

Asegurar el empleo del dispositivo de elevación apropiado.
El acoplamiento se suministra preparado con productos conservantes y se puede almacenar durante 6 meses en un lugar seco y exento de polvo adecuado para ello. Si se piensa en un almacenamiento más prolongado, recomendamos consultar a Jaure.

☞ **A T E N C I Ó N!**

Si el acoplamiento se debe almacenar más de 6 meses, se recomienda desmontar las juntas de los alojamientos en el acoplamiento y se deberán mantener en una zona exenta de ozono.

☞ **A T E N C I Ó N!**

Los almacenes húmedos (humedad de aire superior al 65%) son inadecuados. Hay que prestar atención a que no se origine ninguna condensación.

REGISTRO DE CAMBIOS / CHANGE HISTORY

Rev.	Author	Date	Reviewed	Date	Approved	Date
05	XVL	14/09/2011	OGU	14/09/2011	IGM	14/09/2011
Rev.05: - Cambios realizados según ANP000989						

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Acoplamiento flexible de láminas

Lamidisc®

Instrucciones de montaje, alineación y mantenimiento.

Montaje de cubos. Alineación de máquinas. Instalación de las láminas y el espaciador.

1.- Instalación de los cubos en los ejes de las máquinas a acoplar.

a) Ejes cilíndricos con chaveteros.
JAURE suministra los cubos del Acoplamiento Lamidisc® mecanizados a **H7** (tolerancias ISO-286). JAURE recomienda que el eje sea mecanizado para que resulte un ajuste con interferencia, como **s6** (ISO-286).

Si los ejes están mecanizados a una tolerancia distinta que s6, JAURE podrá mecanizar los cubos a la medida necesaria para proporcionar el ajuste correspondiente. JAURE recomienda las siguientes tolerancias.

Tolerancia del eje	Tolerancia del cubo
h6	**T7**
k6	**R7**
m6	**P7**
n6	**N7**
p6	**M7**

b) Anillos de sujeción.
Cuando se utilicen anillos de sujeción, como anillos cónicos, Jaure recomienda que los ejes sean mecanizados a **g6** para un agujero standard del Lamidisc® (H7).

Para otros tipos de fijación, consulte nuestro Departamento Técnico.

2.-Alineación de maquinaria.
Si las máquinas están alineadas según las especificaciones de montaje de este catálogo, los acoplamientos Lamidisc funcionarán durante un período prolongado. Sin embargo, se debe considerar que la vida útil del acoplamiento está directamente relacionada con la desalineación de funcionamiento: cuanto mejor sea la alineación, mayor será la vida del acoplamiento.

Aunque el acoplamiento Lamidisc puede funcionar satisfactoriamente según las desalineaciones de catálogo, tanto la vida del acoplamiento como la de los rodamientos se ve sustancialmente mejorada si la desalineación es menor que la máxima dada en catálogo. Jaure recomienda que la desalineación en montaje sea menor que el 20% de la dada en catálogo. A continuación se muestran las recomendaciones de Jaure para las desalineaciones máximas recomendadas:

Se deben verificar los 3 tipos de desalineación (radial, angular y axial).

• La máxima desalineación radial que el acoplamiento Lamidisc" puede absorber es una función de la distancia entre los paquetes de láminas. Para la configuración SX esta distancia es prácticamente la misma que la de los extremos de ejes. Esto no es así para las configuraciones CC, DO, CX, DX.

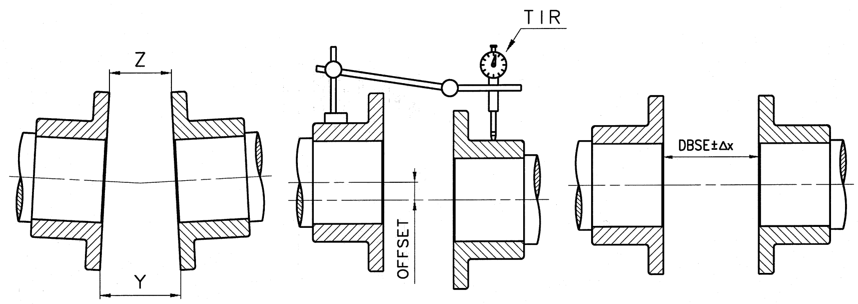
Si los ejes tienen una desalineación radial con una desalineación angular mínima, los valores de desalineación radial máxima en el montaje figuran a continuación:

Lamidisc® 6 tornillos: TIR < (Distancia entre paquetes de láminas) / 150
Lamidisc® 8 tornillos: TIR < (Distancia entre paquetes de láminas) / 300
Lamidisc® 10 tornillos: TIR < (Distancia entre paquetes de láminas) / 350
(NOTA: El TIR es la indicación total del reloj como se muestra en la figura. La desalineación radial u offset es la mitad de este valor)
Ejemplo: Para el tamaño 380-6, configuración SX . TIR < DBSE/150.

• La desalineación angular máxima en cada paquete durante el montaje figura a continuación. Esta desalineación angular puede ser verificada midiendo la distancia entre extremos de bridas (ver dibujo a continuación). Se procederá posteriormente a restar la medida máxima de la mínima (Y-Z).
El máximo valor de (Y-Z) depende del diámetro de la brida, y por tanto del tamaño del acoplamiento. Se recomiendan los siguientes valores de (Y-Z):

Lamidisc® 6 tornillos: (Y-Z) < Tamaño acoplamiento / 300
Lamidisc® 8 tornillos: (Y-Z) < Tamaño acoplamiento / 600
Lamidisc® 10 tornillos: (Y-Z) < Tamaño acoplamiento / 700

Ejemplo: Para el tamaño 380-6 (desalineación angular máxima de 1º) (Y-Z) no debe exceder 380/300 = 1.27 mm. en el montaje.



• La desalineación axial permitida entre ejes durante el montaje Δx no deberá ser superior al 20% de la suministrada en catálogo Δka (Ver tabla 1). Dicha desalineación depende del tamaño del acoplamiento así como del número de tornillos empleados. Cuanto mayor es el acoplamiento, mayor es la desalineación axial permitida; cuantos más tornillos se empleen, menor es la desalineación axial permisible.

La desalineación axial crea tensiones importantes en las láminas. De cara a obtener una vida prolongada de las láminas se recomienda que éstas estén tan paralelas como sea posible a la superficie de la brida en funcionamiento. Por tanto se deberán considerar los movimientos de los ejes originados por expansiones térmicas. Por ejemplo, si la distancia entre extremos de ejes cambia en –5 mm (los ejes se acercan el uno al otro) de una situación en parado, a otra en funcionamiento, la distancia entre extremos de ejes en parado deberá aumentarse en 5 mm intencionadamente cuando se instale el acoplamiento.

Tabla 1. Alineación axial permitida en montaje (20% de los valores de catálogo, Δx=0.2Δka).
Dicho valor podrá ser añadido o sustraido a la DBSE nominal. Valores para 2 paquetes de láminas.

	(±) Δx instalación (mm.)
6 Tornillos	**OD/250**
8 Tornillos	**OD/375**
10 Tornillos	**OD/500**

OD: Diámetro ext. acoplamiento en mm.
Ejemplo: Tamaño 228-6:±Δka = 228/250 = ±0.9 mm, para 2 paquetes de láminas en el montaje.

3.- Instalación de los paquetes de láminas y espaciador

La instalación de los componentes depende del tipo de Lamidisc: las únicas herramientas necesarias son llaves, boquillas y una llave dinamométrica. **Es muy importante el apriete de los tornillos al par indicado.**

a) Configuración standard tipos SX y SXR
Los únicos tornillos que deben apretarse son aquellos que fijan los paquetes de láminas a los cubos y al espaciador. Se deben colocar los tornillos, siempre que sea posible, con la cabeza del mismo apoyando contra la brida del cubo o espaciador. Se deberán apretar las tuercas con una llave dinamométrica impidiendo que gire la cabeza del tornillo.

Tabla 2. Valores de par de apriete tornillos en Nm.
Prevalecerán los valores del plano específico en caso de que éste existiera.
Valores del par de apriete de los tornillos de las láminas en Nm.

Tamaño	Par de apriete de los tornillos de las láminas (no lubricado)	Tamaño	Par de apriete de los tornillos de las láminas (no lubricado)	Tamaño	Par de apriete de los tornillos de las láminas (no lubricado)
110	30	302	600	540	4100
132	30	325	600	570	5100
158	60	345	780	605	6200
185	100	380	1100	635	7900
202	150	410	1500	675	9900
228	230	440	2000	700	12200
255	450	475	2600	730	12200
278	450	505	3300	760	14800

NOTA: Para roscas lubricadas, dichos valores deben reducirse en un 20%
Para tornillos en acero inoxidable, consulte nuestro departamento técnico.

Valores del par de apriete de los tornillos del espaciador para los tipos CX y DX en Nm.

Tamaño	Tipos CX y DX	Tamaño	Tipos CX y DX
132-6/10	8	302-8/40	230
158-6/15	20	325-8/45	230
185-6/20	68	345-8/50	325
202-6/25	108	380-8/55	325
255-6/30	108	410-8/60	325
278-8/35	230	540-8/70	565

Valores del par de apriete en Nm, de los tornillos de unión, entre cubo y elemento central. Tipos DO-6 y DO-8.

Tamaño	Par de apriete de los tornillos (no lubricado)	Tamaño	Par de apriete de los tornillos (no lubricado)	Tamaño	Par de apriete de los tornillos (no lubricado)	Tamaño	Par de apriete de los tornillos (no lubricado)
110-6	35	302-6	780	278-8	108	475-8	660
132-6	35	325-6	780	302-8	108	505-8	660
158-6	69	345-6	580	325-8	325	540-8	760
185-6	120	380-6	780	345-8	325	570-8	760
202-6	190	410-6	1000	380-8	325	605-8	760
228-6	295	440-6	1500	410-8	565		
255-6	580	475-6	2000				
278-6	580	505-6	2000				

NOTA: Para roscas lubricadas, dichos valores deben reducirse en un 20%
Para tornillos en acero inoxidable, consulte nuestro departamento técnico.

Tabla 3. Valores de l_1, l_2 y s para tipos CC y CCR según catálogo.

Tamaño	l_1 - l_2	s	Tamaño	l_1 - l_2	s
110	50	8.4	302	135	24.4
132	60	8.4	325	145	26
158	70	11.2	345	155	28.2
185	80	14.0	380	170	32
202	90	15.5	410	185	33.2
228	100	17.5	440	195	36.4
255	115	20.5	475	210	38.2
278	125	21.2	505	230	42

b) Configuración con cubos invertidos tipos CC y CCR
La configuración CC ha sido concebida para su utilización en máquinas cuyos ejes a acoplar están muy próximos entre si y en los que no se puede utilizar el tipo SX. Para ello se ha reducido el diámetro exterior del cubo para poder ser introducido en el orificio interior del paquete de láminas.

A la hora de instalar los cubos en los ejes, los extremos de los ejes deberán distar como mínimo la longitud de un cubo (ver dimensión l_1 y l_2 en tabla 3). Para instalar el acoplamiento, los paquetes de láminas pueden ser fijados al espaciador, y posteriormente fijarse a uno de los cubos. A continuación, se deberán acercar las máquinas para ser fijado el segundo paquete de láminas.

Se puede proceder a continuación a la alineación de los ejes. Se deberá comprobar la distancia axial midiendo la distancia entre los extremos de las bridas (dimensión "S" en tabla 3). La desalineación radial y angular se deberá verificar como se ha descrito anteriormente. Se deberán apretar, según el par fijado, los tornillos que unen los cubos y el espaciador. Se deberán apretar las tuercas impidiendo el giro de los tornillos.

c) Configuración anillo-guarda (Drop-out) tipo DO. *Ver tabla 4 en pág. 4.*
La configuración tipo anillo guarda permite el montaje y desmontaje del acoplamiento, sin necesidad de desmontaje de los cubos del eje. El acoplamiento se envía desde Jaure con el elemento central montado y con su par de apriete correspondiente. Sin embargo, si fuera necesario el desmontaje del elemento central (en caso de cambio de láminas), las tuercas deberían apretarse al par de apriete correspondiente (valores no mostrados en estas instrucciones) mediante una llave dinamométrica, impidiendo el giro del tornillo. La alineación de las máquinas debe efectuarse con anterioridad al montaje del acoplamiento.

Si se mantiene la distancia entre extremos de ejes, no podrá montarse el elemento central a menos que se comprima el acoplamiento (utilizando los tornillos de transporte en los orificios creados a tal efecto) . Una vez comprimido éste, irá a su posición original dentro de las guías macho del plato.

Una vez en su posición, el acoplamiento se alojará en las guías del plato y los tornillos deberán fijarse al par de apriete fijado por Jaure (ver tabla 2). Dicha operación se debe realizar cuidadosamente ya que estos tornillos transmiten todo el par.

Para desmontar el acoplamiento, se deberán soltar los tornillos de unión de los cubos. A continuación se deberá comprimir el elemento central introduciendo los tornillos de las bridas en los orificios de transporte, para poderlo desplazar fuera de las guías del cubo.

d) Momento reducido con espaciador según AGMA 516, tipo CX.
La configuración de momento reducido es utilizada cuando las tensiones en los ejes requieren que el centro de gravedad del acoplamiento esté próximo a los rodamientos de las máquinas a acoplar. Esta configuración también permite desplazar una de las máquinas desmontando el espaciador, sin necesidad de soltar ningún paquete de láminas.

La instalación del acoplamiento requiere los siguientes pasos:
- Instalación de los cubos en los ejes.
- Medir la distancia entre extremos de ejes (DBSE)
- Alinear las máquinas como se ha descrito anteriormente.
- Fijar cada paquete y camisa a cada cubo, apretando la tuerca e impidiendo el giro del tornillo.
- Colocar el espaciador entre las dos camisas. No deberá existir ninguna interferencia ni holgura entre las camisas a la hora de colocar el espaciador. Se deberá corregir la distancia entre máquinas, ya que cualquier desalineación axial afecta negativamente a la vida del acoplamiento.
- Introducir los tornillos del espaciador. Se deberán fijar las tuercas al par dado impidiendo el giro del tornillo.
- Verificar la alineación y corregir en su caso.

e) Configuración "drop-out" con espaciador, bridas según AGMA 516, tipo DX.
La alineación se deberá realizar con anterioridad al montaje del acoplamiento. La configuración "drop-out" permite la instalación y el desmontaje del elemento central sin necesidad de desmontar los platos de los ejes. El acoplamiento se recibe desde Jaure con los tornillos de las láminas fijados a su par de apriete. Si, por el contrario, es necesario desmontar el acoplamiento, (en el caso de sustitución de láminas), las tuercas deberán apretarse mediante una llave dinamométrica impidiendo el giro de los tornillos.

El elemento central encajará entre los platos siempre y cuando la distancia entre extremos de ejes sea la correcta. Una vez en su lugar se deberá conectar el elemento central con los platos correspondientes mediante el apriete de las tuercas, con llave dinamométrica. Esta operación se deberá realizar con cuidado, ya que estos tornillos transmiten todo el par. Así mismo se deberá impedir el giro de los tornillos durante el apriete de las tuercas.

Acoplamiento Lamidisc®

Tabla 4, tipo DO.

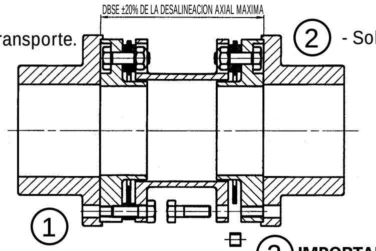
Tipo DO con STANDARD HUB

Instrucciones de montaje y desmontaje

Montaje

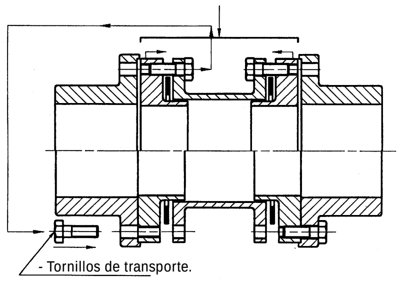
1 - Posición de transporte.

2 - Soltar los tornillos de las bridas.



2 **IMPORTANTE:** Quitar los casquillos de transporte previo a la instalación, cuando se suministren (tamaños grandes).

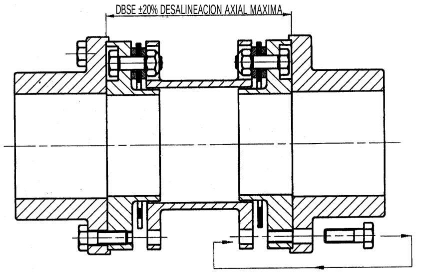
3 - Introducir los tornillos de la brida en los agujeros de transporte y comprimir el elemento central, para que el elemento central salve las guías.



4 - Atornillar con el par de apriete recomendado.

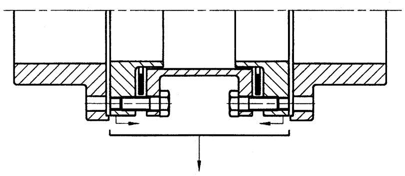
5 - Posición de trabajo.

Desmontaje



1 - Posición de trabajo.

2 - Soltar los tornillos de las bridas.



3 - Introducir los tornillos de la brida en los agujeros de transporte y comprimir el elemento central.

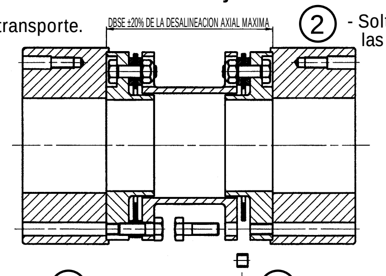
Tipo DO con JUMBO HUB

Instrucciones de montaje y desmontaje

Montaje

1 - Posición de transporte.

2 - Soltar los tornillos largos y cortos de las bridas.

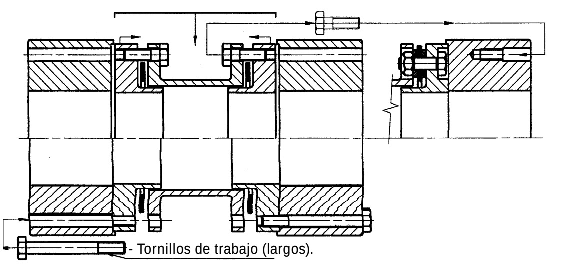


1

2 **IMPORTANTE:** Quitar los casquillos de transporte previo a la instalación, cuando se suministren (tamaños grandes).

3 - Introducir los tornillos de transporte y desmontaje (cortos) en los agujeros de transporte y comprimir el elemento central, para que el elemento central salve las guías.

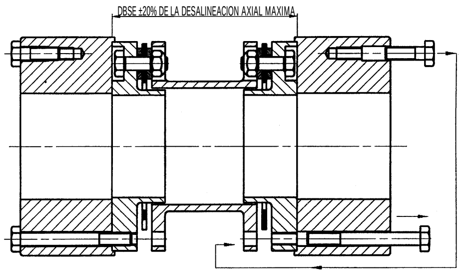
- Después soltar los tornillos de transporte y guardarlos en los agujeros roscados de los cubos.



4 - Atornillar los tornillos largos con el par de apriete recomendado.

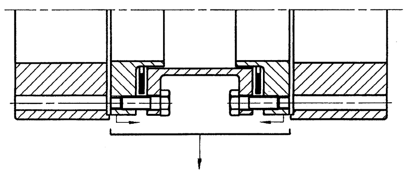
5 - Posición de trabajo.

Desmontaje



1 - Posición de trabajo.

2 - Soltar los tornillos de las bridas (largos) y los de transporte y desmontaje (cortos).



3 - Introducir los tornillos de transporte y desmontaje (cortos) en los agujeros de transporte y comprimir el elemento central.

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ISO 9001 DNV ACCREDITED BY ENAC CERTIFICATED FIRM

OTZARRETA (Zarautz) - Mod.: JAU0117586 - Dep. Leg.: SS-30/2000

ISO 9001 DNV ACCREDITED BY ENAC CERTIFICATED FIRM

All steel disc coupling

JAURE®

Lamidisc®

Installation, alignment and maintenance instructions.

Installation of hubs . Machinery alignment.
Installation of disc packs and spacer.

1.- Installation of the hubs on the machine shafts.

a) Straight shafts with keyway.
Jaure supplies Lamidisc hubs machined machined with **H7** (ISO-286) tolerances. Jaure recommends that the shaft should be machined for an interference fit, using tolerance **s6** (ISO-286).

Whenever the shafts are already machined with a different tolerance from s6, Jaure will customize the hub bores. The following tolerances are recommended by Jaure.

Shaft tolerance	Hub tolerance
h6	**T7**
k6	**R7**
m6	**P7**
n6	**N7**
p6	**M7**

b) Clamping devices.
When clamping devices, such as tapered bushings, are used, Jaure recommends that the shafts should be machined with **g6** tolerances, for a standard Lamidisc bore.

For other type of connections, please consult our Technical Department.

2.- Machinery Alignment.
As long as the machines are aligned within the specifications from this catalog, the Lamidisc couplings will operate for a long time. However, it should be understood that the useful life of any disc pack coupling is directly influenced by the operating misalignment: the better the alignment, the longer the coupling life.

Although the Lamidisc couplings can operate satisfactorily at the misalignment listed in the catalog, both the coupling life and machine bearing wear can be greatly improved if the machines are aligned better than the maximum that the coupling can accomodate. Jaure recommends that the installation misalignment should not exceed 20 % of the catalog values. Therefore, the following formulas show Jaure´s recommendations for maximum misalignment.

Three types of machine misalignment (offset, angular, and axial) should be checked. Jaure has the following recommendations:

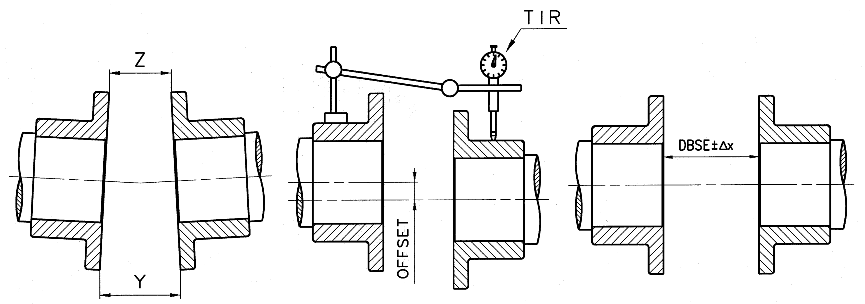
• The maximum offset misalignment that the Lamidisc coupling can accomodate is a function of the distance between the disc packs. For the configurations SX this distance is practically the same as the distance between the shaft ends. This statement is not valid for other configurations, such as CC, DO, CX, DX.

If shafts have an offset misalignment with minimum angular misalignment, the following maximum values for the offset are applicable for installation.

Lamidisc® with 6 bolts TIR = (disc pack to disc pack distance) / 150
Lamidisc® with 8 bolts TIR = (disc pack to disc pack distance) / 300
Lamidisc® with 10 bolts TIR = (disc pack to disc pack distance) / 350
(NOTE : TIR is the Total Indicator Reading, which is twice the shaft offset)
Ex.: For size 380-6, SX type: TIR < DBSE/150.

• The maximum angular misalignment at each disc pack during installation is listed in the tables. This angular misalignment can be verified by measuring the flange-to-flange distance (see figure below) and substracting the smallest reading from the largest reading (Y-Z). The maximum value of (Y-Z) depends on the flange diameter, therefore on the coupling size. Based on the data from the tables, the following maximum values for (Y-Z) are recommended:

Lamidisc with 6 bolts (Y-Z) = Coupling size / 300
Lamidisc with 8 bolts (Y-Z) = Coupling size / 600
Lamidisc with 10 bolts (Y-Z) = Coupling size / 750



Example: For Lamidisc size 380-6 (maximum angular misalignment of 1º). (Y-Z) should not exceed 380/300 = 1.27 mm. during installation.

• The axial displacement allowable between shafts during installation (Δx), should not exceed 20% of the allowable displacement given in the catalog (Δka) (See table 1). This displacement is a function of the coupling size and the number of bolts utilized. The larger the size the larger axial displacement.
The axial displacement creates large stresses in the discs. For a long life it is recommended that the discs are as close as possible to being flat. Therefore, the movements of the shafts as caused by thermal expansion should be carefully considered. For instance, if the distance between shaft ends changes by 5 mm (the shafts are coming closer to each others) from cold to hot machines, the distance between shaft ends with cold machines should be intentionally be made larger by 5 mm when the coupling is installed.

Table 1. Allowable installation axial displacement (20% of catalog valves, Δx=0.2Δka).
This value can be added or subtracted from the nominal DBSE. Values for 2 disc packs.

	(±) Δx installation (mm.)
6 Bolts	**OD/250**
8 Bolts	**OD/375**
10 Bolts	**OD/500**

Coupling OD in (mm.)
Example: Size 228-6:±Δka = 228/250 = ±0.9 mm, for 2 disc packs during installation.

3.- Installation of disc packs and spacer.
The installation of the coupling components depends of the type Lamidisc coupling: the only tool needed are regular wrenches or sockets, and a torque wrench. **Tightening the bolts of a coupling to specification is very important.**

a) Standard configuration. SX and SXR types.
The only bolts to be installed and tightened are the ones that attach the disc packs to the hubs and spacer. Place the spacer and install the bolts with their heads at the flange and not at the disc pack. The nuts shall be turned with the torque wrench, while the heads of the bolts are held stationary.

Table 2. Bolt tightening torque values.
In case an specific exists, refer to the values mentioned in it if they differ from the values below.

Values for Disc bolt tightening torque:

Size	Disc bolt non-lubricated tightening torque (Nm)	Size	Disc bolt non-lubricated tightening torque (Nm)	Size	Disc bolt non-lubricated tightening torque (Nm)
110	30	302	600	540	4100
132	30	325	600	570	5100
158	60	345	780	605	6200
185	100	380	1100	635	7900
202	150	410	1500	675	9900
228	230	440	2000	700	12200
255	450	475	2600	730	12200
278	450	505	3300	760	14800

NOTE: For lubricated threads reduce the given values by 20%.
For stainless-steel bolts refer to our technical Dep.

Values for spacer (type CX) and flange (type DX) bolt non lubricated tigthening torque in Nm.

Size	CX and DX types	Size	CX and DX types
132-6/10	8	302-8/40	230
158-6/15	20	325-8/45	230
185-6/20	68	345-8/50	325
202-6/25	108	380-8/55	325
255-6/30	108	410-8/60	325
278-8/35	230	540-8/70	565

Values for dry tightening torque in Nm for flange connecting bolts. Types DO-6 and DO-8.

Size	Bolt tigthening torque (Nm)	Size	Bolt tigthening torque (Nm)	Size	Bolt tigthening torque (Nm)	Size	Bolt tigthening torque (Nm)
110-6	35	302-6	780	278-8	108	475-8	660
132-6	35	325-6	780	302-8	108	505-8	660
158-6	69	345-6	580	325-8	325	540-8	760
185-6	120	380-6	780	345-8	325	570-8	760
202-6	190	410-6	1000	380-8	325	605-8	760
228-6	295	440-6	1500	410-8	565		
255-6	580	475-6	2000				
278-6	580	505-6	2000				

NOTE: For lubricated threads reduce the given values by 20%.
For stainless-steel bolts refer to our technical Dep.

Table 3. l_1, l_2 and s catalog valves for CC, CCR types.

Size	l_1 - l_2	s	Size	l_1 - l_2	s
110	50	8.4	302	135	24.4
132	60	8.4	325	145	26
158	70	11.2	345	155	28.2
185	80	14.0	380	170	32
202	90	15.5	410	185	33.2
228	100	17.5	440	195	36.4
255	115	20.5	475	210	38.2
278	125	21.2	505	230	42

b) Close coupled configuration. CC and CCR types.
The CC coupling type was created for use with machines that have the shafts too close for the use of the standard SX coupling. The outside diameter of the hubs was reduced to be inserted in the inside of the hole of the disc pack.

To install the hubs on their shafts, the shafts must be spaced apart at least the length of one hub (see dimension l_1 and l_2 in table 3). To install the coupling, the disc packs can be first attached with their bolts to the spacer, and then slid over one of the hubs, and attached to it. Next, the machines must be brought in position so that the second disc pack can be attached to its hub.

The machine alignment can now be performed. Because the spacer covers the shaft ends, the axial spacing must be checked by measuring the flange to flange distance (dimension “S” in the table 3). The offset and angular misalignments can be checked as previously described.

The bolts that attach the disc packs to the hubs and spacer must be tighten to specification, using a torque wrench at the nuts, while the bolts heads are held stationary.

c) Drop-out configuratio . DO type. *(See table 4 in page 4).*
The drop-out configuration allows the installation and removal of the coupling assembly , without the need to remove the hubs from their shafts. The coupling is received from Jaure fully assembled, with the bolts tightened to specifications. If, however, there is a need to disassemble the coupling assembly in case the disc packs need to be replaced) the nuts should be tightened to Jaure's specification (valves not shown in these instructions) using a torque wrench, while the bolt heads are held stationary.

The coupling assembly will not fit between the hubs, as long as the shaft-to-shaft distance was correctly set. The coupling ends should be brought together, by compressing the disc packs using the flange screws in the shipping holes, so that the assembly will fit between the male rabbets.

Once in position, the coupling will snap in place, and the bolts that attach the assembly to the shaft hubs must be tightened to Jaure specifications (see table 2) using a torque wrench. This operation must be carefully performed, as these bolts transmit the full coupling torque.

Machine alignment should be done before the coupling assembly is in place.

To remove the coupling assembly first remove all the bolts that retain it to the shaft hubs. Then compress the assembly by introducing the existing flange bolts in the shipping holes, and press the coupling assembly away from the male rabbets.

d) Reduced moment coupling with spacer according to AGMA 516, CX type.
The reduced moment configuration is used whenever the shaft stresses require that the center of gravity of the coupling is very close to the machine bearings. This configuration also allows either machine to be removed by dropping the spacer, without the need to disturb the disc-pack assemblies.

The installation of this coupling requires the following steps:
- Install the hubs on their shafts.
- Measure and adjust the shaft to shaft (DBSE) distance.
- Align the machine shafts as previously described.
- Attach one disc pack and a short sleeve at each hub, by tightening the nuts to specifications, while holding the bolt heads stationary.
- Place the spacer between the two sleeves. It should fit without interference, or without a gap remaining between the flanges. Correct the machine spacing if necessary, as any axial displacement can adversely affect coupling´s long term performance.
- Insert the flange bolts and tighten the nuts to specifications using a torque wrench and adaptor, while holding the bolt heads stationary.
- Recheck the alignment, and correct if necessary.

e) Drop-out coupling with floating assembly, flanges according to AGMA 516, DX type.
The drop-out configuration allows the installation and removal of the coupling assembly, without the need to remove the hubs from their shafts. The coupling is received from Jaure fully assembled, with the bolts tightened to specifications. If, however, there is a need to disassemble the coupling assembly (in case the disc packs need to be replaced) the nuts should be tightened to specification using a torque wrench, while the bolt heads are held stationary.

The coupling assembly will fit between the hubs, as long as the shaft-to-shaft distance was correctly set. Once in position, the nuts that attach the assembly to the shaft hubs must be tightened to specifications using a torque wrench and adaptor, while the bolt heads are held stationary. This operation must be carefully performed, as these bolts transmit the full coupling torque.

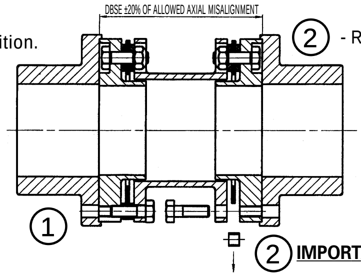
Machine alignment should be done before the coupling assembly is in place.

DO Type with STANDAR HUB
Mounting and dismounting instructions.

Mounting

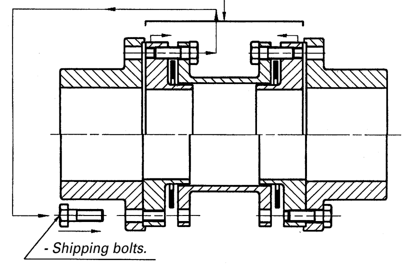
1 - Shipping position.

2 - Remove the flange bolts.



2 **IMPORTANT:** Remove shipping bushings for instalation. (when supply, only big couplings).

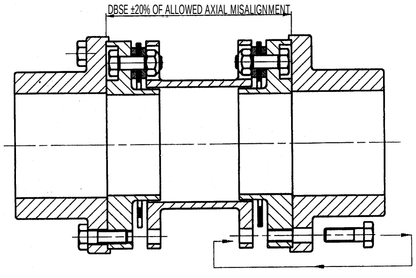
3 - Introduce the flange bolts in the shipping holes in order to compress the central element and save the guiding rabbets.



4 - Bolt up with the recomended tightening torque.

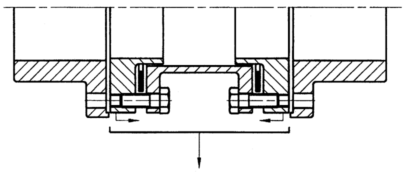
5 - Work position.

Dismounting



1 - Work position.

2 - Remove flange bolts.



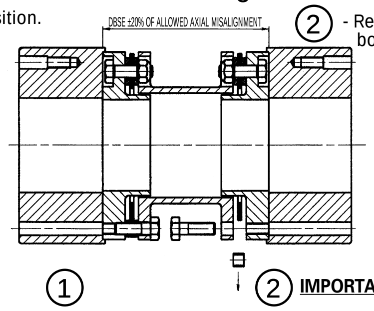
3 - Introduce the flange bolts in the shipping holes in order to compress the central element.

DO Type with JUMBO HUB
Mounting and dismounting instructions.

Mounting

1 - Shipping position.

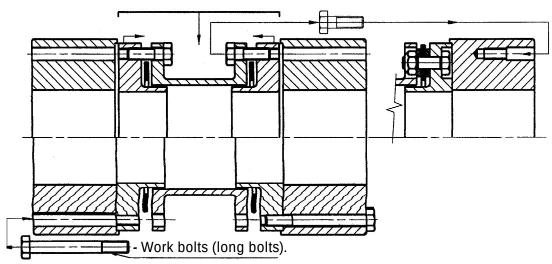
2 - Remove the long and short flange bolts.



2 **IMPORTANT:** Remove shipping bushings for instalation. (when supply, only big couplings).

3 - Introduce the shipping-dismounting bolts (short bolts) in the shipping holes in order to compress the central element and save the guiding rabbets.

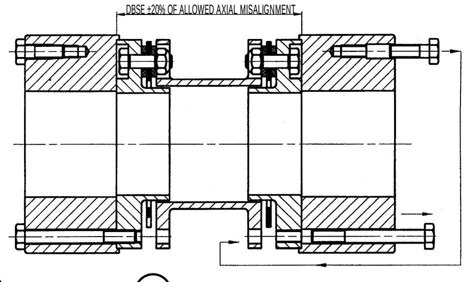
- After remove shipping bolts and store in screw bores of the hubs.



4 - Bolt up the long bolts with the recomended tightening torque.

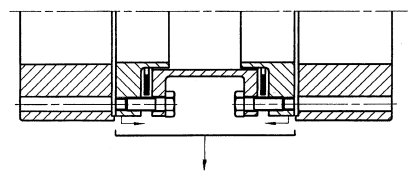
5 - Work position.

Dismounting



1 - Work position.

2 - Remove flange bolts (long bolts) and shipping-dismounting bolts (short bolts).



3 - Introduce the shipping-dismounting bolts (short bolts) in the shipping holes in order to compress the central element.

JAURE, S. A.

Ernio bidea, s/n - 20150 ZIZURKIL (Guipúzcoa) SPAIN
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Código Postal/Post address: 47 - 20150 VILLABONA (Guipúzcoa) SPAIN
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OIZARRETA (Zarautz) - Mod.: JAU0117586 - Dep. Leg.: SS-30/2000

Voith Turbo

VOITH

Technical Documentation
Instruction Manual

Translation of the original Instruction Manual

Code
Flowserve Ashuganj S 1

Variable-speed turbo coupling
562 SVTL HP

Techn. Documentation No. 215001154-0400-02-EN

Revision 2

Appendix_A_
Appendix_B_

If you have questions regarding the Variable-speed turbo coupling, please contact the Service Center (aeva) of the Product Group "Variable Speed Drives' (stating the serial number) at Voith Turbo GmbH & Co. KG Crailsheim

Voith Turbo GmbH & Co. KG
P.O. Box 15 55
D-74555 Crailsheim
Switchboard:+49 7951 32-0
Main fax:+49 7951 32-650
E-mail: regelbare.antriebe@voith.com

Service Center - Variable Speed Drives
www.voith-coupling-service.com
E-mail:
service.regelbare.antriebe@voith.com

Tel. +49 7951 32 1666
Fax +49 7951 32 903

This Instruction Manual describes the technological level of the Variable-speed turbo coupling at the time of delivery.
Subsequent changes in the design of the Variable-speed turbo coupling are not incorporated in this Instruction Manual.

Date prepared: 2015-03-06
Techn. Documentation No. 215001154-0400-02-EN
Version 1.02

Printed in Germany

VOITH

Voith Turbo

Voith Turbo GmbH & Co. KG
Voithstraße 1
74564 Crailsheim, Germany

Declaration of incorporation for partly completed machinery
(as defined by EC Directive 2006/42/EC, Annex IIB)

We,

Voith Turbo GmbH & Co. KG
Voithstraße 1
74564 Crailsheim

hereby declare that the

machinery denominated:	Voith Variable Speed Turbo Coupling
Code:	"Flowserve Ashuganj S 1"
Type:	562 SVTL HP
Serial No.:	8211674 - 8211675
Voith Order No.:	38003425

corresponds to the essential health and safety requirements as per Annex I of Directive 2006/42/EC (Machinery Directive). Moreover, we declare that relevant technical information for this partly completed machinery has been issued as per Annex VII Part B.

Other directives and harmonized standards applied, particularly
- 2006/95/EC - Low Voltage Directive, 2004/108/EC - EMC Directive
- DIN EN ISO 12100-1, DIN EN ISO 13857, DIN EN 349, DIN EN 60204-1

We undertake to transmit in response to a reasoned request by the national authorities, relevant technical information on the partly completed machinery. The method of transmission will be agreed with the national authorities. You may request the relevant technical information from the person authorized for technical information at

Voith Turbo GmbH & Co. KG
Mr. Hans Schirle, aeve Dept.
Voithstraße 1
74564 Crailsheim

The partly completed machinery must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of Machinery Directive 2006/42/EC, where appropriate.

It is not allowed to change anything on the machinery, unless Voith Turbo gave their express written approval.

Date / Signature: 2015-03-09 i.A. Hofmann

Particulars to the Undersigned: Head of Product Line

Date / Signature: 2015-03-09 i. V.

Particulars to the Undersigned: Head of Sales

(Einbauerklärung_en.doc)

Version - Log

Version 1.00

- Changes, replacement in the individual chapters/ pages of the Instruction Manual.
- Supplements within an Instruction Manual

- Complete replacement of the entire Instruction Manual

Overhaul	Version	Revision	Date
0	1.00	First edition of the Instruction Manual	2015-02-26
1	1.01	Section: 1.2 Operating data Section: 7.1 Operating the equipment Section: 11 Drawings, Schematics, Diagrams; 215001154-0020 (3); 215001154-0030 (3); 215001154-0010 (2) Section: 14.1 Attaching Parts (Thermowell)	2015-03-27
2	1.02	Section: 1.2 Operating data Section: 7.1 Operating the equipment Section: 11 Drawings, Schematics, Diagrams; 215001154-0020 (4); 215001154-0030 (4); 215001154-0010 (3) Section: 14.1 Attaching Parts (204.001585110)	2015-05-20

Date	Author	Head of product group
2015-02-26	aevpd / Kapp-PRe	aevec / Hofmann

General Information on the Instruction Manual

Economical operation

This Instruction Manual contains important information on how to operate the variable-speed turbo coupling safely, properly and economically. Your observations help to avoid hazards, repair costs and down-times and to increase the lifetime of the variable-speed turbo coupling.

Reading the Instruction Manual

Read this Instruction Manual carefully, to become familiar with the proper handling and operation.

Installation site

The Instruction Manual must always be available at the installation site of the variable-speed turbo coupling.

Copyright

Definition of the target groups

The contents of this Instruction Manual are intended for various target groups.
The level of knowledge that the target group must have is defined here.

All target groups must have read this Instruction Manual and have a good understanding of the content.

Operating personnel must,

- be 18 years old.
- be trained in handling of the variable-wpeed turbo coupling.
- know the country-specific accident prevention regulations.

Maintenance personnel must,

- be 18 years old.
- know the maintenance points on the variable-speed turbo coupling.
- know the country-specific environmental protection regulations for disposing of lubricants and cleaning materials.

Service personnel must,

- be 18 years old.
- have a sound school education and vocational education.
- be trained by Voith Turbo GmbH & Co. KG in the service activities on the variable-speed turbo coupling.
- be trained in the rules of conduct in case of faults.

Technical modifications

Our systems are under continual further development and improvements.
The data contained in this edition corresponds with the latest technology.

We reserve the right to any changes in technical details differentiating from the information and images in the Instruction Manual.

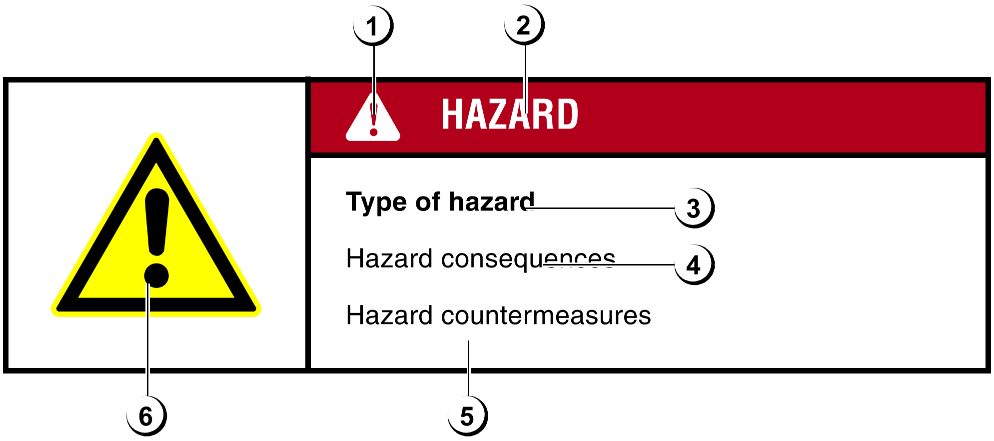
Accident prevention regulations

Besides those regulations for accident prevention stipulated in the Instruction Manual, those in the country of use and the installation location, the recognized technical regulations for safety and proper work practices are to be observed.

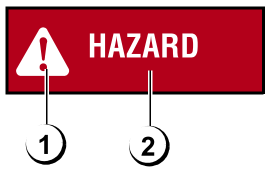
Notes on using the Instruction Manual

Structure of safety information

Operation-related warning information:



Summarized safety information and additional notes before the respective chapters:



Type of hazard 3

Hazard consequences 4

Hazard countermeasures 5

1. Safety symbol
2. Signal word Hazard level
3. Type and source of hazard
4. Possible consequences of hazard
5. Measures for averting the hazard
6. Safety symbol

Techn. Documentation No. 215001154-0400-00-EN, Version 1.00, aevpd / Kapp-PRe
Serial No. 8211674 - 8211675

Notes

NOTE

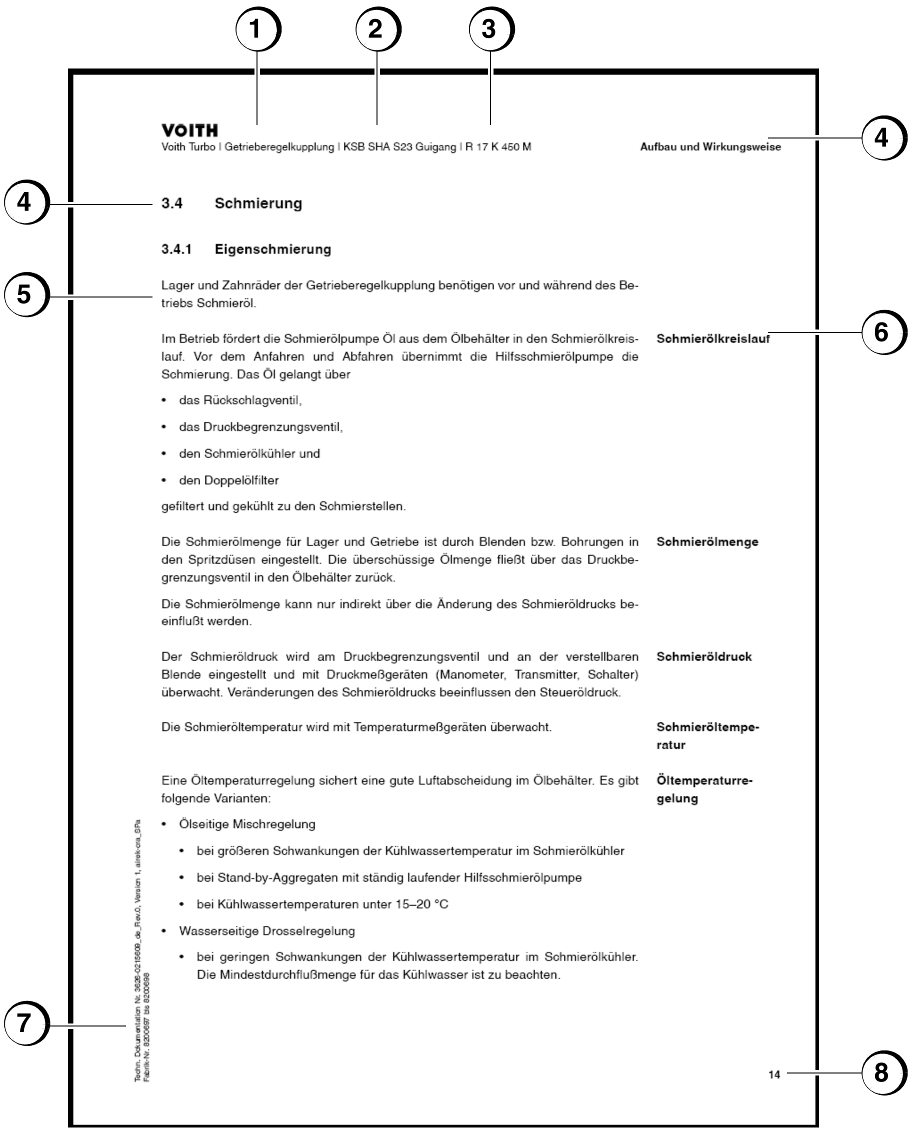
Indicates information that contains important notes on the use and/or procedures to be used. Non-observance/non-compliance can cause malfunctions.

Font designations

Texts are designated according to their functionality in the following ways:

Font	Designation	Function
Action instruction	**1.**, **2.**, etc.	instruction to perform an activity
List 1st level	•	indicates individual elements of the numbered list
List 2nd level	–	indicates sub-points of the list
Cross-reference	➔	indicates other chapters or points in the text

Page structure:



1. Plant type
2. Code
3. Coupling size
4. Chapter designation
5. Text column
6. Marginal column
7. Technical Documentation No., Language, Version and Author
8. Page number

Contents

Techn. Documentation No. 215001154-0400-00-EN, Version 1.00, aevpd / Kapp-PRe
Serial No. 8211674 - 8211675

1 Technical Data

variable-speed turbo coupling	562 SVTL HP
Code	Flowserve Ashuganj S 1
Order number	38003425
Serial No.	8211674 - 8211675

1.1 Machine data

Variable-speed turbo coupling

variable-speed turbo coupling as centrifugal pump drive		
Ambient temperature of the **variable-speed turbo coupling**	Max. **+40 °C (104 °F)**	Min. **-18 °C (-0.4 °F)**
Rotation viewed in direction of power flow:		**CCW**
• Scoop tube stroke (H)		**147** mm
Power requirement of the driven machine	P_a	**3174** kW
Motor speed	n_e	**2981** rpm
Full-load slip	s	**3.59** %
Max. output speed	n_a	**2874** rpm
Regulation range		4:1 downward
Capacity of oil reservoir		**450** l
Required oil viscosity		ISO VG **32**
Weight:		
• Total (without oil)		**2200** kg
Noise emission:[1]		
• Surface sound pressure level	L_{pA}	≤ **85** dB

1. Measurement as stipulated in EN ISO 3744
Values obtained from measurements made on identical equipment

Attaching Parts

Filling pump

Filling pump	1 Filling pump for the working oil and lube oil circuits
Filling pump type	TZP **280 B**
Drive	Mechanically by input shaft of the variable-speed turbo coupling

Auxiliary lube oil pump

Type	„Type: R 35/40 FL-Z“
Drive	Electric motor

Motor for auxiliary lube oil pump

Type	„Typ: 2 P 100 L WFF2“
Power consumption	**3.0** kW
Supply voltage	**400** V / **50** Hz
Speed	**3000** rpm
Degree of protection	**IP55**

Duplex oil filter

Type	„Type: DSF.176.43838.10VG“
Grade of filtration	10 µm
Filter retention rate	ß 10 > 10 and ß 15 > 200[1]
Filter element	Use, not cleanable. Fiberglass insert must be replaced.

1. Filter retention rate as defined in ISO 16889

Voith electro-hydraulic positioning control	**For electronic control and terminal plan please see** „Terminal Plan Sheet 1-6/ 215001154-0040“
Type	14.10 „Voith Electro-Hydraulic Positioning Control (VEHS)“
Design	• control magnet • 4/3-way valve • double-acting positioning cylinder • position pickup with position transmitter

Connecting couplings	
Input side	„not supplied by Voith-Crailsheim“
Output side	„not supplied by Voith-Crailsheim“

Oil level indicator/switch	
Indicator - Type	„Type: FSA 254.2.0/12“
Design	Liquid level indicator
Switch - Type	„Type: LT 255.XX (4-20 mA)“
Design	Level transmitter

Heat exchanger	
Working oil cooler type	„Type: not supplied by Voith-Crailsheim“
Lube oil cooler type	„Type: not supplied by Voith-Crailsheim“

Instruments
See Chapter 14 „Attaching Parts (descriptions)“ in this Instruction Manual

➔For detailed documentation regarding the components mentioned, see Chapter 14 „Attaching Parts (descriptions)“ in this Instruction Manual.

1.2 Operating data

1.2.1 Variable-speed turbo coupling

Temperatures ( )[1]

Bearing temperatures (30.1-30.3)	Operating range Alarm at Shutdown at	**< 95 °C (203 °F)** **> 95 °C (203 °F)** **> 105 °C (221 °F)**
Working oil temperature *downstream* of the scoop tube (18)	Operating range Alarm at Shutdown at	**< 100 °C (212 °F)** **> 100 °C (212 °F)** **> 110 °C (230 °F)**
Lube oil temperature *downstream* of the oil cooler (31)	Operating range	**< 55 °C (131 °F)**
Working oil temperature *downstream* of the oil cooler (34)	Operating range	**< 80 °C (176 °F)**
Oil sump temperatures (60)	Operating range Main motor release Alarm at	**> 30 °C (86 °F)** **> 10 °C (50 °F)** **> 95 °C (203 °F)**

1. The item numbers in parentheses identify the measuring points mentioned in the „Oil Circuit and Measuring Point Scheme 215001154-0020“.

Pressures ( )[1]

Lube oil pressure at the pressure gauge (16)		**> 0.3 bar**
Lube oil pressure at the pressure transmitter (17; 17.1)	Operating range Main motor **ON** Main motor **OFF** Auxiliary lube oil pump **OFF** Auxiliary lube oil pump **ON**	**> 2.5 bar** **> 1.9 bar** **< 1.3 bar** **> 2.4 bar** **< 1.6 bar**
Pressure differential across differential pressure transmitter (41.1)	Operating range Alarm and switch duplex oil filter at	**> 0.3 bar** **> 0.8 bar**
Oil pressure at test port (55.1; 55.3)	Operating range	on the basis of the above values at the measuring points **16; 17; 17.1; 41; 41.1**

1. The item numbers in parentheses identify the measuring points mentioned in the „Oil Circuit and Measuring Point Scheme 215001154-0020“.

Oil level ( )[1]

Oil level switch / oil level transmitter (37)	Operating range	**Oil level between MIN - MAX**
	Alarm / shutdown	**> 15 mm above MAX = 18.3 mA**
	Alarm / shutdown	**< 15 mm below MIN = 5.7 mA**

1. The item numbers in parentheses identify the measuring points mentioned in the „Oil Circuit and Measuring Point Scheme 215001154-0020“.

Oil sump heating ( )[1]

Heater / temperature controller (36) Oil sump temperature (36)	Operating range Heater **ON** Heater **OFF**	**> 10 °C (50 °F)** **< 10 °C (50 °F)** **> 15 °C (59 °F)**
Heater / temperature limiter (36)	Operating range Heater **OFF**	**< 95 °C (203 °F)** **> 130 °C (266 °F)**

1. The item numbers in parentheses identify the measuring points specified in the „Oil Circuit and Measuring Point Scheme 215001154-0020“.

Oil quantities

Working oil flow rate	**567** l/min
Lube oil flow rate for the variable-speed turbo coupling at **2.0 - 3.0 bar**	**30** l/min
Lube oil flow rate for external equipment: Total (at **1.5** bar; **50** °C) Motor (at __ bar) Pump (at __ bar)	 **19** l/min

Actuator

Positioning time	**10** sec./ **100**° Speed

1.2.2 Heat exchanger

Design data

Working oil heat exchanger
„Type: not supplied by Voith-Crailsheim“

Heat exchanger - max. pressure drop (oil side)	1.5 bar at cold start	0.8 bar at operating temperature
Heat exchanger design pressure (oil & water side)	10 barg	
Heat exchanger - design temperature (oil side)	130 °C working oil	80 °C lube oil

Working oil heat exchanger
„Type: not supplied by Voith-Crailsheim“

Heat to be dissipated	636 kW
Nominal flow rate	567 l/min
Inlet temperature (oil side)	95 °C
Outlet temperature (oil side)	55 °C
Attention: Ventilation of heat exchanger is necessary	

Lube oil heat exchanger
„Type: not supplied by Voith-Crailsheim“

Heat exchanger - max. pressure drop (oil side)	1.5 bar at cold start	0.8 bar at operating temperature
Heat exchanger design pressure (oil & water side)	10 barg	
Heat exchanger - design temperature (oil side)	120 °C working oil	70 °C lube oil

Lube oil heat exchanger
„Type: not supplied by Voith-Crailsheim“

Heat to be dissipated	14 kW
Nominal flow rate	49 l/min
Inlet temperature (oil side)	55 °C
Outlet temperature (oil side)	45 °C
Attention: Ventilation of heat exchanger is necessary	

2 Safety Information

2.1 Basic principles underlying the design of the equipment

Basic principle

The variable-speed turbo coupling has been designed and manufactured using the latest technology and in accordance with accepted safety principles. Nevertheless, its use can result in danger to life and limb of the user or damage to the equipment itself and other property.

Use of the equipment

The variable-speed turbo coupling is to be operated only if it is in proper working condition and only for the designated use, in a safety-conscious manner that complies with the Instruction Manual, including knowledge of the associated dangers! Immediately correct any situations that adversely affect safety.

2.2 Proper use of the equipment

Use of the equipment

The variable-speed turbo coupling is used to transmit power in a wear-free manner from a driving machine to a driven machine. Use the equipment only for the designated purpose.

Complying with proper use also means satisfying the manufacturer's requirements regarding operating conditions, maintenance and repair.

Use of the equipment for any other purpose is considered improper use. The manufacturer assumes no liability for damage arising from improper use; this risk associated with improper use is borne by the user.

2.3 Improper use of the equipment

The permissible power that can be transmitted by the coupling in a stationary installation for a given input speed, power input, direction of rotation, oil flow rate in external machines, and oil reservoir content is specified in the Instruction Manual. Any other use beyond that described herein, e.g. for higher power levels, higher speeds, possibly lower speeds, with other operating fluids, under operating conditions that have not been agreed upon or involving physical modifications is considered improper use.

2.4 General safety information

2.4.1 Safety symbol

The safety symbol is used to alert you to possible risk of personal injury. Heed all instructions following this symbol in order to avoid possible injury or death.

2.4.2 Hazard classification

Hazard classification applicable to warnings about procedures (see following examples), summarized safety information and additional instructions at the beginning of each chapter.

Hazard

Indicates an immediate, potentially dangerous situation which – if the safety regulations are not observed – could result in death or serious bodily injury.

Warning

Indicates a potentially dangerous situation which – if the safety regulations are not observed – could result in death or serious bodily injury.

Caution

Indicates a potentially dangerous situation which – if the safety regulations are not observed – could result in damage to equipment or slight to moderate bodily injury.

Caution - with safety symbol

Indicates a potentially dangerous situation which – if the safety regulations are not observed – could result in damage to equipment.

CAUTION

2.4.3 Maintaining and replacing safety symbols

The safety of the operator must always take priority.

- Replace all damaged or lost safety symbols.
- Use a mild cleaning agent and water to clean the safety symbol.

Do not use any cleaning agents that contain solvents.

2.4.4 Personal safety

The Instruction Manual and safety symbols described therein must be read and understood by all individuals who work on or with the variable-speed turbo coupling.

2.5 General safety information

- Compliance with the manufacturer's Instruction Manual is mandatory for operation, maintenance, repair, assembly and transport.
- The operator must provide additional specific safety instructions that reflect the local operating conditions, if deemed to be necessary.
- This Instruction Manual and the safety information contained therein must be stored in a safe location.
- This Instruction Manual and the safety information contained therein must be kept in their entirety and in always legible condition.

Prior to starting any work

- Prior to starting any work, familiarize yourself with first-aid and rescue procedures (how to contact a doctor, the fire department or rescue services in an emergency).
- Familiarize yourself with the location and operation of fire extinguishers as well as the location of fire alarm boxes and fire fighting equipment.

While working

- Never disable safety devices or remove them.
- Wear protective work clothing while working. Remove rings, shawls and open jackets. For certain work, you must wear safety goggles, safety shoes, a safety helmet, protective gloves, a reflecting vest, ear protection etc.
- Refrain from any behavior that adversely affects safety.
- Operate the variable-speed turbo coupling only when it is in safe and functional condition.
- Never operate the equipment with defective monitoring devices.

Environmental protection regulations

- Ensure compliance with applicable environmental protection regulations whenever working on or with the variable-speed turbo coupling.
- Take precautions especially during installation, repair and maintenance work that substances hazardous to the environment such as
  grease and oil or solvent-containing cleaning liquids do not get into the soil and sewage system.
  These substances must be stored, transported, collected and disposed of in suitable containers.
- If the above-mentioned liquids are seeping into the soil, you must stop their escape immediately and treat the area with a liquid-binding absorbent. It may be necessary to remove the soil.
- Dispose of the absorbent and any soil removed properly and in compliance with applicable environmental protection regulations.

2.6 Organizational measures

Instruction Manual

This Instruction Manual contains important information regarding proper handling of the variable-speed turbo coupling. Before installing the equipment and especially before commissioning the entire system, read the Instruction Manual carefully and ensure that it is understood.

Store the Instruction Manual such that it is available to the operating personnel at all times.

Accident prevention / environmental protection

In addition to the Instruction Manual: ensure that regulations regarding accident prevention and environmental protection are accessible and observed.

Physical modifications

In the event of physical modifications:

WARNING

Danger arising from physical modification

Physical modifications of the variable-speed turbo coupling can result in personal injury and damage to equipment.

Modifications, additions or changes to the variable-speed turbo coupling are only permitted with the approval of Voith Turbo GmbH & Co. KG, Crailsheim.

NOTE

Additional components that do not belong to the scope of delivery of Voith Turbo GmbH & Co. KG must be checked for internal damage and contamination (from sealants containing silicone as well) before installation or attachment. Ensure proper operation.

2.7 Personnel selection and qualification, basic obligations

Trained personnel

- Only properly trained and instructed personnel must be allowed to work on the variable-speed turbo coupling. These personnel must be trained, instructed and authorized to
  - Operate and maintain the equipment properly and in a manner that ensures compliance with safety standards

- Dispose of liquids and their associated components, e.g. filters, oil filter elements and oil, properly
- Service and use safety devices in a manner that ensures compliance with safety standards
- Provide first aid and prevent accidents.

Untrained personnel

- Untrained, uninstructed and unschooled personnel as well as personnel currently receiving general training and instruction must not be allowed to perform any actions on the equipment unless they are under the continuous supervision of an experienced individual.

2.8 Obligations of the operator

Variable-speed turbo couplings that are not in proper operating condition can cause personal injury and damage to equipment.

The operator is obligated to operate the variable-speed turbo coupling only if it is in proper operating condition.

Hazardous areas between the variable-speed turbo coupling and customer's equipment must be protected by the operator.

The variable-speed turbo coupling generates heat that raises the temperature in the immediate surroundings and may have an adverse affect on personnel. The operator is obligated to always provide adequate ventilation.

When work is being performed on the equipment, the operator must provide adequate illumination.

2.8.1 Protection systems

Protection systems, interlocks and couplings on the system are to be inspected for safe operation on a regular basis by a qualified specialist.

Areas on the housing of the coupling, working oil lines and the working oil cooler reach surface temperatures > 60°C. Guarding to prevent contact with these areas is not supplied with the coupling, since conditions at the subsequent installation site are not known, and complete guarding to prevent contact can be cumbersome and severely restrict access required for maintenance.

We recommend that, by taking suitable measures at the installation site, e.g. marking aisles, installing warning signs and instructing personnel access be restricted to areas needed during normal operation. These include the instrument panel and oil filters when filter elements must be replaced.

If protective guarding is nevertheless required, this will require an evaluation of conditions on-site. In such a case, Voith Turbo still recommends limiting the guarding to only essential measures, e.g. areas “within arm's length of aisles used during normal operation”. Voith Turbo can offer this as an option after clarification of details.

2.8.2 Designating and instructing responsible individuals

Assign only personnel with proper training or instruction, clearly designate the responsibilities for operation, adjustment, maintenance, repairs.

Safety-conscious work

Regularly check that personnel maintain safety-conscious work habits in compliance with the Instruction Manual and are aware of the dangers involved.

2.8.3 Obligations regarding information

Reading the Instruction Manual

The personnel responsible for performing any work on the system must, prior to starting such work, read the Instruction Manual, and the **Safety Information** chapter in particular. Reading while performing the work is too late.
This applies especially to personnel who work on the system only occasionally, e. g. to perform maintenance on the system.

The Instruction Manual must always be kept in a readily accessible location at the installation site!

2.9 Operation of the system

Information on the system

Heed all safety instructions and hazard notices on the system! Ensure that all safety instructions and hazard notices on the system are present and in legible condition!

Special aspects of operation

Supplement the Instruction Manual with information about monitoring and reporting obligations in order to account for special aspects of operation, e. g. with regard to organization of work, work procedures, assigned personnel.

Risk of injury arising from clothing and the like

The personnel are not allowed to have long, loose hair, or wear loose clothing or jewelry, including rings. These pose the risk of injury, e. g. by becoming caught in machinery.

Protective equipment

Use personal protective equipment whenever necessary or required by regulations!

2.10 Working on the system

Maintenance

Observe the adjustment, maintenance and inspection intervals, including replacement of parts, specified in the Instruction Manual! These activities may only be performed by qualified individuals.

Inform personnel before starting to perform any special or maintenance work! Designate supervisors!

Switching on and off

Comply with all procedures for switching equipment on and off specified in the Instruction Manual as well as instructions regarding servicing of equipment when performing any work that involves operation or adjustment of the system and its safety devices or inspection, maintenance or repair!

Safeguard as large a maintenance area as necessary!

Securing against being switched on

If the system has been switched off completely for maintenance and repair work, it must be secured against being switched on again unexpectedly.

Spare parts

Spare parts must meet the technical specifications of the manufacturer. This is always assured by purchasing genuine Voith replacement parts.

Lifting appliances

Individual parts and larger assemblies are to be carefully fastened and secured to lifting gear when being exchanged so that no danger is posed. Use only suitable lifting appliances and accessories that are in good condition and have the necessary load-carrying capacity! Do not work or stop under suspended loads!

Work performed above body height

When performing assembly work above body height, use the provided or other safety ascent aids and work platforms. Do not use parts of the system as ascent aids!

Connections and threaded fittings

Before starting maintenance/repair work, clean the system, especially connections and threaded fittings, of oil, lubricants or similar substances! Do not use any aggressive cleaning agents! Use lint-free cleaning rags!

Bolted connections

Always tighten bolted connections when performing maintenance or servicing the equipment!

Completion of maintenance and service work

If disassembly of safety devices is required when performing maintenance and repairs, these safety devices are to be reassembled and checked for proper operation immediately after the completion of the maintenance and repair work.

Ensure that all operating fluids and replaced parts are disposed of safety and in an environmentally responsible manner!

In addition to the Instruction Manual, ensure that generally applicable as well as any specific regulations regarding accident prevention and environmental protection are observed and pointed out!

In the event of any system modifications that affect safety or any changes in the operation of the system, shut the system down immediately and notify the responsible party/individuals of the malfunction!

Maintenance/ servicing

Observe the specified deadlines for recurring maintenance/service work!
Always ensure that maintenance instructions and intervals are observed.

Keep access paths to areas needed for service work free of obstructions.

Servicing of the equipment requires tools that are appropriate for the work to be performed.

Relocating the equipment

The system must be disassembled only by qualified personnel who perform their work in compliance with local safety regulations.

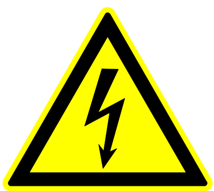
Suitably pack components that are subject to breakage, drain fluids where necessary.

Disposal

Protect the environment. Comply with local regulations.

Prior to disassembly for salvage purposes or scrapping, completely remove any oil or other substances that pose a danger to water.

2.11 Electrical / electronic equipment



HAZARD

Danger to life

Dangerous electric currents and voltages on the Variable-speed turbo coupling can injure or kill individuals.

Only a qualified electrician who is knowledgeable about rules that apply to electronic equipment is allowed to perform work involving the electrical equipment on the Variable-speed turbo coupling.

Electrical energy

Use only new fuses rated for the specified current! Shut down the system immediately in the event of problems with the electricity supply!

Work on electrical equipment or machinery must be performed only by a qualified electrician or by trained individuals under the direction and supervision of a qualified electrician who is knowledgeable about the rules that apply to electronic equipment.

System components on which inspection, maintenance or repair work is being performed must - if so specified - be switched off and secured against being switched on again. Check disconnected components to ensure the absence of electrical voltage, then ground and short circuit them; isolate adjacent components that are still connected to electricity!

The electrical equipment must be inspected/checked on a regular basis. Deficiencies such as loose wires or charred cables must be replaced immediately.

2.12 Special types of hazards

Oil, grease and aerosols

When handling oil and grease, observe the safety regulations that apply to the product!
Exercise caution when handling hot operating fluids and similar substances (risk of burns and scalding)!
Escaping aerosols can be absorbed into the body via the skin, eyes and lungs, causing irritations or injuries. The operator is obligated to always provide adequate ventilation.

2.13 Interface to machinery from others

The danger area that arises at an interface to machinery from others must be protected by the operator.

2.14 Prohibition against arbitrary modifications

Modifications

Do not make any alterations, modifications or add any attachments to the system that could affect safety before receiving approval from Voith Turbo GmbH & Co.KG Crailsheim!

2.15 Cleaning the Variable-speed turbo coupling

WARNING

Risk of injury

Rotating parts on the system can cause injury.

Shut down the system when it is necessary to clean these parts.

2.15.1 Cleaning agents

WARNING

Risk of injury

Flammable solvents can burst into flame and cause injury.

Use only approved cleaning agents.

2.15.2 For normal dirt

- Use commercially available, non-flammable solvents.
- If solvent vapors can be inhaled, breathing protection must be worn.
- Do not allow solvents to drain into the sewage system.
- Note the identifying information and instructions on the containers and the packaging of the cleaning agent.

2.16 Individual phases of operation

WARNING

Equipment damage

The variable-speed turbo coupling is delivered without any oil in it. Operation without oil will damage the equipment within a few seconds.

Prior to startup, fill the variable-speed turbo coupling with the working oil!

NOTE

Proper operation of the Variable-speed turbo coupling requires that the instruments be functioning correctly.

Commissioning

- The Variable-speed turbo coupling can be damaged if
  - it is started without working oil,
  - the heat exchanger and the lines to the heat exchanger have not been flushed prior to commissioning,
  - a working oil not approved by Voith is used,
  - the equipment was filled with contaminated working oil,
  - the heat exchanger does not have adequate cooling capacity.
- The Variable-speed turbo coupling can also be damaged,
  - if the driving machine is not rotating in the correct direction or at the specified speed or
  - if the components that are supplied with lubricating oil from the variable-speed turbo coupling are sealed with silicone-containing gaskets.

Maintenance

- Perform specified maintenance at the times indicated!
- Immediately repair or exchange components that are not in perfect operating condition. Use only genuine Voith replacement parts!

The working oil in the variable-speed turbo coupling may be under pressure.
Prior to performing any maintenance or repair work, disconnect the equipment from the electricity (observe local regulations!)
The housing, oil lines, connecting couplings and working oil may be very hot - in extreme cases, up to 110°C. Contact can cause burns on the skin.

The variable-speed turbo coupling must be allowed to cool prior to maintenance or repair work!

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Cleaning

When steam cleaning or using a stream of water under high pressure, dirt may be forced into the equipment.

Protect shaft seals (labyrinth seals) and breather filters on the variable-speed turbo coupling, so that the stream of water or steam does not strike them directly.

Disposal of used oil

Note the following when disposing of used oil:

CAUTION

Environmental damage

Used oil that escapes into the soil or sewage system can cause serious damage to the environment.

Dispose of used oil in a proper manner that complies with national statutory regulations.

2.17 Warranty

The conditions and deadlines specified in the general terms of delivery of Voith Turbo GmbH & Co. KG Crailsheim apply. Warranty claims will be rejected if they are attributable to one or several of the following causes:

- Unsuitable and improper use, faulty assembly, improper transportation, storage, setup, commissioning or operation.
- Natural wear, faulty or negligent treatment, change in operating conditions and operating media, especially filling with contaminated oil, with different oil types or with an oil type not included in the list authorized by Voith or not approved by Voith Turbo GmbH & Co. KG, Crailsheim.
- Maintenance not in accordance with instructions, unsuitable operating means, operating material, insufficient constructional work, unsuitable foundation,
- chemical, electrochemical or electrical influences.
- Damages due to corrosion, erosion and pitting, as well as damages to sealings by chemical or mechanical attack or aging.
- If service and repair work as well as changes influencing the function are not done by Voith service engineers or trained staff.
- Non-observance of the information with regard to the safety at work and of the product contained in the instruction manual.

NOTE

During the warranty period, repairs to the variable-speed turbo coupling may be performed only with the approval of Voith Turbo GmbH & Co. KG Crailsheim.

3 Design and Principle of Operation

3.1 Design

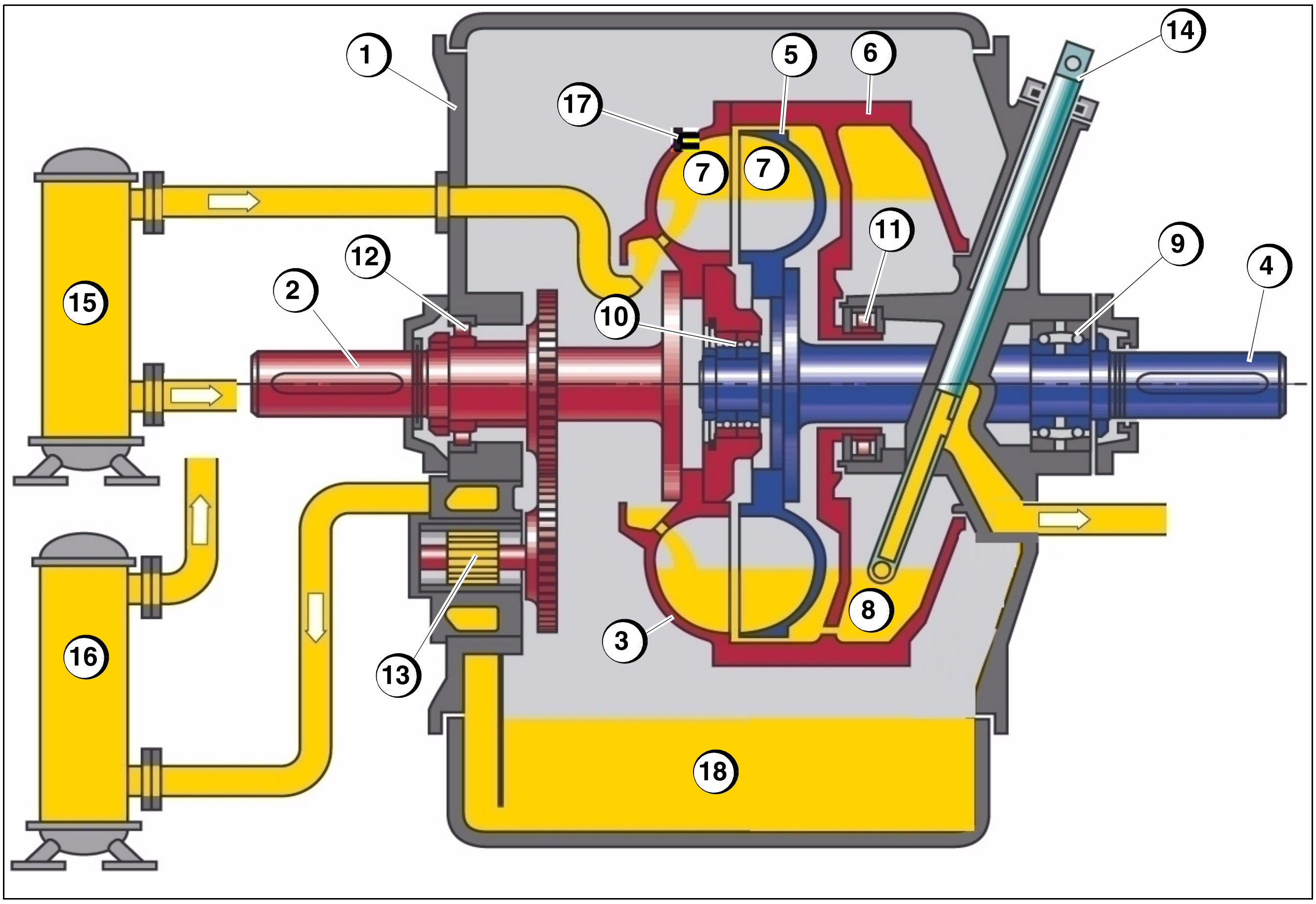

Illustration 3-1: The design of the Variable-speed turbo coupling

1 Housing with oil reservoir
2 Primary shaft
3 Primary wheel
4 Secondary shaft
5 Secondary wheel
6 Shell
7 Working chamber
8 Scoop chamber
9 Thrust and radial bearings 3
10 Thrust and radial bearings (relative bearing)
11 Radial bearing 1
12 Radial bearing 2
13 Filling pump
14 Scoop tube
15 Working oil heat exchanger
16 Lube oil heat exchanger
17 Fusible plug
18 Oil sump

Housing

The variable-speed turbo coupling has been designed using a tunnel concept and is enclosed within a one-piece sheet steel housing. This housing also functions as the oil reservoir.

Coupling

The coupling consists of the

- primary shaft and primary wheel,
- secondary shaft and secondary wheel,
- shell (flange-mounted to the primary wheel, encloses the secondary wheel) as well as the
- Scoop tube housing with actuator.

The primary shaft and primary wheel are permanently attached to one another, the same is true of the secondary wheel and secondary shaft. The primary shaft is connected to the driving machine; the secondary shaft is connected to the driven machine.

The primary wheel, secondary wheel and shell form the working circuit. The working oil circulates within the working chamber.

The scoop tube with the scoop tube housing is integrated in the housing of the variable-speed turbo coupling. The secondary shaft is mounted in the scoop tube housing.

Bearings

The primary and secondary shafts of the variable-speed turbo coupling are supported by roller bearings. The primary shaft is guided axially by a relative bearing (between the primary shaft and secondary shaft).

Oil pumps

A filling pump in the oil reservoir delivers the operating oil for the working oil and lube oil circuits. The filling pump is driven mechanically by the primary shaft of the variable-speed turbo coupling.

The electrically driven auxiliary lube oil pump supplies the system with lube oil during startup, shutdown and in the event of a malfunction.

3.2 Power transmission

The variable-speed turbo coupling transmits power in a wear-free manner from a driving machine to a driven machine. The power is transmitted in the following way:

- by means of a connecting coupling between the driven machine and Variable-speed turbo coupling,
- hydrodynamically by means of the working oil between the primary wheel and the secondary wheel,
- by means of a connecting coupling between the driven machine and variable-speed turbo coupling.

The speed of the driven machine can be varied continuously with the aid of the scoop tube.

Mechanical energy – kinetic energy

The power from the driving machine is transmitted by the primary wheel (function: pump) to the working oil; the working oil is accelerated in the primary wheel, and the mechanical energy is converted into kinetic energy. The secondary wheel (function: turbine) picks up the kinetic energy and converts it into mechanical energy. This energy is transmitted to the driven machine.

The torque at the primary wheel is identical to that at the secondary wheel.

Slip

The speed of the secondary wheel is lower than that of the primary wheel during power transmission. This speed difference is called slip. The power loss resulting from the speed difference (slip) heats the working oil. To dissipate this heat, the oil must be cooled.

Working oil circuit

The working consists of a closed circuit, superimposed by an open circuit to change the fill level.

Closed circuit

Oil flows into the coupling working chamber through the **working oil orifice** forming a rotating oil ring in the scoop chamber due to centrifugal force. The position of scoop tube determines the thickness of oil ring in the scoop chamber and thus also the fill level in the working chamber. The scoop tube scoops up the heated working oil in the scoop chamber transferring it directly through the working oil cooler. After that the cooled working oil flows again back into the coupling working chamber.

If the working oil fill level in the coupling needs to be increased it is necessary to adjust the scoop tube.

Open circuit

The filling pump (gear pump) delivers the oil from the oil tank through the lube oil cooler and through the **lube oil orifice**. To fill the Variable-speed turbo coupling oil flows through the **pressure relief valve** from the open into the closed circuit of coupling. The amount of oil delivered by the filling pump in excess flows through the **overflow valve** back into the oil tank. This applies also in case of a change in fill level of Variable-speed turbo coupling.

Working oil temperature

The working oil temperature depends on the power loss (slip) and the working oil recirculation rate. It is monitored by temperature sensors.

Fusible plugs

If as the result of a malfunction the oil temperature rises to 160°C (320°F), the fusible plugs in the coupling melt, and oil is diverted into the housing of the variable-speed turbo coupling. The coupling empties partially, reducing the power transmitted, and the speed of the driven machine slows.

3.3 Speed control

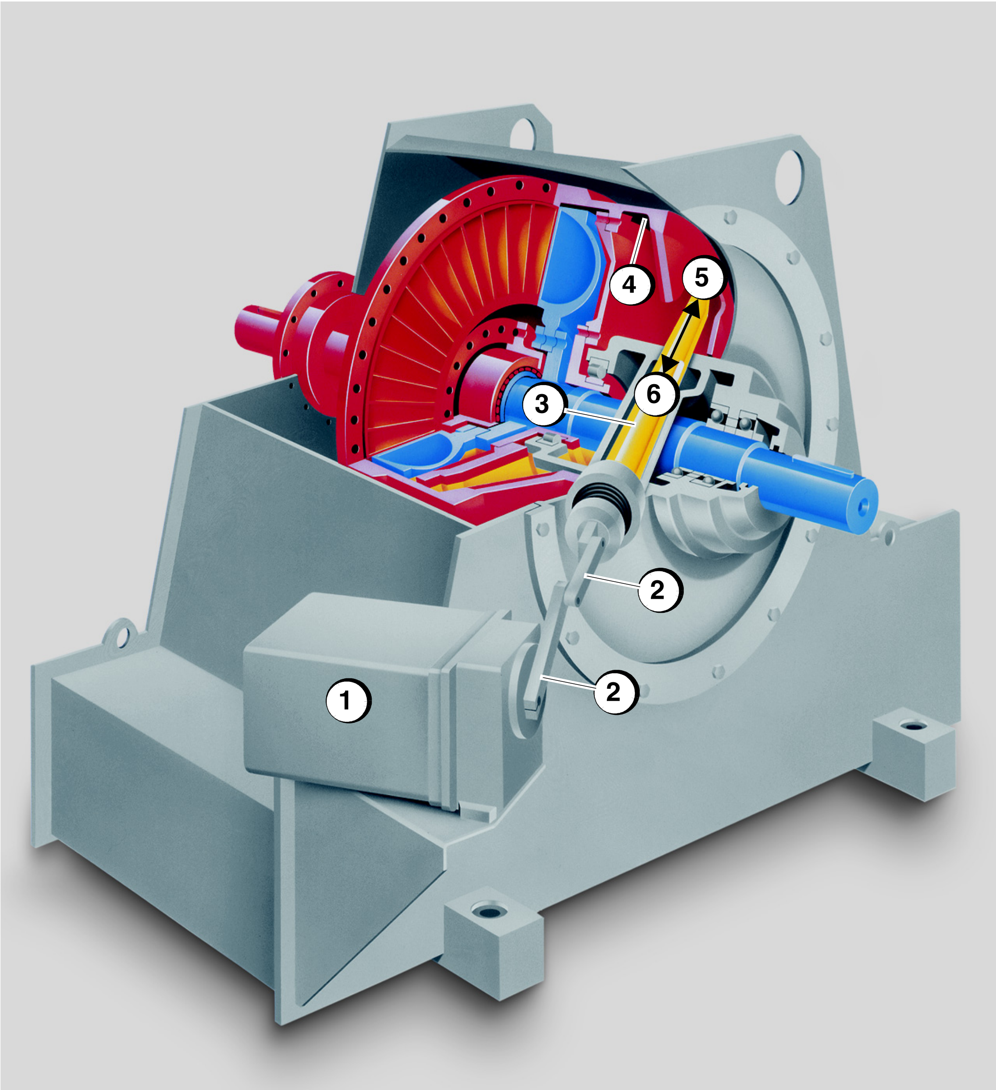

Illustration 3-2: Speed control by means of the scoop tube

1 Actuator
2 Scoop tube linkage
3 Scoop tube
4 Oil ring
5 Scoop tube position-0%
6 Scoop tube position-100%

The speed of the driven machine is infinitely variable. This is accomplished by varying the amount of oil in the coupling during operation with the aid of the adjustable scoop tube:

- Scoop tube *advanced* as far as possible *into* the scoop chamber of the coupling (0% position): minimum oil ring, minimum output speed.
- Scoop tube *retracted* as far as possible *out of* the scoop chamber of the coupling (100% position): maximum oil ring, maximum output speed.

3.4 VEHS - Voith Electro-Hydraulic Positioning Control

The **V**oith **E**lectro-**H**ydraulic Po**s**itioning Control (**VEHS**) is a positioning control unit.

Design of VEHS

It consists of:

- control magnet with
  - PID positioner
  - magnetic force controller

- 4/3 way valve
  - control pin

Assigned to this VEHS are:

- a double-acting hydraulic positioning cylinder with its piston being mechanically connected with the scoop tube.
- Position pickup for actual determination of scoop tube position.

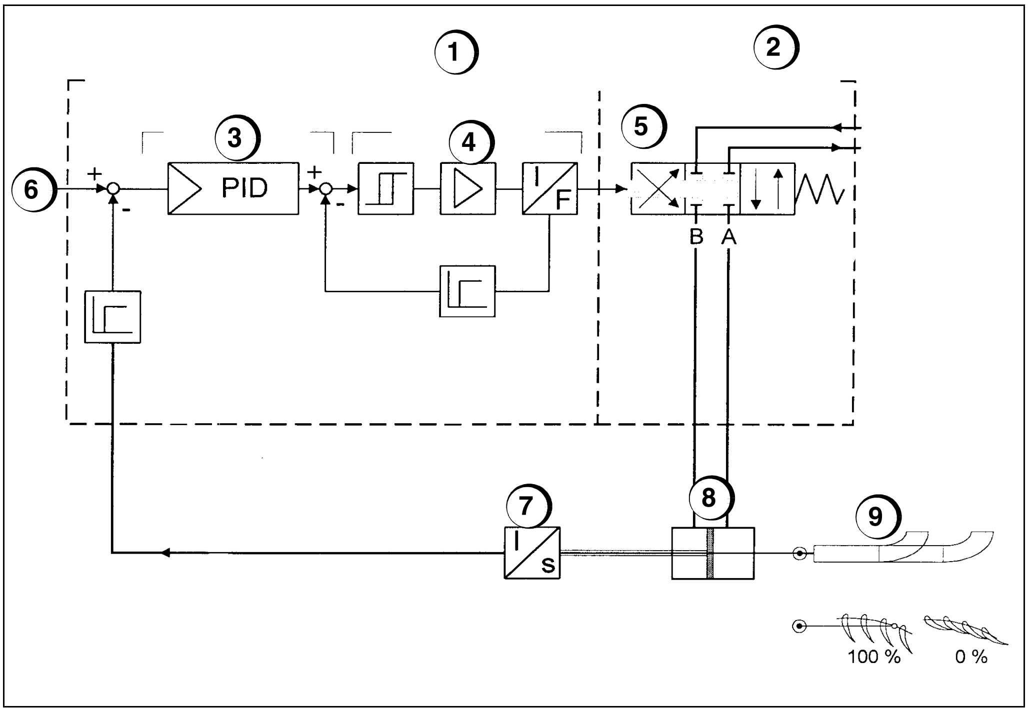

Illustration 3-3: Block diagram of VEHS positioning control unit

1 Control magnet
2 4/3-way valve
3 Positioning controller
4 Magnetic force controller
5 Control pin
6 Master controller
7 Position pickup
8 Double-acting positioning cylinder
9 Scoop tube

Operation of VEHS

A process controller (master control loop) is arranged before the VEHS positioning control unit, from which a setpoint (signal) of 4-20 mA is given.

NOTE

For electronic control and terminal plan please

➔ See „Terminal Plan Sheet 1-6/ 215001154-0040“.

The scoop tube position operates as a function of the VEHS control (**V**oith **E**lectro-**H**ydraulic Po**s**itioning Control).

The scoop tube position is

- initialized by actual value output on the positioner in order to use a remote indication.

Change of output speed

The process controller gives a setpoint (signal) to the VEHS positioning control unit, e.g. „max. output speed“ (100%).

The positioning control loop compares the „scoop tube position actual value“ of the position pickup with the „setpoint (signal)” of process controller.

The difference determined signals the magnetic force controller a change in the position of control pin the 4/3-way valve.

Due to the change in control pin position control oil flows *to* and also *from* the double-acting scoop tube positioning cylinder.

Max. output speed

The control oil flows into chamber (a) of scoop tube positioning cylinder pressing the piston with the scoop tube in 100% direction (out of the scoop chamber). The working oil pump fills the working oil circuit.

The position pickup records the change in scoop tube positioning cylinder position, which is continuously signalled to the positioning control loop.
With decreasing differential signal also the change of control pin position in the 4/3-way valve is reduced until setpoint and actual value are conform.

Min. output speed

In the reverse order, the control oil flows into chamber of positioning cylinder and presses the scoop tube in 0% direction (into the scoop chamber). The coupling drains. Through the pressure relief valve the working oil is fed back into the oil tank.

Control oil

The oil for the hydraulic scoop tube control is branched off the lube oil circuit upstream of adjustable orifice plate.

Control oil pressure

- The control oil pressure is set on the **sequence valve** as a function of the lube oil pressure.

3.5 Lubrication

3.5.1 Self-lubrication

The bearings and gears of the variable-speed turbo coupling need lubricating oil before and during operation.

Lube oil circuit

During operation, the filling pump delivers oil from the oil reservoir. The lube oil is diverted into the lube oil circuit through the lube oil orifice.

The oil flows through the

- heat exchanger
- the duplex oil filter and the

lube oil orifice

to the lubrication points after being cooled and filtered.

Lube oil flow rate

The lube oil flow rate for the bearings and gears is set by means of the lube oil orifice or orifice openings in the lube oil nozzles.

The lube oil flow rate can be altered only indirectly by means of the lube oil pressure.

Lube oil pressure

The lube oil pressure is set at the lube oil orifice and monitored with pressure measuring devices (pressure gauge, pressure switch).

Lube oil temperature

The lube oil temperature is monitored by temperature measuring devices (e.g. resistance thermometers).

3.6 Lubrication of external equipment

The oil for lubrication of the driving machine and the driven machine is taken from the lube oil circuit of the variable-speed turbo coupling via the external oil orifice and returned to the oil reservoir of the Variable-speed turbo coupling.

Lube oil pressure, lube oil flow rate

The lube oil pressure and lube oil flow rate are set with the aid of the external oil orifice downstream of the duplex oil filter.

The lubricating oil pressure is monitored with pressure measuring devices (pressure gauge, switch).

NOTE

The lube oil flow rate and lube oil pressure for supplying external units are stated in the order confirmation.

If oil must subsequently be provided for external equipment, contact our Service Center:

➔ See contact information.

4 Transport and Storage

4.1 Safety information

The following safety information applies to the entire chapter. It must be observed in addition to the various specific instructions.

Hazard from loss of stability and danger arising from masses

WARNING

As the result of inadequate packaging and securing, the coupling may have become unstable and could shift unintentionally, causing serious injury.

Maintain a safe distance! Allow only knowledgeable personnel to handle transport!

Hazard from loss of stability and danger arising from masses

WARNING

Unqualified personnel could misjudge the weight of the coupling. This could (for instance, as the result of selecting unsuitable lifting equipment) allow the load to drop on someone underneath, resulting in serious injury or death and/or cause severe damage to the coupling.

➔ For weight data, see Chapter 1 „Technical Data“ and „Assembly Plan - variable-speed turbo coupling 215001154-0010“.

Allow only knowledgeable personnel to handle transport!

Hazard of crushing of upper and lower body limbs

WARNING

Improper handling of the coupling, especially during transport by a crane, poses the risk of crushing and serious injury.

Maintain a safe distance! Allow only knowledgeable personnel to handle transport!

Impact hazard

WARNING

The suspended and swinging coupling could strike someone and cause serious injury.

Maintain a safe distance! Allow only knowledgeable personnel to handle transport!

Friction and abrasion hazard

CAUTION

The suspended and swinging coupling could rub against someone and cause friction or abrasion wounds.

Maintain a safe distance! Allow only knowledgeable personnel to handle transport!

Impact hazard during transport

CAUTION

While being transported, the coupling could strike a person or object, resulting in serious injury or damage.

Allow only knowledgeable personnel to handle transport!

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4.2 As-delivered condition

4.2.1 State of assembly and test run

The variable-speed turbo coupling cannot be used on its own in the as-delivered condition.

State of assembly

- The variable-speed turbo coupling is fully assembled and ready for installation.
- All internal piping for the working oil and lube oil is in place.
- All external piping connections are provided in the form of welding neck flanges with gaskets, and are sealed for protection during transport.
- If connecting couplings are being supplied by Voith or have been provided by the customer, their hubs have been mounted on the input and secondary shafts of the variable-speed turbo coupling.
- All instruments (indicating instruments, switchgears etc.) are attached to or mounted on an instrument gauge board. The panel is attached to the housing by means of vibration-absorbing mounts.
- Electrical indicating instruments and switches are wired to a terminal strip in a junction box.
- The instruments installed are identified.
- The scoop tube actuator is installed.

Operation check

Prior to shipment, the variable-speed turbo coupling underwent a trial run at the Voith test facility or was subjected to an extensive final inspection.

The following items were checked:

- Attachments (such as duplex oil filter, electric motor etc.)
- Operation of the actuator

The following items were adjusted:

- Actuator
- Oil flow rates
- Oil pressures
- Operating points of the instruments installed

4.2.2 Preservation/corrosion prevention and packing

The variable-speed turbo coupling and all attached components have been treated (preserved) and packed in a manner that provides protection for 12 months.

4.3 Storage and preservation

Corrosion protection for shipment within Europe

The internal surfaces of the variable-speed turbo coupling have a light film of oil in the as-delivered condition (either from the oil used during the trial run or from having had solvent-free corrosion-inhibiting oil sprayed on as corrosion protection[1]). This film of oil provides 12 months of protection within Europe, provided that the coupling is stored in a dry location.

Corrosion protection for shipment overseas

For shipment overseas, the variable-speed turbo coupling is additionally sealed in plastic film. Bags of desiccant inside the packaging absorb some of the humidity. Equipment packaged in this way can also be stored for 12 months in a dry location, provided that the plastic film is not punctured or damaged.

➔ (see Section 4.5 „Preservation specification“ on page 35).

Preservation/ corrosion prevention after delivery

For variable-speed turbo couplings that are to be stored for periods of longer than 12 months, Voith Turbo GmbH & Co. KG Crailsheim offers special long-term corrosion prevention with storage instructions after delivery.

➔ Appendix _A_ (see „Preservation Method and Instructions for Storage after Delivery 3625-006714“)

1. used by the factory as well as recommended (see Section 4.5.1 „Internal corrosion-inhibiting oils“ on page 37)

4.4 Unpacking, transportation

The variable-speed turbo coupling is delivered ready for installation. If necessary, it is also protected by a crate. Both the coupling and the crate have specified lifting points.

1. If necessary, remove the crate.

WARNING

Risk of injury

Improper lifting of the variable-speed turbo coupling can result in equipment damage and personal injury.

The variable-speed turbo coupling is to be suspended only from the specified lifting points.

Use only appropriate lifting appliances that conform to safety requirements!

CAUTION

Equipment damage

Transporting and setting the variable-speed turbo coupling down improperly can results in damage to the coupling.

The variable-speed turbo coupling is to be transported only when it is properly secured and with the transport rails attached!

Set it down only on a firm and appropriate surface!

Rest it only on the feet attached to the housing or the feet attached to the oil reservoir!

NOTE

The lifting points provided on the variable-speed turbo coupling are intended only for the weight of the coupling itself.

Do not lift any other equipment at the same time! The variable-speed turbo coupling is to be lifted only without oil in it!

1. Check lifting points (1) for cracks, deformation and corrosion before using.

2. The variable-speed turbo coupling is to be suspended only from the specified lifting points (1) (see Illustration 4-4 „Lifting points“).

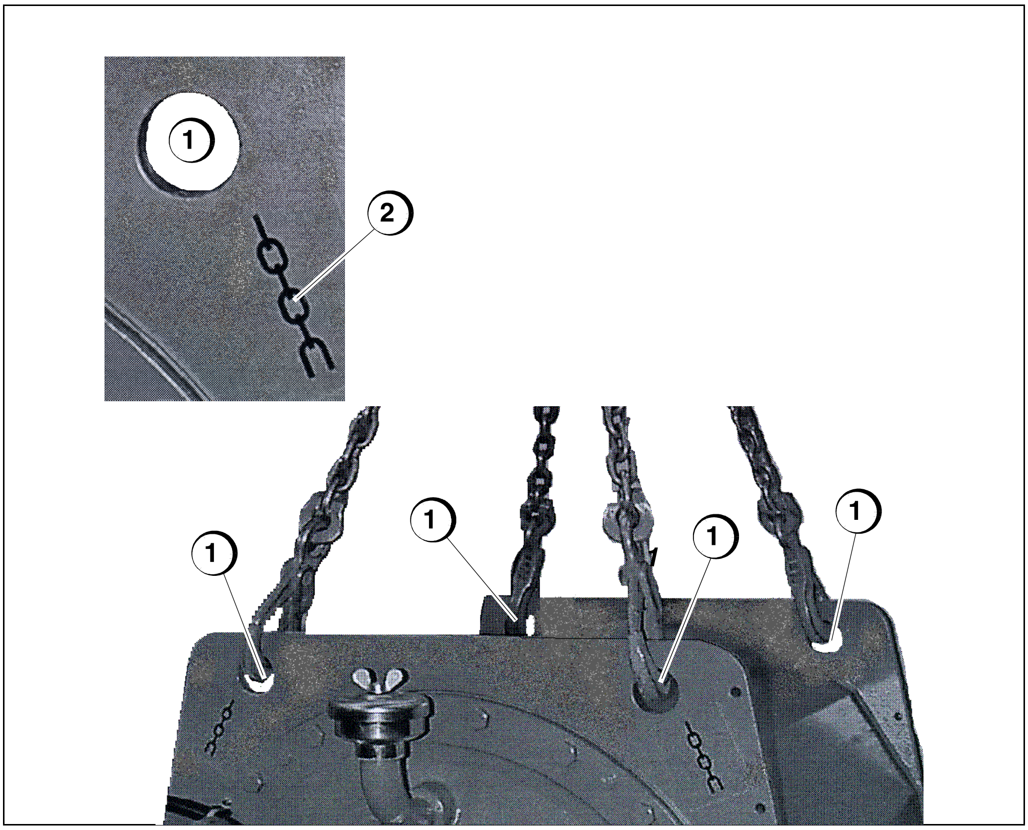


Illustration 4-4: Lifting points

1) Lifting points

2) Sticker

3. Unscrew the machine from the transport framework and pull the frame from under the machine.

4. Set the variable-speed turbo coupling down on the feet attached to the oil reservoir.

4.5 Preservation specification

Source: Sheet 3625-006212 de, date of issue 2002- 11- 20

These specifications apply to protection of internal and external surfaces (insofar as the surfaces are not treated and/or corrosion-resistant or made of cast aluminum), as well as the packing of shipments.

Overview

		Preservation		
Transport, storage and duration of storage	**Packaging No.**	**External**	**Internal with test run**	**Internal without test run**
• Overland/air transport for immediate installation at the destination (or storage in a closed building for up to 6 months)	Packaging No. 1	External preservation No. 1	Internal preservation No. 1	Internal preservation No. 2
• Sea transport and / or storage for up to 12 months after the date of packaging	Packaging No. 2			
• Sea transport and / or storage for up to 24 months after the date of packaging	Packaging No. 3			
• Extended protection (after expiration of the initial protection)	Replace plastic film and reseal	External preservation No. 2	Internal preservation No. 3	

External preservation No. 1

- Painting as specified in order documents.
- Bright iron parts sprayed with "Shell Ensis Fluid S"[1]).
- See note.

External preservation No. 2

- Painting as specified in order documents.
- If necessary, reapply depending on the condition of preservation No. 1.
- Replace desiccant.

NOTE

If use of VCI preservation products for an order is ensured throughout the entire packaging chain, corrosion protection based on this preservation method is permissible if agreed upon.

1. Before installing the coupling or parts, clean sprayed surfaces with solvent (white spirits or petroleum).

Internal preservation No. 1

- Internal preservation from oil used during test run.
- If the order documents call for "Inspection" after the test run, spray with solvent-free corrosion-inhibiting oil ("Shell Ensis Engine Oil 20" used at the factory) to the extent possible. For alternatives to "Shell Ensis Engine Oil 20" see 3625-006237).

Internal preservation No. 2

- All surfaces of iron parts (including holes, cavities and internal surfaces of pipes) sprayed, immersed or flushed with solvent-free corrosion-inhibiting oil during assembly (with Shell Ensis Engine Oil 20 at the factory) based on installation progress. All assemblies sprayed during assembly to the extent possible.
  For alternatives to "Shell Ensis Engine Oil 20" see 3625-006237).

Internal preservation No. 3

- Inspect the preservation.
- Spray all rotating parts and wall surfaces with solvent-free corrosion-inhibiting oil (e.g. “Shell Ensis Engine Oil 20”), turn rotating parts while spraying. For alternatives to "Shell Ensis Engine Oil 20" see 3625-006237).
- Spray the inside of piping with solvent-free corrosion-inhibiting oil (see above).
  As an alternative, fill the interior of the coupling with dry air, relative humidity max. 10%.

Packaging No. 1[1]

- Means suitable for transport (e. g. transport frame, holder, support)
- Transport means provides protection from the weather.

Packaging No. 2[1]

- Means suitable for transport (e. g. transport frame, holder, support)
- Sharp edges and supporting surfaces covered with elastic materials.
- Sealed in PE film.
- Desiccant in acc. with DIN 55 473 / 55 474.
- Water-resistant carton or wooden crate.
- Inside of crate lid covered with closed ribbed PE sheets (Akylux). With PVC film underneath at butt joints.

Packaging No. 3

Identical to packaging No. 2. Difference: sealed in aluminized plastic film instead of PE film.

1. The unit is packaged in accordance with the latest version of the packaging guidelines issued by the German Association for Wooden Packaging -Pallets - Export Packaging (HPE) e. V.

4.5.1 Internal corrosion-inhibiting oils

NOTE

The variable-speed turbo coupling is not filled with working oil!

Source: Sheet 3625-006237 de, date of issue: June 1996

HD engine oils with especially pronounced anti-corrosion properties are recommended as internal corrosion-inhibiting oils. Special ingredients in these solvent-free corrosion-inhibiting oils promote the formation of strongly adhering protective films that protect vertical surfaces effectively.

(Shell Ensis Engine Oil 20 used at the factory)

Recommended grades:

Supplier	Designation
AGIP	AGIP RUSTICA 10W-20
ARAL	ARAL Oil KONIT SAE 20 W 20
DEA	DEA DEAMOT EKM 162 N (SAE 20 W-20)
ESSO	ESSO MKZ Engine Oil HD 20W-20
FINA	FINA RUSAN MOTOR OIL SAE 20 W-20
MOBIL	MOBILARMA 524 (SAE 30)
SHELL	SHELL Ensis Engine Oil 20
WINTERSHALL	WINTERSHALL Antikorrol 20 W-20

(This list makes no claim regarding completeness.)

4.5.2 To be ensured on the jobsite:

Installed units or units ready for installation

Special attention should be paid to the effectiveness of the preservation applied to these units, since it often subjected to additional hazards such as water, accumulation of large amounts of dirt and physical damage.

Complete systems installed on a foundation

This includes measures that provide supplemental internal protection when idle times of up to about 12 months are to be expected and when the original corrosion prevention coating has been disturbed.

Fill units with water-free working oil. The following can be performed at intervals of 1-2 months, depending on the state of installation:

- System that is ready to operate:
  - Start and operate only briefly (approx. 5 minutes) to coat the surface of internal parts with oil; do not run until warm.
- System that is not ready to operate:
  - Units with a ready-to-operate electric auxiliary lube oil pump or oil pump and oil reservoir:
  - Switch on pump; allow system to operate, if possible. Move operating components (e. g. joints).
  - Units without a ready-to-operate electric auxiliary lube oil pump or oil pump:
  - Remove oil from the sump, spray inside through openings in the housing and circulate oil through the piping with the aid of a separate oil pump, run for approx 5 minutes: allow system to operate, if possible. Move operating components (e. g. joints).

NOTE

Before filling with the operating fluids, contact the suppliers to confirm compatibility with the internal corrosion preventative.

5 Assembly

5.1 Safety information

The following safety information applies to the entire chapter. It must be observed in addition to the various specific instructions.

Hazard from improper installation

WARNING

Improperly installed or assembled components could loosen, electrical lines could be incorrectly connected or routed, the insulation on poorly routed cables could be abraded and, as a result, cause serious personal injury or equipment damage.

Only a qualified electrician who is knowledgeable about rules that apply to electronic equipment in the country of installation is allowed to perform work involving the electrical equipment on the variable-speed turbo coupling.
Use only cables with insulation that can withstand the ambient operating conditions!

Danger in areas that cannot be fully viewed

WARNING

A person could be severely injured while working on the machine when starting it up.

Attach suitable protective covers that cannot be removed without the respective tool, between the coupling and the shaft!
Only work on the machine when the system is shut down (no power)!
Operation is only permitted after visually ensuring that no persons are in the hazard areas!

Hazard from maximum pressures, pressure shocks, pressure rise or pressure loss

WARNING

An unsuitable or poorly maintained heat exchanger, improperly sized oil lines, the absence of shutoff valves, incorrectly set pressure relief valves or an improperly installed check valve could result in high pressures that might destroy the equipment, causing serious personal injury due to flying objects as well as damage to the environment.
A severe pressure drop could damage bearings.

– Allow only trained personnel to perform installation, maintenance and service work on the equipment and to operate it!
– Confirm that check valves are installed correctly!
– Observe maintenance intervals!
– Comply with limits!
– Do not install shutoff valves in the oil circuit; make sure that the oil circuit conforms to the schematic provided!

Equipment damage

CAUTION

Creepage or stray electric currents can reach the variable-speed turbo coupling via the drive shaft, leading to spark erosion damage on bearing surfaces and the surfaces of teeth on the drive gears in the pump drive.

Provide appropriate grounding / insulation for the driving machine (e.g. between the connecting coupling) and take the necessary measures to interrupt the flow of electric current!

Equipment damage

CAUTION

Dirt caused by construction, flying sparks, grinding and water can get into the variable-speed turbo coupling and cause the equipment to malfunction.

Cover the variable-speed turbo coupling with a tarpaulin completely during construction work at the installation site!

Protect instruments, electrical cables and cable trays particularly well!

Use only appropriate sealants that are oil resistant up to 130°C and do not contain silicone. Failure to comply with the above will have an adverse effect on oil quality and can cause damage to the variable-speed turbo coupling.

Equipment damage

CAUTION

Improper installation can result in malfunctions and premature wear in the equipment.

Setup and initial commissioning should be performed by a Voith technician!

5.2 Tools and auxiliary means

- Metric tools
- Torque wrench
- Sealant (must not contain silicone) (see „Sealant“ on page 113)
- Lifting appliances
- Device for mounting the coupling hubs
- Shims
- Brackets and adjusting bolts for horizontal alignment on the concrete foundation
- Adjusting bolts for vertical alignment
- Alignment device

5.2.1 Sealing the keyway

How to seal the keyway in the case of an oil-filled or grease-filled connecting coupling.

- Connecting coupling hub provided or still to be provided with a taphole above the keyway.
- Mount the hub on the shaft.
- Fill the taphole 2/3 with the sealing compound[1].
- Insert and tighten set screw. Remove any sealing compound squeezed out of the face side.

1. LOCTITE 5910; When applying, please follow the instructions on the tube.
Supplier: Loctite Deutschland, Arabellastrasse 17, D-81925 Munich

5.3 Mounting the connecting couplings

NOTE

Gear couplings or all-metal couplings with low radial restoring forces are suitable. Connecting couplings with a flexible compensating element (flexible element) are to be agreed upon only in individual cases.

Factory mounting

If the connecting couplings are being supplied by Voith or have been provided by the customer, the input- and output-side connecting coupling halves will have been mounted at the factory:

- The end cover (2) and coupling hub (3) have been mounted on the shaft ends (1)
- The coupling sleeves are packaged separately.

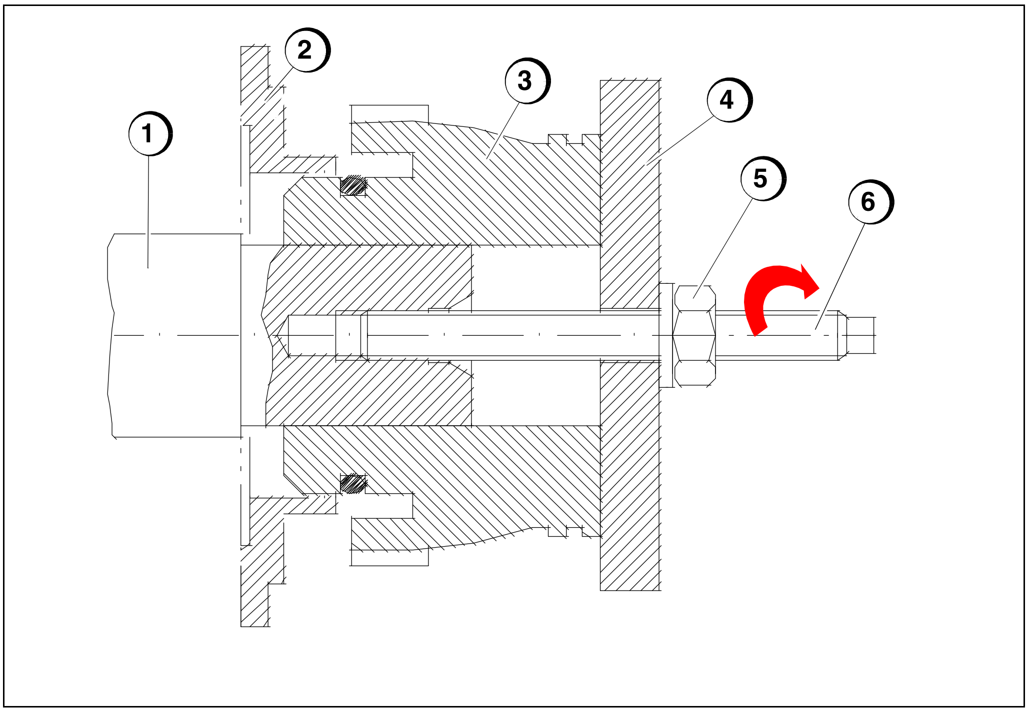


Illustration 5-5:
Coupling hub on shaft

1) Shaft end
2) End cover
3) Coupling hub

Mounting device
4) Plate
5) Bolt
6) Threaded spindle

On-site mounting

If the connecting couplings are not yet mounted:

➔ Manufacturer's specification for connecting coupling

NOTE
Check the connecting coupling for existence of the puller thread at the face end and taphole above the keyway.

Gear couplings with key

1. Clean the shaft (1) and hub (3) from preservation agents using gasoline or cellulose thinner (not petroleum) and degrease.
2. Check the bore, shaft, key and keyway for dimensional accuracy.
3. Remove the key from the shaft keyway and fit it into the hub keyway. Then fit the key into the shaft keyway again. Check the height of the key: the back clearance between the keyway and key must be 0.2 – 0.3 mm.
4. Apply a thin coat of Molykote D Paste[1] or an equivalent lubricant to the shaft.
5. Slide the end cover (2) and O-rings over the shaft end.
6. Mount the coupling hub using a mounting device (4, 5, 6).
7. Seal the keyway of the connecting coupling hub (see Section 5.2.1 „Sealing the keyway“).
8. Connecting couplings without an intermediate piece: slide the sleeve over the hub.
9. Connecting couplings with an intermediate piece: mount the sleeve only after alignment.
10. Protect the connecting couplings against corrosion and cover them.

1. Molykote D Paste; When applying, please follow the instructions on the tube / can. Manufacturer Dow Corning Europe Rue General de Gaulle 62 B-1310 La Hulpe

5.4 Setting the variable-speed turbo coupling down on a concrete foundation

Prior to setting down

Checks:

- Are the foundations for all machines in the system properly sized? (height, center position, flatness)
- Is the height of the concrete foundation measured so that there is free space of 10 mm for putting shims beneath the variable-speed turbo coupling and foundation rails?
- Does the space provided for installation match that stated on the assembly plan for variable-speed turbo couplings?
- Are the connecting coupling sleeves mounted or has a sufficient distance been provided between the shafts for connecting couplings with an intermediate piece, in order to mount the sleeve later?
- Can the oil lines be installed after positioning the variable-speed turbo coupling?
- Is the driven machine fixed axially?
- Is the axial clearance of the driving machine within tolerances?
  Is the rotor of the driving machine in operating position?
- Are the shims present?

5.4.1 Setting down on a concrete foundation

Prerequisites

To set the variable-speed turbo coupling down on a concrete foundation either

- 2 foundation rails or
- 4 strong foundation plates

with holes for the anchor bolts are required.

NOTE
Paint the foundation with oil-resistant paint so that oil cannot seep into the foundation and damage the concrete.

Setting down

1. Set the variable-speed turbo coupling down on the concrete foundation with the aid of suitable lifting appliances once the anchor bolts are inserted and the 2-mm support shims and foundation rails or plates are in place. Maintain the specified axial clearance between the connecting couplings in this case.
2. Place the support shims under the foundation rails or plates for the variable-speed turbo coupling align approximately.
3. Grout the anchor bolts and foundation rails or plates with concrete and allow it to set.

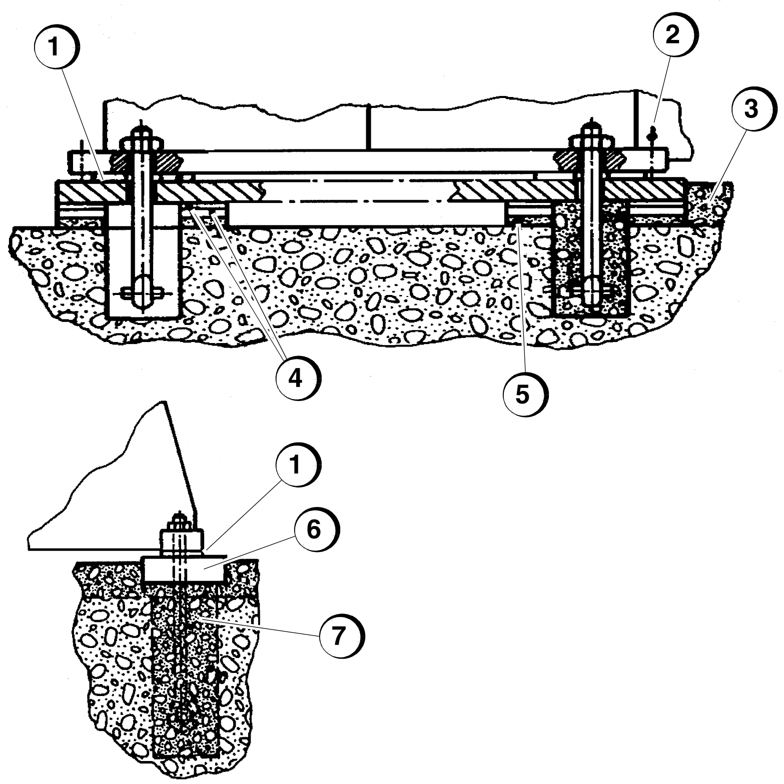


Illustration 5-6: Grouting the concrete foundation

1) Shim (10mm)
2) Adjusting screw
3) Grout
4) Shim
5) Compressed concrete
6) Foundation rail or foundation plate
7) Concrete grout

4. Use the adjusting screws provided to adjust the height of the coupling.

➔ For measurements, see Section 5.5 „Machine alignment“ on page 46.

NOTE

All machines involved (driving machine, variable-speed turbo coupling, driven machine) should be set in position prior to performing the alignment.

5.4.2 Setting down on a steel foundation

Setting down

1. Set the variable-speed turbo coupling down on the steel foundation with the aid of suitable lifting appliances. Maintain the specified axial clearance between the connecting couplings in this case.
2. Use the adjusting screws to adjust the height of the coupling.
3. Place the greased support shims provided under the coupling. Align the coupling laterally by moving the coupling on the support shims with the aid of the adjusting screws.

5.5 Machine alignment

The system components must be aligned with one another. All machines must be at the standstill temperature. At operating temperature, the shafts must be optimally aligned.

Normal alignment sequence:

1. Align the Variable-speed turbo coupling with the driven machine
2. Align the driving machine with the variable-speed turbo coupling

NOTE

The machine alignment procedure described here is based on a measuring method using dial gauges.

It is also possible to use equivalent systems such as “electronic / optical measuring methods”, for example, the electronic CTC measuring method, Optalin measuring system or Indikon measuring system as well as others.

Additional information regarding alignment can be found in:

– VDI Directive VDI 2726 “Alignment of Gearboxes”
– Manual for practical use “Alignment of Shafts in Machine Sets”, VDI Publishers

5.5.1 Shaft misalignment and alignment tolerance

Shaft misalignment

When aligning the variable-speed turbo coupling, dimensional changes arising from the following must be taken into account:

- Warming and expansion of the housing during operation

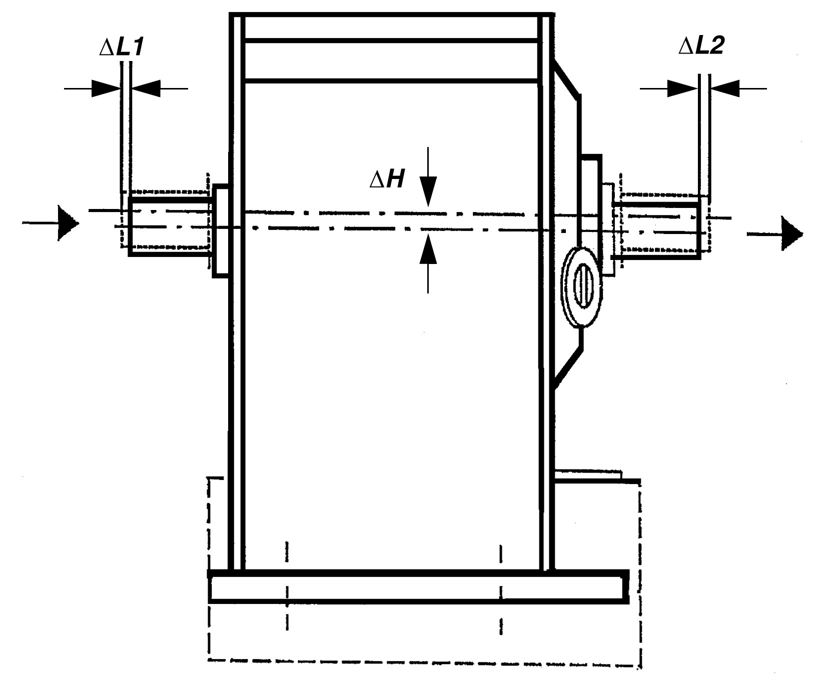


Illustration 5-7: Radial and axial displacement

Radial displacement vertical Δ H

Axial displacement Δ L1
Axial displacement Δ L2

Radial displacement, vertical[1]	ΔH	**0.35** mm
Axial displacement[1]		
• input side (driving side)	$\Delta L1$	**0.45** mm
• output side (driven side)	$\Delta L2$	**0.45** mm

1. assumed housing temperature: at installation 20°C (68°F), during operation 60°C (140°F)
Values represent the greatest possible shaft displacement, including bearing clearance.

This means that the shafts connected by means of connecting couplings should not be aligned at standstill, but rather must have a radial/angular/axial offset. This offset compensates for the displacement arising at startup and during operation.

Alignment tolerance at operating temperature

When rotating both shafts by 360°:

- Radial measurement A: radial offset ± 0.03 mm
- Angular measurements B and C:
  Angular misalignment ± 0.03 mm/100 mm Radius R_m

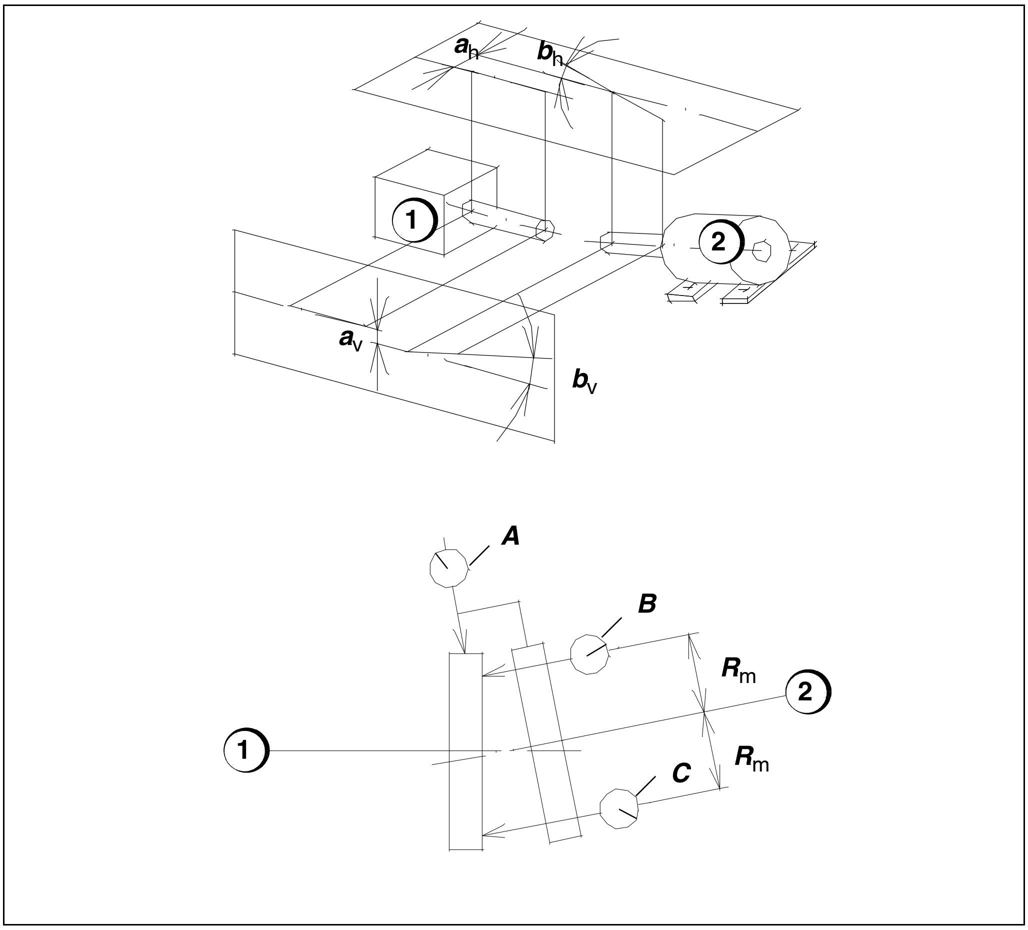


Illustration 5-8: Angular displacement and radial offset

1) Machine aligned
2) Machine still to be aligned

Radial offset horizontally a_h and vertically a_v

Angular misalignment horizontally b_h and vertically b_v

Radius R_m

5.5.2 Connecting couplings with an intermediate piece

In most cases, a connecting coupling with an intermediate piece is placed between the driven machine and the variable-speed turbo coupling, I.e. there is a space between the shaft ends.

NOTE

Gear couplings or all-metal couplings with low radial restoring forces are suitable. Connecting couplings with a flexible compensating element are to be agreed upon only in individual cases.

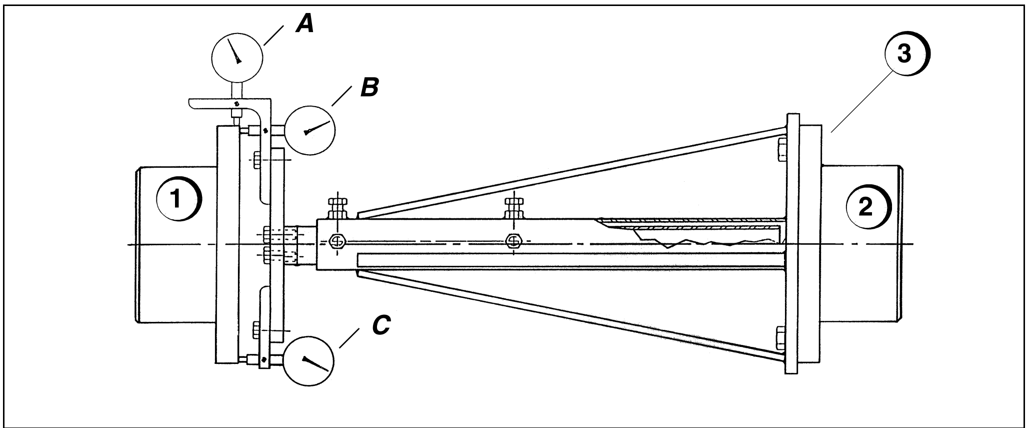


Illustration 5-9: Alignment using the alignment device for connecting couplings with an intermediate piece

1) Machine aligned
2) Machine still to be aligned
3) Alignment device with dial gauge

1. Fabricate a solid alignment device out of flat stock, round bar stock and steel profiles (3) and bolt to the shaft end of the machine to be aligned (2).

NOTE

The initial value or reading on the dial gauge can be 5.00 as assumed in the following examples.

2. Insert the dial gauges so that they are free from play and secure them.

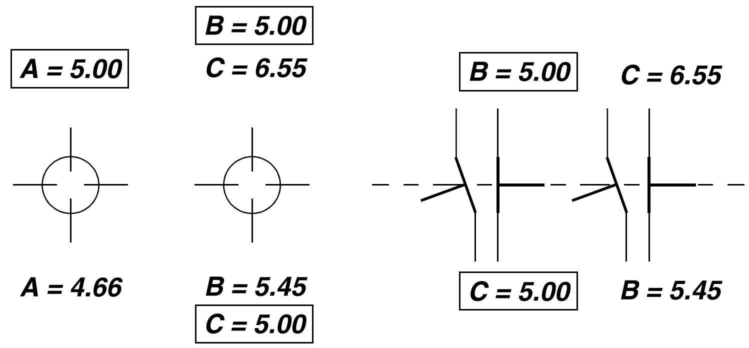
Radial run out check

3. Check the radial run-out of the already aligned machine (1): rotate the shaft (1) by 360°.

   Value to be aimed at: dial gauge deflection ≤ 0.02 mm;
   permissible value: see instruction manual of driven machine.

Precision alignment in vertical plane

4. Reset the dial gauges to the initial value.
5. Rotate shaft (2) by 180°.
6. Enter the dial gauge deflection in the coordinate system of the installation check form.



Evaluation:

Radial measurement A:
Radial offset, vertical = (5,00 - 4,66) : 2 = 0,17 mm

Angle measurement B+C:
Angular misalignment, vertical = (6,55 - 5,45) : 2 = 0,55 mm

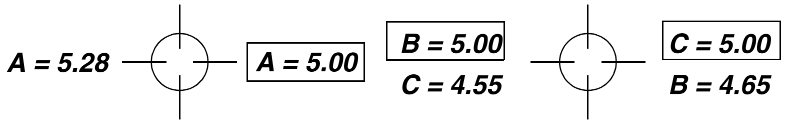
Illustration 5-10: Example of radial measurement A and angular measurements B and C in the vertical plane

For the angular measurements: half of the difference between two angular measurements is the amount of the angular misalignment.

7. Correct the vertical radial offset and the vertical angular misalignment by means of the adjusting bolts.

Precision alignment in the horizontal plane

8. Place the alignment device (3) in the horizontal position (rotate 90° with respect to the original position).
9. Repeat the measurement.



Evaluation:

Radial measurement A:
Radial offset, horizontal = (5,28 - 5,00) : 2 = 0,14 mm

Angle measurement B+C:
Angular misalignment, horizontal = (4,65 - 4,55) : 2 = 0,05 mm

Illustration 5-11: Example of radial measurement and angular measurement in the horizontal plane

10. Move the variable-speed turbo coupling horizontally using the adjusting bolts and in this way correct the horizontal radial offset and the horizontal angular misalignment.

5.5.3 Connecting couplings without an intermediate piece

In most cases, a connecting coupling without an intermediate piece is placed between the driving machine and the variable-speed turbo coupling, I.e. there is no space between the shaft ends.

Rough alignment

Prior to performing the precision alignment, it is advisable to first align the machines roughly use a feeler gauge and straightedge.

NOTE

Gear couplings or all-metal couplings with low radial restoring forces are suitable. Connecting couplings with a flexible compensating element are to be agreed upon only in individual cases.

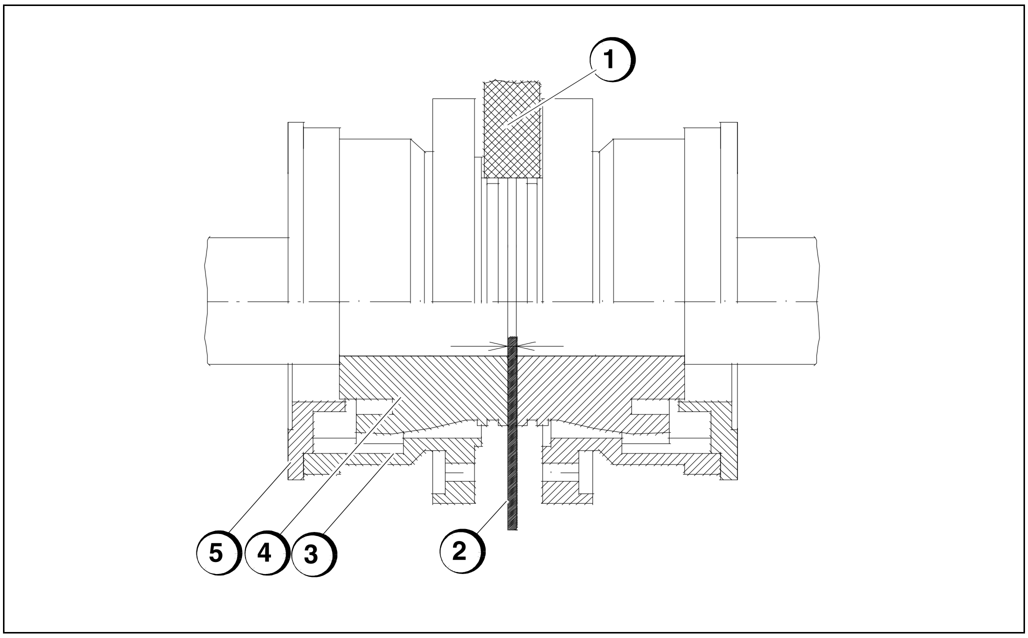


Illustration 5-12: Rough alignment of connecting couplings without an intermediate piece

1) Straightedge
2) Feeler gauge
3) Coupling sleeve
4) Coupling hub
5) End cover

1. Check the shaft spacing using the thickness gauge (2).
2. Check the radial and axial misalignment with a short straightedge (1).

Precision alignment in vertical plane

Following this, align the machine precisely using an alignment device with dial gauges.

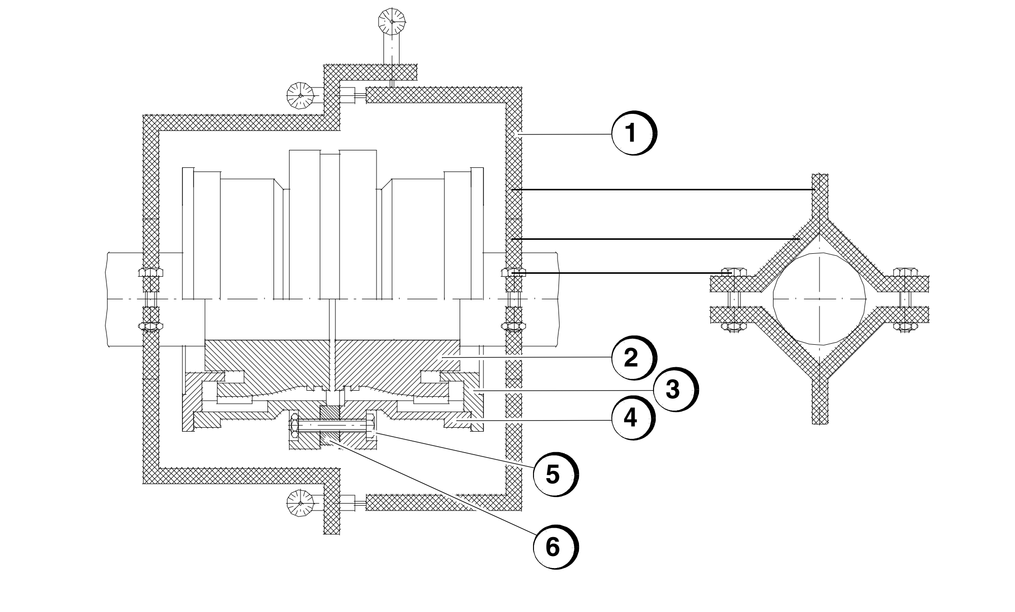


Illustration 5-13: Rough alignment of connecting couplings without an intermediate piece

1) Alignment device with dial gauge
2) Coupling hub
3) End cover
4) Coupling sleeve
5) Bolt
6) Spacer

3. Fabricate an alignment device out of flat bar steel (1) and attach it to the shafts.

NOTE

The initial value or reading on the dial gauge can be 5.00 as assumed in the following examples.

4. Insert the dial gauges so that they are free from play and secure them.
5. Connect the sleeves of the connecting couplings (4) with each other using 2 bolts (5) and 2 spacers (6) of about 20 mm.
6. Slide the flat steel between the two sleeves and rotate the two shafts by 180°.
7. Continue measuring in the vertical and horizontal planes as outlined in Section 5.5.2 „Connecting couplings with an intermediate piece“ on page 49.

5.6 Securing the machine to the foundation

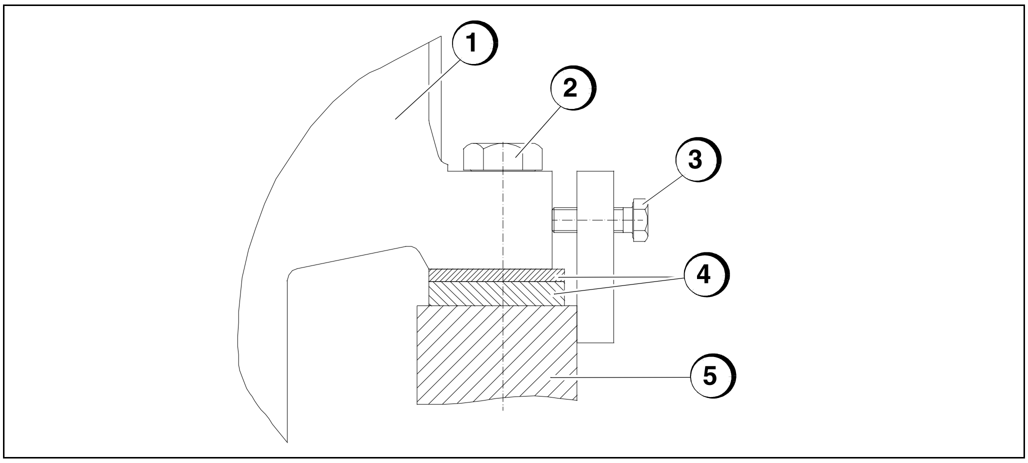


Illustration 5-14: Securing the foundation

1) variable speed turbo coupling
2) Fastening bolts
3) Adjusting screws
4) Shims
5) Foundation

1. Place shims under each fastening bolt of the coupling housing. Ensure that all shims support equally (see Illustration 5-14 „Securing to the foundation“ on page 54).
2. Unscrew the adjusting screws slightly.
   The machine is seated completely on the shims.
3. Tighten the fastening bolts.
4. Check the alignment.
5. Record the final measurements in the coordinate system of the installation check form.

5.6.1 Realigning the entire system at a future date

If the entire system is to be realigned after a long period of operation, the variable-speed turbo coupling will have to be shifted on the shims. With the fastening bolts centered in the base plate, they will have enough clearance for movement in the holes (see Illustration 5-14 „Securing to the foundation“ on page 54).

After the realignment, secure the fastening bolts to the shims to prevent them from turning.

5.7 Plumbing the machine to the heat exchanger

For installation dimensions for the heat exchanger:

➔ Heat exchanger installation diagram (see Chapter 14 „Attaching Parts (descriptions)“) in this documentation.

5.7.1 Installing the heat exchanger

NOTE
If possible, install heat exchanger below the oil level and close to the machine!

For an arrangement above the oil level, heat exchangers and pipes may drain into the oil reservoir when the system is at standstill, causing overfilling, leaks and malfunctions on start-up.

If the heat exchanger is installed above the oil level, observe the measures described in this document.

Draining of the heat exchanger and/or pipes is permissible only if the oil reservoir was designed sufficiently for a corresponding spare (rundown) volume.

In case of long pipes (> 8 m single length), the nominal width and assembly of pipes might have to be optimized. Please consult Voith Turbo in this respect.

Applications in case of extreme low ambient and / or low cooling water temperatures.

Here an exact matching of heat exchanger design, installation, control system and logic is necessary.

In case of extreme ambient temperatures, you may ask for to make available the installation and piping plan, the pressure loss calculation, the dimensions of the pipes and the oil volumes for checking.

For pressure losses on cold start, see section 'Pressure losses'

In case of cooling water temperatures < 5 °C, add antifreezer.

Antifreeze (glycols) reduces the heat transfer which has to be considered when designing the heat exchanger.

5.7.2 Arrangement of heat exchangers

The following figures show horizontally arranged heat exchangers. When planning the arrangement, please observe the dimension required to remove the tube bundle.

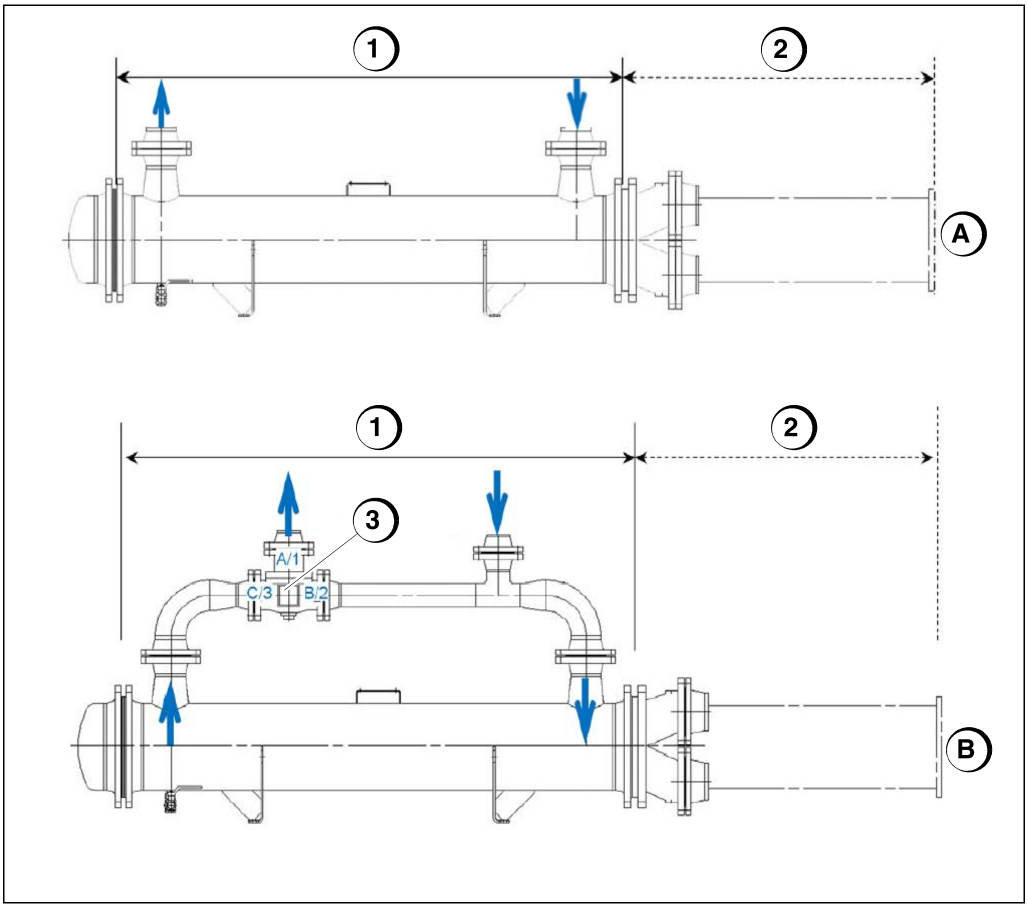


Illustration 5-15: Dimension for removing the tube bundle

A) Heat exchanger without optional temperature control valve on the oil side

B) Heat exchanger with optional temperature control valve on the oil side

1) Tube bundle length

2) Dimension for removing the tube bundle

3) Optional temperature control valve on the oil side

5.7.3 Horizontal installation below the oil level

The heat exchanger is arranged below the machine. Pipes and heat exchanger cannot run empty.

Usually, the nominal widths of connecting lines are to be provided as on the machine.

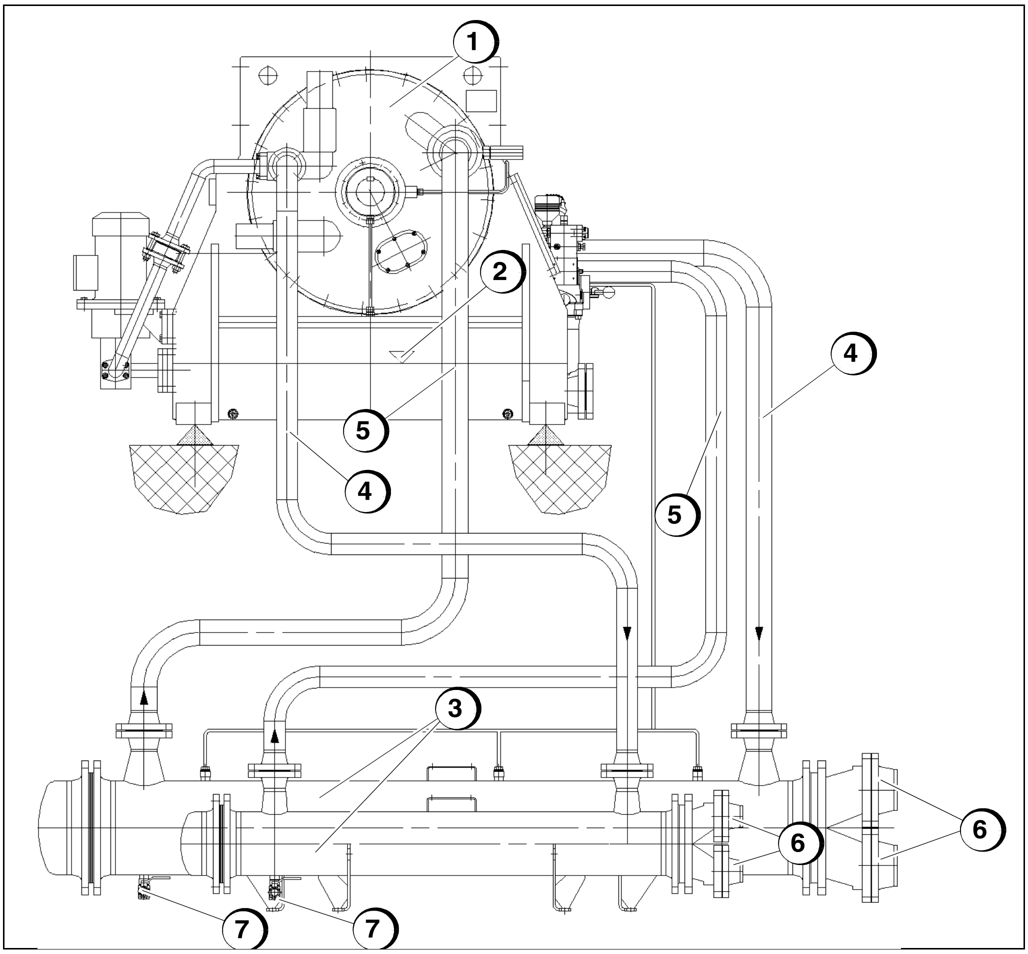


Illustration 5-16: Horizontal heat exchangers

1) Variable speed turbo coupling
2) Oil level
3) Heat exchanger below the oil level
4) Oil "supply"
5) Oil "return"
6) Cooling water "supply and drain"
7) Draining

5.7.4 Horizontal installation above the oil level

Oil supply and return pipes must be laid in a way to prevent the oil of the heat exchanger and, as far as possible, from the pipes from returning into the oil reservoir at standstill.

To do so, the pipes must be run upwards gooseneck-shaped from the heat exchanger.

Connect the supply and return pipe at the highest point by a compensating pipe (e.g. DN 15 mm) with an orifice ø 3 - 6 mm, dependent on the system size to prevent draining of the heat exchanger at standstill.

For long pipelines, the horizontal sections must be run below the oil level of the machine.

Where not possible, lay the gooseneck in the vicinity of the machine.

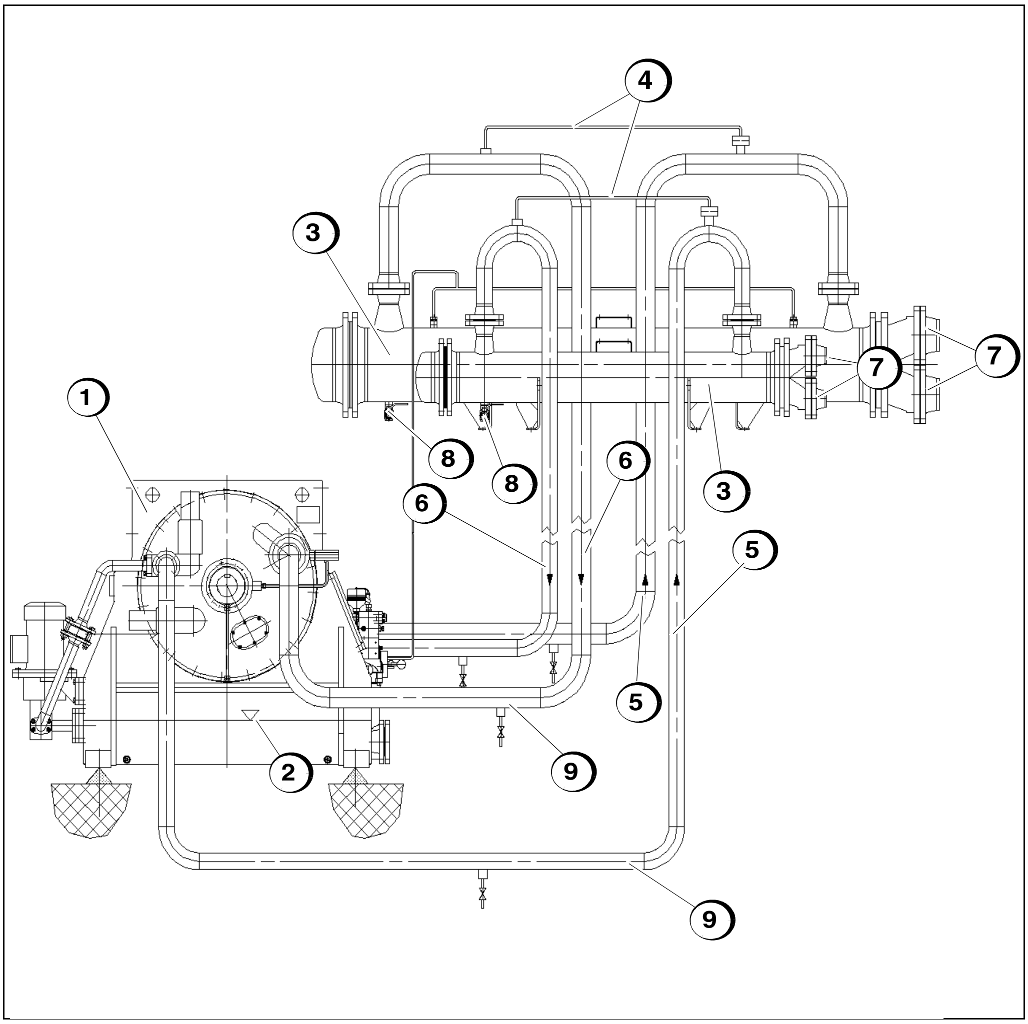


Illustration 5-17: Horizontal heat exchangers

1) Variable speed turbo coupling
2) Oil level
3) Heat exchanger above the oil level
4) Compensating pipe with orifice ø 3 - 6 mm
5) Oil "supply"
6) Oil "return"
7) Cooling water "supply and drain"
8) Draining
9) Run longer pipelines below the oil level

5.7.5 Vent and drain connections

Vent connections on the oil and/or water side are required at the heath exchanger if otherwise no complete ventilation would be possible via the connected oil pipes, e.g. for lateral oil connections or a vertical cooler position.

Drain connections must be available at the heat exchanger and the pipes at suitable points.

Pressure losses

The entire pressure loss in the pipes, the temperature control valve (if any) and the heat exchangers shall be below the following standard values:

< 1.3 bar at operating temperature (heat exchanger alone up to 0.8 bar)

< 2.0 bar at start-up temperature (heat exchanger alone up to 1.5 bar)

Temperature control

A temperature control shall be provided for the following conditions:

	Temperature controller
Moderate variations of the water temperature	Not required
Major variations of the water temperature (e.g. seasonally extremely varying cooling water temperatures)	Required

Cleanliness of system and connection of pipes

It is imperative to carefully flush the heat exchangers. We recommend meeting at least the cleanliness grade stated in API 614.

Pipes made on the jobsite must be cleaned on their inside. For de-scaling, we recommend pickling the pipes and flushing them in addition. After pickling it is mandatory to neutralize and preserve the pipes. Ensure to mount the pipes free of stress.

Pickling of oil pipes: (see Section 5.7.8 „Pickling of oil lines“ on page 62).

5.7.6 Installing the oil lines

NOTE

It is preferable to run the oil lines below the oil level in the variable-speed turbo coupling.

The oil lines should be as short as possible (< 8 m). If possible, the oil lines should be run below the oil level, while keeping the installation instructions for heat exchangers in mind (see Illustration 5-16 „Horizontal heat exchangers“ on page 57 and Illustration 5-17 „Horizontal heat exchangers“ on page 58).

Size the oil lines upstream and downstream of the heat exchanger to allow the lube oil and working oil to flow at a velocity between 1.0 m/s and 4.0 m/s.

Maintain a constant oil line diameter over the entire length. In the case of larger connections on the cooler, increase the line size directly at the cooler.

➔ Heat exchanger assembly plan (see Chapter 14 „Attaching Parts (descriptions)“) in this Instruction Manual.

Requirement

The machine is aligned exactly.

Installing the oil lines

1. Remove the weld-neck flanges from the machine.
2. Plumb the heat exchanger to the variable-speed turbo coupling as shown in (see Illustration 5-16 „Horizontal heat exchangers“ on page 57 and Illustration 5-17 „Horizontal heat exchangers“ on page 58). Ensure that the installed piping is free from stress.
3. Support the lines.
4. Horizontal heat exchangers H1–H2:
   – If a venting connection is provided on the heat exchanger shell, attach a collection line to the vent connection on the working oil heat exchanger.
   – For the purpose of draining the oil, attach a drain line with shutoff valve to the drain connection on the working oil heat exchanger.
5. Install the external lube oil lines (e.g. for the driving machine, driven machine and /or the connecting couplings.

Drilling of orifices for lube oil supplied to external units

6. Switch on the auxiliary lube oil pump. Pilot bore orifices at the lube oil outlets from the variable-speed turbo coupling to the driving machine and driven machine or install already pilot-bored orifices.

   The lube oil flow rate and lube oil pressure for external units depend on the diameter of these orifices and possibly on additional orifices upstream of bearing locations on the driving and driven machines.
   ➔ For required lube oil flow rates, please refer to Section 1.2 „Operating data“ on page 4.

5.7.7 Vent line assembly

1. It is necessary to vent the oil cooler continuously.

Vent line oil cooler (H1, H2)

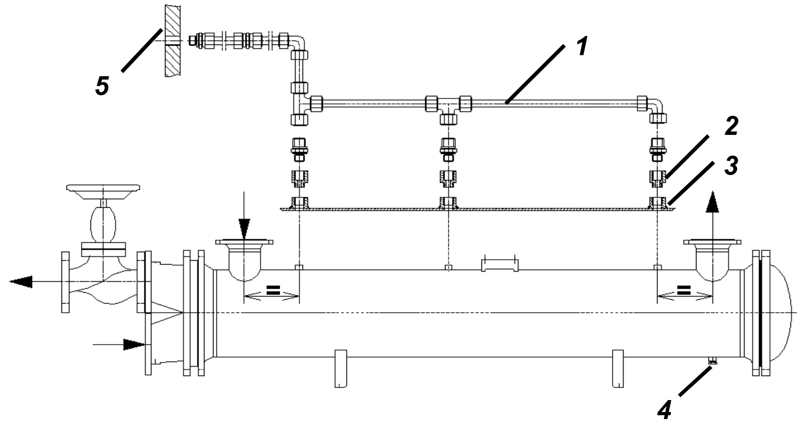


Illustration 5-18: Vent line for working oil cooler

1 Manifold
2 Screw-in orifice
3 Vent socket
4 Drain socket
5 Coupling housing

2. Assemble the vent line as shown (see Illustration 5-18 „Vent line for working oil cooler“ on page 61).
3. Mount three screw-in orifices (2) on the three vent sockets (3) of oil cooler shell.
4. Orifice hole at normal and increased cooler oil pressure: 4 mm.
5. Connect the orifices with a manifold DN 20 (1).
6. Assemble the manifold up to the Variable-speed turbo coupling (5) (tie-in point see Section „Assembly Plan - variable-speed turbo coupling 215001154-0010“ on page 116).

Oil compensating pipe DN 8

When installing the oil cooler above the oil level of Variable-speed turbo coupling, the oil compensating pipe (H2) between the two siphon-like assembled pipes prevent that the oil coolers are drained during standstill.

➔ Connect the oil compensating pipe as shown (see Illustration 5-17 „Horizontal heat exchangers“ on page 58).

5.7.8 Pickling of oil lines

NOTE

Before preparing this or another pickle, be sure to read and understand the specifications, safety information (data sheets) and application information.

WARNING

Hazard from dangerous substances

Hazardous substances (pickling solutions) can cause injuries or burns.

Wear personal protective equipment, especially safety goggles, when cleaning and pickling oil lines!

Pickling oil lines made of steel (neither rust-proof nor acid-proof)

Oil lines assembled and welded on site must be disassembled and pickled in an immersion bath to ensure that they are free from scale and rust. Only then can they be reassembled and flushed.

1. Unscrew the oil lines.
2. Degrease heavily oiled or greased workpieces prior to pickling, e.g. by means of steam cleaning or immersion in a degreasing bath.
3. Mix the pickle[1] with water.
4. To remove dirt, light oil films, graphite or carbon deposits: add pickling degreaser[2] to the pickle.
5. Heat the solution to 40°C.
6. Place parts into the pickle.
7. Remove the parts from the pickle. After pickling, they should be bright and free from scale and rust.

	Pickling period
Rust film	approx. 5–10 min.
Rust	approx. 15–30 min.
Rolling skin	approx. 50 min.

1. Recommendation: product BETONA, manufacturer Karowa Co., Memmingerstr. 39A, Neu-Ulm, Germany, or equivalent pickle. Mixture: 1 part pickle to 10 parts water
2. Recommendation: product S13, manufacturer Karowa Co., Memmingerstr. 39A, Neu-Ulm, Germany, or equivalent pickle. Mixture: 1–3 l to 100 l of pickling solution.

	Pickling period
Descaling of annealed steel parts	approx. 120 min.

8. Allow the parts to dry protected from dripping water (24–48 hours at 20°C).
   Do not wash off! If the drying time cannot be observed, rinse again with clean water.
9. Spray parts internally with the working oil and externally with paint.

Pickling of oil lines made of rust-proof and acid-proof steel (stainless steel)

Oil lines assembled and welded on site must be disassembled and pickled in an immersion bath to ensure that they are free from scale, temper colors and rust.
Only then can they be reassembled and flushed.

NOTE

Before preparing this or another pickle, be sure to read and understand the specifications, safety information (data sheets) and application information.

1. Unscrew the oil lines.
2. Degrease heavily oiled or greased workpieces prior to pickling, e.g. by means of steam cleaning or immersion in a degreasing bath[1].
3. Prepare the pickle[2].
4. Place parts into the pickle.
5. Remove the parts from the pickle. After pickling, they should be bright and free from scale and rust.

   The pickling period depends on the
   – temperature and
   – life (age of the pickle)

   and the influence of the pickling fluid

   Pickling procedure for materials with the material nos.1.4541, 1.4550, 1.4571

Age of pickle	Pickling period
New pickle up to 1 week old	20 to 30 min.
1 to 4 weeks	40 to 60 min.

1. Recommendation: product DERUSTIT 1622, manufacturer Deutsche Derustit GmbH • Emil von Behringstrasse 4 • Dietzenbach/Germany • or equivalent degreaser.
2. Recommendation: product DERUSTIT pickle 1234, manufacturer Deutsche Derustit GmbH • Emil von Behringstrasse 4 • Dietzenbach/Germany • or equivalent pickle.

Age of pickle	Pickling period
4 weeks and older	up to 120 min.

Pickling procedure for materials with the material nos. 1.4301, 1.4306, 1.4401

Age of pickle	Pickling period
New pickle up to 1 week old	10 to 15 min.
1 to 4 weeks	20 to 30 min.
4 weeks and older	60 to 120 min.

CAUTION

Environmental damage

Pickle that escapes into the sewers or ground can cause damage to the environment.

Dispose of used pickle in a proper manner that complies with national statutory regulations.

6. Flush the part with water[1], making sure to comply with protection regulations.
7. Spray the wet parts with a passivation solution[2].
8. For final cleaning of the parts, flush them with water[3].
9. Let the parts dry in clean rooms. Allow parts with cavities to dry in pure nitrogen.
10. Spray parts internally with the working oil and externally with paint.

1. High pressure 160 bar
2. DERUSTIT passivation solution 2016, contact time 5-10 minutes
3. Fully demineralized water with a conductivity of 10 µm

5.8 Connecting electrical instruments

WARNING

Risk of injury

Dangerous electric currents and voltages on the variable-speed turbo coupling can injure or kill individuals.

Only a qualified electrician who is knowledgeable about rules that apply to electronic equipment in the country of installation is allowed to perform work involving the electrical equipment on the variable-speed turbo coupling.

WARNING

Risk of injury

Hazard resulting from improper insulation.

As the result of improper insulation, an individual could come into contact with electrical components and be seriously injured.

Use only cables with insulation that can withstand the ambient operating conditions!

CAUTION

Risk of injury / equipment damage

Stray currents in the variable-speed turbo coupling can cause personal injury or damage gear teeth and bearings.

Take suitable grounding measures on all components of the drive line!

1. Connect all power consuming equipment.
2. Connect all control units.
3. Check motors for their direction of rotation, current draw and protection by fuses.

➔ Terminal diagram for wiring in the junction box.

➔ (see Chapter 14 „Attaching Parts (descriptions)“) of this Instruction Manual for detailed information on the instruments installed.

5.9 Attaching guards

Types of guarding and protection

- Guarding to prevent accidental contact with rotating and hot components (connecting couplings, oil lines) and other recognizable source of danger
- Protection from noise
- Protection from the weather in the event of outdoor installation (roof or enclosure)

5.9.1 Attaching guarding to prevent contact

WARNING

Risk of injury

Entanglement or trapping hazard in the vicinity of rotating shafts and in the vicinity of the rotating connecting couplings.

Clothing, long hair or loose objects (lines, cords and ropes/cables) could become entangled in the danger zone and cause serious injury / damage.

Attach suitable guarding over the connecting couplings that can only be removed by using tools!

CAUTION

Burn hazard

The housing, oil lines, connecting couplings and working oil may be very hot - in extreme cases, up to 130°C. Contact can cause burns on the skin.

The variable-speed turbo coupling must be allowed to cool prior to maintenance or repair work!

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Attach guarding to prevent contact with rotating and hot components and other recognizable sources of danger in compliance with the safety regulations of the operator and/or the country where the equipment is being installed.

Attach the guarding to the connecting couplings using size 80 holes (Ø 8 mm) for air exchange.

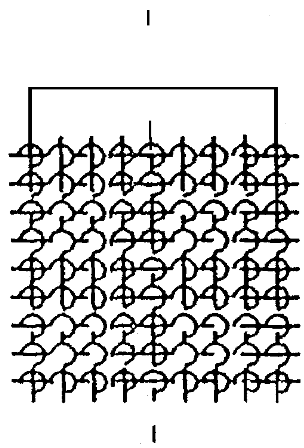

Illustration 5-19: Ventilation holes on the guarding for the connecting couplings

5.9.2 Attaching sound-absorbing covers

Unimpeded work

Attach sound-absorbing covers in such a way as to not impede continued performance of the following activities.[1]

- Reading instruments on the instrument panel and on piping
- Reading the oil level from the oil level indicator
- Cleaning the duplex oil filter
- Actuating shutoff valves
- Installing and removing instruments
- Performing service work (topping up lubricant, e.g. in connecting couplings and the like)

WARNING

Poisoning hazard

Use of sound-absorbing covers without openings can result in poisoning.

Poisoning and suffocation can result from gas leaks when compressors are operating.

Always provide sound-absorbing covers with vent holes to exchange the air!!

1. Instructions based on VDI Directive 2711 "Sound Protection by Encapsulation"

CAUTION

Explosion hazard

Heat may accumulate when using sound-absorbing covers without openings.

Always provide sound-absorbing covers with vent holes to dissipate the heat and exchange the air!

Heat dissipation and ventilation

- Avoid exposing instruments, control units, electrical insulation and equipment to excessive operating temperatures.
- Provide separate ventilation for electric motors. The cooling air for an air-cooled electric motor can be used for ventilation, if necessary (consider the characteristic curve of the cooling fan and the required motor cooling).
- Regulate the air flow in the cover to ensure heat dissipation (determine the flow rate for a cooling air temperature increase of 10°C).
- Route the vented air from the housing and coverings (closed connecting coupling covers) through the sound-absorbing covers via ducts.
- Provide openings and seals for shaft passages, windows for viewing of instruments, pipe and cable entry points and vents.

6 Commissioning

6.1 Safety information

The following safety information applies to the entire chapter. It must be observed in addition to the various specific instructions.

Entanglement or trapping hazard in the vicinity of rotating shafts and in the vicinity of the rotating connecting couplings

WARNING

Clothing, long hair or loose objects (lines, cords and ropes/cables) could become entangled in the danger zone and cause serious injury / damage.

Attach suitable guarding over the connecting couplings that can only be removed by using tools!

Hazard from the hydraulics

WARNING

Oil can escape from leaking connections or seals, create a slipping hazard and cause injury as well as damage to the environment.

Clean up leaking oil immediately!

Hazard from dangerous substances

CAUTION

Escaping operating fluids could cause burns or injuries as well as damage to the environment.

Wear personal protective equipment, in particular, safety goggles when filling oil, when checking for leaks and when changing filters!
Follow the procedures specified on the material safety data sheet for the particular operating fluid!

Equipment damage

CAUTION

The variable-speed turbo coupling is delivered without any oil in it. Operation without oil will damage the equipment within a few seconds.

Prior to startup, fill the Variable-speed turbo coupling with the working oil!

Note

NOTE

Before starting the driving machine, check attaching parts (instruments, actuator, motor etc.) for:
Proper connection of the supply voltage, transmittal / processing of control and monitoring signals.

6.2 Fill the working oil

Criteria for suitable working oil

For Voith's list of recommended oils, see Section 6.6 „Operating fluids“. The oil grades contained in this list have been selected on the basis of the following criteria:

- Lowest possible viscosity
  (Initial viscosity $\leq$ 250 mm^2/s (cSt) at a temperature of 5°C)
- Superior lubricity
- Best possible air separation
- Resistance to aging
- Chemical neutrality with respect to metals and seals
- Compatibility with the human organism

NOTE

If using an oil grade that does not appear in the recommended oil list: check compatibility with Voith's corrosion-inhibiting oil (Shell Ensis Engine Oil 20). Check the suitability of the oil on the basis of the criteria listed in Section 6.6 „Operating fluids“. Clean the inside of the variable-speed turbo coupling thoroughly.

For the required amount of oil: see Section 1.1 „Machine data“ and the instructions regarding the heat exchanger (see Chapter 14 „Attaching Parts (descriptions)“) in this Instruction Manual.

NOTE

Fill the working oil as soon the piping for the system has been completed.

Filling oil

1. Add oil using the filling port provided, V2 (see „Assembly Plan - variable-speed turbo coupling 215001154-0010“).
2. Filter the oil during filling (filter fineness < 10µm or finer, filter retention rate ß 10 > 10 und ß 15 > 200[1]).
3. After the piping and heat exchangers have been filled and vented, the oil level should be midway between the min. and max. marks on the oil level indicator.

➔ (see Illustration 7-24 „Oil level check“ on page 87).

1. Filter retention rate as defined in ISO 16889

6.3 Flushing the coupling

Oil lines assembled and welded on site must be disassembled and pickled in an immersion bath to ensure that they are free from scale and rust (see Section 5.7.8 „Pickling of oil lines“). Only then can they be reassembled and flushed.

NOTE

Put the lube oil supply system according to the manufacturer‘s regulations into operation.

When flushing the oil pipes ensure that no dirt enters the Variable-speed turbo coupling, install filters at the lube oil inlet.

Oil cleanliness grades

Cleanliness grade according to ISO 4406:1999 (SAE AS 4059)

After flushing (with falling tendency)		During operation
- / 16 / 13 (8)	↓	- / 15 / 12 (7)

NOTE

VOITH recommends first cleaning roughly the oil lines prior to pickling and flushing (removal of welding residues).

The newly installed oil lines must be flushed for several days prior to the actual commissioning (corrosion protection and filtering of the oil).

6.3.1 Flushing the piping system (VOITH recommendation)

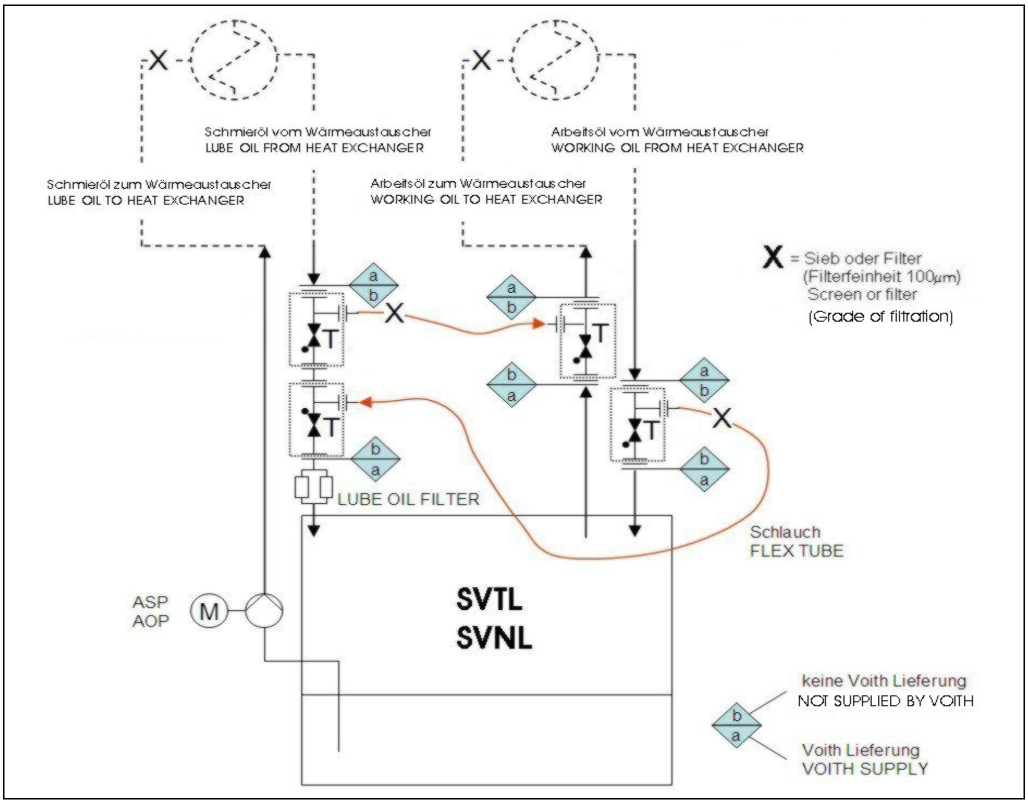

Illustration 6-20: Flushing the pipes (removing and reinstalling the strainer or filter and T-piece)

T T - Stück

x Sieb oder Filter

Preparing the flushing circuit

1. Remove the flange connection of the oil lines upstream and downstream of the "working oil heat exchanger".
2. Replace the detachable spacers in the respective pipes by T-pieces (T) (see Illustration 6-20 „Flushing the pipes (removing and reinstalling the strainer or filter and T-piece)“.
3. Fit the flushing hose with strainer or filter (grade of filtration 100 µm) between T-piece "lube oil downstream of heat exchanger" and T-piece "working oil upstream of heat exchanger".
4. Fit the flushing hose with strainer or filter (grade of filtration 100 µm) between T-piece "working oil downstream of heat exchanger" and T-piece "lube oil upstream of duplex filter".
5. Install the strainer or filter (grade of filtration 100 µm) into the lube oil line directly upstream of the heat exchanger.
6. Install the strainer or filter (grade of filtration 100 µm) into the working oil line directly upstream of the heat exchanger.

Checks prior to flushing

7. Check the oil level (should be midway between the min. and max. marks on the oil level indicator).
8. Check that threaded connections in the oil lines are oiltight.

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9. Check the direction of rotation of the auxiliary lube oil pump.

Starting the flushing operation

10. Start the electrically operated auxiliary lube oil pump (lock out the driving machine in case it would otherwise start automatically).
11. The working oil circuit fills.
12. Check the oil lines for leaks.
13. Remove and clean the strainer or filter after flushing for 5 to 10 minutes.
14. Shorten or extend the removal intervals dependent on the contamination.
15. When the pressure differential increases to the max. permissible value (see Section 1.2 „Operating data“), switch the duplex oil filter to the cleaned filtering jug and clean the dirty filtering jug, or replace it by a new element (see Section 8.3 „Replacement of the filter element“).

Additional items to be checked during flushing

16. Check the lube oil flow rate for external equipment and, if necessary, correct by changing the size of the openings in the orifices.
17. Check the amount of oil injected into the connecting coupling when working with injection lubrication (manufacturer's specification) and, if necessary, correct by installing orifices (see Chapter 14 „Attaching Parts (descriptions)“.
18. Check the oil level and, if necessary, add working oil (should be midway between the min. and max. marks on the oil lever indicator).

Ending the flushing

19. Flush the oil lines until the duplex oil filter remains clean (one to several days).
20. Switch off the auxiliary lube oil pump.
21. Replace T-pieces (x) by detachable spacers in the respective pipes (see Illustration 6-20 „Flushing the pipes (removing and reinstalling the strainer or filter and T-piece)“.
22. Remove the strainer or filter (X) from the respective pipes (see Illustration 6-20 „Flushing the pipes (removing and reinstalling the strainer or filter and T-piece)“.
23. Remount the flange connections of the oil lines upstream and downstream of the "working oil heat exchanger".

6.4 Trial run

6.4.1 Preparing for the trial run

Items to be checked and adjusted prior to the trial run

1. Check the alignment of the coupling and correct as necessary.
2. Check attachment to the foundation.
3. Loosen connecting couplings and check the direction of rotation of the drive motor with the variable-speed turbo coupling uncoupled.
4. Check and add lubricant for attached parts such as connecting couplings as necessary.
5. Check for proper installation of connecting couplings and guarding.
6. Check that manufacturer specifications are met when adjusting the supply of lubricating oil to external equipment.
7. Check the oil level (should be midway between the min. and max. marks on the oil level indicator).
8. Check for proper connection of the supply voltage to the electrical system as well as transmittal / processing of signals.
9. When using water/oil heat exchangers, open the valves on the water side, vent the water side of the oil cooler and check the flow rate.
   For operating data, see Section 1.2.2 „Heat exchanger" and the operating instructions for the heat exchangers (see Chapter 14.15 „Heat exchanger") in this Instruction Manual.

NOTE

Check the **V**oith **E**lectro-**H**ydraulic Po**s**itioning Control (VEHS) only with running auxiliary lube oil pump. Prevent automatic start of driving machine (see „Terminal Plan Sheet 1-6/ 215001154-0040").

10. Check the setting (signal 4-20 mA) through the VEHS positioning control unit and the actuator function from 0% to 100% scoop tube position. Set the scoop tube position to 0 %.

Run-up time, Downward regulation time

Set the ramp time of the VEHS via the ramp function.

➔ Instruction (see Chapter 14 „Attaching Parts (descriptions)" in this Instruction Manual.

11. Move the scoop tube to 0% position.
12. Check that the entire system is ready to operate.

6.4.2 Conducting the trial run

1. Start the auxiliary lube oil pump.
2. When the lube oil pressure reaches the required value, switch on the driving machine or monitor automatic startup.
3. Once the driving machine is up to speed and the required lube oil pressure has been reached, monitor automatic shutdown of the auxiliary lube oil pump or switch off the pump manually.

Minimum speed

4. Operate the system at minimum speed.
5. Monitor smooth operation, temperatures lube oil pressure and filter condition.

Increase the speed slowly

6. Slowly increase the speed of the driven machine.
7. Monitor and log temperatures and pressure until they stabilize.
8. Measure the vibration. Evaluate whether the equipment is operating smoothly and log the scoop tube position, speed and reading at measurements points.

NOTE

Prior to shipment, the variable-speed turbo coupling was subjected to a no-load test at VTCR. As a consequence, scoop tube vibration and/or scoop tube noise may occur under operating conditions.
To remedy the situation, the scoop tube orientation should be optimized, (see Section 6.5.1 „Setting the optimal scoop tube position“ on page 78).

9. If the hubs for the connecting couplings have not been provided and balancing of the complete arrangement was performed without original hubs: rebalance the input and output shafts if the equipment does not operate perfectly smoothly.
10. Measure the vibration. Evaluate whether the equipment is operating smoothly and log the scoop tube position, speed and reading at measurements points.

Operating over the entire speed range

If the characteristic of the system is to be optimized on the basis of the operating conditions:

11. Operate the system over its entire speed range.

Slowdown

12. Bring the system/unit down to minimum speed.
13. After switching off the driving machine, check that the auxiliary lube oil pump switches on automatically.
14. Once the driving machine and the driven machine have come to a stop, switch off the auxiliary lube oil pump.

After the trial run

15. Clean the duplex oil filter as necessary and fill with working oil (see Section 8.3 „Replacement of the filter element“).
16. Check the oil level and correct (should be midway between the min. and max. marks on the oil level indicator).
17. Check the piping for leaks.

6.5 Adjustment of lube oil and control oil pressure

NOTE

All valves and orifices are set at VOITH for the indicated operating conditions. Re-adjustment is necessary only in case of changed operating conditions! (see Section 1.2 „Operating data“).

NOTE

Adjust the oil pressures only at operating temperature!

Adjust the lube oil and control oil pressure at the **sequence valve**. Lube oil and control oil pressure are not adjusted separately; these are interacting.

(see Section 1.2 „Operating data“).

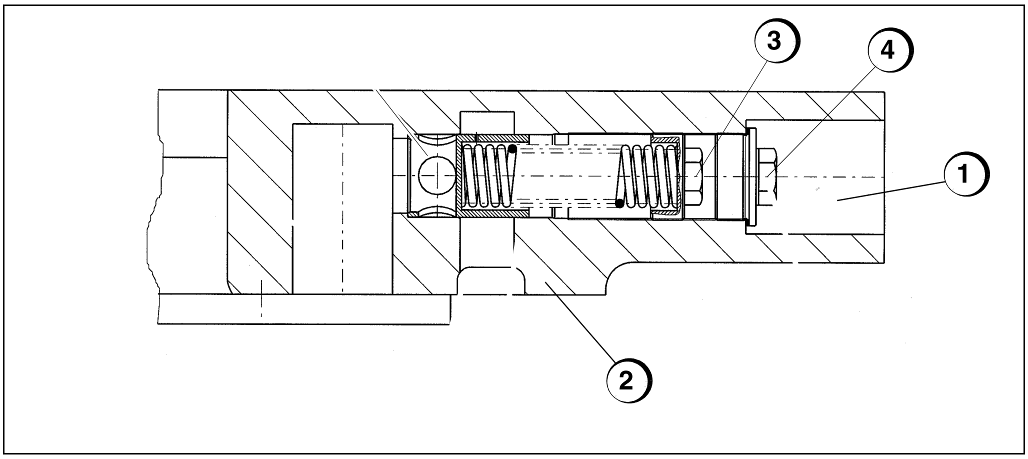


Illustration 6-21: Sequence valve "lube oil"

1 Sequence valve
2 Housing
3 Adjusting screw
4 Screw plug

Adjustment through Sequnce valve (1)

1. Unscrew screw plug (4).
2. Insert adjusting screw (3).
3. Check the pressure rise at the lube oil pressure gauge and adjust, if necessary:

WARNING

It is not allowed to remove adjusting screw (3) from the housing (2). (see Illustration 6-21 „Sequence valve "lube oil"" on page 76).

This may cause injury by pressurized and hot oil

- turn the adjusting screw to the right:
  increasing lube oil and control oil pressure
- turn the adjusting screw to the left:
  reducing lube oil and control oil pressure

4. Check the control oil pressure at the control oil pressure gauge and correct, if necessary, using the adjustable orifice. (see „Assembly Plan - variable-speed turbo coupling 215001154-0010").
5. Fit screw plug (4) with sealing ring.

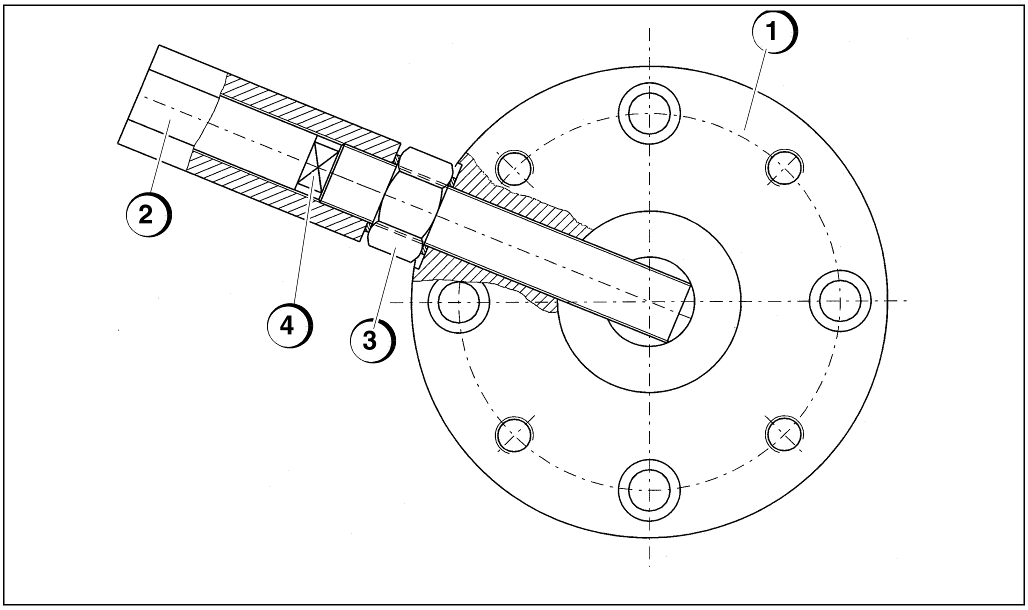


Illustration 6-22: Adjustable orifice

1 Orifice
2 Cap
3 Check nut
4 Adjusting screw

Adjustment through adjustable orifice (1)

1. Remove cap (2) (see Illustration 6-22 „Adjustable orifice" on page 77).
2. Slacken check nut (3).
3. Check the pressure rise at control oil and lube oil pressure gauge and adjust, if necessary:

   – Turn adjusting screw (4) to the right:
     increasing the control oil pressure, reducing the lube oil pressure

   – Turn the adjusting screw (4) to the left:
     reducing the control oil pressure, increasing the lube oil pressure

4. Tighten check nut (3).
5. Fit cap (2) with sealing ring.

6.5.1 Setting the optimal scoop tube position

NOTE

Re-establishing the optimal position of the scoop tube is necessary only if the scoop tube has been replaced or if vibration and noise occur during commissioning of the variable-speed turbo coupling.

Work steps

CAUTION

Equipment damage

The work described in the following is performed while the variable-speed turbo coupling is operating. During operation, the scoop tube is subjected to hydraulic forces that have a pushing, pulling and rotating action.
Improper handling could thus result in damage to the variable-speed turbo coupling.

Only qualified personnel should be permitted to work on the variable-speed turbo coupling, (see Section 2.7 „Personnel selection and qualification, basic obligations“ on page 11).

1. Start the whole unit.

NOTE

On movement ensure that the scoop tube is not exactly at 0% and100% scoop tube position as otherwise frictional forces may occur during movement.

2. Using the scoop tube actuator, move the scoop tube over its entire range of adjustment (scoop tube positions 0% to 100%).

Adjusting the scoop tube

If the scoop tube vibrates in the axial direction or the sound pressure level is high, the scoop tube must be adjusted:

3. Move the scoop tube to the position with maximum vibration.
4. Insert the torsion rod into the bore provided.

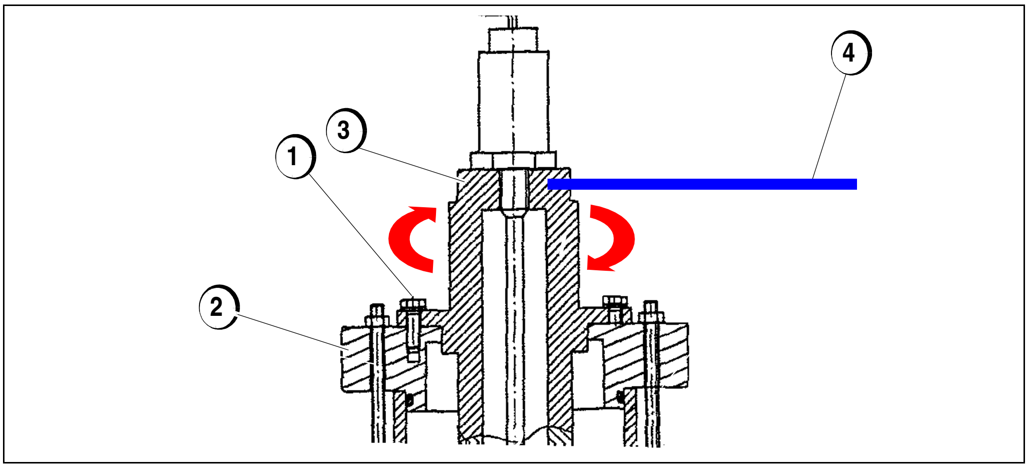


Illustration 6-23: Adjusting optimal scoop tube position

1 Hex. screws and washers
2 Connecting flange
3 Guide (scoop tube)
4 Torsion rod

> **WARNING**
>
> **Do not rotate the scoop tube more than 40° in either direction.**

5. Unscrew the hex. screw and turn the guide (scoop tube) to the best position by means of the torsion rod.
6. Repeat steps 3 to 5 at other scoop tube positions until there is a minimum vibration over the whole scoop tube positioning range.
7. Check free movement of scoop tube over the whole positioning range by slowly turning the Variable-speed turbo coupling.

6.6 Operating fluids

Grade selection by operator and oil supplier

The following can be used, provided they satisfy the requirements:

Hydraulic oils HLP 32 as specified in DIN 51524, Part 2

Do not mix different oil grades. Approval to use oil mixtures must be clarified with the oil supplier.

Requirements (characteristics) of the operating fluids and recommended grades:

➔ Appendix_B_ (see „Operating fluids to ISO VG 32 for hydrodynamic circuits 3625-006072“)

7 Operation

7.1 Safety information

The following safety information applies to the entire chapter. It must be observed in addition to the various specific instructions.

Danger in areas that cannot be fully viewed

WARNING

A person could be severely injured while working on the machine when starting it up.

Attach suitable protective covers that cannot be removed without the respective tool, between the coupling and the shaft!
Only work on the machine when the system is shut down (no power)!
Operation is only permitted after visually ensuring that no persons are in the hazard areas!

Entanglement or trapping hazard in the vicinity of rotating shafts and in the vicinity of the rotating connecting couplings

WARNING

Clothing, long hair or loose objects (lines, cords and ropes/cables) could become entangled in the danger zone and cause serious injury / damage.

Attach suitable guarding over the connecting couplings that can only be removed by using tools!

Hazard from loss of stability and danger arising from masses

WARNING

In the event of severe imbalance, a shaft could break as the result of vibrations and cause serious injury or damage to the equipment.

If the imbalance is impermissibly high or the equipment is not running smoothly, conduct an inspection immediately!

Danger of slipping on leaked oil

WARNING

Leaking oil on or next to the machine could cause someone to slip or fall and be seriously injured.

Check for oil and leaks regularly!
Clean the machine regularly!

Hazard from the hydraulics

WARNING

Oil can escape from leaking connections or seals, create a slipping hazard and cause injury.

Clean up leaking oil immediately!

Fire hazard

WARNING

In conjunction with high temperatures and oil, an electrical short circuit due to an abraded cable or water leaking into the junction box could trigger a fire and cause personal injury or damage to the environment.

Allow only a qualified electrician to install the equipment!
Observe the maintenance intervals!

Fire hazard

WARNING

Leaking (hot) oil or oil mist could trigger a fire and cause serious injury.

Check for oil and leaks regularly!

Danger caused by incorrect assembly

WARNING

Not observing the correct direction of rotation could damage the machine and severely injure persons.
The incorrect assembly of the machine or individual parts could damage the machine.

Allow only trained personnel to perform assembly, maintenance and service work!

Hazard from pressure shocks, pressure rise or pressure loss

CAUTION

Pressure shocks can cause vibration and pipe failure, and result in personal injury due to leaking oil.

Ensure that the installation complies with the designated use of the equipment and that the operating data and ambient conditions are taken into account!

Noise hazard

CAUTION

A sustained sound pressure level above 85 dBA could lead to loss of hearing.

Wear hearing protection!

Environmental pollution

CAUTION

Leaking oil could damage the environment.

Check for oil and leaks regularly!

7.2 Starting up and slowing down the equipment

CAUTION

Equipment damage

The Variable-speed turbo coupling is delivered without any oil in it. Operation without oil will damage the equipment within a few seconds.

Prior to startup, fill the Variable-speed turbo coupling with the working oil!

Checks prior to start-up

1. Check the same items that were checked prior to the trial run (see Section „Items to be checked and adjusted prior to the trial run“ on page 74).
2. Check that the entire system is ready to operate.
3. Place the scoop tube in the 0% position.

   The variable-speed turbo coupling can, in principle, be started up with the scoop tube in any position. However, starting up with the scoop tube in the 0% position is preferred, since the driving machine can come up to speed with practically no load.

Start-up

➔ (see Section „Logic Diagram Sheet 1-26/ 215001154-0050“ on page 116).

Operating conditions	Action	Result
Oil temp. < 10 °C/ 50 °F Oil temp. > 15 °C/ 59 °F	Heater ON Heater OFF	The oil in the sump starts to warm.
	Place the scoop tube in the 0% position.	
	Aux. lube oil pump ON	The variable-speed turbo coupling and driven machine are at standstill. Bearings are being lubricated
At a lube oil pressure > 1.9 bar:	Switch the driving machine ON	Driving machine starts up. The variable-speed turbo coupling fills and starts to rotate.
3 min. after starting the driving machine and at a lube oil pressure of > 2.4 bar:	Switch the aux. oil lube pump OFF	The variable-speed turbo coupling and working machine are operating.
	Place the scoop tube in the n% position.	Driven machine is operating at the desired speed.

Shutdown

➔ (see Section „Logic Diagram Sheet 1-26/ 215001154-0050“ on page 116).

Operating conditions	Action	Result
	Place the scoop tube in the 0% position.	The variable-speed turbo coupling empties. Driven machine is operating at minimum speed.
At a lube oil pressure < 1.3 bar:	Switch driving machine **OFF**	Driving and driven machines come to a stop. Bearings continue to be lubricated.
Automatically when driving machine is OFF or at lubricating oil pressure < 1.6 bar:	Switch aux. lube oil pump **ON**	Bearings continue to be lubricated.
After equipment comes to a stop	Switch the aux. oil lube pump **OFF**	Bearings are no longer lubricated.

7.3 Operating the equipment

7.3.1 Monitoring the equipment

The following items must be monitored during operation:

- Temperatures
- Lube oil pressure
- Pressure differential (oil filter)
- Oil level

NOTE

If the behavior of the variable-speed turbo coupling changes during operation, this indicates the need for service.
(see Section 8.2.2 „Service/repair measures and intervals“).

Temperatures

Bearings

Bearing temperatures (measuring point 30.1-30.3)	Operating range Alarm at Shutdown at	< 95 °C (203 °F) > 95 °C (203 °F) > 105 °C (221 °F)

The bearings can have different temperatures. Reasons:

- Different shaft speeds
- Different bearing loads
- Heat load from working oil

Set trip point for the message "Bearing temperature too high" to 95°C (203°F).

Working oil/lubricating oil

Oil temperature downstream of the scoop tube (measuring point 18)	Operating range Alarm at Shutdown at	< 100 °C (212 °F) > 100 °C (212 °F) > 110 °C (230 °F)
Lube oil temperature *downstream* of the heat exchanger (measuring point 31)	Operating range	< 55 °C (131 °F)
Working oil temperature *downstream* of the heat exchanger (measuring point 34)	Operating range	< 80 °C (176 °F)
Oil sump temperature (measuring point 60)	Operating range Main motor release Alarm at	> 30 °C (86 °F) > 10 °C (50 °F) > 95 °C (203 °F)
Oil temperature *at heater* (measuring point 36.1-36.3)	Operating range Heater **ON** at Heater **OFF** at Operating range Shutdown	> 10 °C (50 °F) < 10 °C (50 °F) > 15 °C (59 °F) < 95 °C (203 °F) > 130 °C (266 °F)

➔ Location of the measuring points (see Oil Circuit and Measuring Point Scheme 215001154-0020) mentioned in this Instruction Manual.

Fusible plugs

The fusible plugs melt when the working oil temperature in the scoop chamber reaches 160 °C (320 °F), thus preventing overheating of the coupling.

Reasons for a brief increase in working oil temperature could be:

- interrupted operation of the heat exchanger
- overloading of the variable-speed turbo coupling

Fusible plugs that have melted result in the following:

- slight change in the control behavior of the variable-speed turbo coupling
- almost max. power output
- slight increase of the oil temperature in the reservoir
- longer time for the driven machine to come up to speed

Pressures

Working oil/lube oil/control oil

Filling pump pressure at operating temperature		2.0 to 4.0 bar
Lube oil pressure at pressure gauge (measuring point 16)	Operating range	> 0.3 bar
Lube oil pressure at pressure transmitter (measuring point 17; 17.1)	Operating range Main motor **ON** Main motor **OFF** Switch aux. lube oil pump **OFF** Switch the aux. oil lube pump **ON**	> 2.5 bar > 1.9 bar < 1.3 bar > 2.4 bar < 1.6 bar
Lube oil pressure at differential pressure transmitter (measuring point 41.1)	Operating range Alarm at Switch duplex oil filter	> 0.3 bar > 0.8 bar
Oil pressure at test port (measuring point 55.1; 55.3)	Operating range	on the basis of the above values at the measuring points 16; 17; 17.1; 41; 41.1

➔ Location of the measuring points (see Oil Circuit and Measuring Point Scheme 215001154-0020) mentioned in this Instruction Manual.

Oil level

Oil level check

Start up the variable-speed turbo coupling with the scoop tube in the 0% position and, depending on the placement of the heat exchanger, vent accordingly. Make sure that in this operating state the oil level is in the middle of oil level range h1. If necessary, add operating oil.

Oil level switch (measuring point 37)	Operating range Shutdown / alarm Shutdown / alarm	Oil level between MIN - MAX > 15 mm above MAX = 18.3 mA < 15 mm below MIN = 5.7 mA

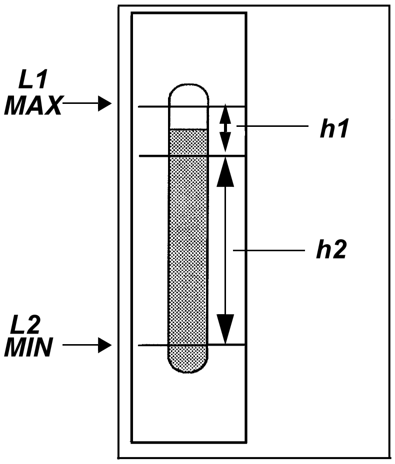


Illustration 7-24: Oil level check

h1 = Fill level range at scoop tube position of 0%
h2 = Fill level range at scoop tube position of 100%
L1 = MAX. mark
L2 = MIN. mark

For L1/ L2 and h1 (fill range), see oil level indication in
(see Assembly Plan - variable-speed turbo coupling 215001154-0010)

During operation when the oil is warm, the oil level must not exceed the Max. mark L1 when the scoop tube is at the 0% position, or drop below the Min. oil level mark L2 when the scoop tube is at the 100% position.

When the scoop tube is in a position between 0% and 100%, the oil level drops, since the coupling runner is being filled with oil. Even after shutting down the variable-speed turbo coupling with the scoop tube at the 0% position, some of the working oil remains in the coupling runner.

An exact check of the oil level is possible only while the variable-speed turbo coupling is operating and the scoop tube is in the 0% position.

7.3.2 VEHS - **V**oith **E**lectro-**H**ydraulic Po**s**itioning Control

The **V**oith **E**lectro-**H**ydraulic Po**s**itioning Control (**VEHS**) positions the scoop tube between 0 % and 100 %. The speed of driven machine is determined by the scoop tube position.

A master controller positions the **V**oith **E**lectro-**H**ydraulic Po**s**itioning Control (VEHS) using a reference signal of 0 or 4 to 20 mA.

NOTE

For electronic control and terminal plan please (see „Terminal Plan Sheet 1-6/ 215001154-0040“)

➔ (see Chapter 14 „Attaching Parts (descriptions)“) of this Instruction Manual for detailed descriptions of the actuator.

7.3.3 Rotation of the auxiliary lube oil pump in the reverse direction

NOTE

A **3** mm hole is provided in the check valve to permit bleeding of the auxiliary lube oil pump. For this reason, the auxiliary lube oil pump rotates in the reverse direction at a low speed of 50-100 rpm during normal operation (auxiliary lube oil pump switched off).

7.3.4 Changing over the duplex oil filter

Pressure differential across duplex oil filter	Switch and clean filter at	> 0.8 bar

The duplex oil filter cleans the lubricating oil. It has two filtering jugs, through only one of which oil flows during operation. To monitor the pressure differential across the filter, a differential pressure indicator and/or a differential pressure switch is installed. The pressure indicator or switch triggers an alarm when the difference between the lube oil pressure upstream and downstream of the filter is too great. If an alarm occurs, the filter housing no longer allows sufficient oil through during operation and must be cleaned (see Section 8.3 „Replacement of the filter element“ on page 99).

NOTE

During transportation, storage and setup of the variable-speed turbo coupling as well as when attaching the oil lines, impurities can make their way into the variable-speed turbo coupling.
Accordingly, during commissioning always monitor the state of the duplex oil filter and, if necessary, clean it (possibly even several times).

Flooding the clean filtering jug

Before the duplex oil filter is switched to the second filter, it must be flooded.

NOTE

If the clean filtering jug is not flooded, the lube oil pressure drops too drastically upon switching the duplex oil filter, and the system is shut down by the monitoring instruments.

NOTE

Flooding the clean filtering jug
Servicing and cleaning.

➔ (see Chapter 14.9 „Duplex filter“)

7.4 Measures to take in the event of tailspin and rotation in the opposite direction

Tailspin

The term "tailspin" describes the slow rotation of the variable-speed turbo coupling caused by the driven machine after the system has been shut down, e.g. in the case of fan drives.

- Switch on the auxiliary lube oil pump to ensure that the bearings are lubricated.

Rotation of the secondary shaft in the opposite direction

If the driven machine can cause rotation in the opposite direction, a device to monitor the direction of rotation must be provided. If this rotation monitoring device signals rotation in the opposite direction:

- Switch on the auxiliary lube oil pump without delay.
- Set the scoop tube to the 100% position.
- Close the shutoff valve on the driven machine.
- Limit rotation in the opposite direction to max. 1–3 minutes.

NOTE

Check the variable-speed turbo coupling after the driven machine has rotated in the opposite direction. Inspect the bearings for signs of overheating. Check the fusible plugs. Switch on the auxiliary lube oil pump and check the oil pressures.

7.5 Taking a sample of the working oil

NOTE

The value of the information obtained from an analysis of the working oil depends on correct and careful sampling. An oil sample is preferably taken from a region with good flow of oil either during operation or immediately after a system shutdown.

In the case of the variable-speed turbo coupling, the oil sample should be taken from the working oil circuit. An oil sample can be taken safely from the oil drain valve on the heat exchanger.

CAUTION

Burn hazard

The heat exchangers, oil lines and working oil can be hot. In an extreme case, up to 100°C for this section of the lube oil circuit.

Wear protective gloves!

WARNING

Risk of injury

Hot, pressurized oil in the duplex oil filter and vent line can cause serious injury.

Wear protective gloves, safety goggles and protective clothing!

CAUTION

Environmental damage

Used oil that escapes into the soil or sewage system can cause serious damage to the environment.

Dispose of used oil in a proper manner that complies with national statutory regulations.

Accessories

- Collection container for initial amount drawn
- Sample collection container(s)

Taking the oil sample

1. Remove the plug from the drain valve.

NOTE

If the drain valve is opened too far, a pressure drop could result, causing the monitoring instruments to shut down the system.

2. Place the collection container for the initial amount beneath the valve and open the drain valve slightly.
3. After drawing off some initial oil, fill the oil sample container with working oil.
4. Close the drain valve and reinsert the plug.

7.6 Measures to take during standby

- Allow the auxiliary lube oil pump to run continuously.

7.7 Measures to be taken during stop periods

When the stop periods are longer than a day:

- Switch on the auxiliary lube oil pump for at least five minutes daily.
- Protect the variable-speed turbo coupling against ingress of water and moisture. Apply corrosion inhibitor to bare metal parts.
- Start up the variable-speed turbo coupling briefly every 1–2 months. Do not allow to operate until warm (risk of condensation forming).

The internal surfaces of the equipment receive a light film of oil and are thus protected against corrosion.
For idle times of heat exchangers: see the operating instructions for heat exchangers (see Chapter 14.15 „Heat exchanger“) of this Instruction Manual.

7.8 Removing the Variable-speed turbo coupling

WARNING

Risk of injury

Dangerous electric currents, voltages and other sources of energy on the variable-speed turbo coupling can injure or kill a person.

Before removing the variable-speed turbo coupling, disconnect every external source of energy.
Drain all liquids.

The variable-speed turbo coupling must be removed only by qualified personnel who perform their work in compliance with local safety requirements.

CAUTION

Environmental damage

Used oil that escapes into the soil or sewage system can cause serious damage to the environment.

Dispose of used oil in a proper manner that complies with national statutory regulations.

Prior to disassembly for salvage purposes or scrapping, completely remove any oil or other substances that pose a danger to water.

The variable-speed turbo coupling is made of steel, lightweight alloys and various plastics. These materials can be salvaged and recycled.

Send problem materials that can no longer be used to an authorized disposal facility.

8 Maintenance

8.1 Safety information

The following safety information applies to the entire chapter. It must be observed in addition to the various specific instructions.

Danger of parts slipping out

WARNING

Without the connecting coupling attached and the protective cover, the key or bolts for the connecting coupling could slip out and injure someone.

Allow only trained personnel to perform assembly, maintenance and service work!
The machine must be started up only after the connecting coupling hub or, if so specified by the manufacturer, the complete connecting coupling and protective guarding are attached.

Hazard from an incompletely shut down and secured system

WARNING

A system that has not been shut down completely and secured could restart and injure anyone working on the equipment.

Only work on the machine when the system is shut down (no power)!

Danger in areas that cannot be fully viewed

WARNING

A person could be severely injured while working on the machine when starting it up.

Attach suitable protective covers that cannot be removed without the respective tool, between the coupling and the shaft!
Only work on the machine when the system is shut down (no power)!
Operation is only permitted after visually ensuring that no persons are in the hazard areas!

Burn hazard

WARNING

A person could burn themselves on the hot machine or on hot operational equipment.

Only touch the machine when it has cooled down!

Risk of being cut

CAUTION

A person could be cut by sheet metal guarding that has not been deburred or by sharp edges on an enclosure.

Allow only trained personnel to perform assembly, maintenance and service work!

Hazard from dangerous substances

CAUTION

Escaping operating fluids could cause burns or injuries as well as damage to the environment.

Wear personal protective equipment, in particular, safety goggles when filling oil, when checking for leaks and when changing filters!
Follow the procedures specified on the material safety data sheet for the particular operating fluid!

Risk of injury

CAUTION

The wrong seals or improperly sealed metal surfaces, flanges, inadequately tightened joints or incorrectly set pressure relief valves could allow oil to escape and cause personal injury.

Allow only trained personnel to perform assembly, maintenance and service work!

Note

NOTE

Keep access to the maintenance work areas free.
Pay attention to dimensions and design in the (see „Assembly Plan - variable-speed turbo coupling 215001154-0010")!

Note

NOTE

Only qualified personnel should be permitted to work on the variable-speed turbo coupling!

➔ (see Section 2.7 „Personnel selection and qualification, basic obligations" on page 11).

8.2 Maintenance and repair

- Maintenance, measures to take to maintain the desired condition
- Repair, measures to take to restore the desired condition.

8.2.1 Maintenance measures and intervals

When the equipment is operating

If the pressure differential across the duplex oil filter increases	• Switch and service the duplex oil filter (see Section 8.3 „Replacement of the filter element“).
If the speed of the driven machine fluctuates	• Check the air separation characteristics of the working oil (see Section 8.4 „Test criteria and notes for evaluating working oils“).
If the oil level is high	• Check the[1] amount of water in the working oil (see Section 8.4 „Test criteria and notes for evaluating working oils“).
Daily, if monitoring of the instruments is not incorporated into a supervisory system	• Checked the oil level (see Section „Oil level“).
Weekly	• Check and document all temperature and pressure readings (see Section 7.3.1 „Monitoring the equipment“).
Monthly	• Check vent filter for external soiling and clean as necessary. • Always check for smooth operation under the same operating conditions[2], record and compare the measurements. • Inspect the working oil [1+3] for suitability

1. Section 8.4 „Test criteria and notes for evaluating working oils“
2. Specification of measurement points within the output speed range.
3. This maintenance interval can be extended, depending on experience with the equipment. This should not exceed 6 months.

When the equipment is idle

If the oil quality is questionable (suitability for use)	• Determine and correct the causes. Separate[1] or exchange the oil (see Section 8.4 „Test criteria and notes for evaluating working oils“).
The vibrations have increased	• Check and correct alignment of the variable-speed turbo coupling. Check attachment to the foundation (see Section 5.6 „Securing the machine to the foundation“).

When the equipment is idle	
After the first 100 hours of operation	• Clean the duplex oil filter (see Section 8.3 „Replacement of the filter element“). • Clean the vent filter. • Make sure that the scoop tube actuator moves freely, check the limiter for the scoop tube stroke, grease the linkage and bare metal parts. • Inspect the oil cooler; if necessary, clean in accordance with the manufacturer's specifications. • Inspect the piping and oil- or grease-lubricated connecting couplings for leaks. • Check the operating oil for impurities and water. Determine and correct the causes. Separate or exchange of oil (see Section 8.4 „Test criteria and notes for evaluating working oils“).
After the first 500 hours of operation	• Clean the[2] duplex oil filter (see Section 8.3 „Replacement of the filter element“). • Clean the vent filter. • inspect the piping and connecting couplings[2] for leaks.
After the first 1000 hours of operation	• Inspections and maintenance as listed for the first 100 hours of operation.
After each additional 1000 hours of operation or when the duplex oil filter becomes clogged	• Check the[3] duplex oil filter; clean as necessary (see Section 8.3 „Replacement of the filter element“).
After every 6000 hours of operation or at least annually	• Analyze the working oil for signs of aging (see Section 8.4 „Test criteria and notes for evaluating working oils“). • Inspect and service the connecting couplings. • Check the alignment of the variable-speed turbo coupling and correct as necessary. Check attachment to the foundation (see Section 5.6 „Securing the machine to the foundation“). • Check the overall condition of the variable-speed turbo coupling. • Open the inspection hole cover and check the condition of the fusible plug (amount of solder present) (see Section 8.5 „Replacing the fusible plugs“).
Changing antifriction bearings • Antifriction bearing life	The antifriction bearings have been designed for a life of Lh 10 > 70000 hours. This corresponds to 8 years of operation.
• After max. 7 years of operation	• Change all antifriction bearings.

1. Observe the specifications of the oil supplier
2. Note the manufacturer's specifications and identification marks regarding balancing
3. Observe the manufacturer's specifications

NOTE

Restarting a variable-speed turbo coupling that was shutdown for some reason

– Check bearings for signs of overheating
– Check the fusible plugs
– Switch on the auxiliary lube oil pump and check the oil pressure

8.2.2 Service/repair measures and intervals

Change in operating behavior	• Determine cause. • Repair the Variable-speed turbo coupling.
After max. 7 years of operation	• Perform a general overhaul.

NOTE

Constant operation subjects units to natural wear, which is also influenced by the surroundings. The scheduled reconditioning of your equipment minimizes the risk of expensive production downtime. Our service department will develop a maintenance strategy that precisely suits your needs. Professional and regular reconditioning by our service team extends the service life of your Voith product.

To avoid the need to wait when performing maintenance, we recommend that spare parts be ordered for stock in time. We will gladly prepare a spare parts proposal upon request (see contact information for Customer Service).

For quick handling of inquiries or requests for a technician or spare parts for the variable-speed turbo coupling, we request that you always state the Serial No., the exact location of the variable-speed turbo coupling and the name of the individual responsible for the equipment.

Assembly work on the variable-speed turbo coupling is to be performed only by our technicians or qualified personnel (see Section 2.4 „General safety information“).

Contact our Service Center for further details:

– See contact information.

8.3 Replacement of the filter element

CAUTION

Burn hazard

The filter housing, oil lines and working oil can be hot. In an extreme case, up to 100°C for this section of the lube oil circuit.

Wear protective gloves!

WARNING

Risk of injury

Hot, pressurized oil in the duplex oil filter and vent line can cause serious injury.

Wear protective gloves, safety goggles and protective clothing!

CAUTION

Environmental damage

Used oil that escapes into the soil or sewage system can cause serious damage to the environment.

Dispose of used oil in a proper manner that complies with national statutory regulations.

NOTE

Do not switch filters while cleaning.

NOTE

Flooding the clean filtering jug (see Section 7.3.4 „Changing over the duplex oil filter“)
Servicing and cleaning.

➔ (see Chapter 14.9 „Duplex filter“)

8.4 Test criteria and notes for evaluating working oils

General

The suitability of working oils for continued use should be checked and evaluated at regular intervals.
The value of the information obtained from an analysis of the working oil depends on correct and careful sampling Section 7.5 „Taking a sample of the working oil“.

NOTE

This list contains aspects to be considered and rough limits for evaluating the suitability of working oils for continued use.
The decision regarding the suitability of the working oil for continued use remains the right of the manufacturer and oil supplier.

The following can only be considered recommendations, since they depend on the operating conditions, formulation and type of working oil.

The oil should be changed when

Visual and sensory check

- It is very black in color
- Residues start to accumulate
- It has a sharp, burnt odor

It is necessary to determine the cause.

Viscosity (DIN 51562)

- Viscosity change > ± 10%

It is necessary to determine the cause.

Neutralization number NZ(s) (DIN 51558)

- Increase in NZ(s) versus that of fresh oil (new working oil)
  - Turbine oil -TD-0.5 -1 mg KOH / g
  - Hydraulic oil -HLP-1 - 1.5 mg KOH / g
  - Lube oil -CLP-1.5 - 2 mg KOH / g

Water content (DIN 51582)

- Water content > 0.05 weight % (500 ppm).

  No oil change is necessary, if the water content is eliminated by means of
  – Centrifuging
  – Filtering through a coalescence separator
  – Vacuum treatment
  – Settling (allowing to rest for 1-2 days) and then draining or pumping off[1]
  – Heating

An oil change is necessary when

- Water content is > 0.2 weight %

It is necessary to determine the cause.

Air separation characteristics LVA (DIN 51381)

- Occurrence of pressure and speed fluctuations, if too low an oil level is to be excluded and the LAV value > 5 minutes (0.2% at 50°C).

1. In the case of synthetic oils with a density >1.0, condensation, for instance, floats on top.

8.5 Replacing the fusible plugs

1. Remove the inspection hole cover (2) from the housing.

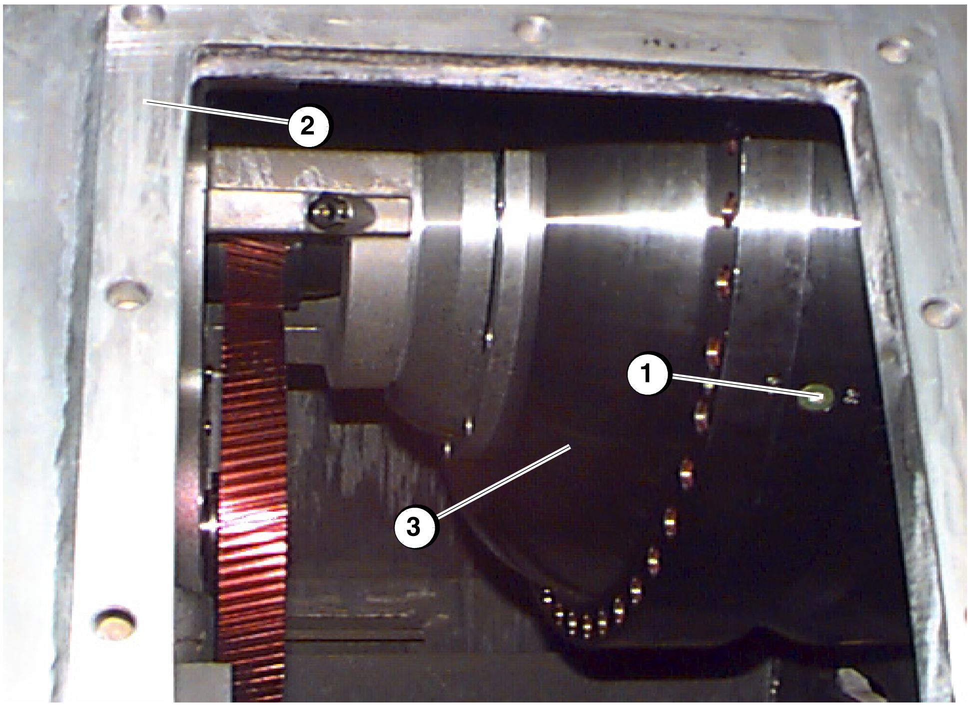


Illustration 8-25: Inspection hole cover

1) Fusible plug
2) Shelf for inspection hole cover
3 Primary wheel

2. Rotate the input shaft until the fusible plugs (1) (or the holes for the fusible plugs) in the primary wheel (3) are visible.
3. Check the solder filling in the plugs, install and tighten new plugs, if necessary. Observe the torque specifications in the sectional drawing.

8.6 Cross references

Topics	Relevant documentation
Working oil	Section 6.2 „Fill the working oil“ Section 6.6 „Operating fluids“ Section 8.4 „Test criteria and notes for evaluating working oils“ Oil supplier's specifications
Fusible plugs	Section 8.5 „Replacing the fusible plugs“
Duplex filter	Section 7.3.4 „Changing over the duplex oil filter“ and Section 8.3 „Replacement of the filter element“
Heat exchanger	Operating instructions for the connecting couplings in Chapter 14.15 „Heat exchanger“ of this Instruction Manual
Alignment	Section 5.5 „Machine alignment“
Temperatures and pressures	Section 7.3.1 „Monitoring the equipment“
Connecting couplings	Manufacturer's specifications Chapter 14.16 „Connecting coupling“
Auxiliary lube oil pump motor	Manufacturer's specifications Chapter 14.11.2 „Motor“

9 Troubleshooting

9.1 Start-up

Malfunction	Cause(s)	Action(s)
Driven machine does not start up after the driving machine has attained its rated speed	• Scoop tube set at 0%	Take the following actions: Move scoop tube towards 100% Trouble shooting (see „VEHS Description - Instruction Manual 3626-015310 en“)
	• Filling pump is not delivering oil	• Take the following actions:
	– Temperature of oil in the reservoir < 0 °C (32 °F) or oil viscosity > 400 mm^2/s	– Warm oil to > 0 °C (32 °F). Close the cooling water supply on the oil cooler.
	– Oil level too low	– Check the oil level and fill to between the min. and max. marks. Check the fusible plugs.
	– Foaming oil (oil temp. too low; water in the oil; poor air separation characteristics; wrong oil grade)	– Check the oil for impurities. Centrifuge or separate the oil Change oil, if necessary – Check the filling pump pressure at pressure measuring points
	– Piping clogged	– Inspect the piping; remove any obstructions.
	– Main motor rotating in the wrong direction	– Inspect the main motor and connect properly.
	• Startup torque too high (high motor inrush current), driven machine blocked (see working oil temperature)	• Check that driven machine turns freely. Check fusible plugs.
The variable-speed turbo coupling becomes excessively hot during start-up.	• The driven machine jams; other obstacles	• Check that driven machine turns freely; remove anything causing resistance. Check fusible plugs.
	• Oil flow rate too low	• Check that oil circulates properly.

9.2 Output speed

Malfunction	Cause(s)	Action(s)
Output speed oscillates even though scoop tube remains at the same position	• Foaming oil (oil temperature downstream of the heat exchanger too low; consequently, oil separation characteristics poor)	• Warm oil in the reservoir to > 45°C.
	• Filling pump draws in air	• Check oil level and, possibly, the filling pump.
	• Pressure or flow fluctuations in the system	• Check the system; if necessary, bleed and stabilize.
Output speed oscillates under automatic control (control lever moves periodically)	• Controller not operating with the correct response time for the control loop	• Tune controller to the control loop (adjust controller damping).
Output speed cannot be controlled	• Scoop tube or scoop tube actuator sticks	• Check that the scoop tube moves freely; remove anything causing it to stick.
	• Scoop tube actuator defective	• Check scoop tube actuator.
Max. output speed not attained	• Scoop tube not at 100%	• Check some scoop tube stroke. • Trouble shooting (see „VEHS Description - Instruction Manual 3626-015310 en“)
	• Fusible plugs have melted	• Determine and correct cause. Install new fusible plugs.
	• Power consumption of the working oil pump too high	• Check the motor rating with the project design data. Check driven machine for smooth running.

9.3 Pressures

Malfunction	Cause(s)	Action(s)
Lube oil pressure too low to enable startup	• Motor for auxiliary lube oil pump connected incorrectly	• Check the connection to power line
	• Delivery of lube oil to external equipment too high	• Adjust orifices
	• Orifice not installed in the filling pump vent line	• Install orifice (see Section 7.3.3 „Rotation of the auxiliary lube oil pump in the reverse direction“).
	• Leak in the oil circuits	• Check the oil level. Check the piping for leaks (take the necessary action to prevent damage to the environment).
	• Duplex oil filter needs cleaning	• Switch lube oil filters and clean filter housing. Check pressure differential monitoring.
Pressure differential across duplex filter too high	• Duplex oil filter needs cleaning	• Switch lube oil filters and clean filter housing.
Lube oil pressure too low during normal operation	• Duplex oil filter needs cleaning	• Switch lube oil filters and clean filter housing.
	• Delivery of lube oil to external equipment too high	• Adjust orifices
	• Check valve in auxiliary lube oil pump circuit jammed (motor for auxiliary lube oil pump rotating in the wrong direction)	• Check the check valve
Filling pump pressure is too low	• Oil temperature in the oil reservoir < 45°C (113°F), resulting in poor air separation characteristics	• Warm oil in the reservoir to > 45°C.
	• Oil level too low	• Check the oil level and fill to between the min. and max. marks. Check fusible plugs.
	• Foaming oil (oil temperature too low; water in the oil; poor air separation characteristics; wrong oil grade)	• Check the oil for impurities. Centrifuge or separate the oil Change oil, if necessary

9.4 Temperatures

Malfunction	Cause(s)	Action(s)
Oil temperatures in the variable-speed turbo coupling are too high during operation	• Cooling water flow rate too low • Cooling water too warm • Heat exchanger needs cleaning	• Increase the cooling water flow rate • Check the thermostatic control valve • Check and clean the cooling system
	• The variable-speed turbo coupling is operating outside the permissible characteristic curve	• Operate the variable-speed turbo coupling within its characteristic curve (check the fusible plugs).
	• Fusible plugs have melted	• Determine and correct cause. Install new fusible plugs.
Bearing temperatures too high	• Bearing damage	• Check for smooth operation. • Check the bearings and replace, if necessary.
	• Lube oil temperature too high	• Check the oil cooler, switch the duplex oil filter and clean the filter housing.
	• Lube oil pressure too low	• Check the lube oil system • Switch lube oil filters and clean filter housing. Check pressure differential monitoring. • Check the oil level. • Increase the lube oil pressure.

9.5 Smooth operation

Malfunction	Cause(s)	Action(s)
Rough operation, vibrations and noise	• Poor alignment	• Check alignment and correct, if necessary
	• Poor support between equipment and foundation (foundation rails); uneven support; equipment cocked	• Check the alignment and support; correct, if necessary
	• Foundation bolts loose, defective foundation, foundation rails not grouted	• Check foundation; retighten the foundation bolts, if necessary
	• Wear or lack of lubrication in the connecting couplings; sleeve in curved tooth coupling does not move axially (teeth worn)	• Check the connecting couplings, lube oil supply and injection nozzles
	• Rotating components unbalanced • Bearing damage	• Measure the vibration and perform a frequency analysis on the entire system. Document the measured values and operating data. • Inspect the bearings on the equipment and, if necessary, replace.

9.6 Cross references

Topics	Relevant documentation
Heat exchanger	Operating instructions for the connecting couplings in Chapter 14 „Attaching Parts (descriptions)“ of this Instruction Manual
Alignment	Section 5.5 „Machine alignment“
Operating data (pressures, temperatures, oil flow rates)	Section 1.2 „Operating data“ Section 7.3.1 „Monitoring the equipment“
Orifices for lubrication of external equipment	Section „Drilling of orifices for lube oil supplied to external units“ on page 60
Foundations	Section 5.6 „Securing the machine to the foundation“
Vent lines	Section 5.7.7 „Vent line assembly“
Auxiliary lube oil pump motor	Operating instructions for the auxiliary lube oil pump motor in Chapter 14 „Attaching Parts (descriptions)“ of this Instruction Manual
Oil	Section 8.4 „Test criteria and notes for evaluating working oils“
Oil level	Section 6.2 „Fill the working oil“
Fusible plugs	Section 8.5 „Replacing the fusible plugs“
Lube oil filter	Section 8.3 „Replacement of the filter element“
Voith **E**lectro-**H**ydraulic Po**s**itioning Control	Operating instructions for the **V**oith **E**lectro-**H**ydraulic Po**s**itioning Control in Chapter 14 „Attaching Parts (descriptions)“ of this Instruction Manual
Connecting couplings	Operating instructions for the connecting couplings in Chapter 14 „Attaching Parts (descriptions)“ of this instruction manual

10 Introduction to General Overhaul

NOTE

Constant operation subjects units to natural wear, which is also influenced by the surroundings. The scheduled reconditioning of your equipment minimizes the risk of expensive production downtime. Our service department will develop a maintenance strategy that precisely suits your needs. Professional and regular reconditioning by our service team extends the service life of your Voith product.

To avoid the need to wait when performing maintenance, we recommend that spare parts be ordered for stock in time. We will gladly prepare a spare parts proposal upon request (see contact information for Customer Service).

For quick handling of inquiries or requests for a technician or spare parts for the variable-speed turbo coupling, we request that you always state the Serial No., the exact location of the variable-speed turbo coupling and the name of the individual responsible for the equipment.

Assembly work on the variable-speed turbo coupling is to be performed only by our technicians or qualified personnel (see Section 2.7 „Personnel selection and qualification, basic obligations“ on page 11)

Contact our Service Center for further details:

➔ See contact information.

10.1 Safety information

The following safety information applies to the entire chapter. It must be observed in addition to the various specific instructions.

Danger of crushing or shearing upper and lower limbs

WARNING

During maintenance and assembly work, especially when turning shafts manually, during assembly work and when positioning the machine, a person's fingers could be crushed or cut off.

Allow only trained personnel to perform assembly, maintenance and service work!

Risk of injury

WARNING

Improper lifting of the variable-speed turbo coupling can result in equipment damage and personal injury.

The variable-speed turbo coupling is to be suspended only from the specified lifting points.

Use only appropriate lifting appliances that conforms to safety requirements!

Damage to equipment and personal injury

CAUTION

Improper disassembly and assembly of the variable-speed turbo coupling can lead to damaging the equipment and to personal injury.

Disassembly and assembly work on the variable-speed turbo coupling is only to be performed by qualified personnel.

Observe the personnel selection and qualifications indicated in the Operating Instructions!

Environmental damage

CAUTION

Used oil that escapes into the soil or sewage system can cause serious damage to the environment.

Dispose of used oil in accordance with the national legal regulations!
Check for oil and leaks regularly!

Danger of slipping on leaked oil

WARNING

Leaking oil on or next to the machine could cause someone to slip or fall and be seriously injured.

Check for oil and leaks regularly!
Clean the machine regularly!

Danger in areas that cannot be fully viewed

WARNING

A person could be severely injured while working on the machine when starting it up.

Attach suitable protective covers that cannot be removed without the respective tool, between the coupling and the shaft!
Only work on the machine when the system is shut down (no power)!
Operation is only permitted after visually ensuring that no persons are in the hazard areas!

Risk of injury

WARNING

A person could burn themselves on the hot machine or on hot operational equipment.

Only touch the machine when it has cooled down!

Danger caused by incorrect assembly

WARNING

Not observing the correct direction of rotation could damage the machine and severely injure persons.
The incorrect assembly of the machine or individual parts could damage the machine.

Allow only trained personnel to perform assembly, maintenance and service work!

Note

NOTE

The variable-speed turbo coupling and removable parts of the variable-speed turbo coupling are always to be put down on a suitable surface (e.g. rubber mat).

Note

NOTE

Keep access to the maintenance work areas free.
Pay attention to dimensions and design in the (see „Assembly Plan - variable-speed turbo coupling 215001154-0010“)!

10.2 Tools and auxiliary means

Tools

- Standard tool kit
- Torque wrench (See diagrams for torques)
- Measurement instruments
- Metric tools
- Lifting appliances
- Hydraulic pre-tensioning tool (HYDROCAM)
- Anchor eyelet for shaft end (Hirth-coupling serrations)

If necessary, special tools may be purchased from Voith.
Disassembling/assembling the variable-speed turbo coupling requires no further special tools.

Accessories

- Surface of rubber or similar material
- Fastening / securing agents
- Sealant

Fastening / securing agents

Use fastening / securing agents that comply with the drawing specifications for "Liquid plastic".

Parts that are connected with one another must be

- clean
- oil- and grease-free.

Cleaning agent: trichloroethane or similar grease dissolving liquids.

Sealant

Sealant must meet the following criteria for use with the variable-speed turbo coupling:

- oil-resistant to 130°C
- does not contain silicone

Voith Turbo recommends HYLOMAR - L[1] as sealant. The sealant is only to be applied in a thin layer and ventilated for approximately 10 minutes. Observe other instructions from the manufacturer.

Cleaning agent: trichloroethane or similar grease dissolving liquids.

1. HYLOMAR-L; Observe information on the tube when applying
   Manufacturer - MARSTON-DOMSEL D-53909 Zulpich

Techn. Documentation No. 215001154-0400-00-EN, Version 1.00, aevpd / Kapp-PRe
Serial No. 8211674 - 8211675

10.3 Preparations

Before disassembling components of the variable-speed turbo coupling, do the following preparatory work:

1. Shut down driving machine, variable-speed turbo coupling allow to cool.
2. Electrically disconnect system motor.
3. Obtain approval to proceed with disassembly from the responsible party.
4. Disconnect electrical connections, when necessary.
5. Remove attached equipment such as cable ducts, wiring or sound insulation covering based on the circumstances.
6. Make the lifting appliance (crane) ready for the variable-speed turbo coupling and components removed.
   Required weight information: (see Section 1.1 „Machine data“).

NOTE
Comply with any additional special on-site safety information!

10.4 List of components

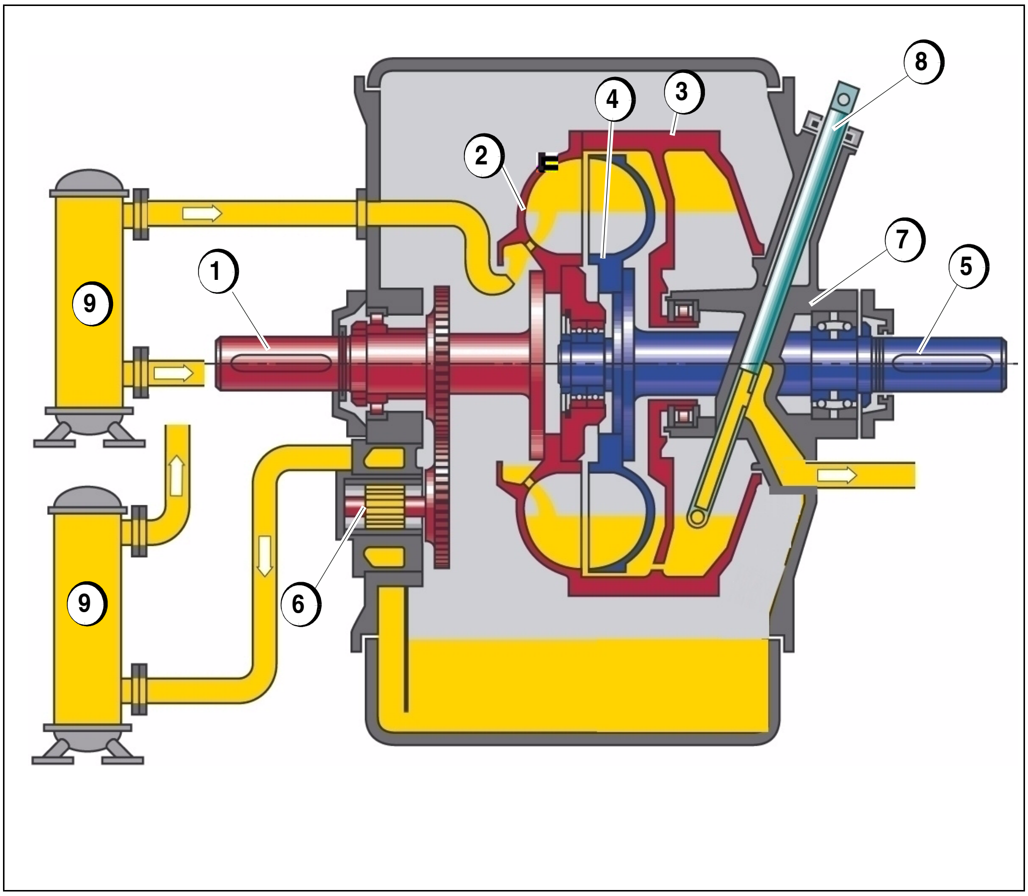
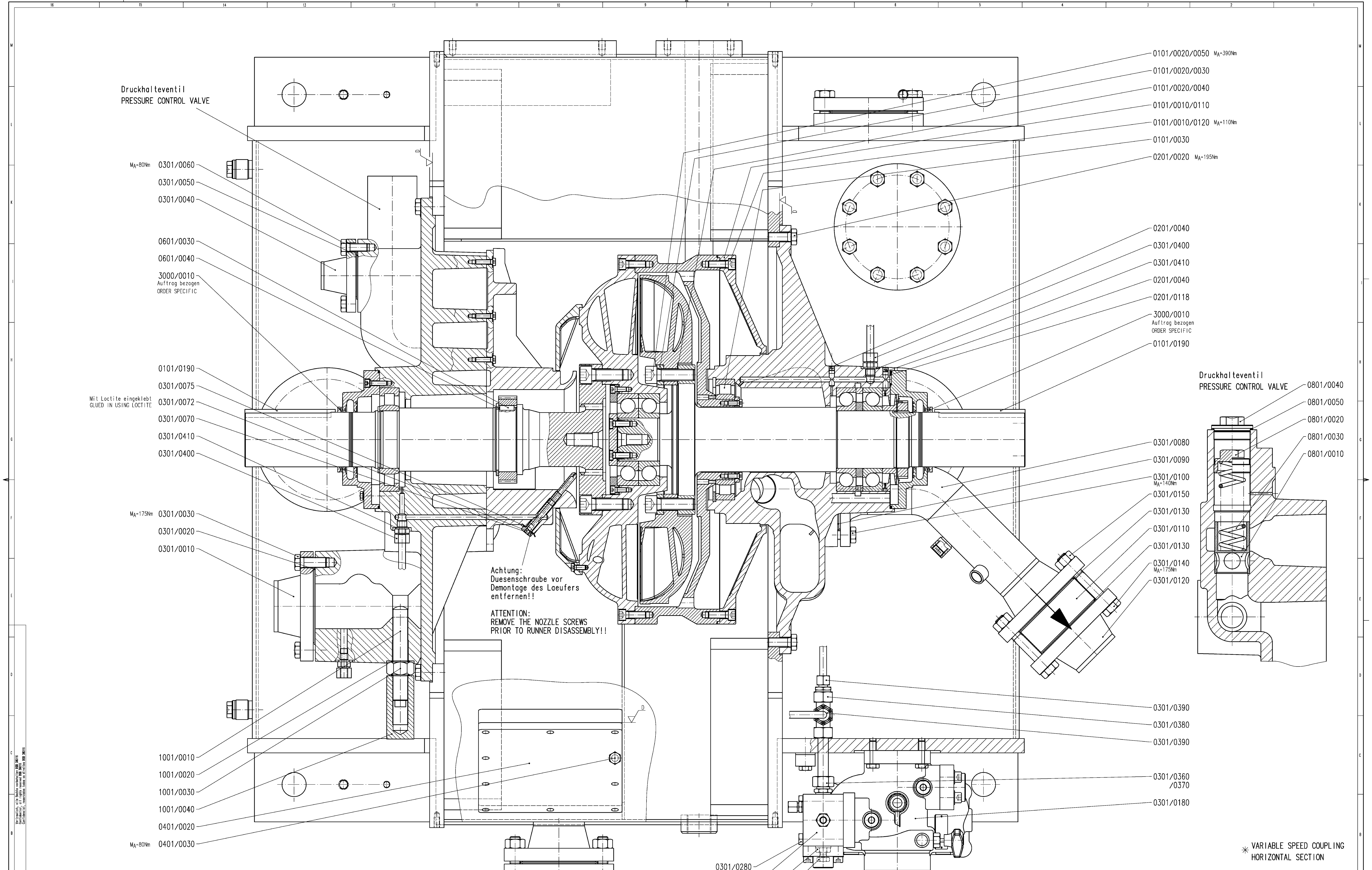


Illustration 10-26: Assemblies in the variable-speed turbo coupling

1 Input shaft (Primary shaft)
2 Primary wheel
3 Shell
4 Secondary wheel
5 Output shaft (Secondary shaft)
6 Filling pump
7 Scoop tube housing
8 Scoop tube
9 Heat exchanger

11 Drawings, Schematics, Diagrams

Sectional Drawings	Sheet 1 - 2/ 20400495810
Assembly V-ring	3623-013395
Oil Circuit and Measuring Point Scheme	215001154-0020
Instrument List	Sheet 1-8/ 215001154-0030
Logic Diagram	Sheet 1-26/ 215001154-0050
Characteristic curve	215001154-0060
Terminal Plan	Sheet 1-6/ 1-12/ 215001154-0040
Assembly Plan - variable-speed turbo coupling	215001154-0010
Heat Exchangers	(see Chapter 14 „Attaching Parts (descriptions)“)



✳ VARIABLE SPEED COUPLING
HORIZONTAL SECTION

D = Beim Zusammenbau mit Dichtmasse abgedichtet!
D = JOINTED WITH SEALING COMPOUND AT ASSEMBLY!

Aend. Rev. Index	Kommt vor Iss.	Aenderungs-Nr. Revision-Nr.	Aenderung Rev. descr. (shop and eng. info only)	Index Index	Datum: Gez. Date: Draw.	Name Name	Gepr. App.
09	-	160961	REVISION		13-05-08	Zin	Leh
08	-	159638	REVISION		13-04-12	Zin	TSto
07	-	102099	REVISION		10-04-28	trp	leh
06	-	98917	REVISION		10-02-01	cra_SSte	TSto
05	-	81482	REVISION		09-03-11	Trp	Leh
04	-	77323	REVISION		08-12-10	Ha	Leh
03	-	74706	REVISION		08-10-28	Trp	Leh
02	-	72170	REVISION		08-09-16	cra_SSte	TSto
01	-	60098	REVISION		08-02-08	cra_SSte	TSto

Passmass Dimension | Abmasse Tolerances

562 SVTL HP

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Kanten Chamfers ISO 13715 | Allg. Toleranzen Gen. Tolerances ISO 2768-mK-E | Tolerierung Tolerancing DIN 7167 | Oberflaechen Surface Quality R_a in µm ISO 1302

Massstab im Orig. Scale of Orig. 1:2 | Masse Mass kg

Werkstoff Material

Modell- / Gesenk-Nr. Pattern / Die No. | Rohteil-Nr. Blank-No.

	Datum Date	Name Name
Gez. Dr.	2008-01-14	cra_SSte
Gepr. Ch.	2008-01-14	TSto
Abt. Dept.	airek	Frei. App. met
Norm Stand.		

Doku-Art Doc. type Z01

Benennung Title ✳ Regelkupplung
Horizontalschnitt

VOITH TURBO ANTRIEBSTECHNIK

Zeichnungs-Nr. / Doku-Nr. Drawing No. / Doc. No. 20400495810

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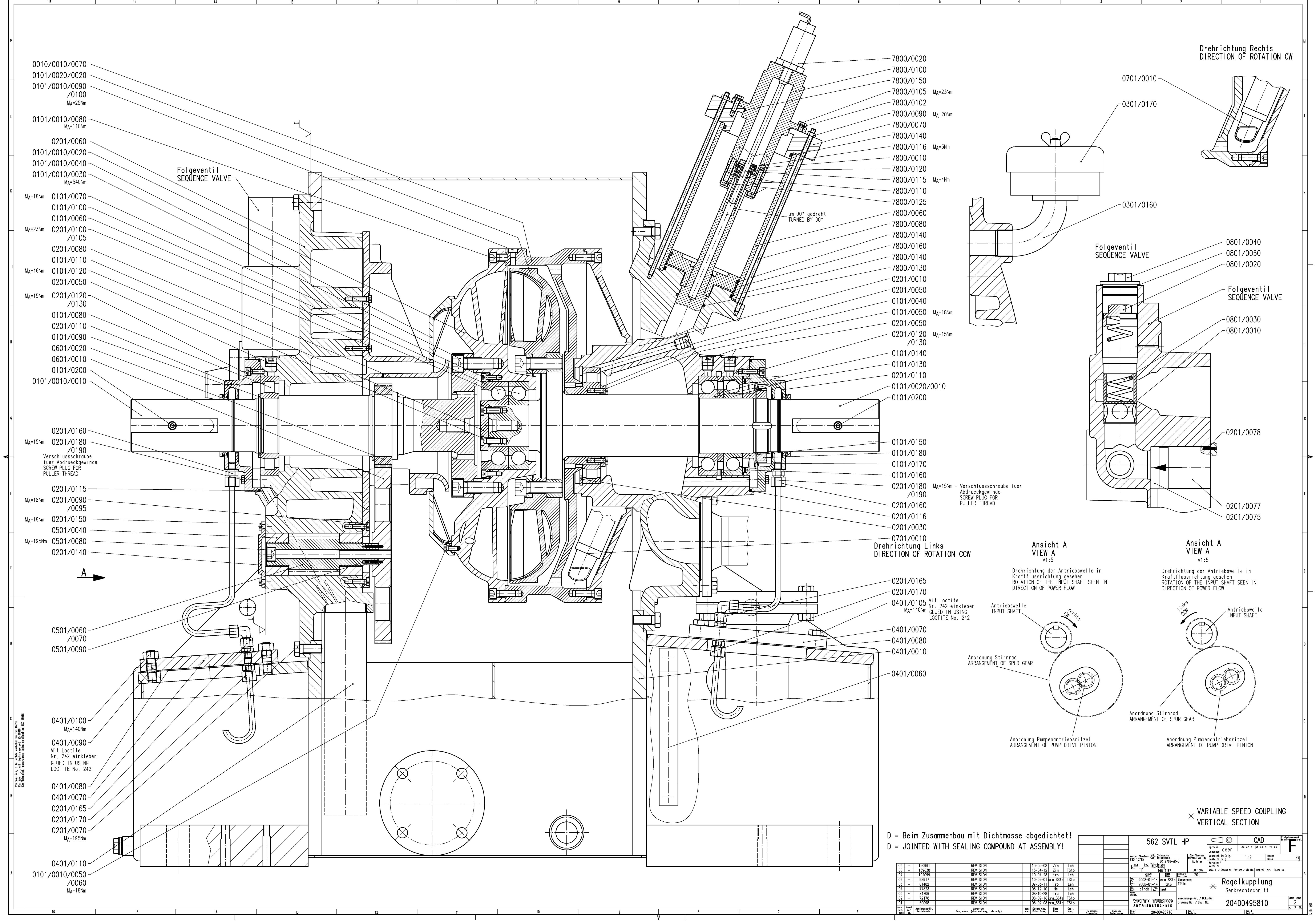

✳ VARIABLE SPEED COUPLING
VERTICAL SECTION

D = Beim Zusammenbau mit Dichtmasse abgedichtet!
D = JOINTED WITH SEALING COMPOUND AT ASSEMBLY!

Aend. Rev. Index	Kommt vor Iss.	Aenderungs-Nr. Revision-Nr.	Aenderung Rev. descr. (shop and eng. info only)	Index Index	Datum: Gez. Date: Draw.	Name Name	Gepr. App.
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08	-	159638	REVISION		13-04-12	Zin	TSto
07	-	102099	REVISION		10-04-28	trp	leh
06	-	98917	REVISION		10-02-01	cra_SSte	TSto
05	-	81482	REVISION		09-03-11	Trp	Leh
04	-	77323	REVISION		08-12-10	Ha	Leh
03	-	74706	REVISION		08-10-28	Trp	Leh
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Massstab im Orig. Scale of Orig.: 1:2 | Masse Mass: kg

Werkstoff Material

Modell- / Gesenk-Nr. Pattern / Die No. | Rohteil-Nr. Blank-No.

Doku-Art Doc. type: Z01

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VOITH TURBO ANTRIEBSTECHNIK

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Passmass Dimension | Abmasse Tolerances | Urspr. Refer.: 20400426710 | Ers. f. Reply for | Ers. d. Repl. by

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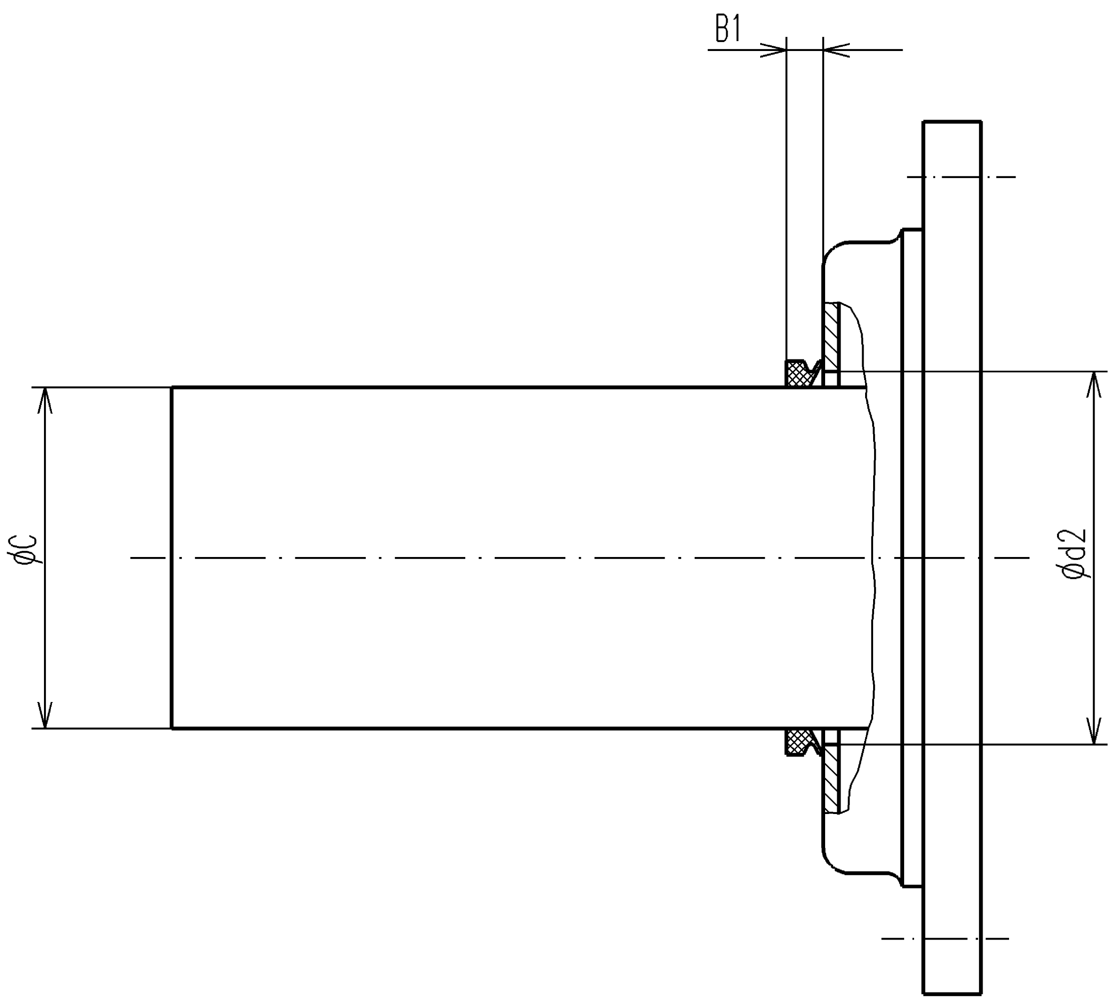
TYPE V-RING	SHAFT DIA. C	WIDTH OF PROFILE (AFTER INSTALLATION) B1	ød2 max.
VA-0060	58-63	7,0±1,0	C+3
VA-0065	63-68	7,0±1,0	C+3
VA-0070	68-73	9,0±1,2	C+4
VA-0075	73-78	9,0±1,2	C+4
VA-0080	78-83	9,0±1,2	C+4
VA-0085	83-88	9,0±1,2	C+4
VA-0090	88-93	9,0±1,2	C+4
VA-0095	93-98	9,0±1,2	C+4
VA-0100	98-105	9,0±1,2	C+4
VA-0110	105-115	10,5±1,5	C+4
VA-0120	115-125	10,5±1,5	C+4
VA-0130	125-135	10,5±1,5	C+4
VA-0140	135-145	10,5±1,5	C+4
VA-0150	145-155	10,5±1,5	C+4
VA-0160	155-165	12,0±1,8	C+5
VA-0170	165-175	12,0±1,8	C+5
VA-0180	175-185	12,0±1,8	C+5
VA-0190	185-195	12,0±1,8	C+5
VA-0199	195-210	12,0±1,8	C+5
VA-0200	190-210	20,0±4,0	C+10
VA-0220	210-235	20,0±4,0	C+10
VA-0250	235-265	20,0±4,0	C+10



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1		A2365/00	Text in spanisch zugefuegt		00-11-14	Ha	Os

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Chamfers ISO 13715 | Gen. tolerances ISO 2768-mK-E | Tolerancing DIN 7167 | Surface quality R_a in µm ISO 1302

Scale of orig. - | Mass

Material

Pattern / Die No. | Blank-No.

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Cn.	2000-11-14	Met
Dept.	airek	App. Met
Stand.		

Doc. type Z01

Title MOUNTING V-RING

VOITH TURBO ANTRIEBSTECHNIK

Drawing No. / Docu-No. 3623-013395

Sheet 1 of 1 Sh.

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DIN A3

Info:Zeichnung=MONTAGE --- Nummer=3623-013395_001 --- Projekt=CR.3623 --- Bibliothek=3623 --- ID: 5/02

UTE TSK TÉCNICAS REUNIDAS ASHUGANJ NORTH	**Ashuganj Power Station Company Ltd. (APSCL)**	

ASHUGANJ COMBINED CYCLE POWER PLANT PROJECT (NORTH)

UTS PROJECT NO. 7485	**UNIT: BOILER FEED WATER PUMPS**
PURCHASE ORDER NUMBER (P.O.R) 074850503 / F557	**EQUIPMENT : LAC**

REVIEW RESPONSE BY PURCHASER:

Purchaser review and comments do not indicate either responsibility or liability for accuracy and completeness of this document or alter any contractual terms and conditions:

☐ REJECTED ☐ Reviewed With Comments ☐ Review. Without Comments

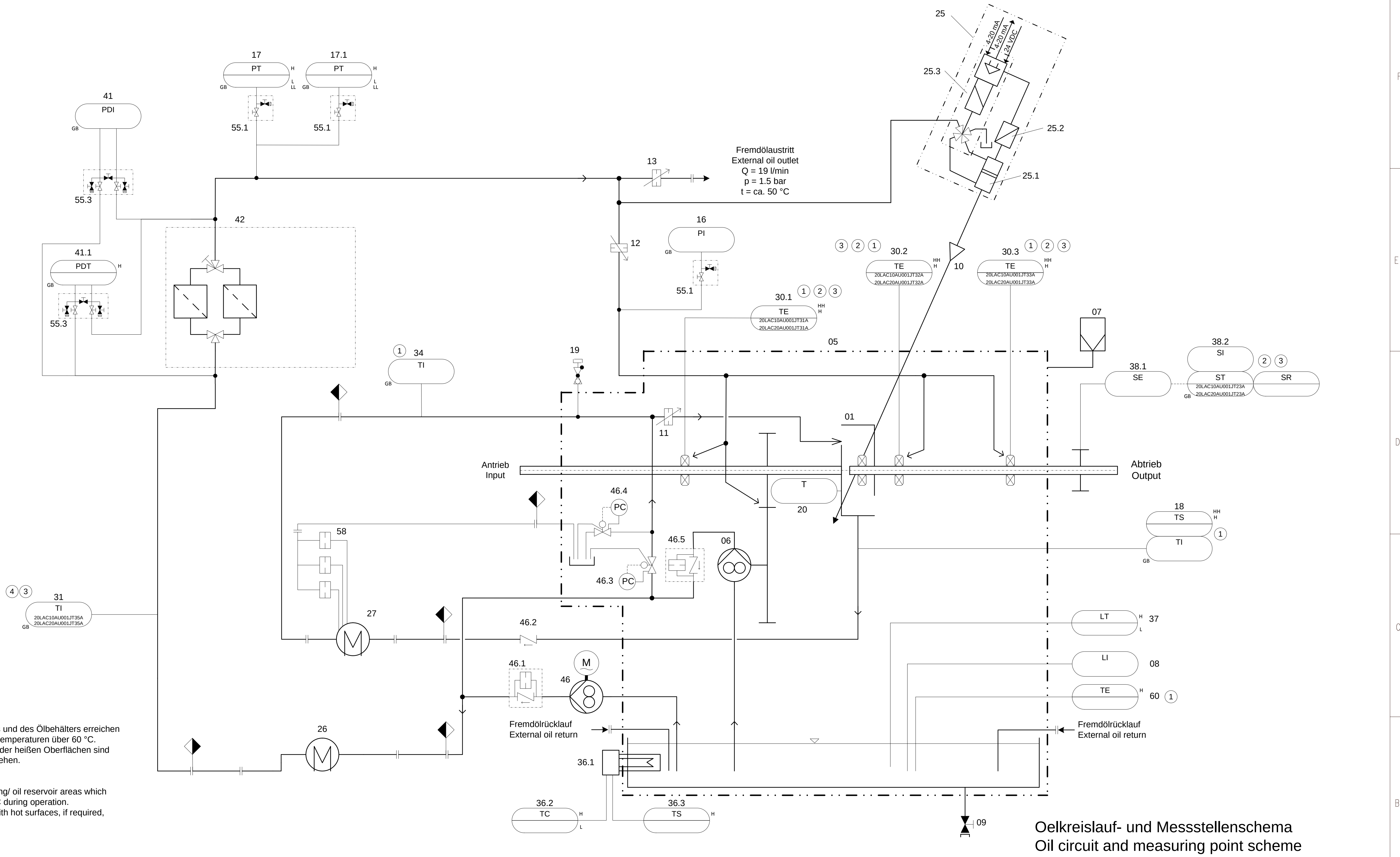
☐ COMMENTS AS NOTED ☐ REVIEWED AS BUILT ☐ FOR INFORMATION

DATE:

DOCUMENT VENDOR IDENTIFICATION: FLOWSERVE

DOCUMENT TITLE: Auxiliary systems P&ID.

VENDOR DOCUMENT No: COS-14-10P40397-6537	REV: 4	CODE: DIA-0002
UTS DOCUMENT No: V-0748505030-0020	REV: 4	
KKS DOCUMENT No.: 07485-20-LAC-YDD-FLS-002	REV: 4	



Heiße Oberflächen
Rohrleitungen, Bereiche des Gehäuses und des Ölbehälters erreichen während des Betriebes der Maschine Temperaturen über 60 °C.
Schutzeinrichtungen gegen Berührung der heißen Oberflächen sind soweit erforderlich kundenseitig vorzusehen.

Hot surfaces
There are pipework sections and housing/ oil reservoir areas which reach surface temperature above 60 °C during operation.
Protection against accidental contact with hot surfaces, if required, shall be provided by others.

Oelkreislauf- und Messstellenschema
Oil circuit and measuring point scheme

Flowserve Ashuganj S 1

Ausgabe- oder Bedienort:
Output location or service location:

- Messort oder Stellort / Measuring point or adjusting point
- GB Örtliche Instrumententafel / Local gauge board
- Zentrale Warte / Control room
- GB Örtliche Instrumententafel / Signalverarbeitung in zentraler Warte / Local gauge board / Signal processing in control room

Hauptteile und Instrumente siehe Liste-Nr. 215001154-0030 / COS-14-10P40397-6519
For main components and instruments, see list no. 215001154-0030 / COS-14-10P40397-6519

VOITH Lieferung / VOITH supply — Keine VOITH Lieferung / Not VOITH supply

Aend. Rev. Index	Kommt vor Iss.	Aenderungs-Nr. Revision-Nr.	Aenderung Rev. descr. (shop and eng. info only)	Index	Datum: Gez. Date: Drow.	Name	Gepr. App.
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02	5x	188472	Revision		2015-01-21	sahoe	
01	6x	184953	Revision		2014-10-23	sahoe	

562 SVTL HP
Auftrags-Nr.:/ Order no.: 38003425

Sprache / Language: deen deen

Kanten Chamfers ISO 13715 — Allg. Toleranzen Gen. Tolerances ISO 2768-mK-E — Tolerierung Tolerancing DIN 7167 — Oberflaechen Surface Quality R_a in µm ISO 1302 — Massstab im Orig. Scale of Orig. — Masse Mass — Werkstoff Material — Modell- / Gesenk-Nr. Pattern / Die No. — Rohteil-Nr. Blank-No.

Gez. Dr.: 2014-10-22 sahoe
Gepr. Ch.: aevec

Benennung / Title:
Regelkupplung
VARIABLE SPEED COUPLING

VOITH TURBO ANTRIEBSTECHNIK

Zeichnungs-Nr. / Doku-Nr. Drawing No. / Doc. No.: 215001154-0020

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Main Components and Instrument List

Revision	Item No. Voith	Item No. Customer TAG No	Components or Instrument, Type: Make:	Measuring range --- Adjusted range	Process Connection --- Electrical Connection	Ingress Protection	Measurement / Measuring point, location	Set value	Nominal value during operation	Remarks
	01		Runner parts							
	05		Coupling housing							
	06		Filling pump							
	07		Vent filter Type: TLF I 3-40 G 25 Make: Bosch Rexroth							
	08		Oil level sight glass Type: FSA 254.2.0/12 Make: Flutec							
	09		Oil drain valve Type: 406-4 Make: Schwabe		G 1 ¼					Housing material: Red brass, Ball material: Yellow brass, chromium plated
	10		Scoop tube							
	11		Adjustable orifice for working oil flow				Working oil inlet			
	12		Adjustable orifice for lube oil flow				Downstream of duplex filter			
	13		Adjustable orifice for external oil flow				External oil outlet			

Main Components and Instrument List

Revision	Item No. Voith	Item No. Customer TAG No	Components or Instrument, Type: Make:	Measuring range --- Adjusted range	Process Connection --- Electrical Connection	Ingress Protection	Measurement / Measuring point, location	Set value	Nominal value during operation	Remarks
	16		Pressure gauge Type: 100-T5500-S-L-04-L-0/1bar Make: Ashcroft	0 - 1 bar	½ NPT	IP 65	Lube oil pressure downstream of orifice		> 0.3 bar	Dial size 100 mm Housing material: Stainless steel ASTM 304, with liquid filling
	17		Pressure transmitter Type: 3051 TG (with HART protocol) Make: Rosemount	0 - 10 bar --- 0 - 4 bar = 4 - 20 mA	½ NPT --- ½ NPT	IP 65	Lube oil pressure downstream of duplex filter	Main motor release: > 1.9 bar Trip: < 1.3 bar Aux.lube oil pump OFF > 2.4 bar Alarm: Aux.lube oil pump ON < 1.6 bar	> 2.5 bar	Housing material: Aluminum with polyurethane coat Measuring cell: SS 316 Supply voltage: 10.5 – 55 V DC
	17.1		Pressure transmitter Type: 3051 TG (with HART protocol) Make: Rosemount	0 - 10 bar --- 0 - 4 bar = 4 - 20 mA	½ NPT --- ½ NPT	IP 65	Lube oil pressure downstream of duplex filter	Main motor release: > 1.9 bar Trip: < 1.3 bar Aux.lube oil pump OFF: > 2.4 bar Alarm: Aux.lube oil pump ON: < 1.6 bar	> 2.5 bar	Housing material: Aluminum with polyurethane coat Measuring cell: SS 316 Supply voltage: 10.5 – 55 VDC

Main Components and Instrument List

Revision	Item No. Voith	Customer TAG No	Components or Instrument, Type: Make:	Measuring range --- Adjusted range	Process Connection --- Electrical Connection	Ingress Protection	Measurement / Measuring point, location	Set value	Nominal value during operation	Remarks
	18		Capillary dial thermometer with contacts Type: 608523-22-10 Make: JUMO	0 - 160 °C	G ½ --- M20x1.5	IP 66	Working oil temperature at scoop tube outlet	Alarm: > 100 °C Trip: > 110 °C	< 100 °C	Dial size 100 mm 2x SPDT contacts Contact rating: 250 V AC / 5 A Housing material: Stainless steel
	19		Pressure measuring connection Type: EMA 3 R1/4 Make: Parker Ermeto				Working oil pressure upstream of orifice			
	20		Fusible plug					Melting point: > 160 °C		
	25		Voith electro hydraulic positioning control (VEHS)			IP 65	Scoop tube position			Input signal: 4–20 mA Output signal: 4–20 mA Supply voltage: 24 V DC, 3.0 A positioning time from 0% to 100% scoop tube position 10 seconds only with running lube oil pump Power supply unit (input: 230 V AC,output 24 V DC) in local junction box
	25.1		Scoop tube piston							
	25.2		Electric position pick-up							
	25.3		4/3-way valve with control magnet							
	26		Lube oil heat exchanger							Not Voith Supply

Main Components and Instrument List

Revision	Item No. Voith	Item No. Customer TAG No	Components or Instrument, Type: Make:	Measuring range --- Adjusted range	Process Connection --- Electrical Connection	Ingress Protection	Measurement / Measuring point, location	Set value	Nominal value during operation	Remarks
	27		Working oil heat exchanger							Not Voith Supply
1) 2)	30.1	20LAC10/20 AU001JT31A	Resistance thermometer 2x PT100, 3-wire system DIN IEC 751 Class B Drawing No. 42035240 Make: JUMO	0 - 180 °C	G ½ --- M20x1.5	IP 65	Bearing temperature / Bearing 1	Alarm: > 95 °C Trip: > 105 °C	< 95 °C	Housing material: Aluminum, coated
1) 2)	30.2	20LAC10/20 AU001JT32A	Resistance thermometer 2x PT100, 3-wire system DIN IEC 751 Class B Drawing No. 42035240 Make: JUMO	0 - 180 °C	G ½ --- M20x1.5	IP 65	Bearing temperature / Bearing 2	Alarm: > 95 °C Trip: > 105 °C	< 95 °C	Housing material: Aluminum, coated
1) 2)	30.3	20LAC10/20 AU001JT33A	Resistance thermometer 2x PT100, 3-wire system DIN IEC 751 Class B Drawing No. 42035240 Make: JUMO	0 - 180 °C	G ½ --- M20x1.5	IP 65	Bearing temperature / Bearing 3	Alarm: > 95 °C Trip: > 105 °C	< 95 °C	Housing material: Aluminum, coated
3) 4)	31	20LAC10/20 AU001JT35A	Capillary dial thermometer without contacts Type: 100-S5500 Make: Ashcroft	0 - 120 °C	G ½	IP 65	Lube oil temperature downstream of heat exchanger		< 55 °C	Dial size 100 mm Housing material: Stainless steel
1)	34		Capillary dial thermometer without contacts Type: 100-S5500 Make: Ashcroft	0 - 160 °C	G ½	IP 65	Working oil temperature downstream of heat exchanger		< 80 °C	Dial size 100 mm Housing material: Stainless steel

Main Components and Instrument List

Revision	Item No. Voith	Item No. Customer TAG No	Components or Instrument, Type: Make:	Measuring range --- Adjusted range	Process Connection --- Electrical Connection	Ingress Protection	Measurement / Measuring point, location	Set value	Nominal value during operation	Remarks
	36.1		Heater Type: NE-F-4-1,3-400D-75 Make: Roni		3" ASME B16.5 class 150 --- 2x 20x1.5	IP 65				2x SPDT contacts Contact rating: 230 V AC / 16 A Supply voltage: 380-415 V / 50 Hz rated power: 3.6-4.3 kW Housing material: Carbon steel, coated
	36.2		Controller (integrated in heater)				Oil temperature in coupling housing	Heater ON: < 10 °C Heater OFF: > 15 °C	> 10 °C < 95 °C	
	36.3		Limiter (integrated in heater)				Oil temperature in coupling housing	Temperature limiter > 130 °C	> 10 °C < 95 °C	
	37		Oil level transmitter Type: LT255:XX A GB 1 H A M X guided radar with coaxial probe (with HART protocol) Make: VEGA - Voith	140 mm = 4 - 20 mA max. oil level = 16.6 m min. oil level = 7.4 mA	G 3/4 --- M20x1.5	IP 66	Oil level / Oil reservoir	Alarm: > 15 mm above maximum oil level = 18.3 mA Alarm / Heater power supply off: < 15 mm below minimum oil level = 5.7 mA		Housing material: Aluminum with polyurethane coat Measuring cell: SS 316 Supply voltage: 14 – 36 V DC
	38.1		Speed pickup Type: A 5 S 31 B Make: Braun		--- M14x1.5	IP 67	Output speed			

Main Components and Instrument List

Revision	Item No. Voith	Item No. Customer TAG No	Components or Instrument, Type: Make:	Measuring range --- Adjusted range	Process Connection --- Electrical Connection	Ingress Protection	Measurement / Measuring point, location	Set value	Nominal value during operation	Remarks
	38.2	20LAC10/20 AU001JT23A	Speed measuring transducer with speed indicator and reverse rotation detector Type: D 124.1 S2 U2M Make: Braun	0 - 3000 rpm			Output speed			Wired to a terminal box IP 65 Temp.: -20 °C /+65 °C Supply voltage: 85 – 265 V AC/DC Input signal: 0 - 3000 Hz Output signal: 4 - 20 mA Indication: 0 - 3000 rpm
	41		Differential pressure indicator Type: 100-F 5509-S-L-25-L Make: Ashcroft	0 – 1.6 bar	¼ NPT	IP 65	Pressure drop on duplex filter		< 0.3 bar	Dial size 100 mm Housing material: Stainless steel ASTM 304, with liquid filling
	41.1		Differential pressure transmitter Type: 3051 CD (with HART protocol) Make: Rosemount	0 - 2.48 bar --- 0 - 1.6 bar = 4 - 20 mA	½ NPT --- ½ NPT	IP 65	Pressure drop on duplex filter	Alarm: > 0.8 bar change over duplex filter	< 0.3 bar	Housing material: Aluminum, coated measuring cell: SS 316 Supply voltage: 10.5 - 55 V DC
	42		Duplex filter Type: DSF 176 Make: Internormen		Flange for pipe 1 1/2"		Lube oil			Filter elements: glass fibre Grade of filtration: 10 micron
	46		Auxiliary lube oil pump Type: R 35/40 FL-Z Make: Rickmeier with WEG motor		Flange SAE 1 1/2"					Delivery: 112 l/min Pressure 5.0 bar Motor: 3.0 kW 380-420 V / 50 Hz Motor protection: IP55 with anti-condensation heater 220-240 VAC / 50 Hz
	46.1		Check valve with orifice bore Type: RK 44 D3 Make: Gestra		PN 16 DN 40		Discharge line of auxiliary lube oil pump			Materials: housing: 2.1050 disc: 1.4571

Main Components and Instrument List

Revision	Item No. Voith	Item No. Customer TAG No	Components or Instrument, Type: Make:	Measuring range --- Adjusted range	Process Connection --- Electrical Connection	Ingress Protection	Measurement / Measuring point, location	Set value	Nominal value during operation	Remarks
	46.2		Check valve Type: RK 86 Make: Gestra		PN 16 DN 80		Working oil downstream of scoop tube			Materials: housing: 2.1050 disc: 1.4571
	46.3		Pressure control valve				Lube oil pressure			Integrated in coupling housing
	46.4		Pressure relief valve				Working oil pressure			Integrated in coupling housing
	46.5		Check valve with orifice bore Type: RK 44 D2 Make: Gestra		PN 16 DN 40		Discharge line of filling pump			Materials: housing: 2.1050 disc: 1.4571
	55.1		2-valve manifold Type: N 342.44.483.21 Make: Schneider		Instrument: ½ NPT Process: ½ NPT Test: ¼ NPT					Housing material: Stainless steel 316 L
	55.3		5-valve manifold Type: N 342.42.482.01 Make: Schneider		Instrument: ½ NPT Process: ½ NPT Test: ¼ NPT					Housing material: Stainless steel 316 L
	58		Orifice for working oil heat exchanger venting		G ¾					Not Voith Supply

Main Components and Instrument List

Revision	Item No. Voith	Item No. Customer TAG No	Components or Instrument, Type: Make:	Measuring range --- Adjusted range	Process Connection --- Electrical Connection	Ingress Protection	Measurement / Measuring point, location	Set value	Nominal value during operation	Remarks
1)	60		Resistance thermometer 2x PT100, 3-wire system DIN IEC 751 Class B Drawing No. 42035240 Make: JUMO	0 - 180 °C	G ½ --- M20x1.5	IP 65	Oil sump temperature	Main motor release: > 10 °C Alarm: > 95 °C	> 30 °C	Housing material: Aluminum, coated

VOITH TURBO

POWER TRANSMISSION

Variable Speed Drives

Voithstrasse 1
D-74564 Crailsheim
Tel.: 07951 / 32 - 0
Fax : 07951 / 32 - 650

Code	:	Flowserve Ashuganj S 1
VC product	:	562 SVTL HP
Order number	:	38003425
Drawing number	:	215001154-0050en
Designation	:	Variable speed turbo coupling - Logic Flow Chart
Symbolic files	:	Symboldatei
File	:	J:\Turbo\ai-VTCR\air\BA-Doku\215\215001100-1199\1154\215001154-0050en.pfd
Department	:	aevec

Issued on	:	14-10-24	by	:	MMar	Number of pages	:	26

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Revision list

Page	Revision description	Index	Revision No.	Date	Name
all	TAG added	1	188472	21.01.15	sahoe

SPACE FOR INPUT SIGNALS | SPACE FOR LOGIC SYMBOLS AND GENERAL COMMENTS | SPACE FOR OUTPUT SIGNALS

GENERAL COMMENTS

Identification of symbols for logic diagram, refer to the following 4 pages of this document.

For item numbers, see Oil Circuit and Measuring Point Scheme 215001154-0020.

Before test run and after each overhaul all switch points and connections have to be checked or adjusted.

For switch points, see designation list of Oil Circuit and Measuring Point Scheme 215001154-0030.

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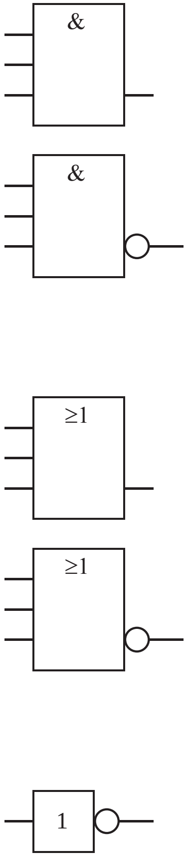
This is the input side

This is the output side.



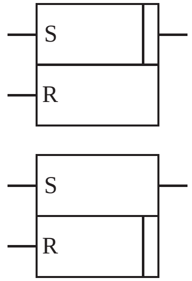
AND
The output will be in the 1-state
if all the connected inputs are
in their defined 1-state.

NAND
The output will be in the 0-state
if all the connected inputs are
in their defined 1-state.

OR
The output will be in the 1-state
if any of the connected inputs is
in its defined 1-state.

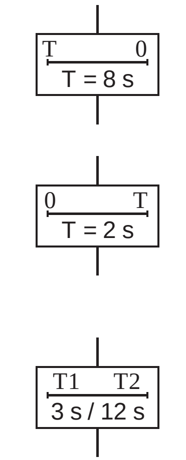
NOR
The output will be in the 0-state
if any of the connected inputs is
in its defined 1-state.

NOT (Negator/Inverter)
The output will be in the 0-state
if the input is in the defined 1-state.



Bistablelogic function symbol
with prevailing S input

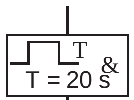
Bistable logic function symbol
with prevailing R input



ON - delay (8 sec)

OFF - delay (2 sec)

ON - delay (3 sec)
and
OFF - delay (12 sec)



The output pulse time is
always 20 sec irrespective
of the input signal duration.

The letter indicates the signal,
the number indicates the page
where the signal is going to.

Example of a connection to another page

				Date	14-10-24	Flowserve Ashuganj S 1	VOITH TURBO	Description of symbols part 1	Order No.:	38003425	
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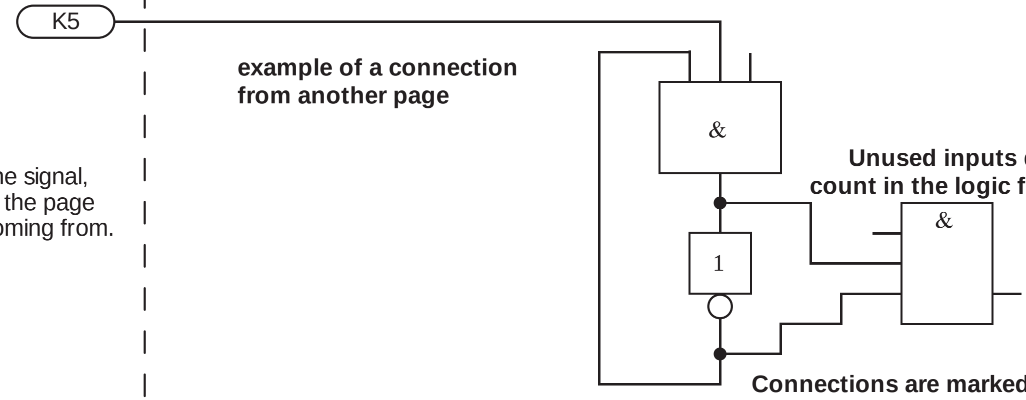
This is the input side

This is the output side.

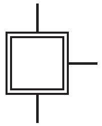


example of a connection from another page

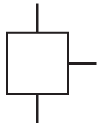
The letter indicates the signal, the number indicates the page where the signal is coming from.

Unused inputs do not count in the logic flow chart.

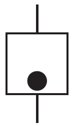
Connections are marked with a dot.



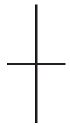
This is the initial step in a process representing the start conditions.



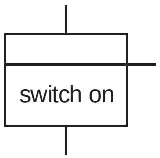
This is a step in a process.



This is a step in a process.
The dot indicates that its condition is logic 1 (fulfilled).



This is a transition. It is located between steps and describes the necessary actions between the steps.



This is a step with a description of the step.

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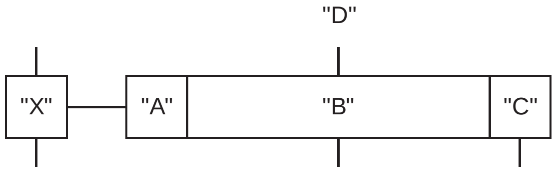
This is the input side



This is the output side

The symbol on the right-hand side to the step symbol is an action symbol.
The action symbol could exist of 3 fields (field "A", "B" and "C").

Commands above and from left of the action symbol are input signals
and are to be treated like an AND connection.
Commands beneath the action symbol are output signals.

Field "A" or "C" are to be used only if required.

Field "B" describes the action if step "X" is fulfilled.

Field "A" descibes the correlation between the step "X" and the action "B",
the following letters are to be used:

S	stored
D	delayed
L	time limited
P	pulse shape
C	conditional

Letter combinations can be used, therefore the order the letters are written is important.

For example: "A" = DSL The input signal "X" will be delayed, stored
and the action "B" limited to a certain time.

Field "C" describes the feedback of the command "B".
The following symbols can be used:

A	Command output
R	Command effect is achieved (response control)
X	Fault signal, command effect is not achieved
1,2...	No. of feedback

For example:

"A" = DSL — The input signal "X" will be delayed, stored and the action "B" limited to a certain time.

If letter c (conditional) is used the action is only enabled if the condition described under "B" is fulfilled.

For example:
"A" = SLC
"B" = lube oil pump ON
"D" = oil level ok

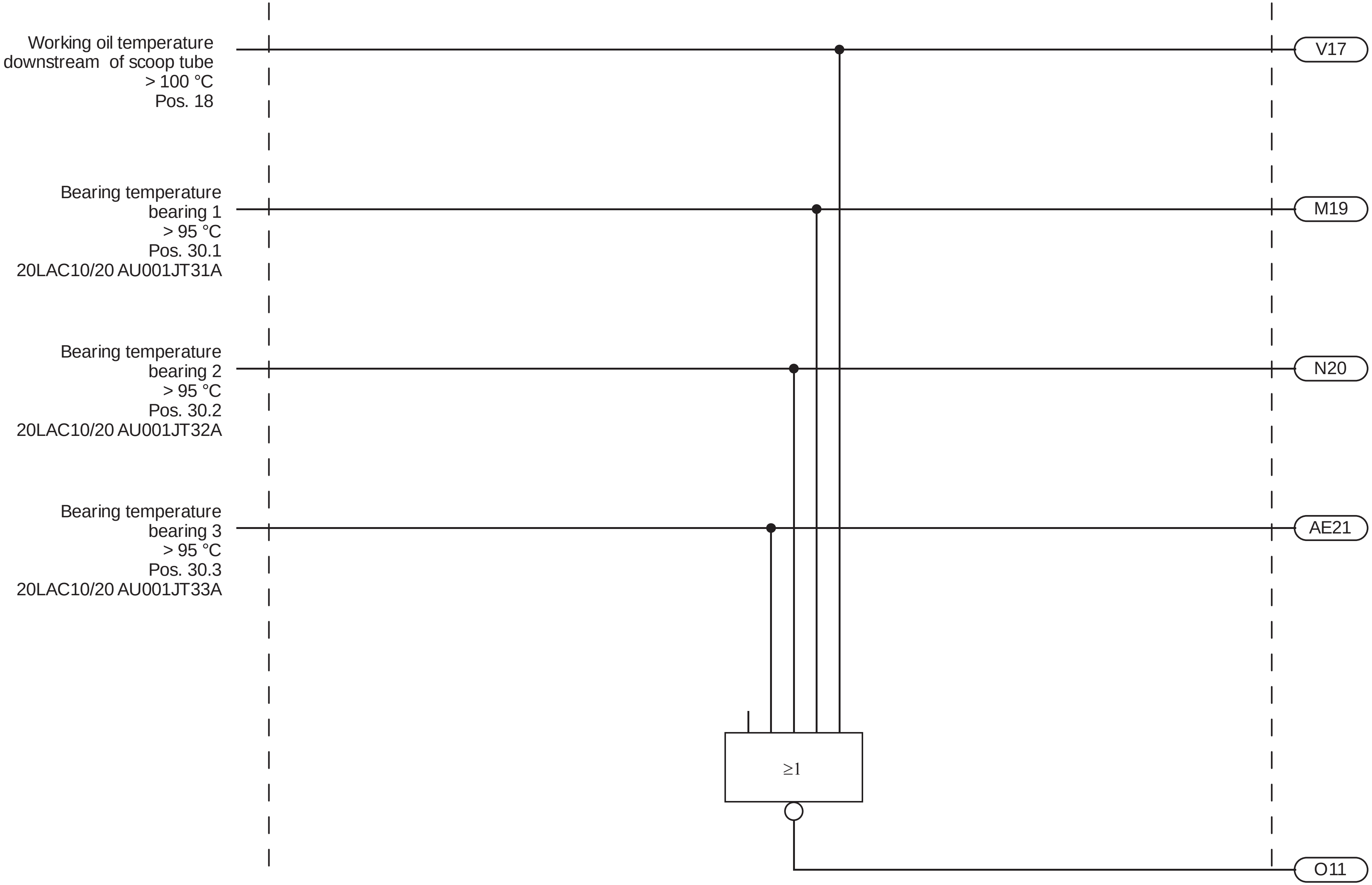
The input signal "X" will be stored and the lube oil pump will be switched ON for a limited time if the oil level is ok.

Field "C" indicates the feedback of the action to be carried out.
In the above example "C" would indicate logic 1 if the lube oil pump is ON.

All connections at the top or at left hand side of a box are inputs.
All connections at the bottom or at right hand side of a box are outputs.

General descriptions:

"If necessary go to logic "Unit Off" (operator action)" means the unit can be operated under this condition. However the operator should be aware that the trip signal could follow soon. The unit should be stopped at the next possible opportunity to check a possible fault.



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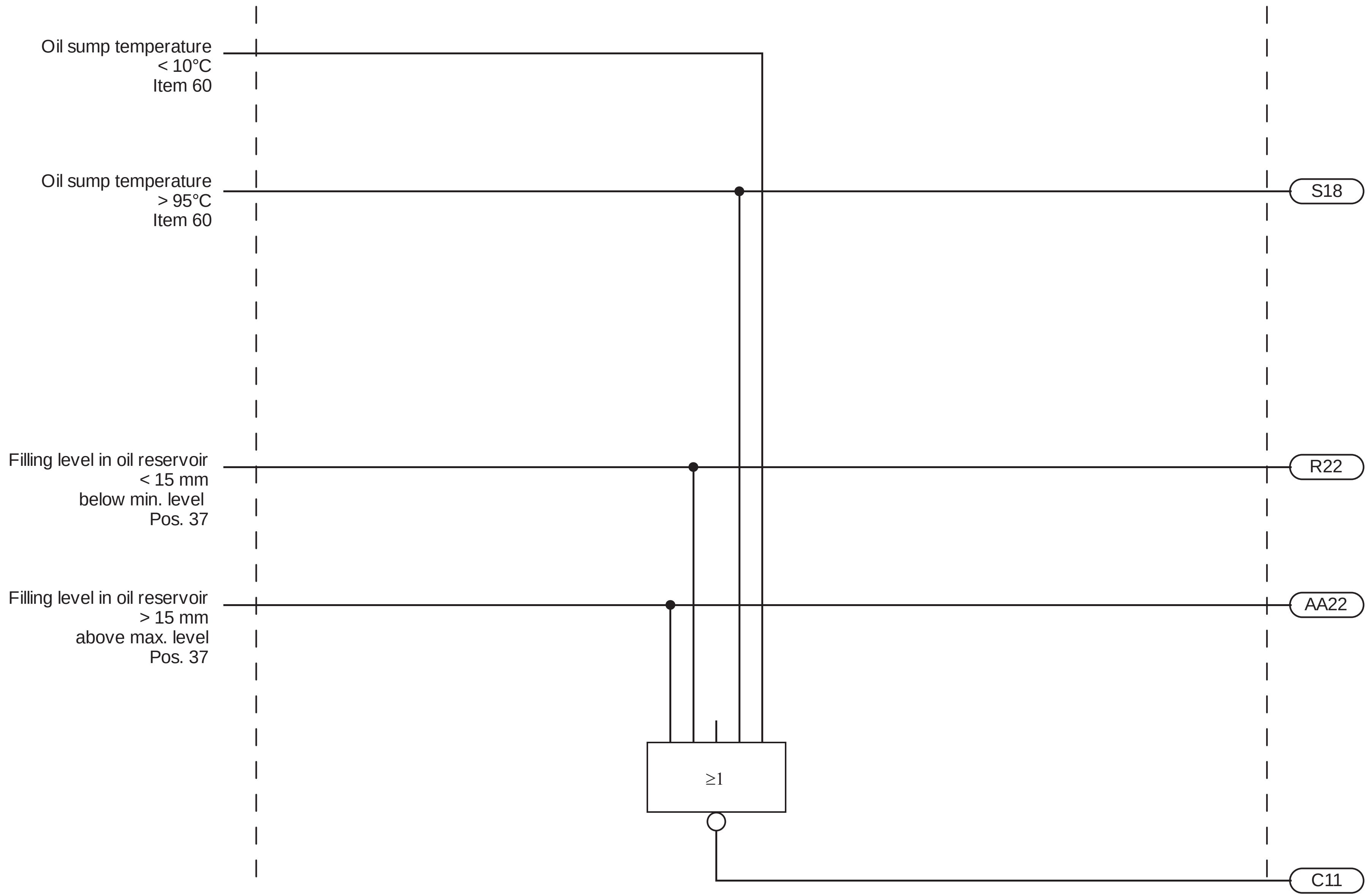

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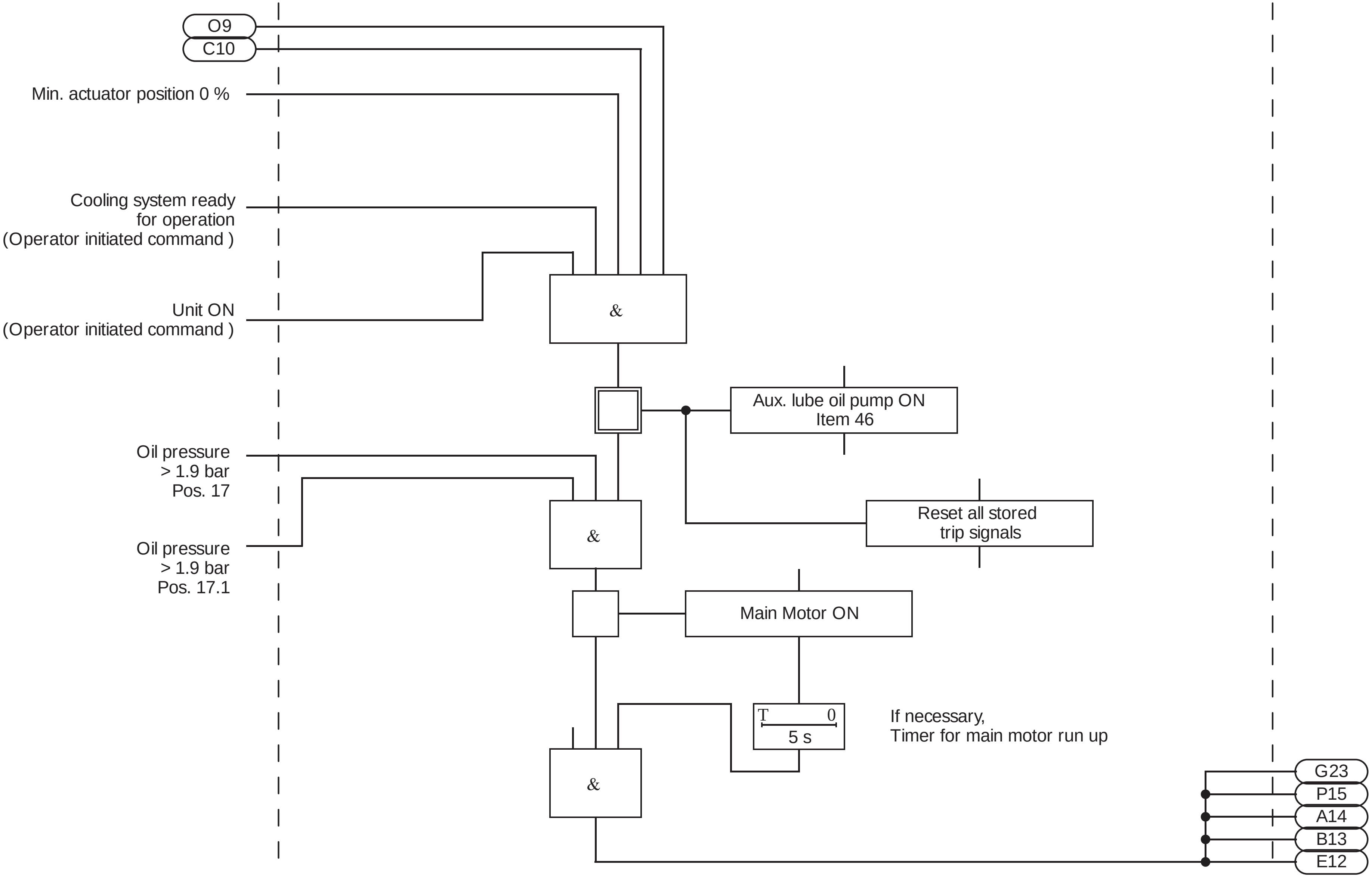

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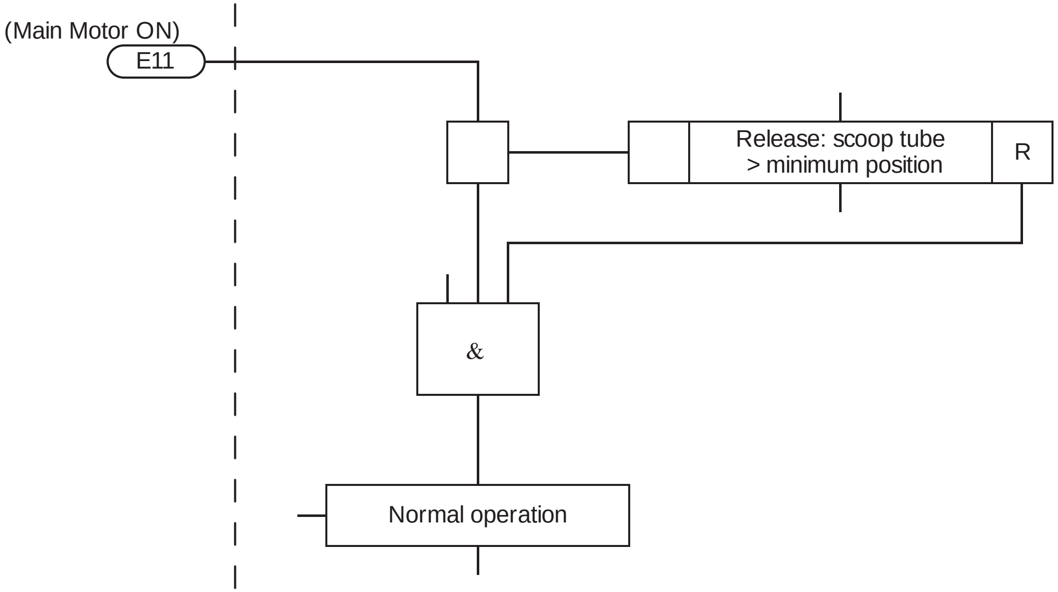

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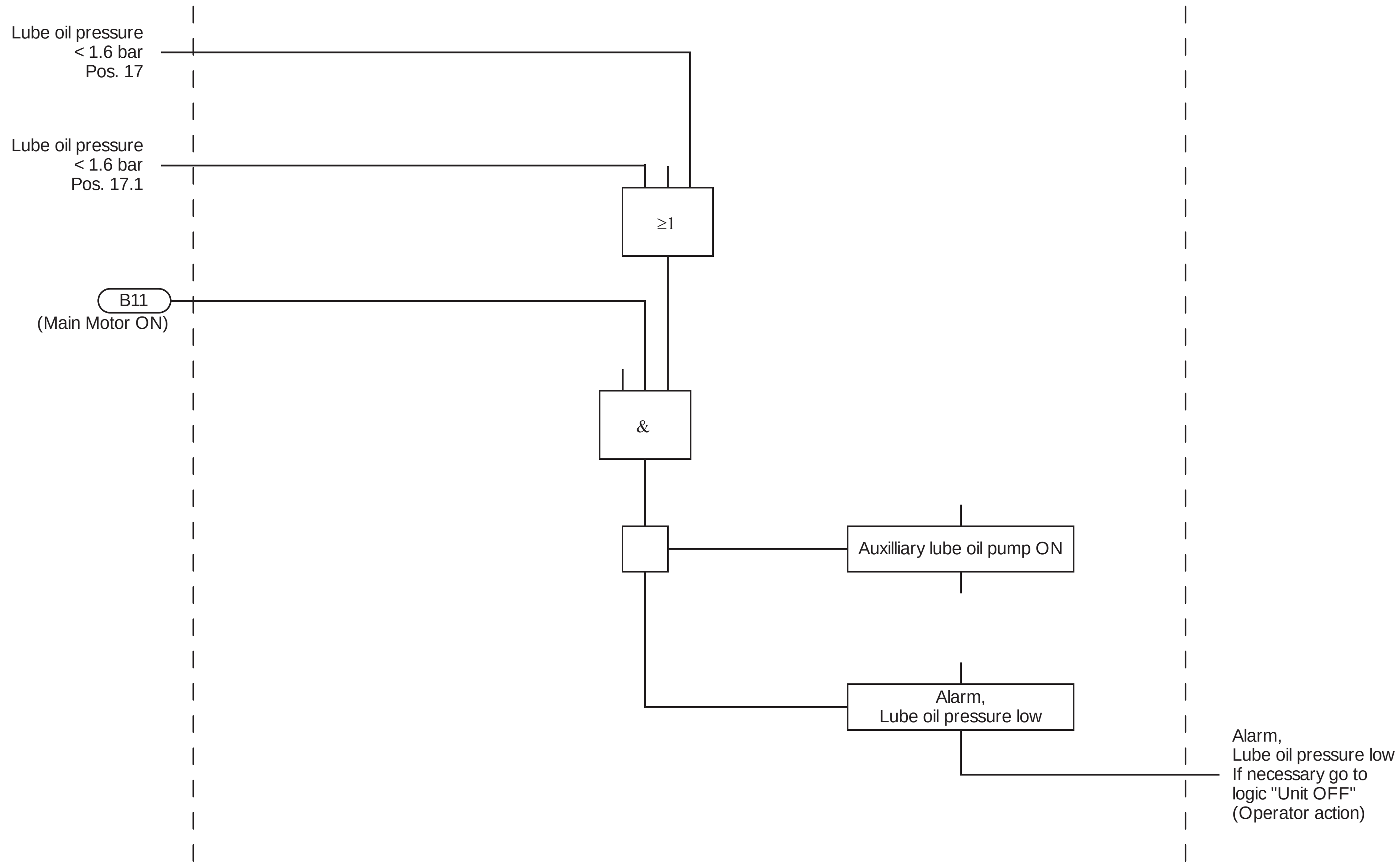

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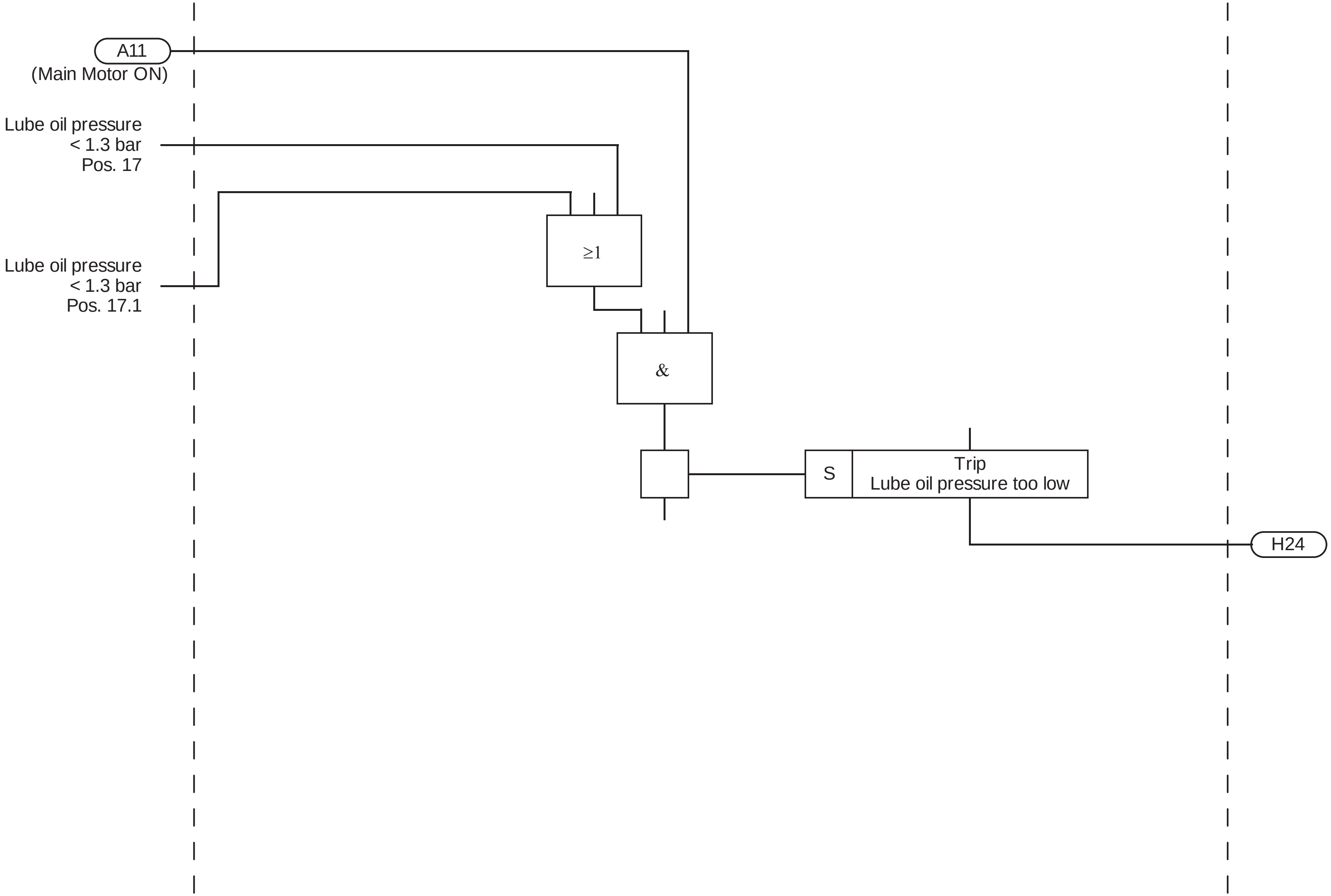

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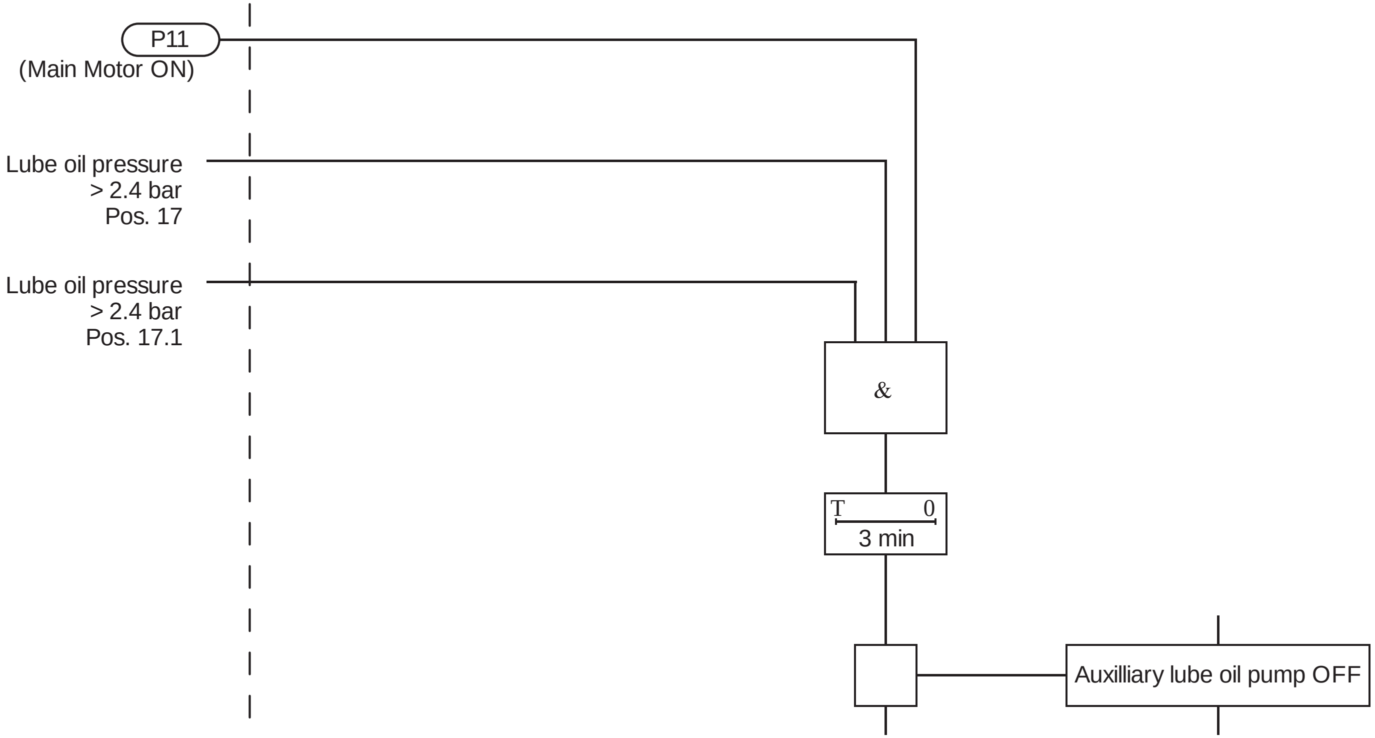

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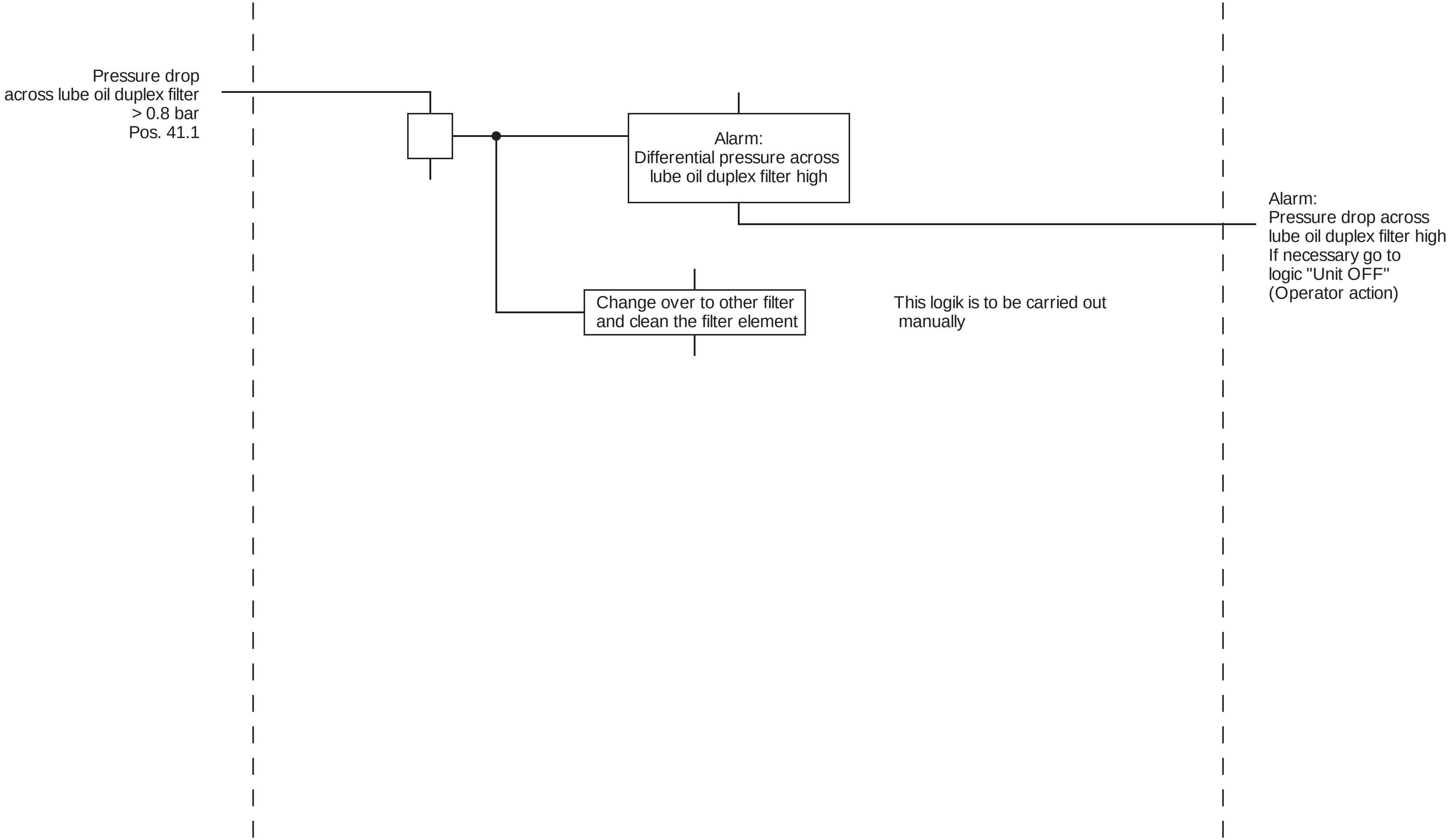

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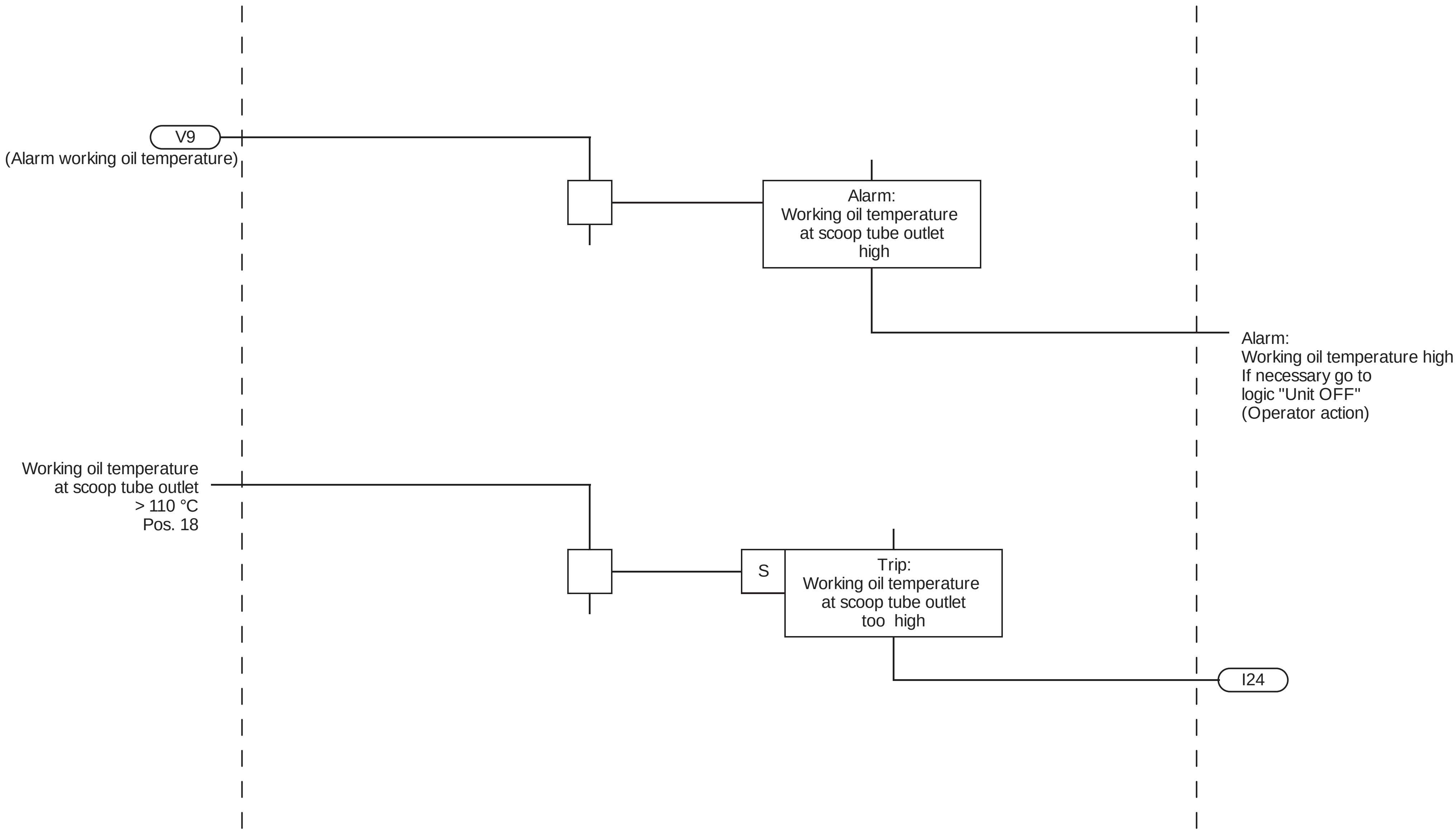

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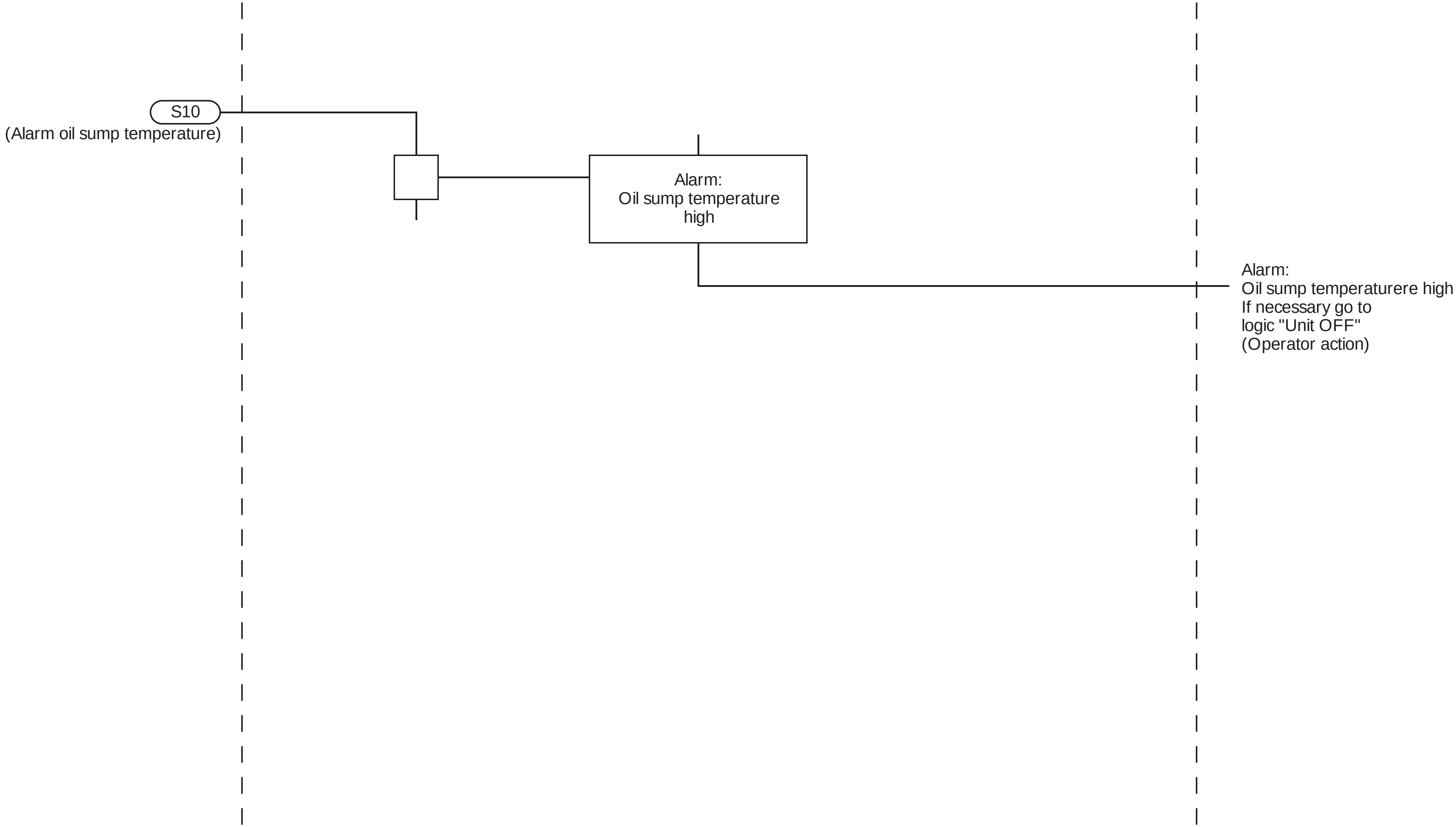

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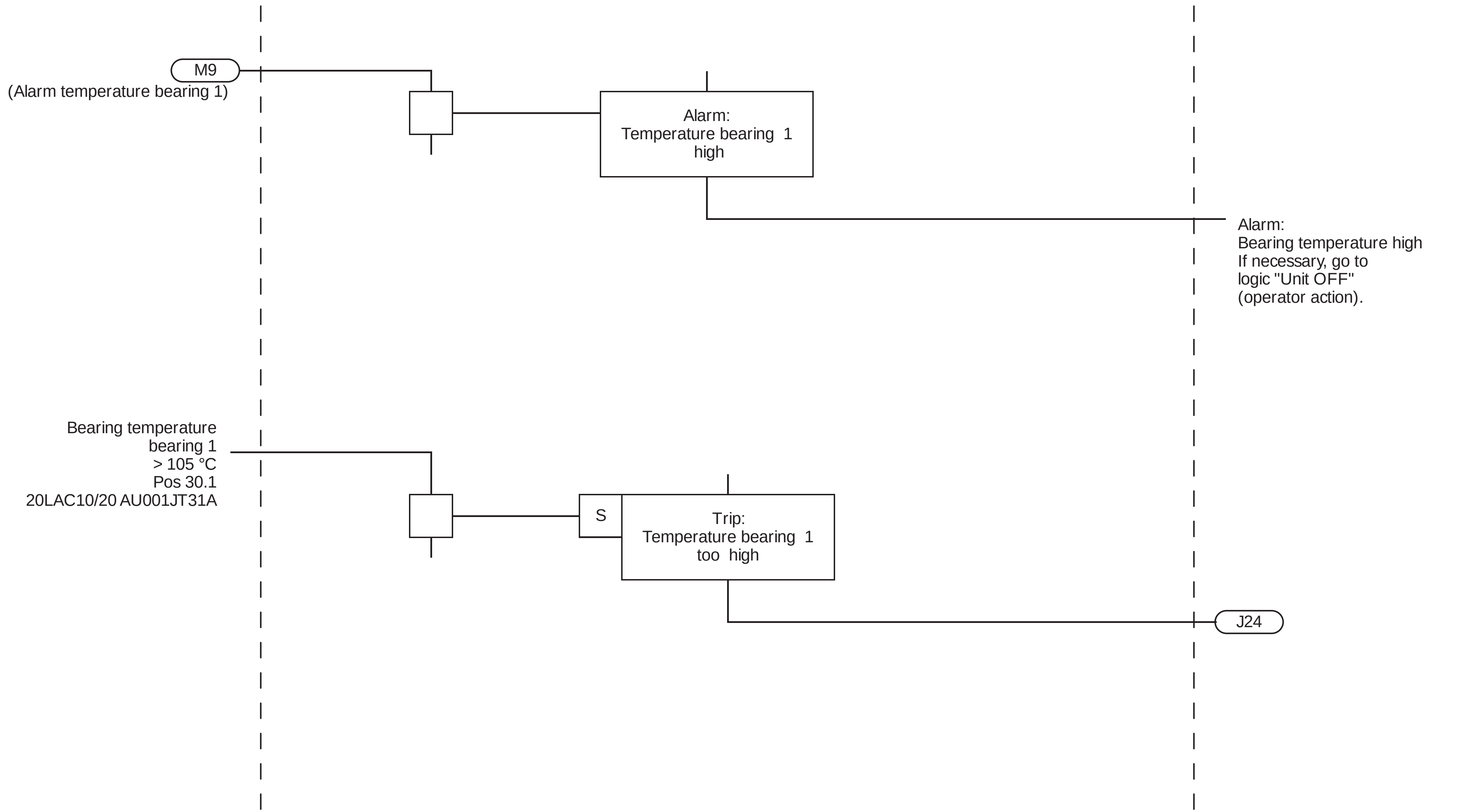

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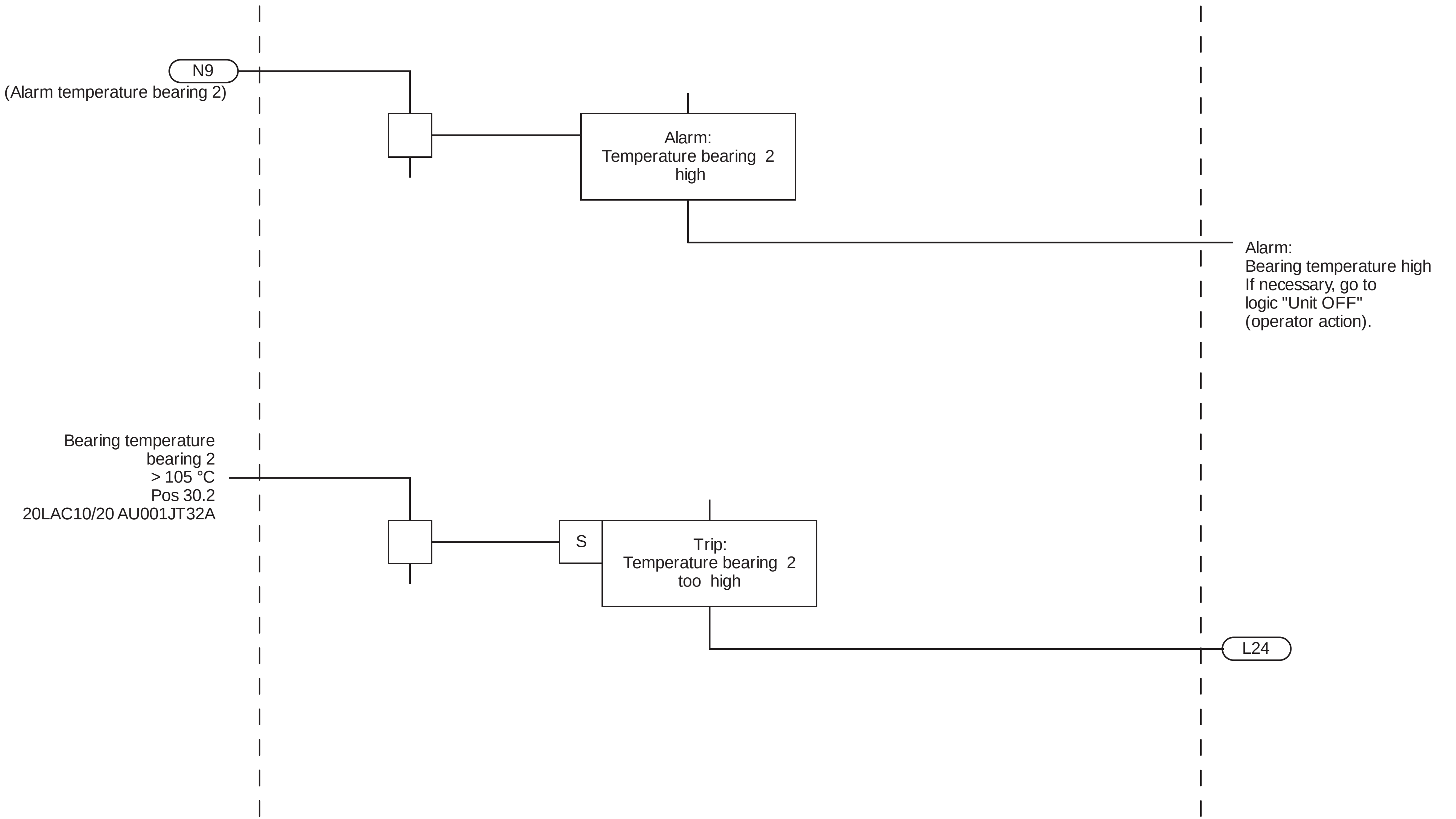

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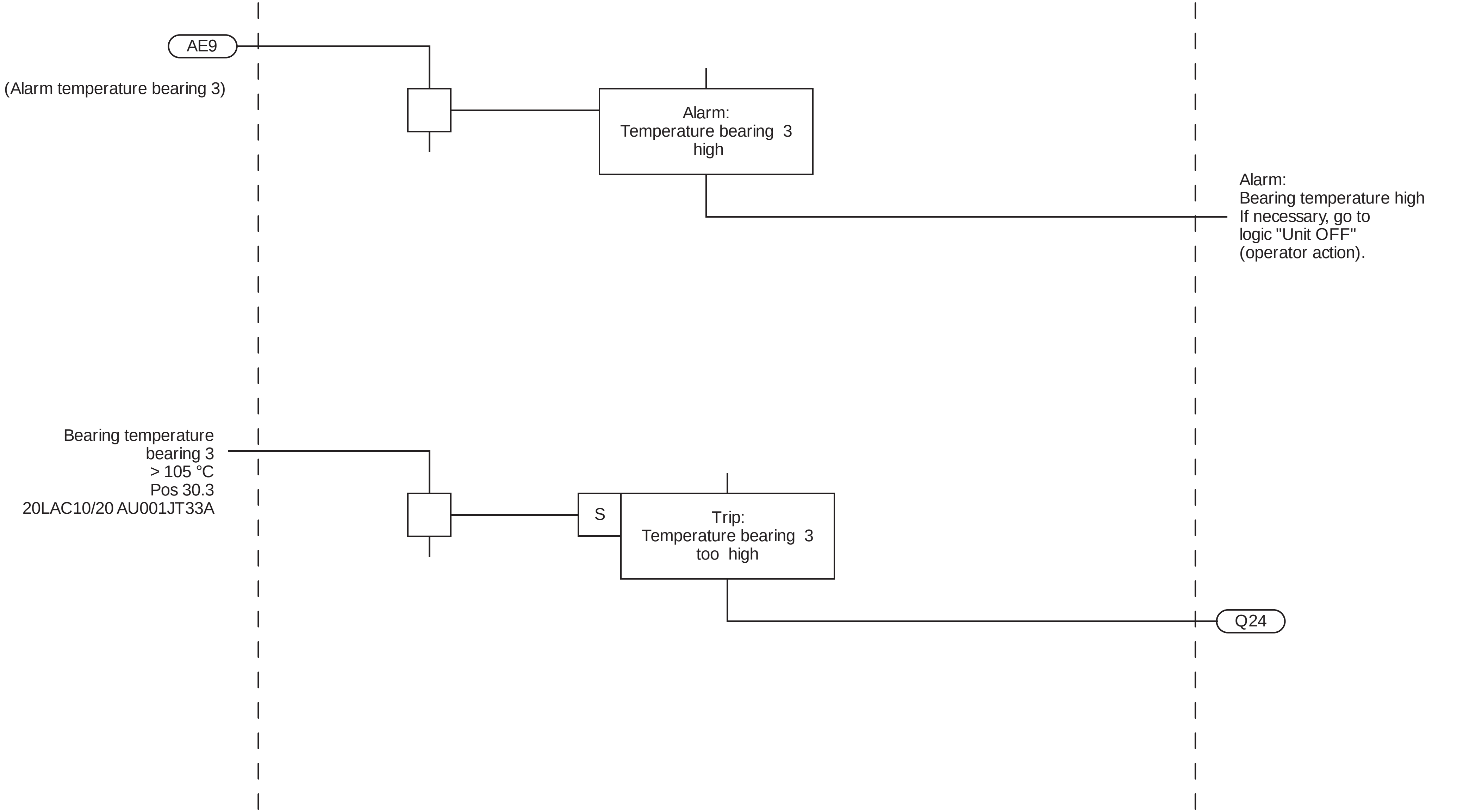

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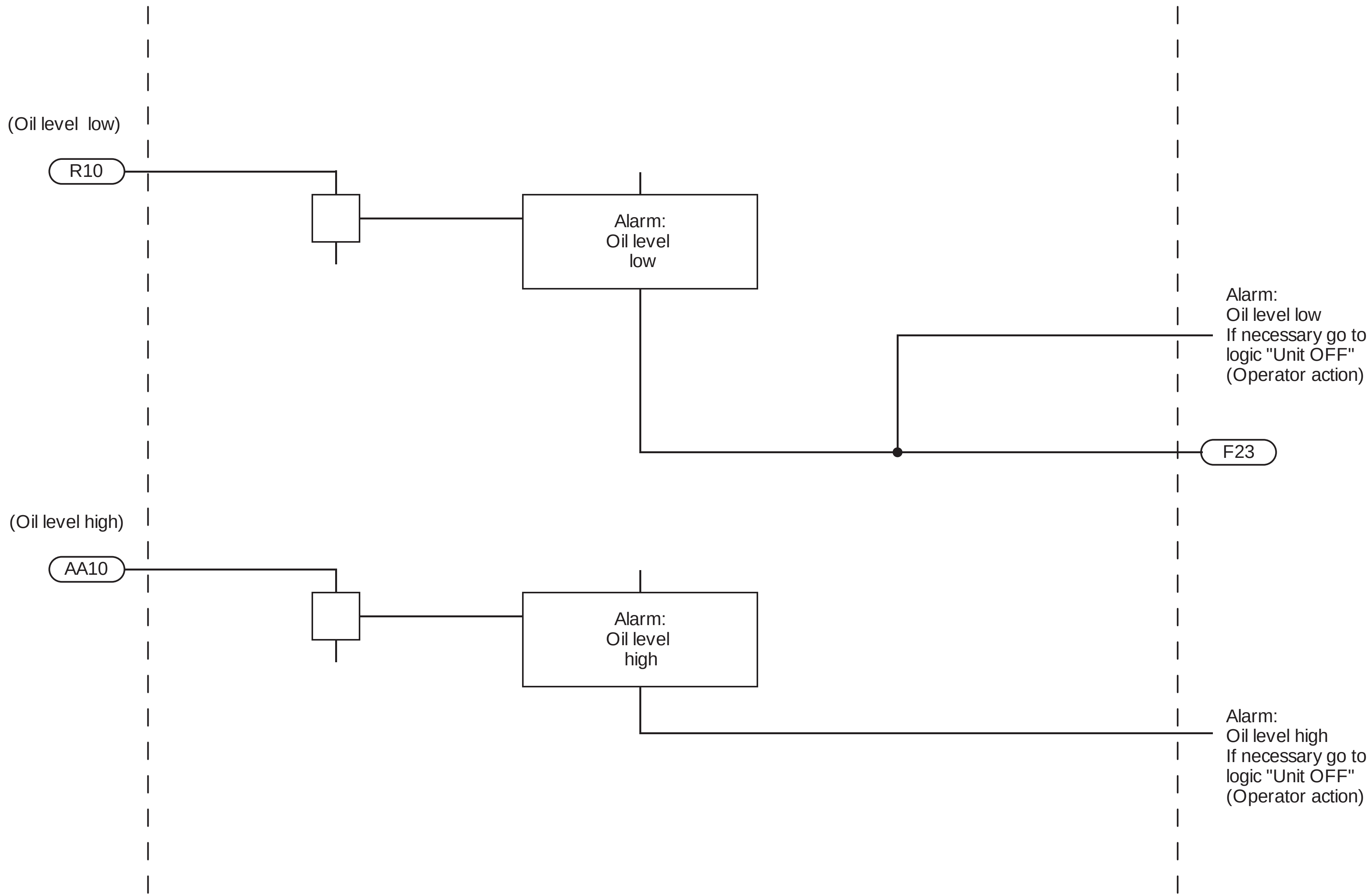

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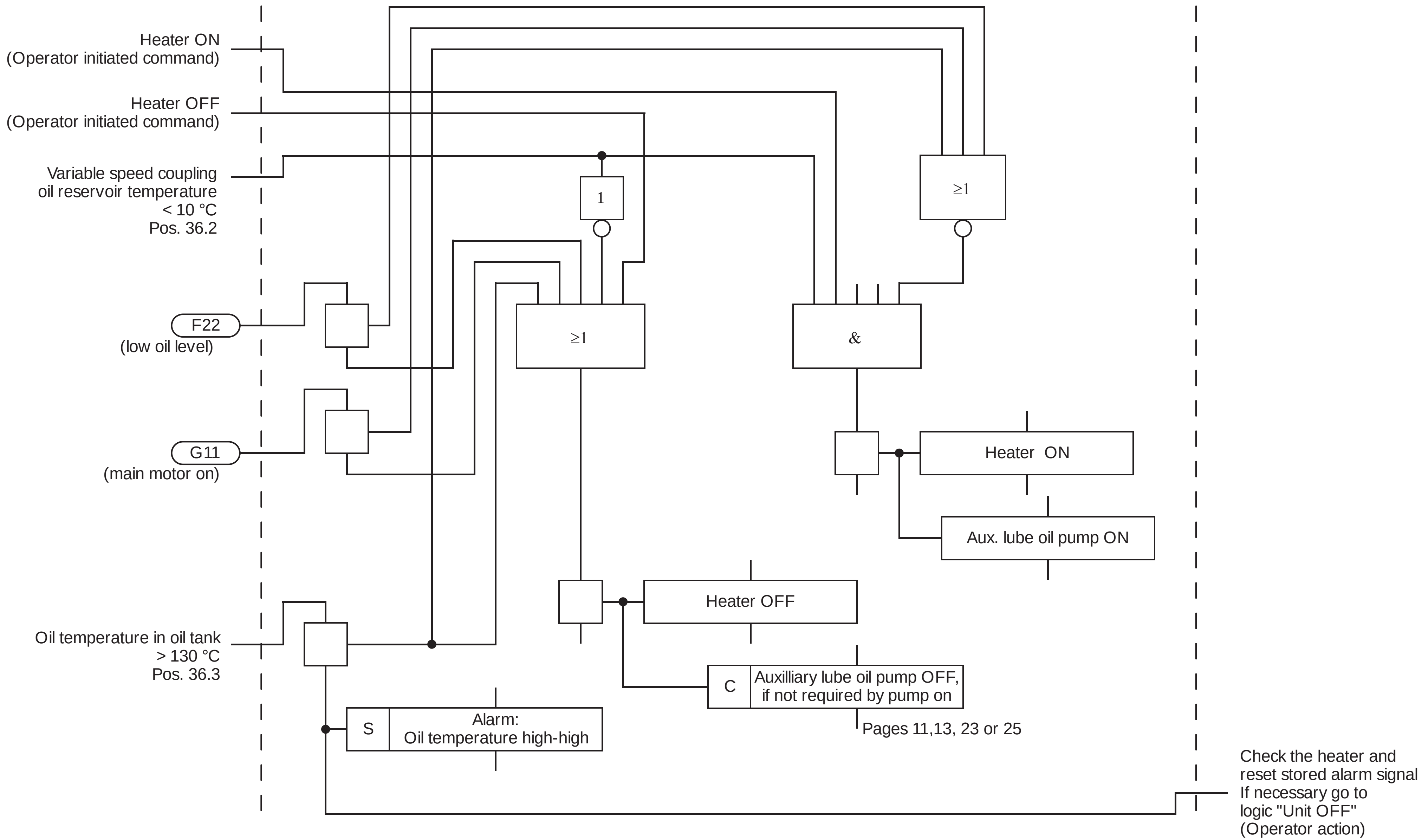

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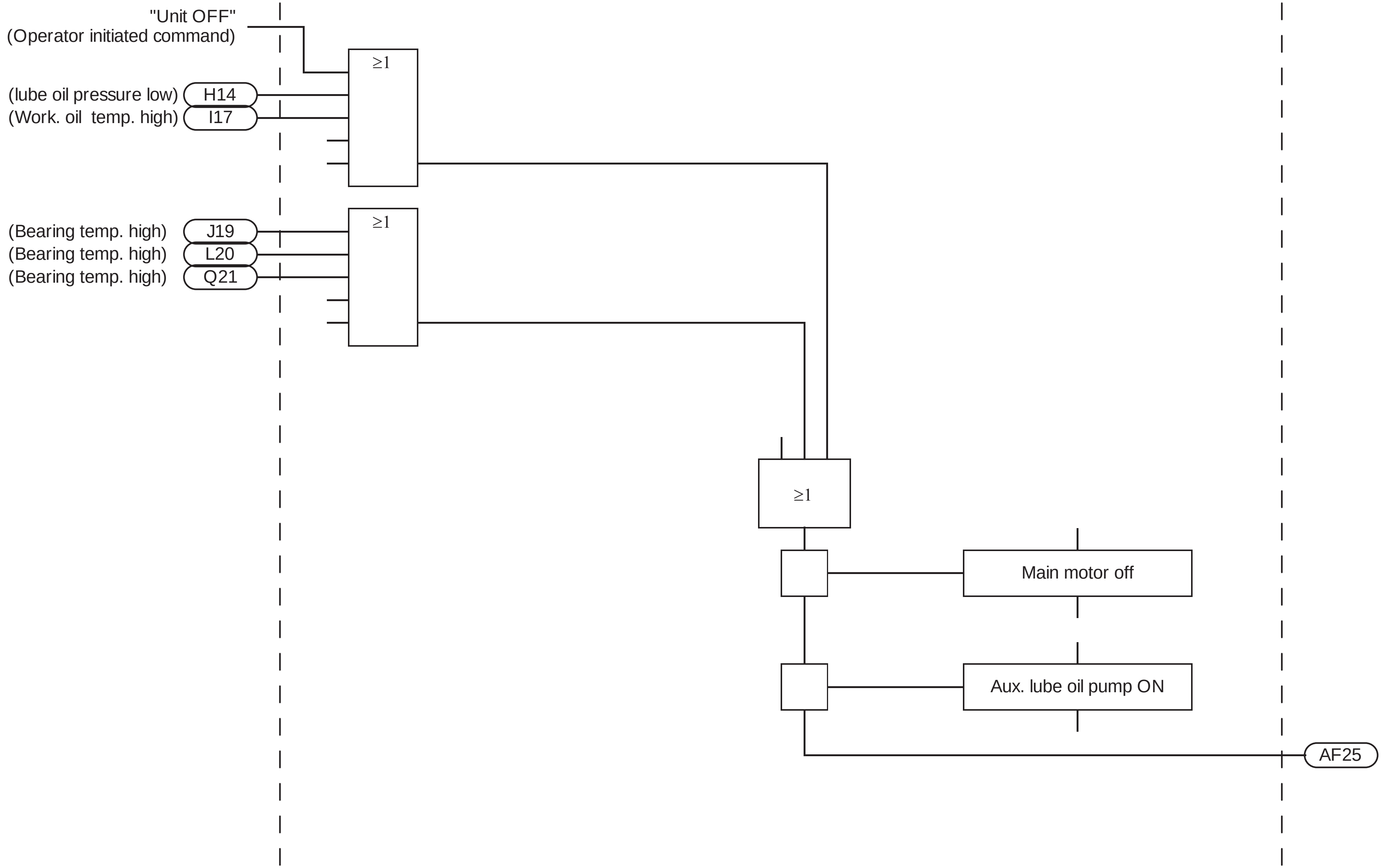

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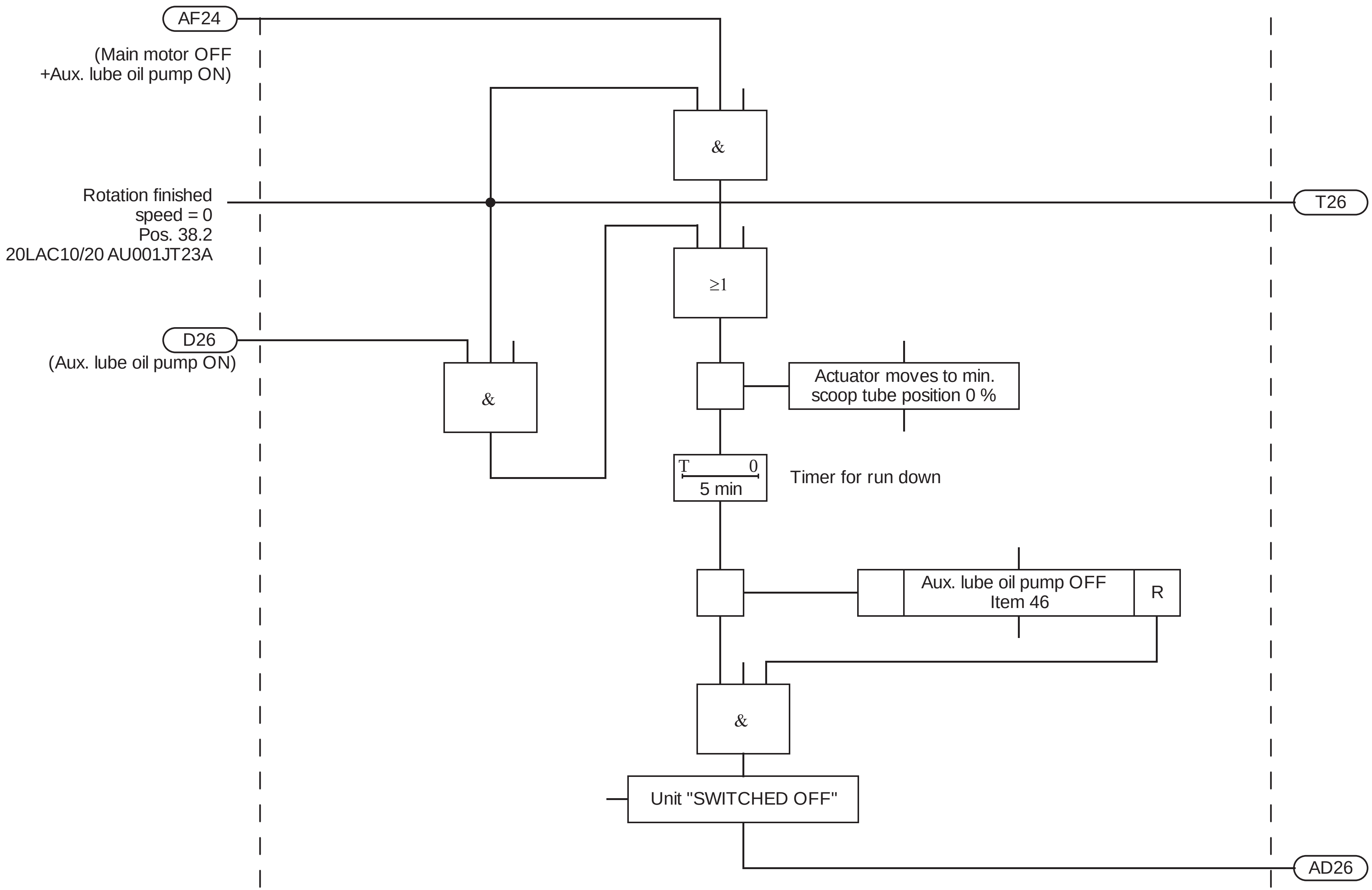

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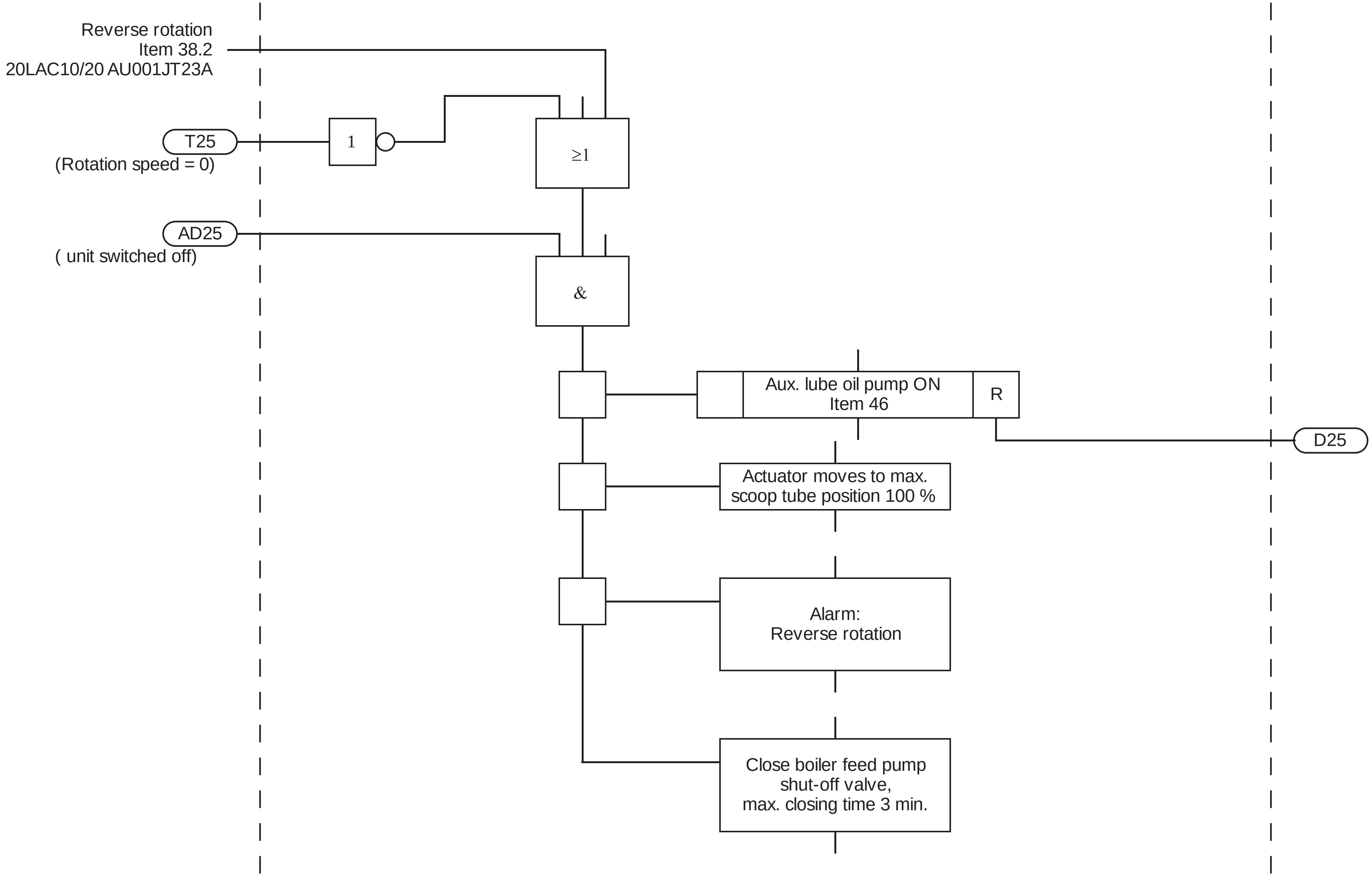
				Editor	MMar						
1	188472	21.01.15	sahoe	Date		562 SVTL HP	Dept.aevec		Drawing No.:	215001154-0050en	Page 25
Index	Rev. No.	Date	Name	Checked							26 P.



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				Editor	MMar						
1	188472	21.01.15	sahoe	Date		562 SVTL HP	Dept. aevec		Drawing No.:	215001154-0050en	Page 26
Index	Rev. No.	Date	Name	Checked							26 P.

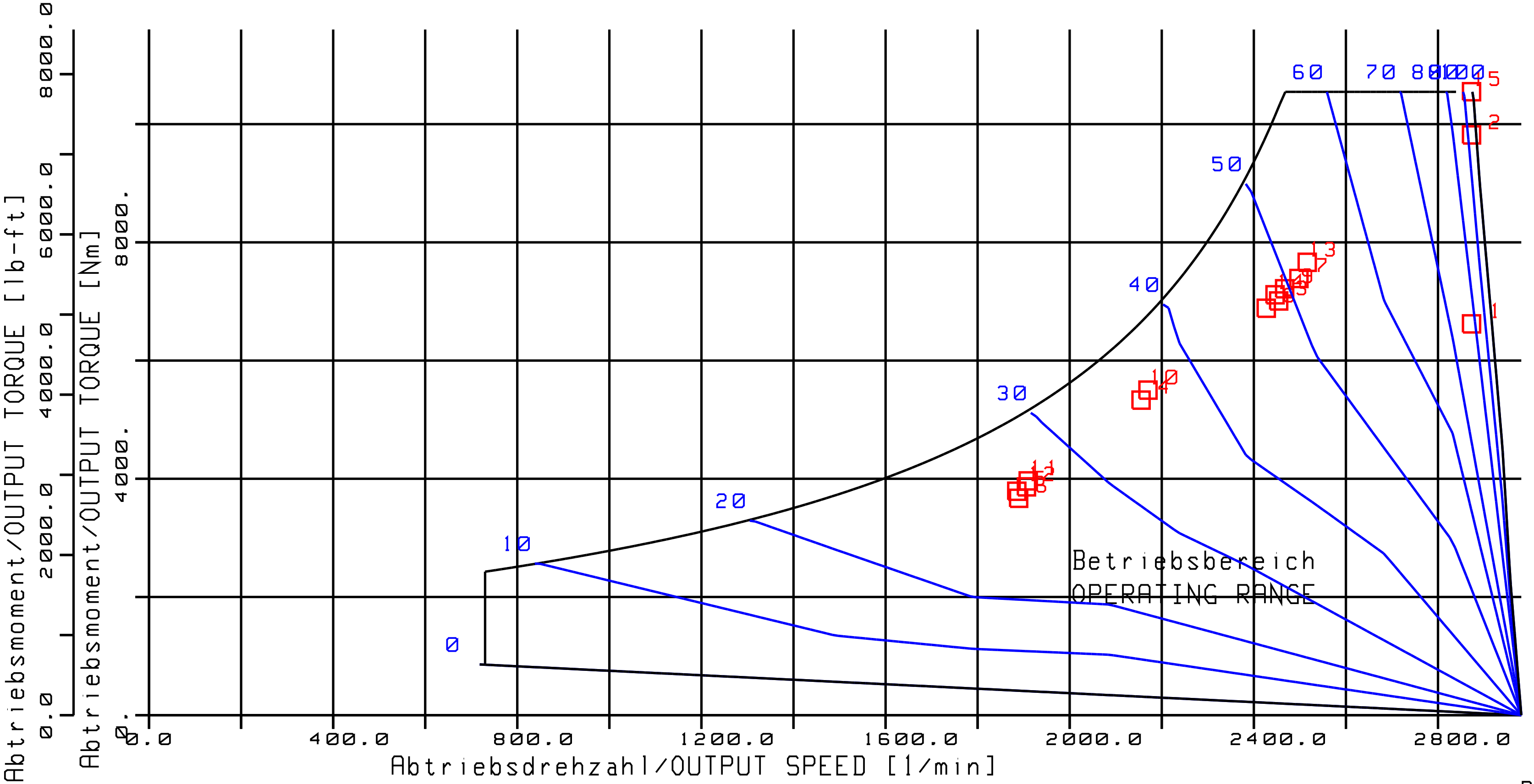
mlb 137 **PC**

...erve_Ashuganj_S1\10_Vertrieb\1020_Auslegung\Rev08\S21404016_GQ_rev08_025

VOITH	PREDICTED CHARACTERISTIC CURVE 10353_Ashuganj	S21404016_GQ_re 562 SVTL HP

Motordrehzahl	/ MOTOR SPEED	2981.	[1/min]		
Primaerdrehzahl	/ PRIMARY SPEED	2981.	[1/min]		
Sekundaerdrehzahl	/ SECONDARY SPEED	2874.	[1/min]		
Abtriebsdrehzahl	/ OUTPUT SPEED	2874.	[1/min]		
Abtriebsleistung	/ OUTPUT POWER	3174.	[kW]	4256.	[HP]
Motorleistung	/ MOTOR POWER	3900.	[kW]	5230.	[HP]

Schoepfrohrpositionen [%]
nur zur Information
Scoop Tube position [%]
for Information only



PKA 635/ 40/ 567
L = 2.25/2.50

2014-10-22 10:41:43 schmela	**Voith Turbo GmbH & Co. KG - D-74555 Crailsheim - Postfach 1555 ·** Telefon +49 7951 32-0 · Fax 32-500	215001154-0060

UTE TSK TÉCNICAS REUNIDAS ASHUGANJ NORTH	Ashuganj Power Station Company Ltd. (APSCL)	

ASHUGANJ COMBINED CYCLE POWER PLANT PROJECT (NORTH)

UTS PROJECT NO. 7485	**UNIT: BOILER FEED WATER PUMPS**
PURCHASE ORDER NUMBER (P.O.R) 074850503 / F557	**EQUIPMENT : LAC**

REVIEW RESPONSE BY PURCHASER:

Purchaser review and comments do not indicate either responsibility or liability for accuracy and completeness of this document or alter any contractual terms and conditions:

☐ REJECTED	☐ Reviewed With Comments	☐ Review. Without Comments
☐ COMMENTS AS NOTED	☐ REVIEWED AS BUILT	☐ FOR INFORMATION

DATE:

DOCUMENT VENDOR IDENTIFICATION: FLOWSERVE

DOCUMENT TITLE: **Hydraulic variator wiring diagram**

VENDOR DOCUMENT No: COS-14-10P40397-8215	REV: 1	CODE: ESQ-0008
UTS DOCUMENT No:	REV: 1	
KKS DOCUMENT No.: 07485-20-LAC-EDP-FLS-007	REV: 1	

VOI1203E/16.Jul.1996

VOITH

VOITH TURBO GmbH & Co. KG

Voithstrasse 1 74564 Crailsheim
Tel: 07951 / 32-0
Fax: 07951 / 32-650

Client	:	Flowserve Spain S.L.
Unit designation	:	562 SVTL HP
Order number	:	38 003 425
Drawing number	:	215 001154-0040 en
Code word	:	Flowserve Ashuganj S 1
Regulating and Control	:	Voith Electro-Hydraulic Positioning System
Equipment - Type	:	VEHS / Balluff - BTL7-E100-M0175-B-KA05
File name without \EPLAN\P	:	\VOI\GA_2014\215 001 154-0040 EN
CAD - Symbolic files	:	DIN_WUP/VC_SYMBL
Designation	:	WIRING DIAGRAM
Department	:	aevese-Ga

Created at : 06.11.2014
Revised edition : 03.02.2015 by : Gaugler

design specification after c132

2

0	1	2	3	4	5	6	7	8	9

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VOI_1201 / 22.März 2001

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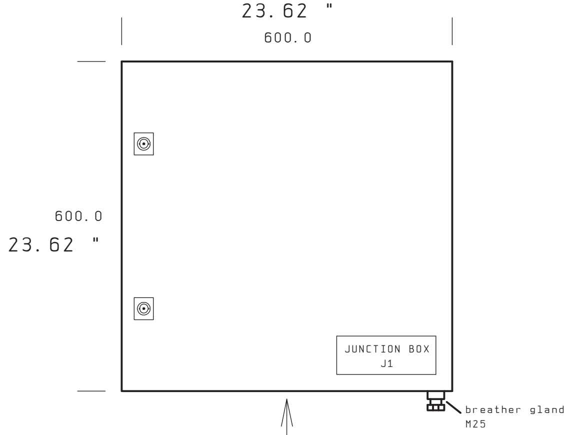
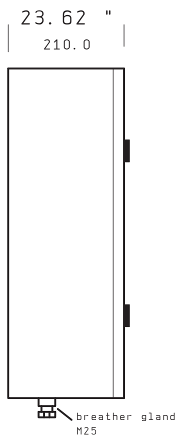
3

junction box
J1

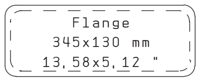
front view



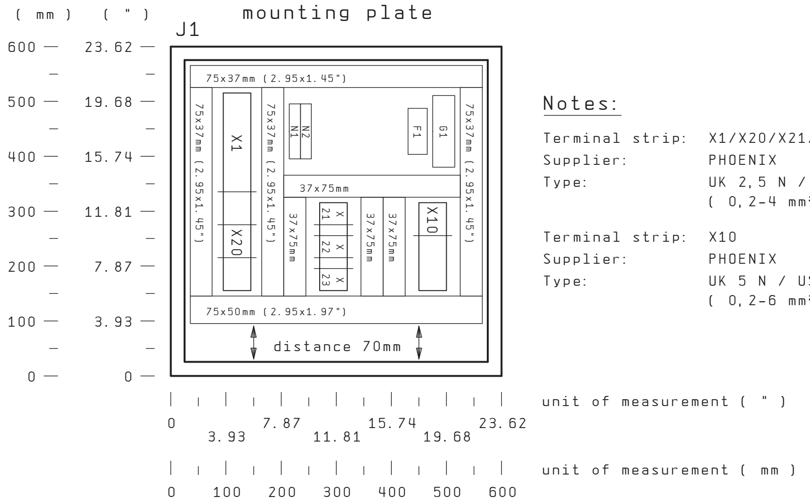
side view



Gland plate for customer



layout
mounting plate



Supplier:	Eldon
Type:	ASR 0606021
junction box dimensions:	23.62x23.62x8.27 " 600x600x210 mm
material:	stainless steel
protection:	IP 65
weight:	approx. 40 kg

scale: 1:10

Notes:

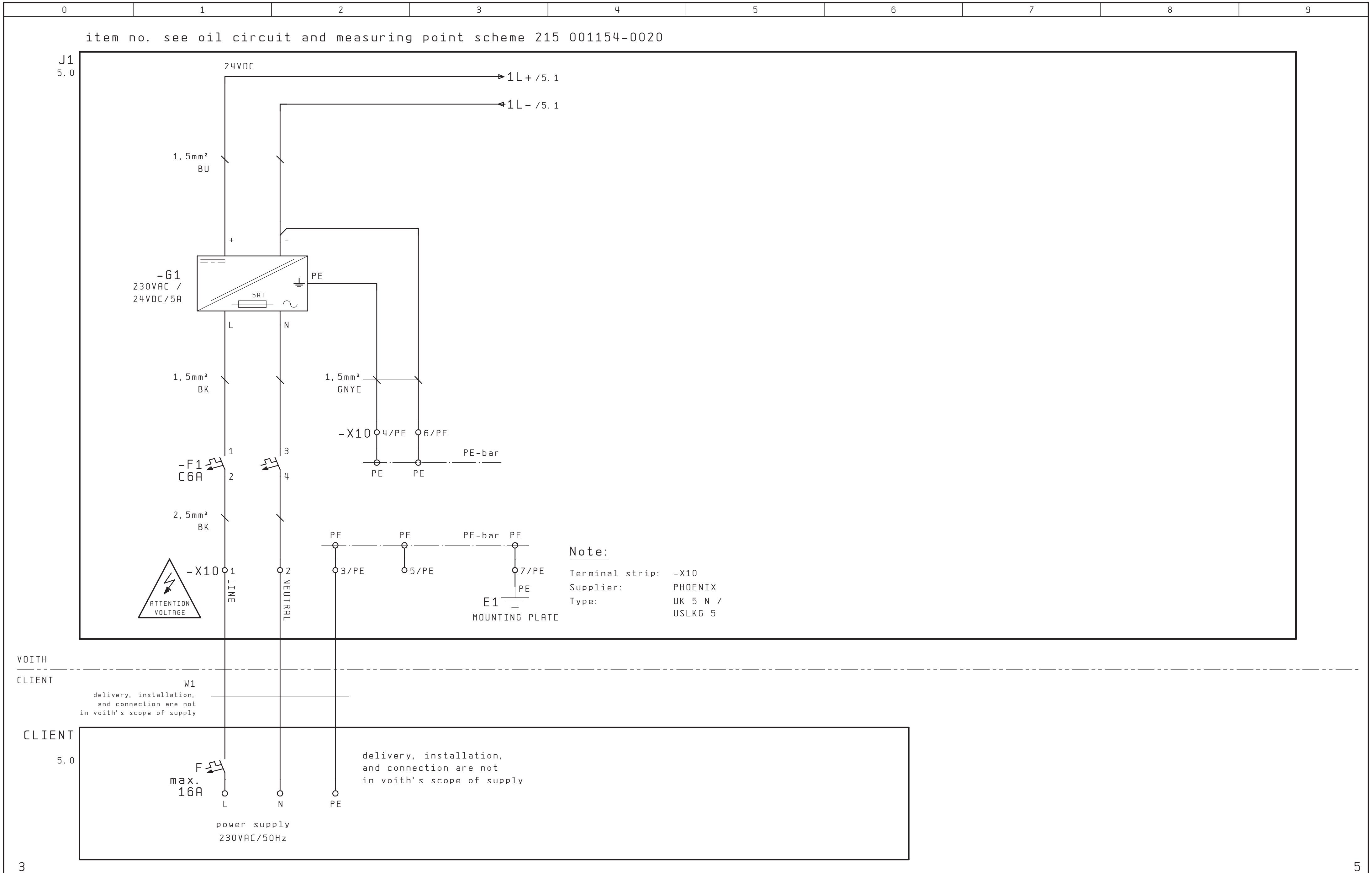
Terminal strip:	X1/X20/X21/X22/X23
Supplier:	PHOENIX
Type:	UK 2,5 N / USLKG 2,5 N (0,2-4 mm²)
Terminal strip:	X10
Supplier:	PHOENIX
Type:	UK 5 N / USLKG 5 (0,2-6 mm²)

ITEM NO.	Symbol designation	Type designation	VTCR - Art. number
1	J1	ASR 0606021	4 178 964 0
2	J1-N1	DN2012AG	204.014 094 10
3	J1-N2	DN2012AG	204.014 094 10
4	J1-F1	FAZ-C6/2	4 222 947 001
5	J1-G1	QUINT-PS/1AC/24DC/5	204.006 031 10

2

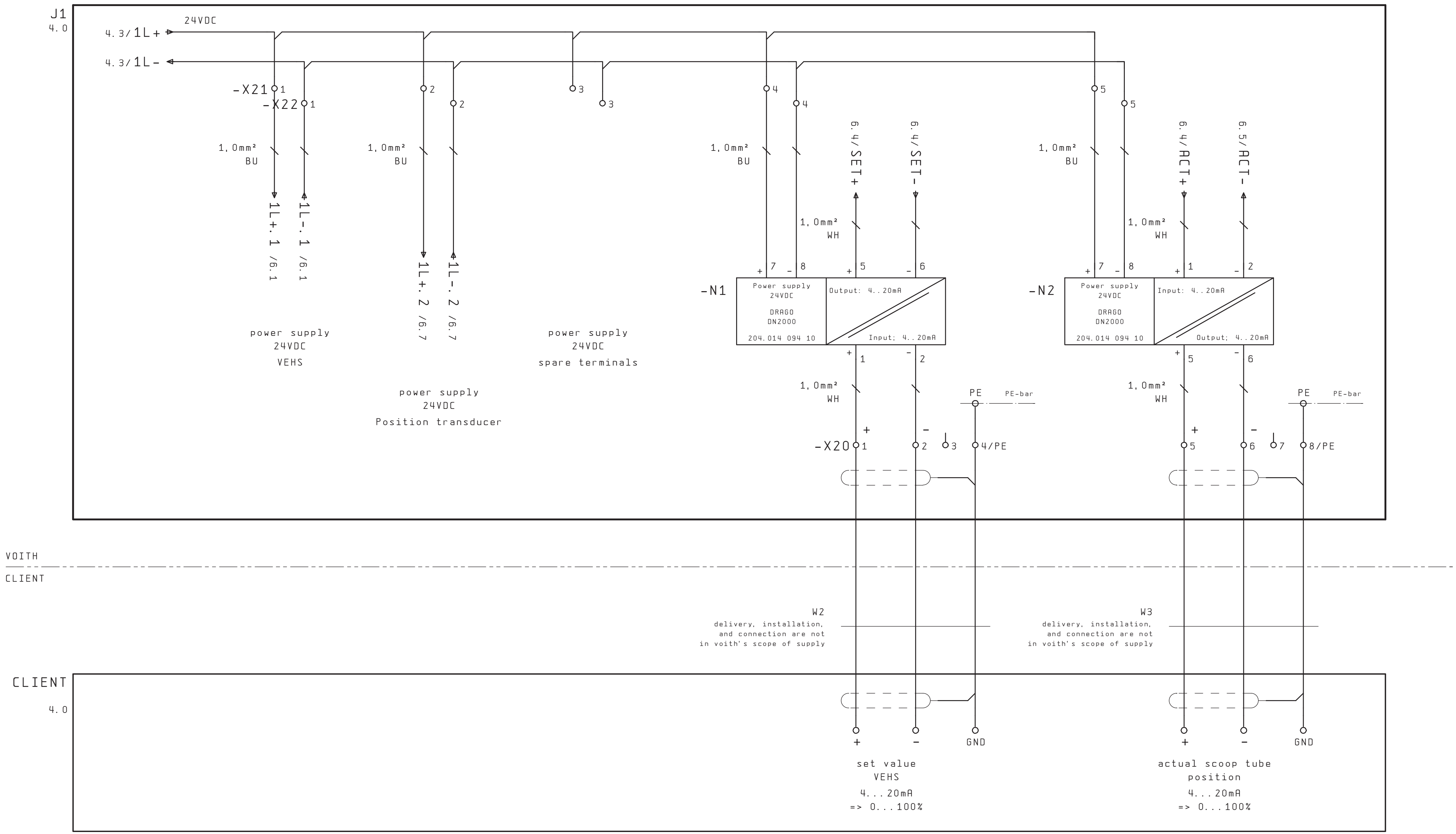
4

item no. see oil circuit and measuring point scheme 215 001154-0020



1	189063	03.02.15	Ga	Date	06.11.2014	Flowserve Ashuganj S 1	VOITH TURBO	power supply 230VAC	Order no.: 38 003 425	=
				Editor	Gaugler					+J1
				Date	03.02.2015	562 SVTL HP	Dep.:aevese-Ga			Page 4
Revisions		Date	Name	Checked		Original / Replacing	Replaced by		Drawing number: 215 001154-0040 en	6 P.

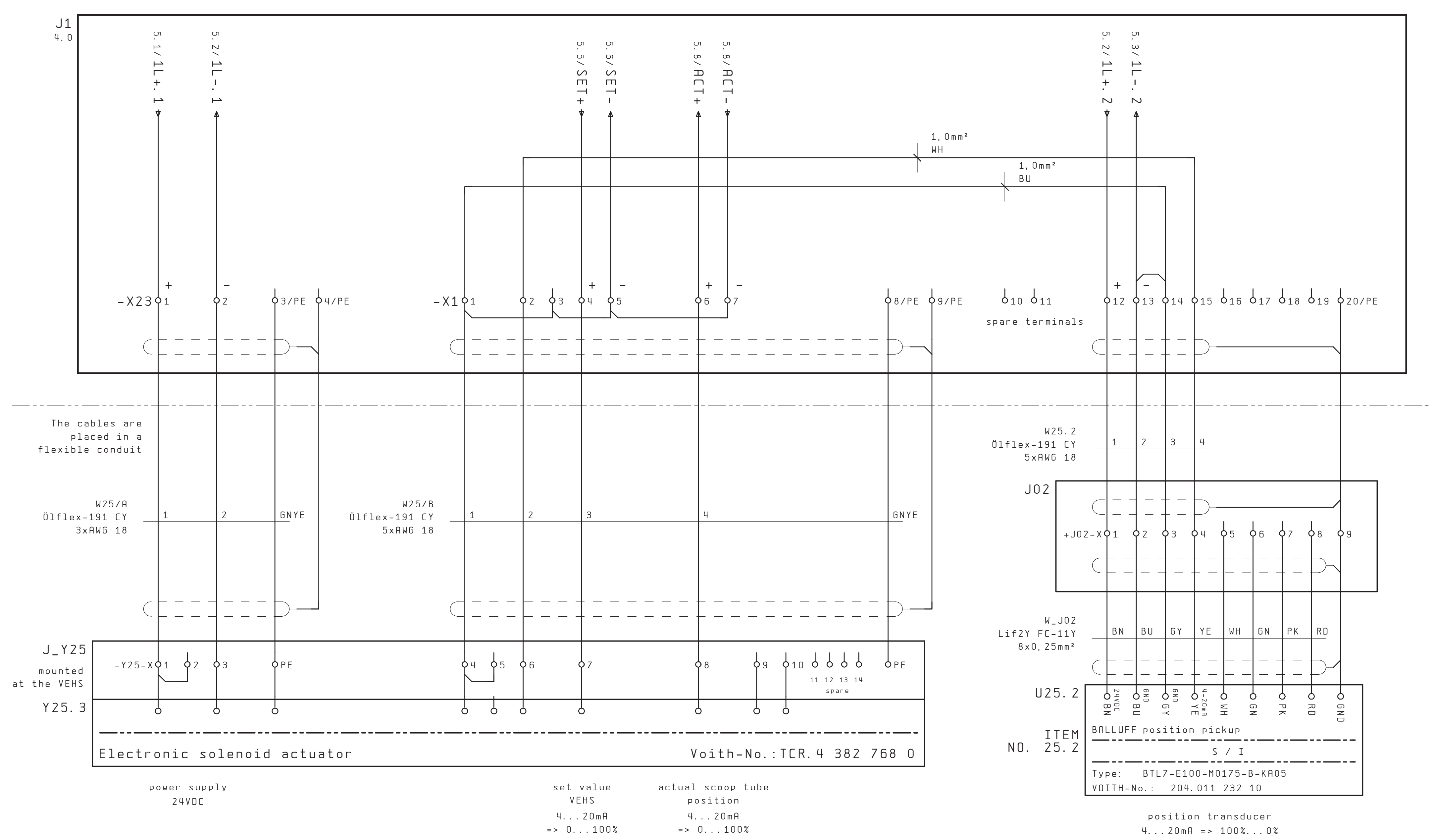
item no. see oil circuit and measuring point scheme 215 001154-0020



4 6

Revisions	Date	Name	Checked					
1 189063	03.02.15	Ga	Date	06.11.2014	Flowserve Ashuganj S 1	VOITH TURBO	set value VEHS / actual scoop tube position	Order no.: 38 003 425
			Editor	Gaugler	562 SVTL HP	Dep.:aevese-Ga		= +J1
			Date	03.02.2015				Page 5
					Original / Replacing	Replaced by		Drawing number: 215 001154-0040 en — 6 P.

item no. see oil circuit and measuring point scheme 215 001154-0020



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+CLIENT/1

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				Editor	Gaugler		
				Date	03.02.2015	562 SVTL HP	Dep.:aevese-Ga
Revisions		Date	Name	Checked		Original / Replacing	Replaced by

Voith Electro Hydraulic Positioning Control - VEHS -

Order no.: 38 003 425

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+J1

Page 6

Drawing number: 215 001154-0040 en

6 P.

VOI1203E/16.Jul.1996

VOITH

VOITH TURBO GmbH & Co. KG

Voithstrasse 1 74564 Crailsheim
Tel: 07951 / 32-0
Fax: 07951 / 32-650

Client	:	Flowserve Spain S.L.
Unit designation	:	562 SVTL HP
Order number	:	38 003 425
Drawing number	:	215 001154-0040 en
Code word	:	Flowserve Ashuganj S 1

Regulating and Control : Voith Electro-Hydraulic Positioning System
Equipment - Type : VEHS / Balluff - BTL7-E100-M0175-B-KA05

File name without \EPLAN\P: \VOI\GA_2014\215 001 154-0040 EN

CAD - Symbolic files : DIN_WUP/VC_SYMBL

Designation : WIRING DIAGRAM - PROPOSAL FOR WIRING -

Department : aevese-Ga

Created at : 06.11.2014
Revised edition : 03.02.2015 by : Gaugler

design specification after c132

+J1/6 2

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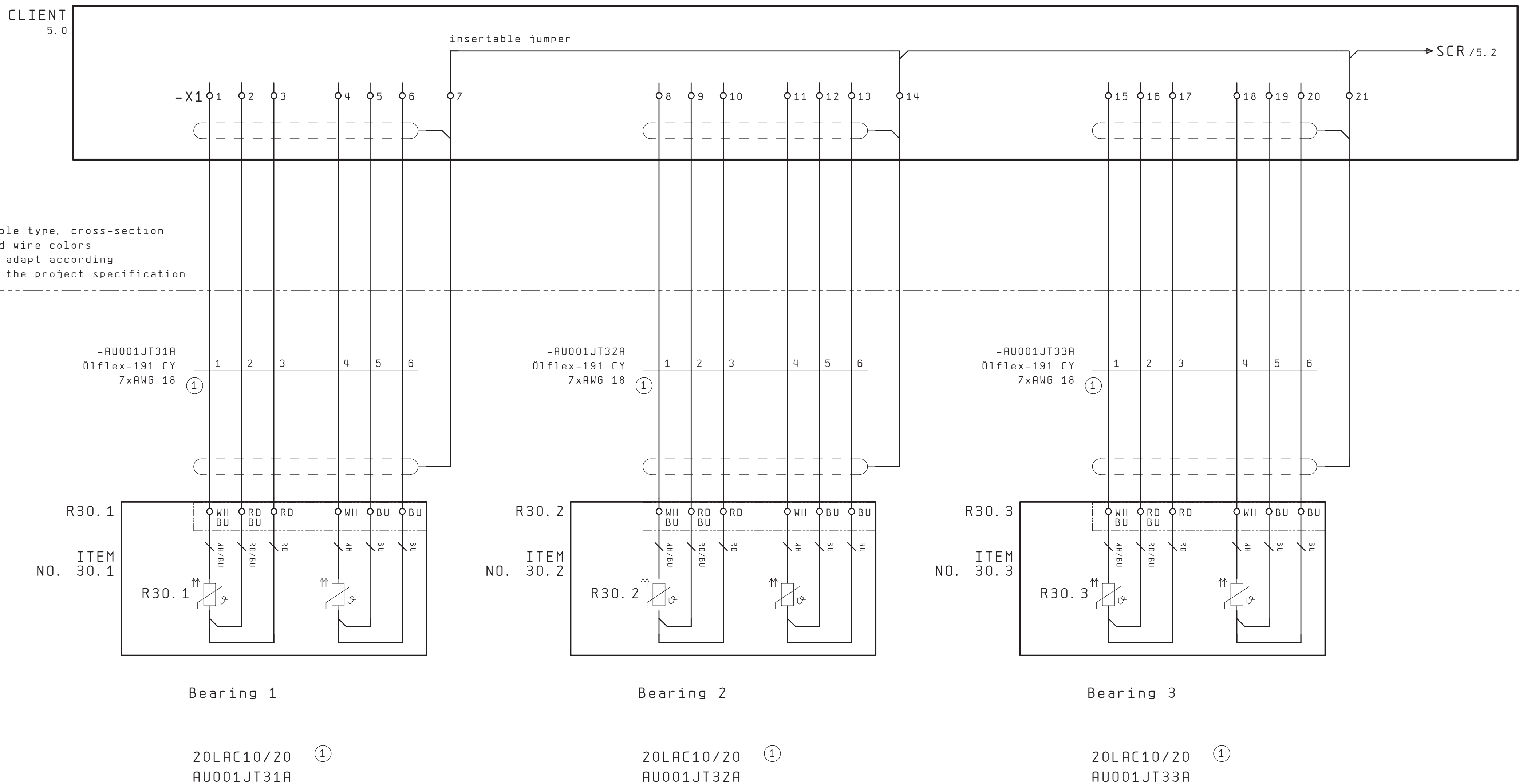
item no. see oil circuit and measuring point scheme 215 001154-0020

CLIENT

FLOWSERVE



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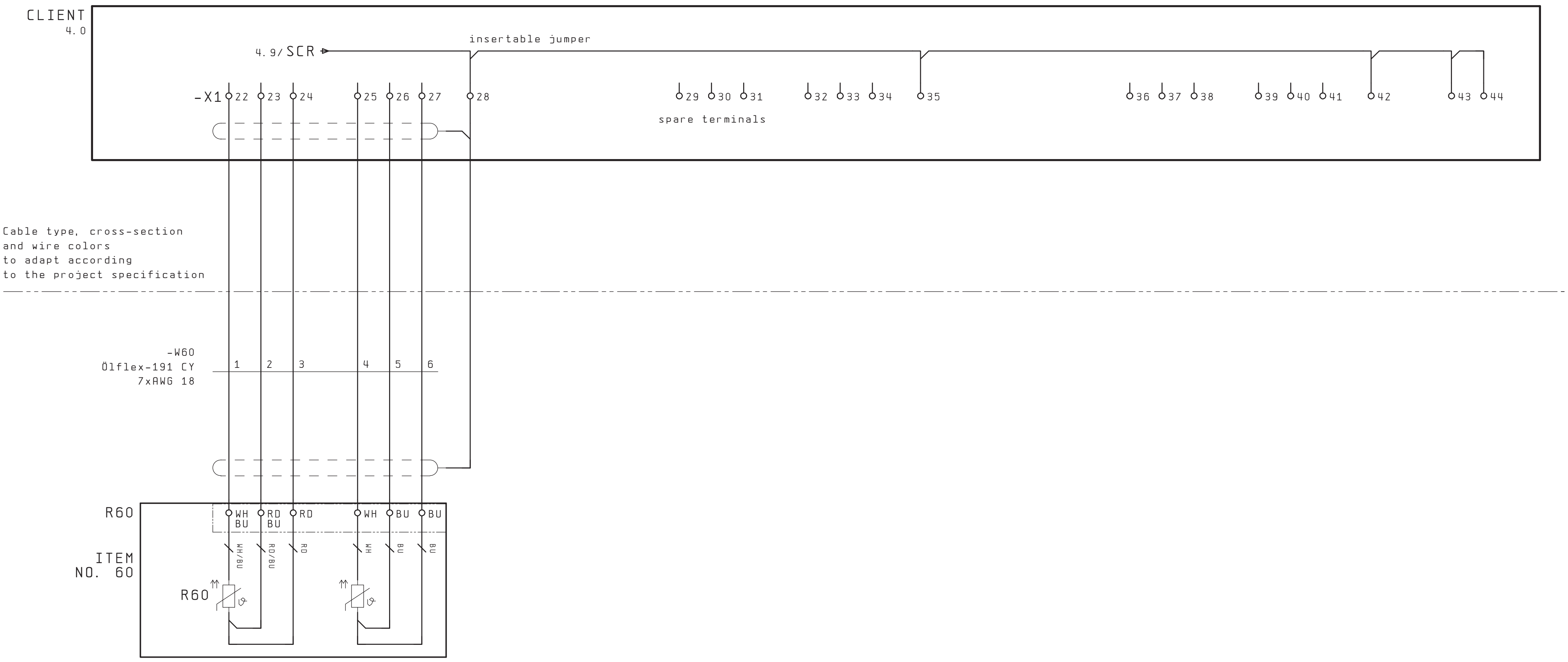
				Editor	Gaugler			PT100	=
				Date	03.02.2015	562 SVTL HP	Dep.:aevese-Ga		+CLIENT
Revisions	Date	Name	Checked			Original / Replacing	Replaced by		Drawing number: 215 001154-0040 en / Page 4 / 12 P.

0	1	2	3	4	5	6	7	8	9

item no. see oil circuit and measuring point scheme 215 001154-0020

CLIENT

FLOWSERVE



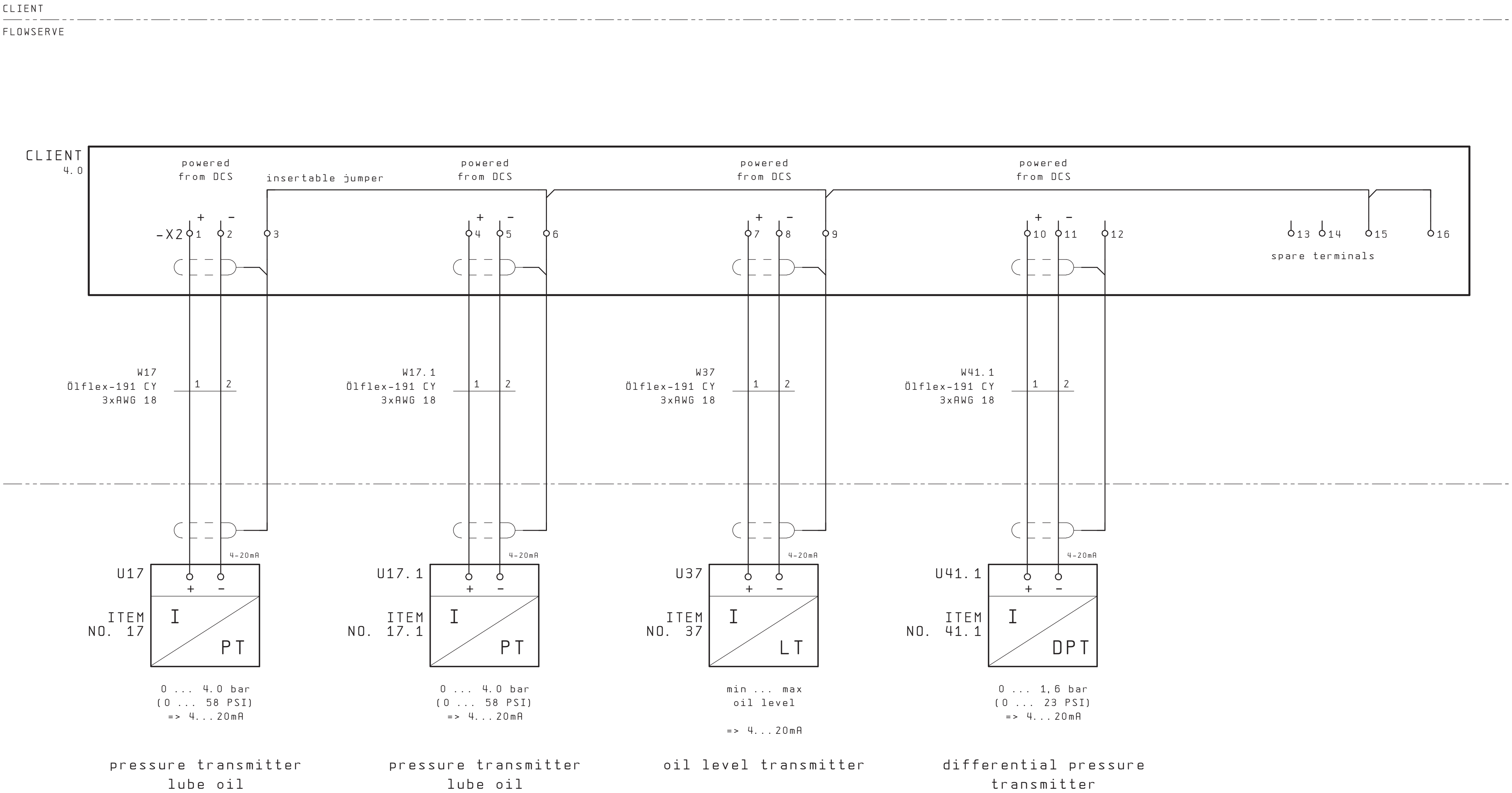
oil temperature
oil reservoir

4 6

1	189063	03.02.15	Ga	Date	06.11.2014	Flowserve Ashuganj S 1	VOITH TURBO	resistance thermometer	Order no.: 38 003 425	=
				Editor	Gaugler			PT100		+CLIENT
				Date	03.02.2015	562 SVTL HP	Dep.:aevese-Ga			Page 5
Revisions		Date	Name	Checked		Original / Replacing	Replaced by		Drawing number: 215 001154-0040 en	12 P.

0 1 2 3 4 5 6 7 8 9

item no. see oil circuit and measuring point scheme 215 001154-0020



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				Date	03.02.2015			
Revisions		Date	Name	Checked		Original / Replacing	Replaced by	

Order no.: 38 003 425

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Drawing number: 215 001154-0040 en

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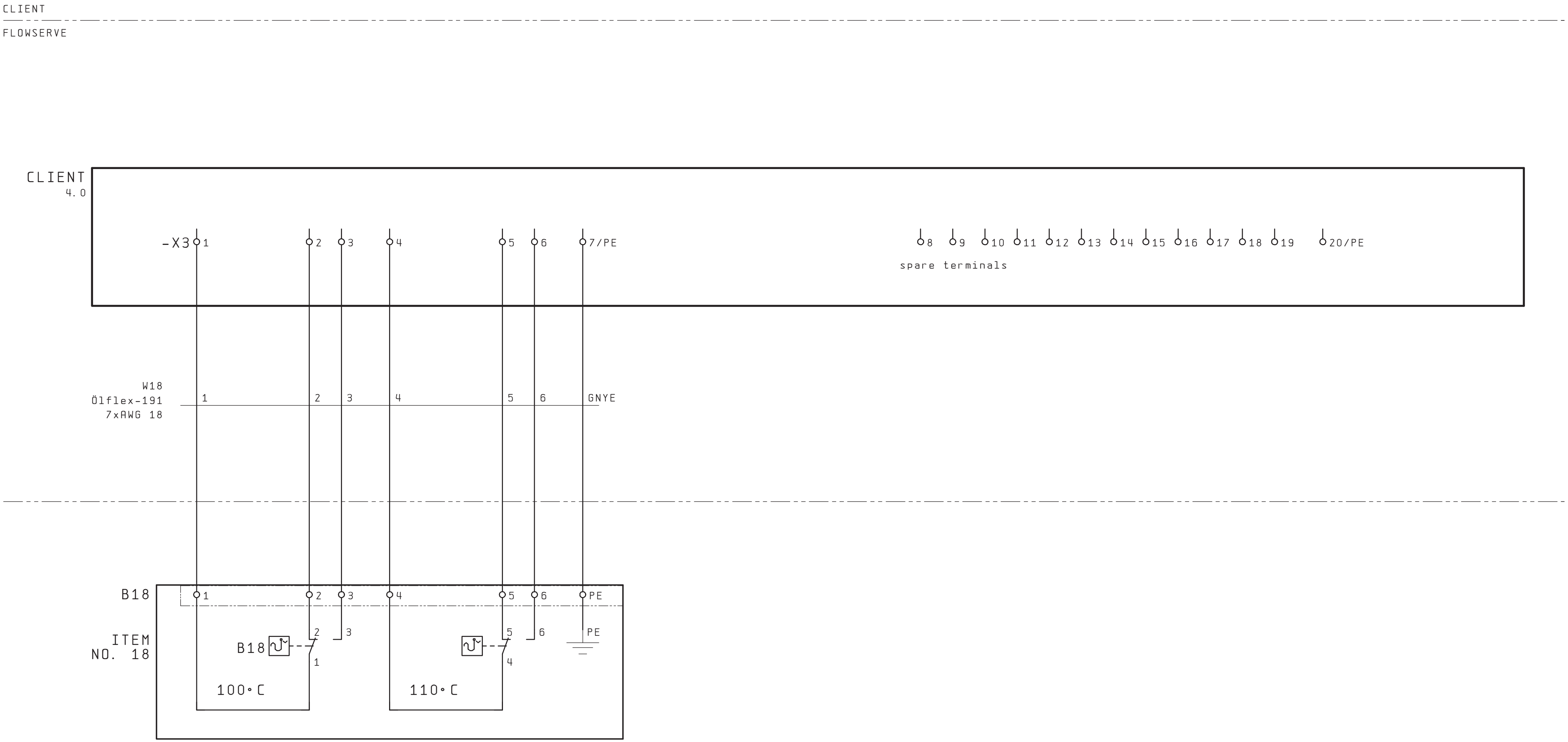
item no. see oil circuit and measuring point scheme 215 001154-0020



working oil temperature
scoop tube outlet

6

8

1 189063	03.02.15	Ga	Date 06.11.2014	Flowserve Ashuganj S 1	VOITH TURBO	temperature switch	Order no.: 38 003 425 / = / +CLIENT
			Editor Gaugler				
			Date 03.02.2015	562 SVTL HP	Dep.:aevese-Ga		Page 7
Revisions	Date	Name	Checked	Original / Replacing	Replaced by		Drawing number: 215 001154-0040 en / 12 P.

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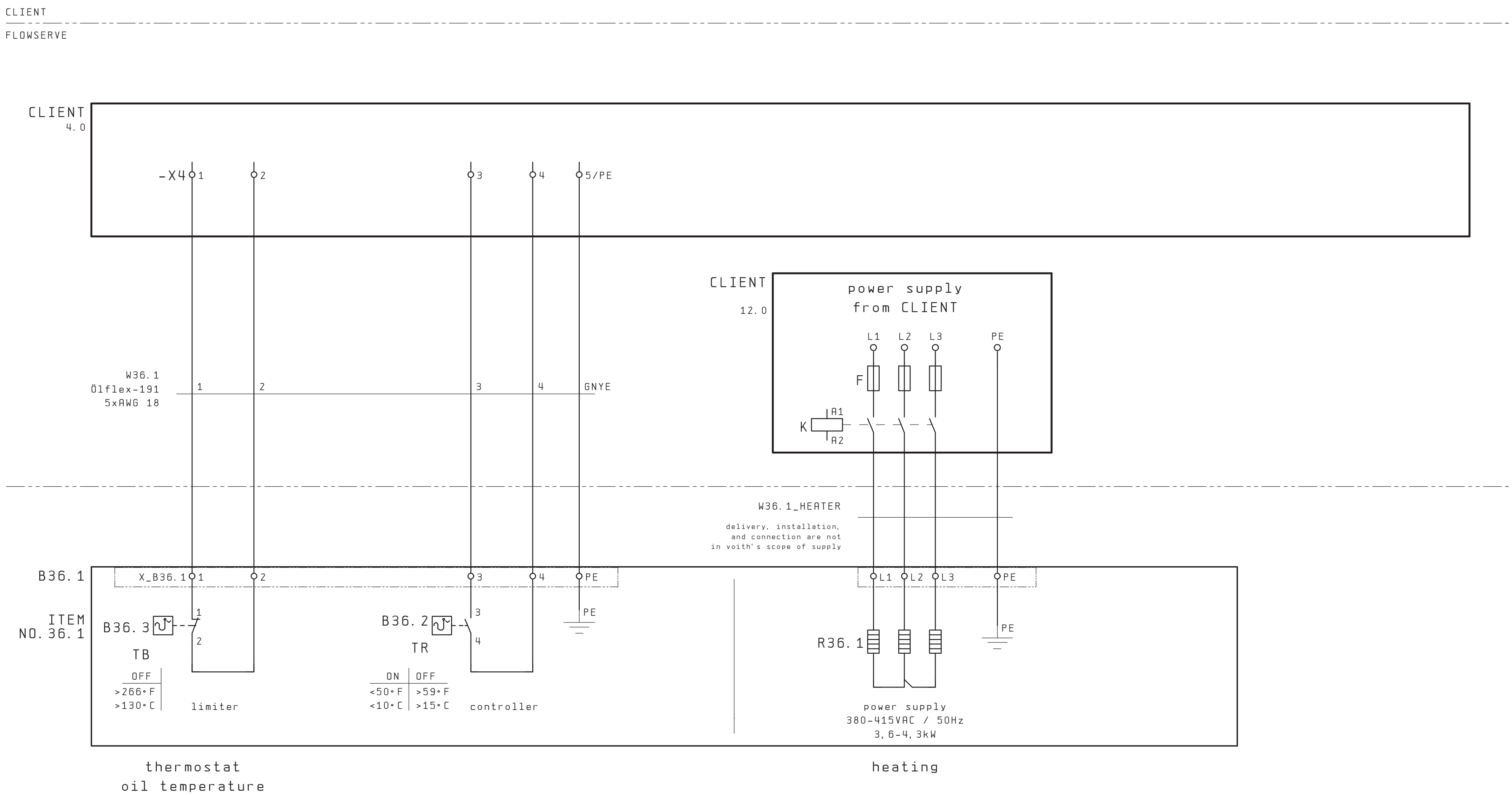
item no. see oil circuit and measuring point scheme 215 001154-0020

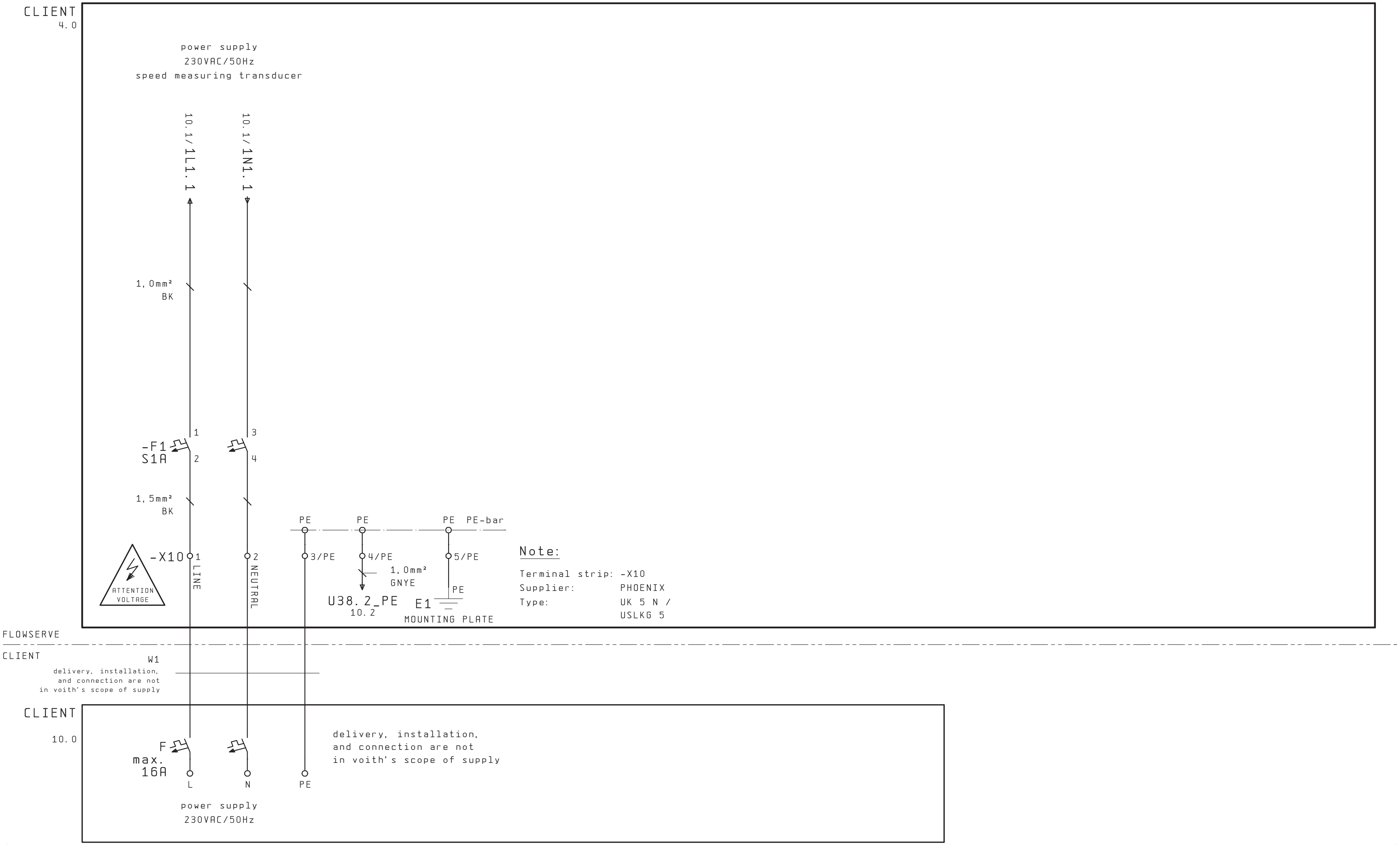


7

9

1	189063	03.02.15	Ga	Date	06.11.2014	Flowserve Ashuganj S 1	VOITH TURBO	oil reservoir	Order no.: 38 003 425	=
				Editor	Gaugler	562 SVTL HP	Dep.:aevese-Ga	for heating system		+CLIENT
				Date	03.02.2015					Page 8
Revisions		Date	Name	Checked		Original / Replacing	Replaced by		Drawing number: 215 001154-0040 en	12 P.

item no. see oil circuit and measuring point scheme 215 001154-0020



8 10

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				Date	03.02.2015			
Revisions		Date	Name	Checked		Original / Replacing	Replaced by	

Order no.: 38 003 425

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+CLIENT

Drawing number: 215 001154-0040 en

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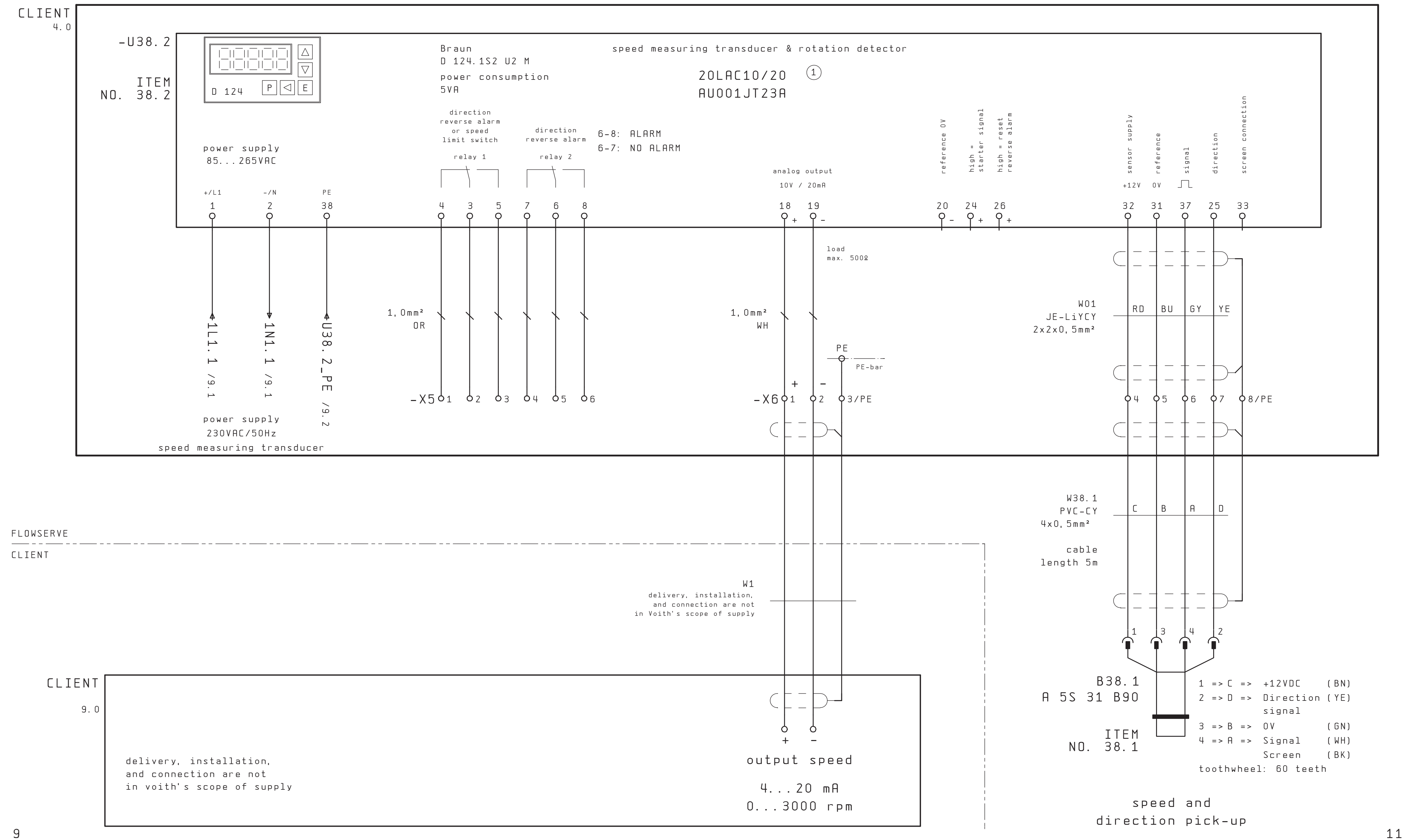
0	1	2	3	4	5	6	7	8	9

item no. see oil circuit and measuring point scheme 215 001154-0020



9

11

1	189063	1x	03.02.15	Ga	Date	06.11.2014	Flowserve Ashuganj S 1	VOITH TURBO	speed measuring transducer
					Editor	Gaugler	562 SVTL HP	Dep.:aevese-Ga	
					Date	03.02.2015			
Revisions			Date	Name	Checked		Original / Replacing	Replaced by	

Order no.: 38 003 425

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+CLIENT

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Drawing number: 215 001154-0040 en

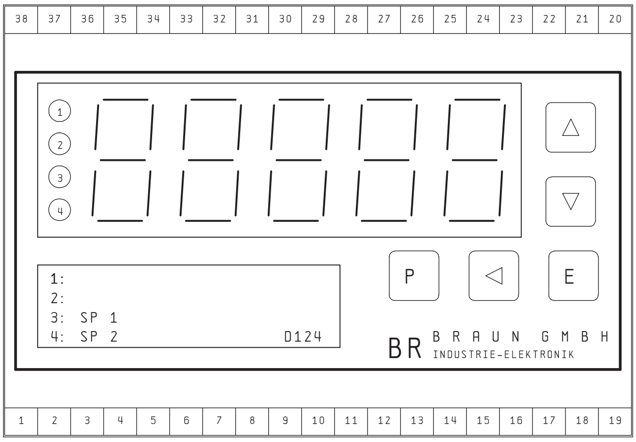
12 P.

Summary of programming steps and initial parameters

Short Form Programming Instructions

Procedure

- To enter the programming phase, press both (E) and (P) keys simultaneously.
- Select program group or step No. by keys △ (for next), ▽ (for previous).
- Switch between group and step select by key ◁.
- Enter parameter by key (E).
- Select digit by key ◁ .
- Adjust figure by key △ (to increase), or ▽ (to decrease).
- Acknowledge by key (E).
- Return to operation by key (P).

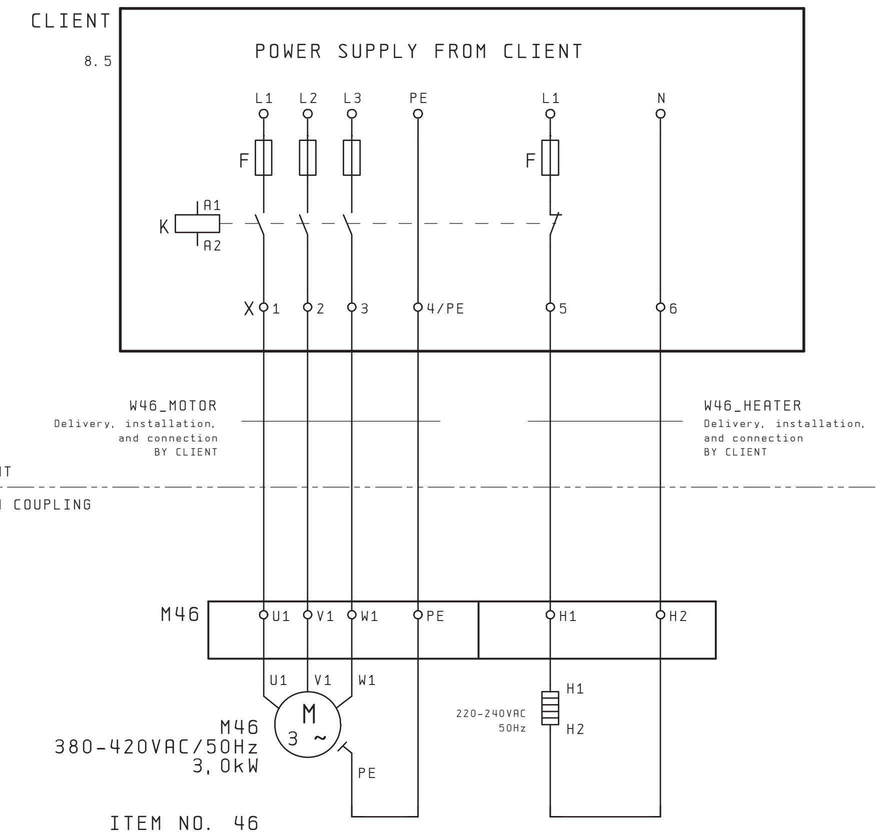


Summary of parameters, and detailed information in selection "Programming" - instruction manual.

program- Step No.	comments on page	parameter function	data set on delivery (initial data)	actual parameter
P00.00	6	access code request	0000	0000
.01	6	new code figure	0000	0000
.02	6	lock status (1 = unlocked, 0 = locked)	1=unlocked	1
.03	6	minimum measuring time (see table)	3=0,4s	4
P01.00	7	scaling: decimals of input signal frequency	0 = none	0
.01	7	value of nominal input frequency (Hz)	00100	03000
.02	7	decimals of corresponding speed	0 = none	0
.03	7	corresponding speed (unit as desired)	00100	03000
.04	7	low end of speed range	00001	00000
P02.00	8	LSDs on zero (least significant digit)	0 = none	0
.01	8	Display updating sequence	0,3 (sec)	0,3
.02	8	Direction output assigned to no-power condition (0=forw,1=rev)	1=reverse	0
.03	8	minimum no of reverse pulses to release reverse alarm	05	05
.04	8	time periode for reset of reverse pulse counter (XXX seconds)	010 sec	010
.05	8	forced direction at zero speed (0=no, 1=forw, 2=rev)	0 = no	1
.06	8	reverse alarm latched unit resetted (0=no, 1=yes)	0 = no	0
P03.00	9	analog high end speed value	10000	03100
.01	9	output: low end speed value	00000	00000
.02	9	zero level (0=dead zero, 1=live zero)	0	1
.03	9	signal voltage (0), current (1) (do not fail to set DIP switch accordingly)	1 (current)	1
P04.00	9	setpoint (SP1) in unit as programmed for display	01000	03000
.01	9	hysteresis bandwidth (XX % of SP1)	05 (%)	0,5
.02	9	hysteresis location (0=above, 1=below, 2=symm.)	1=below SP	1
.03	10	alarm output assigned to "no-power" (see table)	0 <SP	0
.04	10	alarm output assigned to starter phase	0 <SP	0
.05	10	time elapse of starter phase (XXX sec)	000 (sec)	000
.06	10	function of output SP1 (0= setpoint SP1, 1=rev. alarm SP2)	0=setpoint	1
P05.00	10	Data Interface baud rate (see table)	1 = 9600	0
.01	10	"my name" in communication	001	001

Note: Program group P05 ... is irrelevant without the data interface option.

item no. see oil circuit and measuring point scheme 215 001154-0020

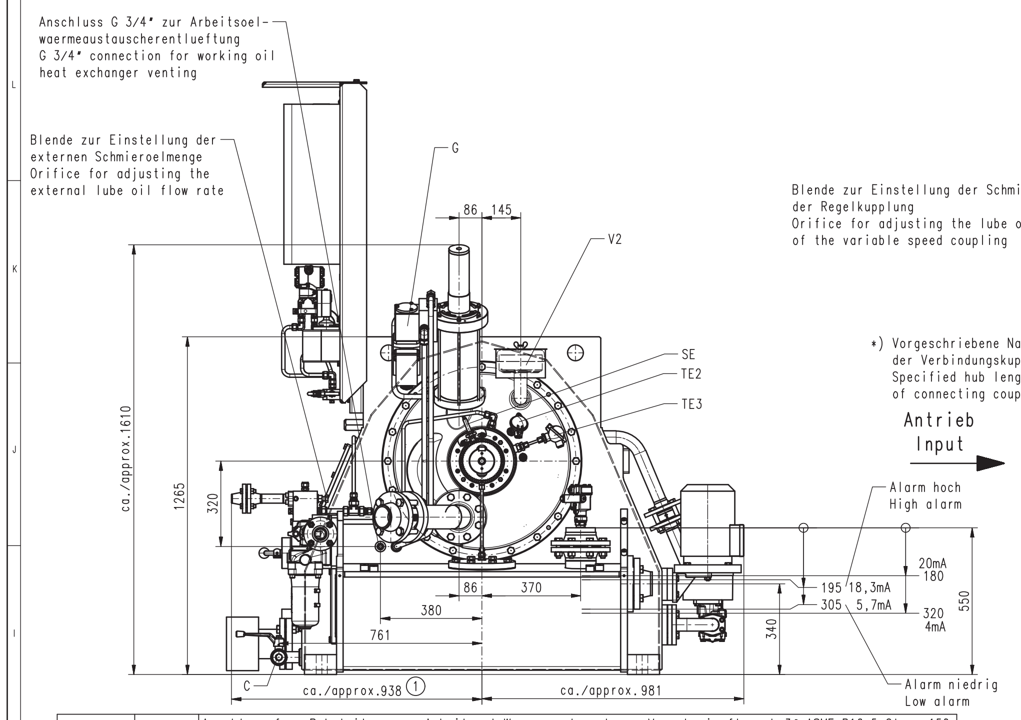


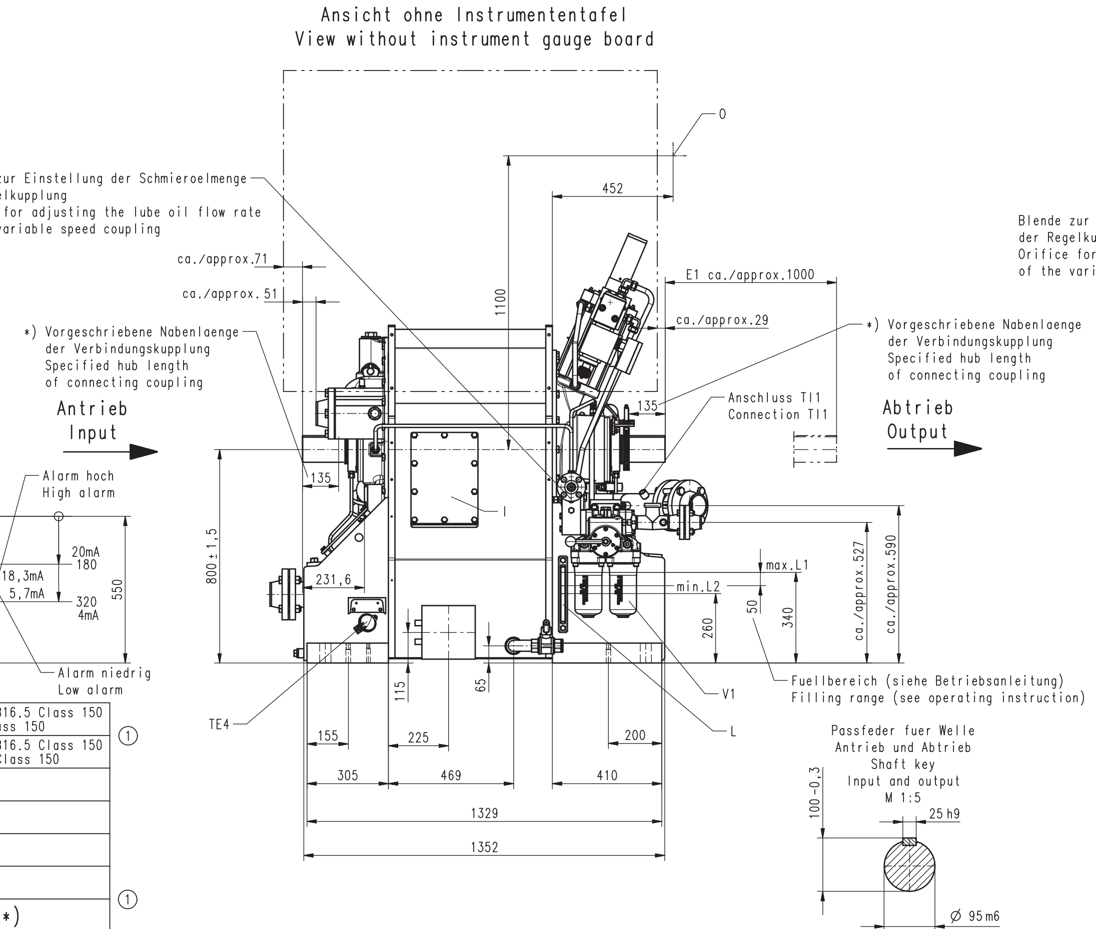
auxiliary lube oil pump

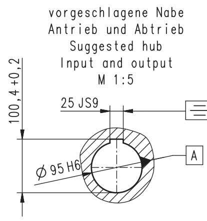
space heater

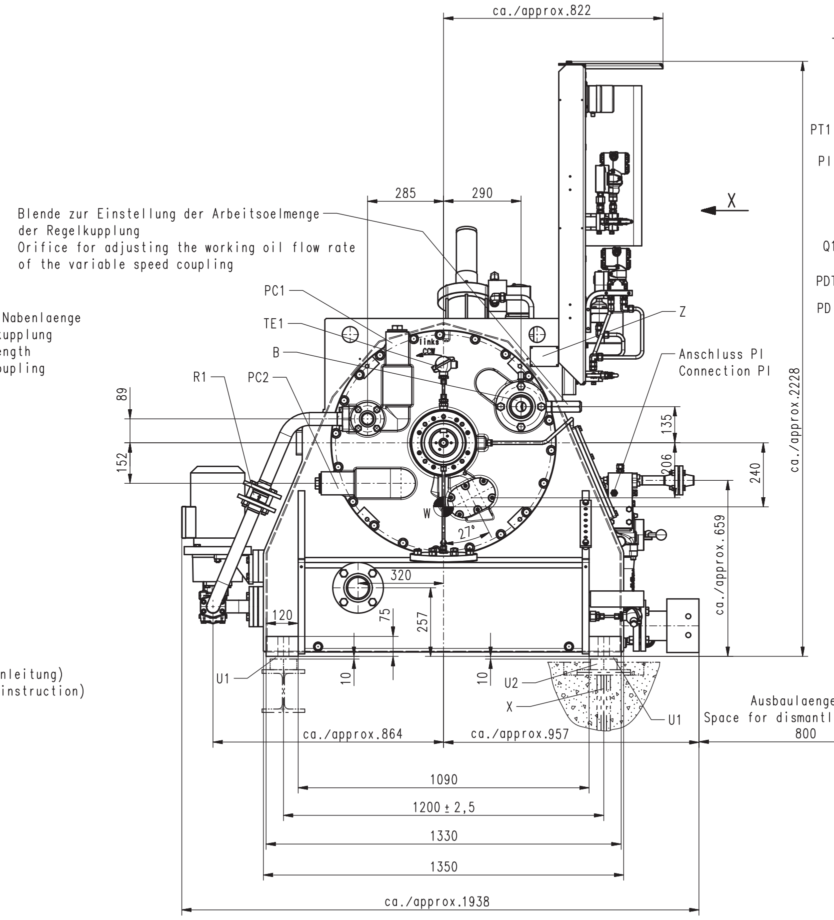
11

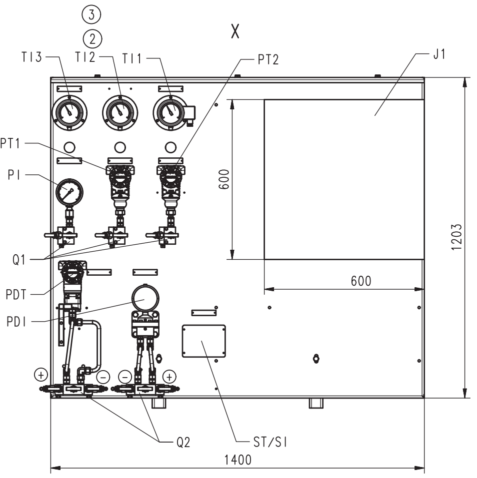
1 189063	03.02.15	Ga	Date	06.11.2014	Flowserve Ashuganj S 1	VOITH TURBO	auxiliary lube oil pump
			Editor	Gaugler	562 SVTL HP	Dep.:aevese-Ga	Order no.: 38 003 425
			Date	03.02.2015			= +CLIENT
Revisions	Date	Name	Checked		Original / Replacing	Replaced by	Drawing number: 215 001154-0040 en

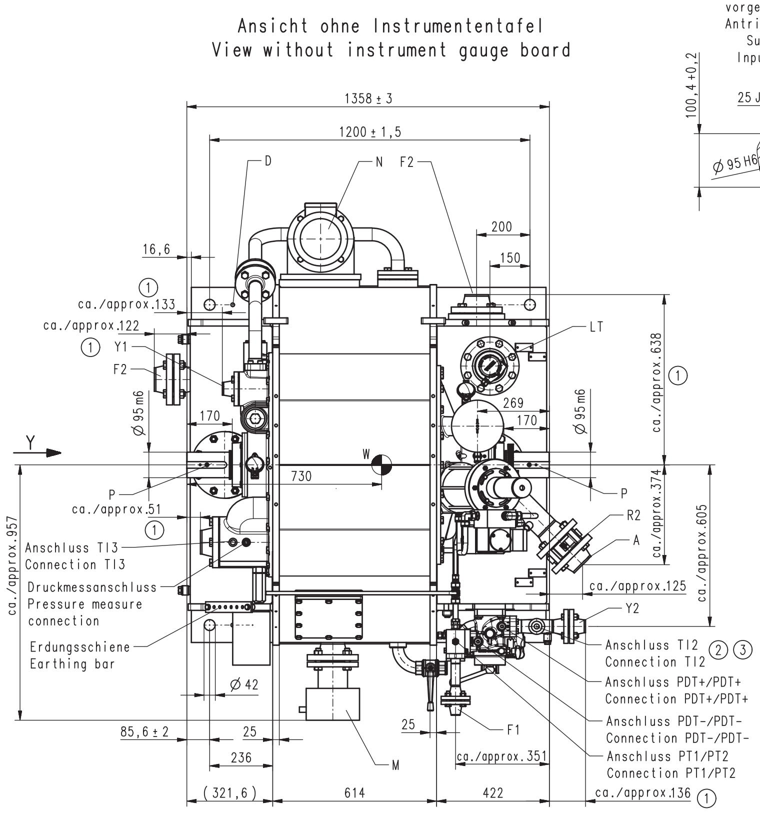


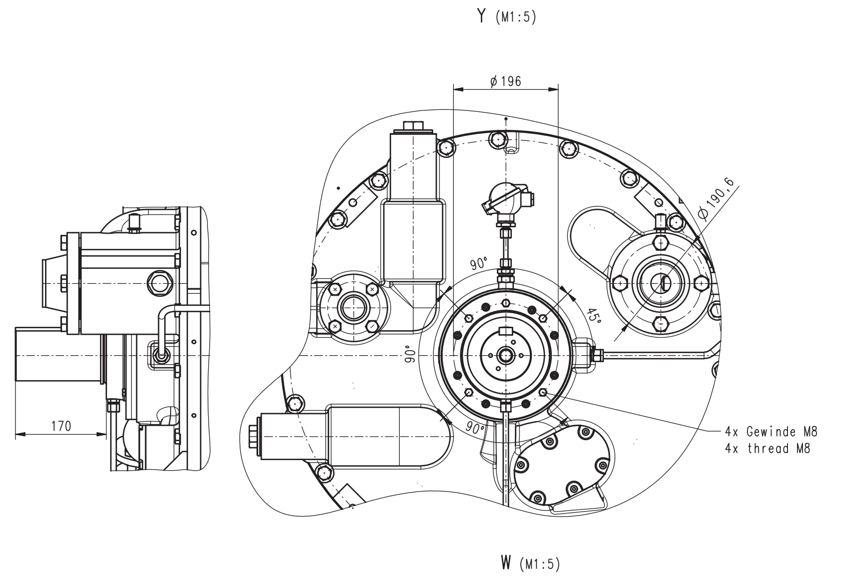


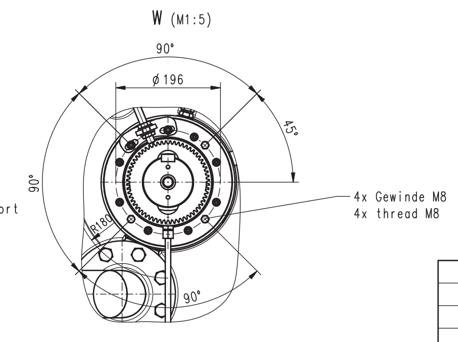


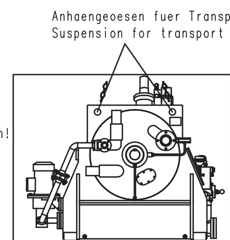












	A	Anschluss fuer Rohrleitung zum Arbeitsoel-Waermeaustauscher - Vorschweissflansch 3" ASME B16.5 Class 150 Connection for pipe to the working oil heat exchanger - weld-neck flange 3" ASME B16.5 Class 150	1
	B	Anschluss fuer Rohrleitung vom Arbeitsoel-Waermeaustauscher - Vorschweissflansch 3" ASME B16.5 Class 150 Connection for pipe from the working oil heat exchanger - weld-neck flange 3" ASME B16.5 Class 150	1
09	C	Oelablassventil Anschluss G 1 1/4" Oil drain valve connection G 1 1/4"	
	D	Gewinde fuer Stellschraube M16 Thread for adjusting screw M16	
	E1	Ausbaulaenge Laeuferteile Clearance for rotating parts removal	
	F1	Anschluss fuer externe Schmieroelversorgung - Vorschweissflansch 1" ASME B16.5 Class 150 Connection for external lube oil supply - weld-neck flange 1" ASME B16.5 Class 150	1
	F2	Anschluss fuer externen Schmieroelruecklauf - Vorschweissflansch 3" ASME B16.5 Class 150 **) Connection for the external lube oil return - weld-neck flange 3" ASME B16.5 Class 150	
25	G	Schoepfrohrsteuerung VEHS Voith electro hydraulic positioning control VEHS	
	I	Inspektionsdeckel Inspection cover	
	J1	Klemmenkasten Terminal box	
08	L	Oelstandsglas Oil level sight glass	
	L1	Oelstand bei Schoepfrohrstellung 0% in Betrieb Oil level at scoop tube position 0% during operation	
	L2	Oelstand bei Schoepfrohrstellung 100% in Betrieb Oil level at scoop tube position 100% during operation	
37	LT	Oelstandstransmitter Oil level transmitter	
36.1	M	Heizgeraet Heater	
46	N	Hilfsschmierpumpe Aux. lube oil pump	
	O	Platz fuer Schoepfrohrausbau Clearance for scoop tube removal	
	P	Passfeder CDS 25x14x150 DIN 6885 Fitted key CDS 25x14x150 DIN 6885	
46.3	PC1	Folgeventil Sequence valve	
46.4	PC2	Ueberdruckventil Pressure relief valve	
41	PDI	Differenzdruckanzeiger Differential pressure indicator	
41.1	PDT	Differenzdrucktransmitter Differential pressure transmitter	
16	PI	Manometer (Oel nach Schmieroelblende) Pressure gauge (Downstream of lube oil orifice)	
17	PT1	Drucktransmitter (Oel nach Schmieroelfilter) Pressure transmitter (Downstream of lube oil filter)	
17.1	PT2	Drucktransmitter (Oel nach Schmieroelfilter) Pressure transmitter (Downstream of lube oil filter)	
55.1	Q1	Zweifach Ventilblock 2-valve manifold	
55.3	Q2	Fuenffach Ventilblock 5-valve manifold	
46.1	R1	Rueckschlagventil DN 40 Non return valve DN 40	
46.2	R2	Rueckschlagventil DN 80 Non return valve DN 80	
SE	38.1	Drehzahlaufnehmer Speed pickup	
ST/SI	38.2	Drehzahlmessumformer mit Drehzahlanzeiger und Drehrichtungsumkehrwaechter Speed measuring transducer with speed indicator and reverse rotation detector	
30.1-30.3	TE1-TE3	Wiederstandsthermometer (Lagertemperatur Lager 1-3) Resistance thermometer (Bearing temperature bearing 1-3)	
60	TE4	Widerstandsthermometer (Oelsumpftemperatur) Resistance thermometer (Oil sump temperature)	
18	TI1	Zeigerfernthermometer mit Kontakten (Oeltemperatur Austritt Schoepfrohr) Capillary dial thermometer with contacts (Oil temperature scoop tube outlet)	
31	TI2	Zeigerfernthermometer (Schmieroeltemperatur nach Schmieroel-Waermeaustauscher) Capillary dial thermometer (Lube oil temperature downstream of lube oil heat exchanger)	2 3
34	TI3	Zeigerfernthermometer (Arbeitsoeltemperatur nach Arbeitsoel-Waermeaustauscher) Capillary dial thermometer (Working oil temperature downstream of working oil heat exchanger)	
	U1	Unterlegbleche 10 mm fuer Fundament Shims for foundation 10 mm	
	U2	Fundamentschiene (keine Voith Lieferung) Foundation rail (not Voith supply)	
42	V1	Doppelfilter Duplex filter	
07	V2	Entlueftungsfilter und Befuellmoeglichkeit G 1 1/2" Vent filter and filling possibility G 1 1/2"	
	W	Schwerpunkt ohne Oel Centre of gravity without oil	
	X	Steinschraube (keine Voith Lieferung) Stone bolt (not Voith supply)	
	Y1	Anschluss fuer Rohrleitung zum Schmieroel-Waermeaustauscher - Vorschweissflansch 1 1/2" ASME B16.5 Class 150 Connection for the pipe to the lube oil heat exchanger - weld-neck flange 1 1/2" ASME B16.5 Class 150	
	Y2	Anschluss fuer Rohrleitung vom Schmieroel-Waermeaustauscher - Vorschweissflansch 1 1/2" ASME B16.5 Class 150 Connection for the pipe from the lube oil heat exchanger - weld-neck flange 1 1/2" ASME B16.5 Class 150	1
	Z	Typenschild Nameplate	

Nr. vom Oelkreislauf- und Messstellenschema 215001154-0020
No. from oil circuit and measuring point scheme 215001154-0020

Heisse Oberflaechen
Rohrleitungen, Bereiche des Gehaeuses und des Oelbehaelters erreichen waehrend des Betriebes der Maschine Temperaturen ueber 60°C. Schutzeinrichtungen gegen Beruehrung der heissen Oberflaechen sind soweit erforderlich kundenseitig vorzusehen.

Hot surfaces
During machine operation, pipes, housing areas and the oil reservoir reach temperatures of more than 60°C. As far as necessary, the customer has to provide protective guards against accidental contact with hot surfaces.

Das Oelvolumen des Waermeaustauschers und das der Rohrleitungen ist in der Fuellmenge nicht enthalten.

The filling does not contain the oil volume of the heat exchanger and pipings.

Instrumentenverrohrung, Verdrahtung und Kabelkanaele sind nicht dargestellt!

Instrument tubing,wiring and cable trays are not illustrated!

Rohranschlusstoleranz nach EN ISO 13920-D

Pipe conncetion tolerance to EN ISO 13920-D

Abdeckungen fuer rotierende Teile entsprechend den gesetzlichen Vorschriften anbringen!

Attach covers for rotating parts according to legal regulations!

Die Turbokupplung ist eine Maschine mit Rohrleitungen, Waermeaustauschern und einwandigem Behaelter fuer Mineraloel. Eventuelle Zusatz-Umweltvorschriften sind anlagenseitig festzulegen!

The turbo coupling is a machine with pipes, heat exchangers and single-truss mineral oil reservoirs. Possible additional environmental regulations have to be determined by the customer!

*)
Bei Abtriebsleistungen ueber 2500 kW muss der Nabenwerkstoff der Verbindungskupplungen eine Streckgrenze von mindestens 500 N/mm² haben.

*)
In case of output powers over 2500 kW the hub material of the connecting coupling must have a yield point of at least 500 N/mm².

**)
Die Entlueftung der Schmieroelruecklaufleitungen von Motor und Pumpe sind vom Kunden vorzusehen.

**)
The customer has to provide the venting of the lube oil return pipes from the motor and the pump.

Groesse Size		562
Gewichtsbelastung Deadload		
Oel im Behaelter Oil in the sump	l	450
Oel in den rotierenden Teilen Oil in the rotating parts	l	34
Gesamtgewicht ohne Oel Total weight without oil	kg	2200
Rotierende Teile mit Oel Rotating parts with oil	kg	354
Massentraegheitsmoment J Mass moment of inertia J		
Primaer mit Oel Primary with oil	kgm²	14,7
Sekundaer mit Oel Secondary with oil	kgm²	1,46
Dynamische Fundamentbelastung F dyn Dynamic foundation loading F dyn		
f dyn ≤ne/60 f dyn ≤ne/60	Hz	
F dyn = y (ne/3600)² F dyn = y (ne/3600)²	N	y=3150
Schoepfrohrhub Scoop tube stroke		
Drehrichtung links Direction of rotation ccw	mm	147

Schwingungen nach Arbeitsblatt C081
Vibrations to work document C081

Flowserve Ashuganj S 1

Einbauplan
Assembly plan

562 SVTL HP
Auftrag-Nr.: / Order-No.:
38003425

CAD
deen

Scale of orig. 1:10

95 H6	+0,022	0
95 m6	+0,035	+0,013
25 JS9	+0,026	-0,026
25 h9	0	-0,052

03	3x	193769	Revision	15-05-18	TSii	sahoe
02	3x	191533	Revision	15-03-23	TSii	sahoe
01	9x	188354	Revision	15-01-19	TSii	sahoe
Rev.	Ins.	Revision-No.	Rev. descr.	Date	Name	Check

Drawn 2014-11-03 TSii
Check 2014-11-05 sahoe

Regelkupplung
Variable speed coupling

VOITH

215001154-0010

Sheet 1 of 1

91500741110

12 Parts List

12.1 Index of parts lists

Drawing designation / Drawing No.	Drawing group	SAP No.
„Sectional Drawings Sheet 1 - 2/ 20400495810“	04	215.001154/ Sheets 1-6

VOITH	Teileliste zur Betriebsanleitung Parts list for instruction manual	Betriebsanl.-Nr.: / Operating inst.No.: 215001154-0400	Datum: / Date: 26.02.2015
	Kennwort: / Reference: Flowserve Ashuganj S 1	Mat.-Nummer: / Material No.: 215.001154	Rev.: / Rev.: 0
	Typ: / Type: 562 SVTL HP	Zeichnungs-Nr.: / Drawing No.: 20400495810	Gruppe / Group: 04
	Auftrags-Nr.: / Order No.: 38003425	Blatt: / Sheet: 1-2	Seite / Page: 1/ 6

Zeichnungs-Pos.-Nr. Drawing item No.	Menge Quantity	ME Unit	Materialnummer Part. No.	Benennung Designation	Fremdbenennung Foreign designation	Zeichnungsgrp. Drawing Group	Ersatzteilkz. Spare part id.
0101/0010/0010	1	ST	204.00047100	Primaerwelle	primary shaft	04	
0101/0010/0020	1	ST	204.00448410	Primaerrad	primary gear	04	
0101/0010/0030	16	ST	TCR.42035830	Schraube Gewichtst.	weight-tol.screw	04	
0101/0010/0040	1	ST	204.00454110	Fangrinne	catch pan	04	
0101/0010/0050	10	ST	TCR.03015029	Zylinderschraube	socket head screw	04	
0101/0010/0060	10	ST	TCR.03111084	Federscheibe	spring washer	04	C3
0101/0010/0070	1	ST	204.00458510	Kupplungsschale	coupling shell	04	
0101/0010/0080	48	ST	TCR.40747350	Schraube Gewichtst.	weight-tol.screw	04	C3
0101/0010/0090	8	ST	TCR.10122460	Schmelzsichergs.Schrau	fusible plug	04	C1
0101/0010/0100	8	ST	TCR.03658010	Dichtring	seal ring	04	C1
0101/0010/0110	1	ST	TCR.42030930	Schalendeckel	shellcover	04	
0101/0010/0120	48	ST	TCR.40747350	Schraube Gewichtst.	weight-tol.screw	04	C3
0101/0020/0010	1	ST	TCR.42029490	Sekundaerwelle	secondary shaft	04	
0101/0020/0020	1	ST	204.00816810	Sekundaerrad	secondary wheel	04	
0101/0020/0030	1	ST	TCR.42030950	Druckring	thrust ring	04	
0101/0020/0040	1	ST	TCR.42031010	Isolierscheibe	insulating disc	04	C3
0101/0020/0050	16	ST	TCR.4202326001	Schraube Gewichtst.	weight-tol.screw	04	
0101/0030	1	ST	TCR.03306129	Zylinderrollenlager	cyl.roller bg.	04	B1
0101/0040	1	ST	TCR.42029530	Lagerhaltering	bearing retaining ring	04	
0101/0050	6	ST	TCR.03015029	Zylinderschraube	socket head screw	04	
0101/0060	1	ST	TCR.42029510	Lagerring	bearing ring	04	
0101/0070	8	ST	TCR.03014065	Zylinderschraube	socket head screw	04	C3
0101/0080	1	ST	TCR.03306019	Zylinderrollenlager	cyl.roller bg.	04	B1
0101/0090	1	ST	TCR.03170100	Sicherungsring	circlip	04	C3
0101/0100	2	ST	TCR.49906010	Schraegkugellager	ang.con.ball bearing	04	B1
0101/0110	1	ST	TCR.42029520	Lagerhaltering	bearing retaining ring	04	
0101/0120	4	ST	TCR.03015038	Zylinderschraube	socket head screw	04	
0101/0130	2	ST	TCR.03305524	Schraegkugellager	ang.con.ball bearing	04	B1

Zeichnungs-Pos.-Nr. Drawing item No.	Menge Quantity	ME Unit	Materialnummer Part. No.	Benennung Designation	Fremdbenennung Foreign designation	Zeichnungsgrp. Drawing Group	Ersatzteilkz. Spare part id.
0101/0140	1	STZ	TCR.42473140	Distanzring	spacer ring	04	L6
0101/0150	1	ST	TCR.42029550	Lagerhaltering	bearing retaining ring	04	
0101/0160	1	ST	TCR.42029540	Lagerhaltering	bearing retaining ring	04	
0101/0170	1	ST	TCR.03374020	Sicherungsblech	tab washer	04	C3
0101/0180	1	ST	H01.010812	Nutmutter	slotted nut	04	C3
0101/0190	2	ST	TCR.4247704002	Passfeder	key	04	L6
0101/0200	2	ST	TCR.03016074	Zylinderschraube	socket head screw	04	
0201/0010	1	ST	TCR.42473130	Schoepfrohrgehaeuse	scoop tube housing	04	
0201/0020	20	ST	TCR.03002291	Sechskantschraube	hexagon bolt	04	
0201/0030	1	ST	TCR.03171210	Sicherungsring	circlip	04	C3
0201/0040	2	ST	TCR.03040014	Verschlussschraube	screw plug	04	
0201/0050	6	ST	TCR.03040270	Verschlussschraube	screw plug	04	
0201/0060	1	ST	TCR.42029640	Pumpengehaeuse	pump housing	04	
0201/0070	20	ST	TCR.03002291	Sechskantschraube	hexagon bolt	04	
0201/0075	1	ST	TCR.42033120	Rueckschlagventil	non-return valve	04	
0201/0077	1	ST	TCR.42033130	Distanzstueck	spacer	04	
0201/0078	1	ST	TCR.03130033	Spannstift	roll pin	04	C3
0201/0080	1	ST	TCR.42029650	Pumpendeckel	pump cover	04	
0201/0090	12	ST	TCR.03015034	Zylinderschraube	socket head screw	04	
0201/0095	12	ST	TCR.03111084	Federscheibe	spring washer	04	C3
0201/0100	37	ST	TCR.03015083	Zylinderschraube	socket head screw	04	
0201/0105	37	ST	TCR.03110008	Federscheibe	spring washer	04	C3
0201/0110	2	ST	TCR.42598960	Labyrinthdeckel	labyrinth cover	04	
0201/0115	1	ST	TCR.03645210	Runddichtring	o-ring	04	C3
0201/0116	1	ST	TCR.03646228	Runddichtring	o-ring	04	C3
0201/0118	1	ST	TCR.03646013	Runddichtring	o-ring	04	C3
0201/0120	16	ST	TCR.03014069	Zylinderschraube	socket head screw	04	
0201/0130	16	ST	TCR.03658008	Dichtring	seal ring	04	C3

Zeichnungs-Pos.-Nr. Drawing item No.	Menge Quantity	ME Unit	Materialnummer Part. No.	Benennung Designation	Fremdbenennung Foreign designation	Zeichnungsgrp. Drawing Group	Ersatzteilkz. Spare part id.
0201/0140	1	ST	TCR.42030810	Pumpendeckel	pump cover	04	
0201/0150	6	ST	TCR.03015032	Zylinderschraube	socket head screw	04	
0201/0160	2	ST	TCR.03032162	Verschraubung	fitting	04	
0201/0165	2	ST	TCR.03032931	W-Verschraub.Einst.	adjust.angle union	04	
0201/0170	2	ST	TCR.03032154	Einschraubverschraubun	screw-in union	04	
0201/0180	10	ST	TCR.03002066	Sechskantschraube	hexagon bolt	04	
0201/0190	10	ST	TCR.03658008	Dichtring	seal ring	04	C3
0301/0010	1	ST	TCR.03000257	Vorschweissflansch	welding-neck flange	04	
0301/0020	1	ST	TCR.03660513	Flachdichtring	flat seal ring	04	C3
0301/0030	4	ST	TCR.03002352	Sechskantschraube	hexagon bolt	04	
0301/0040	1	ST	TCR.03000254	Vorschweissflansch	welding-neck flange	04	
0301/0050	1	ST	TCR.03660507	Flachdichtring	flat seal ring	04	C3
0301/0060	4	ST	TCR.03002282	Sechskantschraube	hexagon bolt	04	
0301/0070	1	ST	TCR.42030800	Duesenschraube	nozzle screw	04	
0301/0072	1	ST	TCR.03040283	Verschlussschraube	screw plug	04	
0301/0075	1	ST	TCR.03114125	Sicherungsblech	tab washer	04	C3
0301/0080	1	ST	204.01480410	Rohrleitung	piping	04	
0301/0090	1	ST	TCR.03661083	Flachdichtring	flat seal ring	04	C3
0301/0100	8	ST	TCR.03002288	Sechskantschraube	hexagon bolt	04	
0301/0110	1	ST	TCR.42467980	Rueckschlagventil	non-return valve	04	
0301/0120	1	ST	TCR.03000257	Vorschweissflansch	welding-neck flange	04	
0301/0130	2	ST	TCR.03660513	Flachdichtring	flat seal ring	04	C3
0301/0140	4	ST	TCR.03001799	Sechskantschraube	hexagon bolt	04	
0301/0150	4	ST	TCR.03072341	Sechskantmutter	hexagon nut	04	
0301/0160	1	ST	TCR.4189582002	Winkel	angle	04	
0301/0170	1	ST	TCR.4188931002	Entlueftungs-Filter	vent filter	04	
0301/0180	1	ST	204.00207800	Doppelfilter	duplex filter	04	
0301/0270	1	ST	204.00202300	Verteilerstueck	distributor piece	04	

Zeichnungs-Pos.-Nr. Drawing item No.	Menge Quantity	ME Unit	Materialnummer Part. No.	Benennung Designation	Fremdbenennung Foreign designation	Zeichnungsgrp. Drawing Group	Ersatzteilkz. Spare part id.
0301/0280	4	ST	TCR.03002235	Sechskantschraube	hexagon bolt	04	
0301/0300	1	ST	TCR.03072232	Dichtmutter	sealing nut	04	C3
0301/0310	1	ST	TCR.42031180	Einstellschraube	adjusting screw	04	
0301/0360	2	ST	TCR.42262910	Verschraubung	fitting	04	
0301/0370	2	ST	TCR.03658021	Dichtring	seal ring	04	C3
0301/0380	1	ST	TCR.4226285001	Verschraubung	fitting	04	
0301/0390	2	ST	TCR.4226286001	Verschraubung	fitting	04	
0301/0400	1	ST	TCR.42262920	Verschraubung	fitting	04	
0301/0410	2	ST	TCR.03658017	Dichtring	seal ring	04	C3
0401/0010	1	ST	204.01448510	Gehaeuse	housing	04	
0401/0020	1	ST	204.01459510	Deckel	cover	04	
0401/0030	10	ST	TCR.03002208	Sechskantschraube	hexagon bolt	04	
0401/0060	1	ST	TCR.21241230	Fluess.Standanzeige	fluid indicator	04	L12
0401/0070	2	ST	TCR.42031140	Flansch	flange	04	
0401/0080	2	ST	TCR.4242819027	Dichtung	seal	04	C3
0401/0090	8	ST	TCR.03045338	Stiftschraube	stud	04	
0401/0100	8	ST	TCR.03072017	Sechskantmutter	hexagon nut	04	
0401/0105	8	ST	TCR.03002298	Sechskantschraube	hexagon bolt	04	
0401/0110	1	ST	TCR.4175750001	Saugrohr	suction pipe	04	
0501/0040	4	ST	TCR.40701260	Gleitlager	plain bearing	04	B2
0501/0060	1	ST	TCR.41370890	Antriebsritzel	input pinion	04	
0501/0070	1	ST	TCR.40586980	Zahnradritzel	gear pinion	04	
0501/0080	1	ST	TCR.03014839	Zylinderschraube	socket head screw	04	
0501/0090	2	ST	TCR.03130039	Spannstift	roll pin	04	C3
0601/0010	1	ST	204.00710910	Stirnrad	spur gear	04	
0601/0020	1	ST	204.00710810	Stirnrad	spur gear	04	
0601/0030	1	ST	TCR.03160101	Passfeder	key	04	
0601/0040	1	ST	TCR.03170110	Sicherungsring	circlip	04	C3

VOITH	Teileliste zur Betriebsanleitung Parts list for instruction manual	Betriebsanl.-Nr.: Operating inst.No.: 215001154-0400 Mat.-Nummer: Material No. 215.001154 Zeichnungs-Nr.: Drawing No.: 20400495810 Blatt: Sheet: 1-2	Datum: Date: 26.02.2015 Rev.: Rev.: 0 Gruppe Group 04 Seite Page 5/ 6
	Kennwort: Reference: Flowserve Ashuganj S 1 Auftrags-Nr.: Order No.: 38003425 Typ: Type: 562 SVTL HP		

Zeichnungs-Pos.-Nr. Drawing item No.	Menge Quantity	ME Unit	Materialnummer Part. No.	Benennung Designation	Fremdbenennung Foreign designation	Zeichnungsgrp. Drawing Group	Ersatzteilkz. Spare part id.
0701/0010	1	ST	204.01440610	Schoepfrohr Bgr.Li	scoop tube ccw ass.	04	L13
0801/0010	2	ST	TCR.41753100	Ventilkolben	valve piston	04	B6
0801/0020	2	ST	TCR.41768860	Einstellschraube	adjusting screw	04	
0801/0030	2	ST	TCR.03210108	Druckfeder	compression spring	04	C3
0801/0040	2	ST	TCR.40378300	Verschlussschraube	screw plug	04	
0801/0050	2	ST	TCR.03658065	Dichtring	seal ring	04	C3
1001/0010	1	ST	TCR.40771510	Einstellschraube	adjusting screw	04	
1001/0020	2	ST	TCR.03658027	Dichtring	seal ring	04	C3
1001/0030	1	ST	TCR.42250240	Mutter	nut	04	
1001/0040	1	ST	TCR.40812170	Hutmutter	cap nut	04	
3000/0010	2	ST	TCR.42471300	V-Ring	v-ring	04	C3
7800/0010	1	ST	TCR.42208270	Magnet	magnet	04	B6
7800/0020	1	ST	204.01123210	Wegaufnehmer	displacement pickup	04	B6
7800/0060	1	ST	TCR.42031060	Zylinder	cylinder	04	
7800/0070	1	ST	TCR.42031070	Anschlussflansch	connecting flange	04	
7800/0080	6	ST	TCR.42031080	Gewindestange	threaded rod	04	
7800/0090	6	ST	TCR.03073008	Sechskantmutter	hexagon nut	04	
7800/0100	1	ST	TCR.42031090	Fuehrung	guide	04	
7800/0102	4	ST	TCR.03103083	Scheibe	washer	04	
7800/0105	4	ST	TCR.03002066	Sechskantschraube	hexagon bolt	04	
7800/0110	2	ST	TCR.42031100	Fuehrungsstueck	guide piece	04	
7800/0115	4	ST	TCR.03015017	Zylinderschraube	socket head screw	04	C3
7800/0116	2	ST	TCR.03014000	Zylinderschraube	socket head screw	04	C3
7800/0120	1	ST	TCR.42033110	Haltering	retaining ring	04	
7800/0125	2	ST	TCR.03014072	Zylinderschraube	socket head screw	04	
7800/0130	1	ST	TCR.03646120	Runddichtring	o-ring	04	C3
7800/0140	3	ST	TCR.03645126	Runddichtring	o-ring	04	C3
7800/0150	1	ST	TCR.03645083	Runddichtring	o-ring	04	C3

Zeichnungs-Pos.-Nr. Drawing item No.	Menge Quantity	ME Unit	Materialnummer Part. No.	Benennung Designation	Fremdbenennung Foreign designation	Zeichnungsgrp. Drawing Group	Ersatzteilkz. Spare part id.
7800/0160	1	ST	TCR.42031130	Fuehrungsring	guide ring	04	C3

13 Recommended Spare Parts List

13.1 Use / installation of genuine Voith spare parts

Genuine Voith spare parts have been designed specifically for use with the variable-speed turbo coupling. We would like to point out that original spare parts that are not supplied by "VOITH" are also not checked and approved by us.
Installation and/or use of non-original spare parts may adversely affect the design characteristics of the variable-speed turbo coupling, thus compromising safety. "VOITH" does not assume any responsibility for damage arising from the use of non-original spare parts.

13.2 Spare parts identification

Spare parts are classified into groups.

Spare parts identification:

- **C** Commissioning parts
- **B** Basic spare parts equipment
- **L** Long term spare parts

NOTE

Item nos. in a drawing (*e.g. 0210/0010/0040*) that appear in the spare parts list without an associated drawing group (*e.g. 04*) are not itemized in the drawings and parts lists (see Section 11 „Drawings, Schematics, Diagrams“ and Section 12 „Parts List“).

13.3 Index of spare parts

Drawing designation / Drawing No.	SAP No.
Spare Parts List	215.001154/ Sheets 1-8

Original spare parts are supplied on the basis of the latest design standard.

We thus suggest that the spare parts in the recommended spare parts list be stored on site.

NOTE

In a few variable-speed turbo couplings, the primary wheel and secondary wheel are balanced together with the shafts and shell using a special technique. In this case, the associated parts are identified accordingly. Therefore, these components can be replaced only at Voith Crailsheim or, in exceptional cases, under the supervision of a Voith service engineer on site using special auxiliary means.

13.4 Ordering spare parts

Ordering spare parts

When ordering spare parts, please indicate:

1. Serial number of the variable-speed turbo coupling (see nameplate) Geared Variable Speed Coupling
2. Full designation such as
   - Drawing item no.
   - Material/Article No.
   - Part name (designation)
   - Quantity

VOITH	**Ersatzteilliste Übersicht** **Survey of Spare Parts Lists**	Kennwort: Code: **Flowserve Ashuganj S 1**	**Voith Turbo GmbH & Co.KG**
		Typ: Type: **562 SVTL HP**	Voithstraße 1 74564 Crailsheim, Germany
	SAP Angebots-Nr.: SAP Offer No.: **20237984**	Serien Nr.: Serial No.: **8211674, 8211675**	Tel. +49 7951 32-1666 Fax +49 7951 32-903 coupling-service@voith.com
	Lieferumfang: Scope of supply: **215.001154**	Betriebsanl.-Nr.: Instruction Manual No.: **215001154-0410**	www.voith-coupling-service.com Datum/Date: **2015-03-02** Rev.No: **0**

C = Teile für Inbetriebnahme / Commissioning parts

C1	1 Satz / set	Schmelzsicherungsschrauben / of fusible plugs
C2	1 Satz / set	Filterelemente / of filter elements
C3	1 Satz / set	Dichtungs- und Revisionsteile allgemein / service kit with a set of sealings

B = Ersatzteilgrundausstattung / Basic spare parts

B1	1 Satz / set	Hauptwellenlager oder Nadellager für Wandler / of main shaft bearings or needle bearings
B2	1 Satz / set	Lager zur Hauptfüllpumpe / of bearings for main filling pump
B4	1 Satz / set	Lager zur Anfahrschmierpumpe ASP / of bearings for aux.lube oil pump
B6	1 Satz / set	Teile für VEHS und Steuerungsteile / of parts for electro-hydraulic positioning control make Voit

L = Ersatzteile für Langzeitbetrieb / Long term spare parts

L2	1 Stück / off	Anfahrschmierpumpe (ASP) plus 1 Motor / aux. lube oil pump plus 1 motor
L5	1 Satz / set	Primärläuferteile / of primary runner parts
L6	1 Satz / set	Sekundärläuferteile / of secondary runner parts
L12	1 Satz / set	Anbauteile für Druck-, Schwingungs-, Drehzahl- und Temperatu / components for pressure, vibration, turn, temperature m
L13	1 Stück / off	Schöpfrohr / scoop tube

Brief instructions for spare parts enquiries or spare parts orders

Item No.		The drawing item number is indicated in the spare parts offer/order position, enabling a clear allocation of parts to the items stated in the spare parts lists and the drawings of the instruction manual.
Quantity		Determines the quantity of parts installed in the unit.
Unit		Physical unit of the material used per article number.
Part No.		Voith Material No.
Designation		Designation of material in SAP.
Drawing Group		Indicates the numbering of the drawing in which the part with the appropriate drawing item number is contained.
Spare part id.		The spare part identification classifies the spare parts in groups for which corresponding recommendations for spare parts storage can be made by the **Voith Coupling Service** . Upon request, the **Voith Coupling Service** prepares individual spare parts proposals for every project with one or several units.
Selection	☐	By ticking, one or several articles are being selected on item level for which an offer or an order confirmation for spare parts needs to be prepared. It is omitted if the field "all items" was ticked and selected.
Enquiry	☐	Selection for enquiry initiating the preparation of a spare parts offer.
Order	☐	Selection for order initiating the preparation of an order confirmation.
All items	☐	By ticking, all items with the corresponding identification are selected for which an offer or an order confirmation needs to be prepared. If individual items are selected, that field has to remain blank.

VOITH	Ersatzteilliste Übersicht Survey of Spare Parts Lists	Kennwort: Code: Flowserve Ashuganj S 1	Voith Turbo GmbH & Co.KG
		Typ: Type: 562 SVTL HP	Voithstraße 1 74564 Crailsheim, Germany Tel. +49 7951 32-1666
	SAP Angebots-Nr.: SAP Offer No.: 20237984	Serien Nr.: Serial No.: 8211674, 8211675	Fax +49 7951 32-903 coupling-service@voith.com
	Lieferumfang: Scope of supply: 215.001154	Betriebsanl.-Nr.: Instruction Manual No.: 215001154-0410	www.voith-coupling-service.com Datum/Date: 2015-03-02 Rev.No: 0

C = Commissioning parts

☐ **Anfrage/Enquiry** ☐ **Bestellung/Order** ☐ **Alle Positionen/All items**

Zeichnungs-Pos.Nr. Item No.	Menge Quantity	ME Unit	Materialnummer Part. No.	Benennung Designation	Zeichnungsgrp. Drawing Group	Ersatzteilkz. Spare part id.	Auswahl Selection
0101/0010/0090	8	ST	TCR.10122460	fusible plug	04	C1	☐
0101/0010/0100	8	ST	TCR.03658010	seal ring	04	C1	☐
0301/0170/0010	1	ST	TCR.4188931007	filter element		C2	☐
0301/0180/	2	ST	TCR.42471470	filter element		C2	☐
0101/0010/0060	10	ST	TCR.03111084	spring washer	04	C3	☐
0101/0010/0080	48	ST	TCR.40747350	weight-tol.screw	04	C3	☐
0101/0010/0120	48	ST	TCR.40747350	weight-tol.screw	04	C3	☐
0101/0020/0040	1	ST	TCR.42031010	insulating disc	04	C3	☐
0101/0070	8	ST	TCR.03014065	socket head screw	04	C3	☐
0101/0090	1	ST	TCR.03170100	circlip	04	C3	☐
0101/0170	1	ST	TCR.03374020	tab washer	04	C3	☐
0101/0180	1	ST	H01.010812	slotted nut	04	C3	☐
0201/0030	1	ST	TCR.03171210	circlip	04	C3	☐
0201/0078	1	ST	TCR.03130033	roll pin	04	C3	☐
0201/0095	12	ST	TCR.03111084	spring washer	04	C3	☐
0201/0105	37	ST	TCR.03110008	spring washer	04	C3	☐
0201/0115	1	ST	TCR.03645210	o-ring	04	C3	☐
0201/0116	1	ST	TCR.03646228	o-ring	04	C3	☐
0201/0118	1	ST	TCR.03646013	o-ring	04	C3	☐
0201/0130	16	ST	TCR.03658008	seal ring	04	C3	☐
0201/0190	10	ST	TCR.03658008	seal ring	04	C3	☐
0301/0020	1	ST	TCR.03660513	flat seal ring	04	C3	☐
0301/0030	1	ST	TCR.03660505	flat seal ring		C3	☐
0301/0050	1	ST	TCR.03660507	flat seal ring	04	C3	☐

VOITH	**Ersatzteilliste Übersicht** **Survey of Spare Parts Lists**	Kennwort: Code: **Flowserve Ashuganj S 1**	**Voith Turbo GmbH & Co.KG**
		Typ: Type: **562 SVTL HP**	Voithstraße 1 74564 Crailsheim, Germany
	SAP Angebots-Nr.: SAP Offer No.: **20237984**	Serien Nr.: Serial No.: **8211674, 8211675**	Tel. +49 7951 32-1666 Fax +49 7951 32-903 coupling-service@voith.com
	Lieferumfang: Scope of supply: **215.001154**	Betriebsanl.-Nr.: Instruction Manual No.: **215001154-0410**	www.voith-coupling-service.com Datum/Date: **2015-03-02** Rev.No: **0**

C = Commissioning parts

☐ **Anfrage/Enquiry** ☐ **Bestellung/Order** ☐ **Alle Positionen/All items**

Zeichnungs-Pos.Nr. Item No.	Menge Quantity	ME Unit	Materialnummer Part. No.	Benennung Designation	Zeichnungsgrp. Drawing Group	Ersatzteilkz. Spare part id.	Auswahl Selection
0301/0075	1	ST	TCR.03114125	tab washer	04	C3	☐
0301/0086	1	ST	TCR.03658021	seal ring		C3	☐
0301/0090	1	ST	TCR.03661083	flat seal ring	04	C3	☐
0301/0130	2	ST	TCR.03660513	flat seal ring	04	C3	☐
0301/0206	2	ST	TCR.03658021	seal ring		C3	☐
0301/0210	1	ST	TCR.03645245	o-ring		C3	☐
0301/0240	1	ST	TCR.03660507	flat seal ring		C3	☐
0301/0300	1	ST	TCR.03072232	sealing nut	04	C3	☐
0301/0307	1	ST	TCR.03658012	seal ring		C3	☐
0301/0320	1	ST	TCR.03072233	sealing nut		C3	☐
0301/0340	1	ST	TCR.03656017	seal ring		C3	☐
0301/0370	2	ST	TCR.03658021	seal ring	04	C3	☐
0301/0410	2	ST	TCR.03658017	seal ring	04	C3	☐
0301/0460	1	ST	TCR.03658014	seal ring		C3	☐
0401/0050	1	ST	TCR.03658042	seal ring		C3	☐
0401/0080	2	ST	TCR.4242819027	seal	04	C3	☐
0401/0140	1	ST	TCR.03658021	seal ring		C3	☐
0401/0170	2	ST	TCR.03658027	seal ring		C3	☐
0501/0090	2	ST	TCR.03130039	roll pin	04	C3	☐
0601/0040	1	ST	TCR.03170110	circlip	04	C3	☐
0801/0030	2	ST	TCR.03210108	compression spring	04	C3	☐
0801/0050	2	ST	TCR.03658065	seal ring	04	C3	☐
1001/0020	2	ST	TCR.03658027	seal ring	04	C3	☐
2005/0020	1	ST	TCR.03660513	flat seal ring		C3	☐

VOITH	**Ersatzteilliste Übersicht** **Survey of Spare Parts Lists**	Kennwort: Code: **Flowserve Ashuganj S 1**	**Voith Turbo GmbH & Co.KG**
	SAP Angebots-Nr.: SAP Offer No.: **20237984**	Typ: Type: **562 SVTL HP**	
	Lieferumfang: Scope of supply: **215.001154**	Serien Nr.: Serial No.: **8211674, 8211675**	
		Betriebsanl.-Nr.: Instruction Manual No.: **215001154-0410**	Datum/Date: **2015-03-02** Rev.No: **0**

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Fax +49 7951 32-903
coupling-service@voith.com
www.voith-coupling-service.com

C = Commissioning parts

☐ **Anfrage/Enquiry** ☐ **Bestellung/Order** ☐ **Alle Positionen/All items**

Zeichnungs-Pos.Nr. Item No.	Menge Quantity	ME Unit	Materialnummer Part. No.	Benennung Designation	Zeichnungsgrp. Drawing Group	Ersatzteilkz. Spare part id.	Auswahl Selection
2006/0020	1	ST	TCR.03660513	flat seal ring		C3	☐
3000/0010	2	ST	TCR.42471300	v-ring	04	C3	☐
5800/0010/	2	ST	TCR.4178049002	o-ring		C3	☐
5800/0010/	1	ST	TCR.4178049001	shaft seal ring		C3	☐
5800/0055	1	ST	TCR.03660027	flat seal ring		C3	☐
5800/0060	1	ST	TCR.03645245	o-ring		C3	☐
5800/0105	2	ST	TCR.03660027	flat seal ring		C3	☐
5800/0130	3	ST	TCR.03645191	o-ring		C3	☐
5900/0100	1	ST	TCR.03658042	seal ring		C3	☐
7000/	5	ST	TCR.49914000	bloc-type rubber element		C3	☐
7000/	5	ST	TCR.42561530	bloc-type rubber element		C3	☐
7180/0040	1	ST	TCR.03658021	seal ring		C3	☐
7301/	1	ST	TCR.03658021	seal ring		C3	☐
7302/	1	ST	TCR.03658021	seal ring		C3	☐
7303/	1	ST	TCR.03658021	seal ring		C3	☐
7310/	1	ST	TCR.03658021	seal ring		C3	☐
7340/0040	1	ST	TCR.03658021	seal ring		C3	☐
7361/0020	1	ST	TCR.03660513	flat seal ring		C3	☐
7370/0030	1	ST	TCR.03660080	flat seal ring		C3	☐
7370/0060	1	ST	TCR.03658027	seal ring		C3	☐
7600/0050	1	ST	TCR.03658021	seal ring		C3	☐
7800/	2	ST	TCR.03002504	hexagon bolt		C3	☐
7800/0030/ 290	5	ST	TCR.03646146	o-ring		C3	☐
7800/0045	1	ST	TCR.03645020	o-ring		C3	☐

VOITH	**Ersatzteilliste Übersicht** **Survey of Spare Parts Lists**	Kennwort: Code: **Flowserve Ashuganj S 1** Typ: Type: **562 SVTL HP**	**Voith Turbo GmbH & Co.KG** Voithstraße 1 74564 Crailsheim, Germany Tel. +49 7951 32-1666 Fax +49 7951 32-903 coupling-service@voith.com www.voith-coupling-service.com Datum/Date: **2015-03-02** Rev.No: **0**
	SAP Angebots-Nr.: SAP Offer No.: **20237984**	Serien Nr.: Serial No.: **8211674, 8211675**	
	Lieferumfang: Scope of supply: **215.001154**	Betriebsanl.-Nr.: Instruction Manual No.: **215001154-0410**	

C = Commissioning parts

☐ **Anfrage/Enquiry** ☐ **Bestellung/Order** ☐ **Alle Positionen/All items**

Zeichnungs-Pos.Nr. Item No.	Menge Quantity	ME Unit	Materialnummer Part. No.	Benennung Designation	Zeichnungsgrp. Drawing Group	Ersatzteilkz. Spare part id.	Auswahl Selection
7800/0115	4	ST	TCR.03015017	socket head screw	04	C3	☐
7800/0116	2	ST	TCR.03014000	socket head screw	04	C3	☐
7800/0130	1	ST	TCR.03646120	o-ring	04	C3	☐
7800/0140	3	ST	TCR.03645126	o-ring	04	C3	☐
7800/0150	1	ST	TCR.03645083	o-ring	04	C3	☐
7800/0160	1	ST	TCR.42031130	guide ring	04	C3	☐

VOITH	**Ersatzteilliste Übersicht** **Survey of Spare Parts Lists**	Kennwort: Code: **Flowserve Ashuganj S 1**	**Voith Turbo GmbH & Co.KG**
		Typ: Type: **562 SVTL HP**	
	SAP Angebots-Nr.: SAP Offer No.: **20237984**	Serien Nr.: Serial No.: **8211674, 8211675**	
	Lieferumfang: Scope of supply: **215.001154**	Betriebsanl.-Nr.: Instruction Manual No.: **215001154-0410**	Datum/Date: **2015-03-02** Rev.No: **0**

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www.voith-coupling-service.com

B = Basic spare parts

☐ **Anfrage/Enquiry** ☐ **Bestellung/Order** ☐ **Alle Positionen/All items**

Zeichnungs-Pos.Nr. Item No.	Menge Quantity	ME Unit	Materialnummer Part. No.	Benennung Designation	Zeichnungsgrp. Drawing Group	Ersatzteilkz. Spare part id.	Auswahl Selection
0101/0030	1	ST	TCR.03306129	cyl.roller bg.	04	B1	☐
0101/0080	1	ST	TCR.03306019	cyl.roller bg.	04	B1	☐
0101/0100	2	ST	TCR.49906010	ang.con.ball bearing	04	B1	☐
0101/0130	2	ST	TCR.03305524	ang.con.ball bearing	04	B1	☐
0501/0040	4	ST	TCR.40701260	plain bearing	04	B2	☐
5800/0010/	1	STZ	TCR.41780490	plain bearing		B4	☐
0801/0010	2	ST	TCR.41753100	valve piston	04	B6	☐
7170/1010	1	ST	TCR.4190372024	pressure transmitter		B6	☐
7171/1010	1	ST	TCR.4190372024	pressure transmitter		B6	☐
7301/	1	ST	TCR.4221515001	resist. thermometer		B6	☐
7302/	1	ST	TCR.4221515001	resist. thermometer		B6	☐
7303/	1	ST	TCR.4221515001	resist. thermometer		B6	☐
7370/0010	1	ST	204.01091010	level transmitter		B6	☐
7381/0070	1	ST	TCR.41789790	speed detector		B6	☐
7381/0071	1	ST	TCR.4178979002	connecting cable		B6	☐
7382	1	ST	TCR.4179305001	speed meas.transf.		B6	☐
7411/2010	1	ST	TCR.4190372071	pressure transmitter		B6	☐
7600/0030	1	ST	TCR.4221515001	resist. thermometer		B6	☐
7800/0010	1	ST	TCR.42208270	magnet	04	B6	☐
7800/0020	1	ST	204.01123210	displacement pickup	04	B6	☐
7800/0030	1	ST	TCR.91867690	way valve		B6	☐

VOITH	**Ersatzteilliste Übersicht** **Survey of Spare Parts Lists**	Kennwort: Code: **Flowserve Ashuganj S 1**	**Voith Turbo GmbH & Co.KG**
		Typ: Type: **562 SVTL HP**	Voithstraße 1 74564 Crailsheim, Germany
	SAP Angebots-Nr.: SAP Offer No.: **20237984**	Serien Nr.: Serial No.: **8211674, 8211675**	Tel. +49 7951 32-1666 Fax +49 7951 32-903 coupling-service@voith.com
	Lieferumfang: Scope of supply: **215.001154**	Betriebsanl.-Nr.: Instruction Manual No.: **215001154-0410**	www.voith-coupling-service.com Datum/Date: **2015-03-02** Rev.No: **0**

L = Long term spare parts

☐ **Anfrage/Enquiry** ☐ **Bestellung/Order** ☐ **Alle Positionen/All items**

Zeichnungs-Pos.Nr. Item No.	Menge Quantity	ME Unit	Materialnummer Part. No.	Benennung Designation	Zeichnungsgrp. Drawing Group	Ersatzteilkz. Spare part id.	Auswahl Selection
5800/0010	1	ST	204.00431210	gear pump		L2	☐
5810/0020	1	ST	204.00536010	motor		L2	☐
0101/0010	1	ST	204.00474510	primary rotor		L5	☐
0101/0020	1	ST	204.00474610	secondary rotor		L6	☐
0101/0140	1	STZ	TCR.42473140	spacer ring	04	L6	☐
0101/0190	2	ST	TCR.4247704002	key	04	L6	☐
0401/0060	1	ST	TCR.21241230	fluid indicator	04	L12	☐
7160/1010	1	ST	TCR.4201477018	pressure gauge		L12	☐
7180/0010	1	ST	204.01584710	pointer thermometer		L12	☐
7310/	1	ST	204.01585110	pointer thermometer		L12	☐
7340/0010	1	ST	204.01585310	pointer thermometer		L12	☐
7361/0010	1	ST	204.00991810001	heating rod		L12	☐
7410/2010	1	ST	TCR.4201595002	dif.pres.manometer		L12	☐
0701/0010	1	ST	204.01440610	scoop tube ccw ass.	04	L13	☐
0701/0010/0030	1	ST	TCR.03170035	circlip		L13	☐

14 Attaching Parts (descriptions)

14.1 Capillary dial thermometer

Voith Article No.: 204.01584710

Type: 608523-22-10 (0-160°C; 2xSPDT)

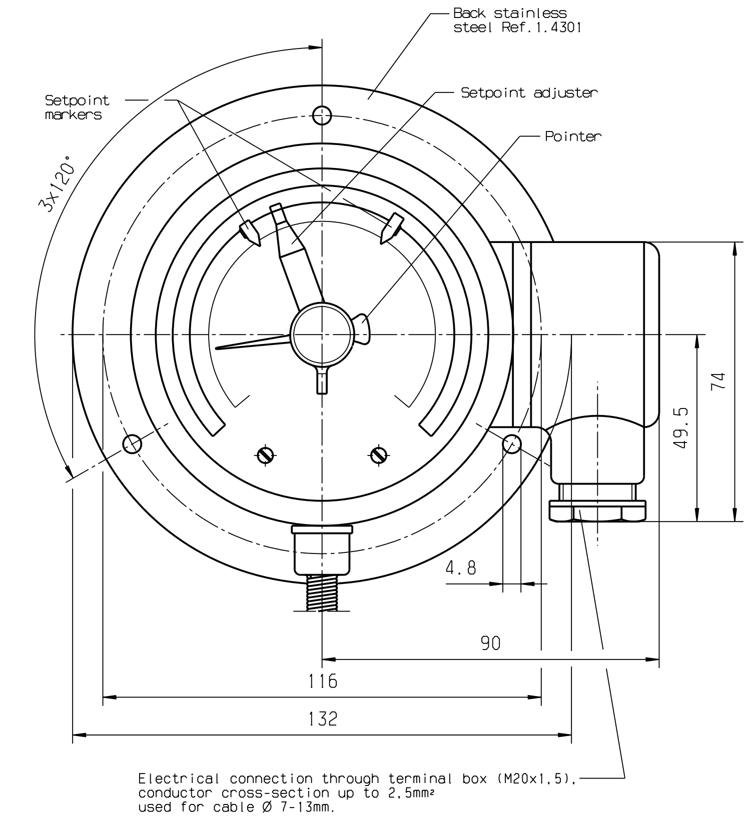
Description . . . . .JUMO

Voith Article No.: 204.01585110
Voith Article No.: 204.01585310

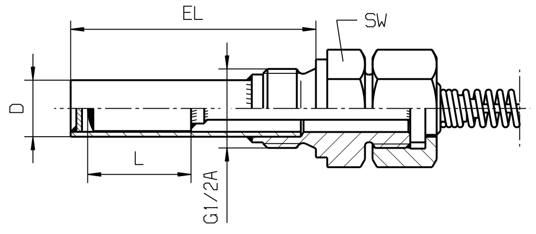
Type: 100-S5500 (0-120°C)
Type: 100-S5500 (0-160°C)

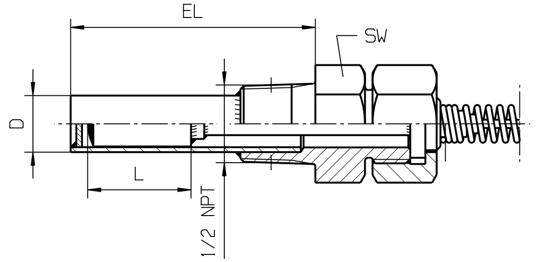
Description . . . . ASHCROFT

Manufacturing Drawing: —

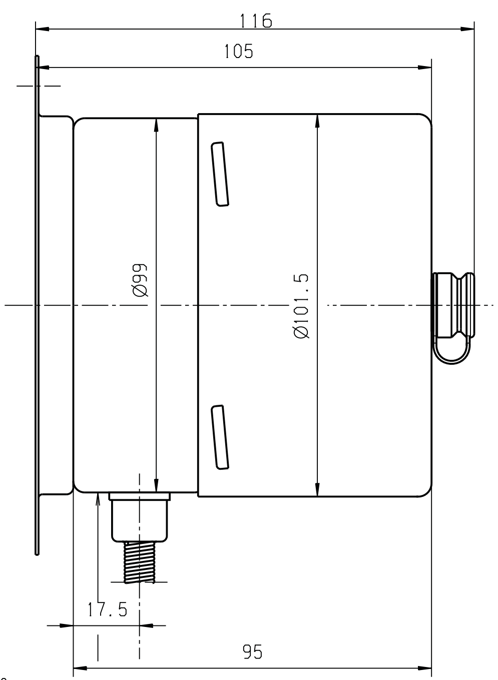


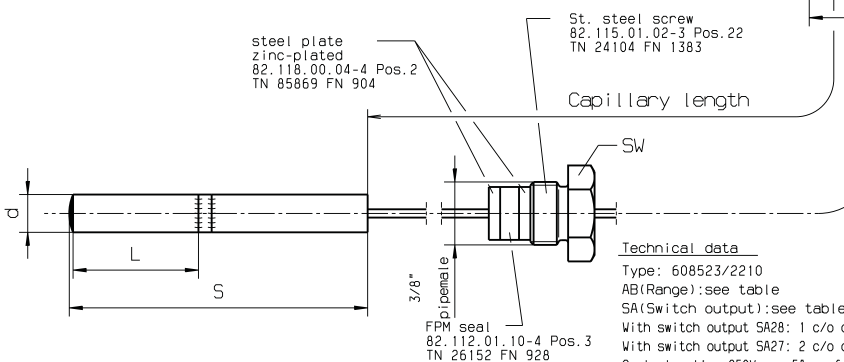
Probe form TA03 with pocket SH05





Probe form TA25 without screw fitting, suitable for TA25 with protection tube Drg.No. 82.118-F01-4M





Technical data

Type: 608523/2210
AB(Range):see table
SA(Switch output):see table
With switch output SA28: 1 c/o contact
With switch output SA27: 2 c/o contacts
Contact rating:250Va.c. 5A, p.f.=1;
48Vd.c. 0.5A; 24Vd.c. 1A; 12Vd.c. 3A
FL(Capillary):see table
TF(Probe):see table
TA(Mounting):see table
SH(Pocket):see table

Special notes

Final inspection to test specification EP8-022 Kl. 1,5
Label to be marked as follows:
-Type
-Order number
-Manufacturing date
-Ident-No. Voith acc.order specification
-Protection IP66

Temperature limit for storage and transport -20 to +80°C

Model	AB (Range)	L (Active probe length)	SA (Switch output)	FL (Capillary)	TF (Temperature probe)	TA (Probe mounting)	SH (Pocket)	SW a/f	System charge	on housing per°C ambient temperature change	on capillary per°C ambient temperature change	Fa. Voith Ident-No.	Fa. Jumo Ref.No.
9	Technische Daten nach Kundenangaben												
8	0 +160°C	ca.27,5mm	SA27	FL04-5500mm-St. steel (1.4571)-Ø2.2mm	TF01-St. steel (1.4571)-d=12mm	TA03-St. steel (1.4571)	SH05-1/2 NPT-St. steel (1.4571)-D=15mm-EL=65mm	27	Paraffin oil	0,15 %	0,023 %/m	41894160	00310948
7	0 +120°C	ca.35mm										41894150	00310947
6							SH05-1/2"pipe-St. steel (1.4571)-D=15mm-EL=65mm	27				41722720	85002580
5				FL04-3000mm-St. steel (1.4571)-Ø2.2mm								41722710	85002579
4				FL04-5500mm-St. steel (1.4571)-Ø2.2mm	TF05-St. steel (1.4571)-d=10mm-S=80mm	TA25	—	17				41722700	85002578
3				FL04-3000mm-St. steel (1.4571)-Ø2.2mm								41722690	85002577
2	0 +160°C	ca.27,5mm		FL04-5500mm-St. steel (1.4571)-Ø2.2mm	TF01-St. steel (1.4571)-d=12mm	TA03-St. steel (1.4571)	SH05-1/2"pipe-St. steel (1.4571)-D=15mm-EL=65mm	27				41722680	85002576
1				FL04-3000mm-St. steel (1.4571)-Ø2.2mm								41722670	85002575

ambient temperature(in % from Range)error based on deviation from 23°C calibration temperature

Voith Drg.-No.: 41713830 en

Änd. Nr.: 108429	Änd. Ind.: 6	Abt./Name: crk/Mar	Datum: 2010-07-19

Lfd-Nr.	Halbzeug	Werkstoff-Nr.	DIN-Kurzbezeichnung	Oberfläche

Bearb.	02.07.2008	Schlott
Gepr.	02.07.2008	Wenzel
Norm.		
Ges.		

Zeigerkontaktthermometer
Type 608523/2210

Zeichnungs-Nr. 85.543-F01-2M

Ersatz für Nr.

Vers.	Änderung	Datum	Name
13	K/E 60.0352	16.07.2008	Schlott
12	K/E 60.0352	02.07.2008	Schlott

JUMO GmbH & Co. KG Fulda Germany

Maße ohne Toleranzangabe DIN ISO 2768-m | Maßstab 1:1 | Teile-Nr. | DIN A2 | Blatt 01/02

Fa. Voith Crailsheim

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Delivery address: Mackenrodtstraße 14
36039 Fulda, Germany
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E-mail: mail@jumo.net
Internet: www.jumo.net

JUMO Instrument Co. Ltd.
JUMO House
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Harlow, Essex CM20 2DY, UK
Phone: +44 1279 635533
Fax: +44 1279 635262
E-mail: sales@jumo.co.uk
Internet: www.jumo.co.uk

JUMO Process Control, Inc.
6733 Myers Road
East Syracuse, NY 13057, USA
Phone: 315-437-5866
1-800-554-5866
Fax: 315-437-5860
E-mail: info.us@jumo.net
Internet: www.jumousa.com

Contact dial thermometer

Type 608523/2210

Special features

- Temperature controller with process value display as panel-mounting or add-on device
- Class 1.5
- Protection rating IP 65
- Case sizes∅: 100 mm

Brief description

Contact dial thermometer are devices with process value display for temperature measurement, control and monitoring and can be used universally.

The temperature depending volume change in a measuring system filled with liquid or the temperature depending pressure change in a measuring system filled with gas is converted to a rotational movement of the process value indicator by a bourdon tube, no transmission gear is required. The microswitch is actuated by the rotational movement of the indicator shaft via a tap system.

Technical data

Case	Case with bayonet lock made of stainless steel (1.4301)
Protection class	IP 65 as per DIN EN 60529
Front pane	Polycarbonate
Scale	white, labeled in black
Display	Class 1.5 similar to DIN EN 13190
Anti-kink spring	for devices with capillary on the case and the temperature probe
Set point adjustment	by set point value setter in the front pane; with screwdriver, protected by screw-fitted cover
Display correction	on the rear, no display correction with design 20
Limit value temperatures	for transport and storage -20°C to +70°C (for display range 0 to +60°C up to max. 65°C; -40 to +40°C up to max. 50°C; -30 to +50°C up to max. 60°C)
Rated position	any

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Technical data

Display range (AB)	Display range in °C	Measuring range in °C	Tolerance in °C
469	-40...+40	-30...+30	1.5
566	-30...+50	-20...+40	1.5
643	-20...+120	-20...+100	3.0
807	0...+60	+10...+50	1.5
810	0...+80	+10...+70	1.5
814	0...+100	+10...+90	1.5
818	0...+120	+20...+100	3.0
826	0...+160	+20...+140	3.0
832	0...+200	+20...+180	3.0
834	0...+250	+30...+220	4.0
926	+50...+250	+70...+230	3.0
840	0...+300	+30...+270	6.0
927	+50...+300	+80...+270	4.0
843	0...+350	+50...+300	6.0
932	+50...+350	+80...+320	6.0
848	0...+400	+50...+350	6.0
851	0...+450	+50...+400	6.0
854	0...+500	+50...+450	8.0
858	0...+600	+100...+500	10.0

	Liquid filling	**Gas filling**
Measuring system	Display range (AB) ≤ 350°C	Display range (AB) ÷ 400°C
Time behavior	approx. 12 s, measured in water, with a probe Ø of 6 mm made of Cu.	approx. 4 s, measured in oil, with a probe Ø of 10 mm made of stainless steel.
Ambient temperature influence effect	In % of the display range (referring to the deviation from the reference value +23°C)	
on case	0.15% of the display range per K ambient temperature change	0.05% of the display range per K ambient temperature change
on capillary (per m)	0.03% of the display range per K ambient temperature change	no influence
	Higher ambient temperature – higher temperature display – lower switching point	

	standard	**Extra code (TZ) 650**
Electric contact **Type of contact**	Single-pole microswitch with mechanically actuate change-over contact	
Contact rating	AC 230 V, +10/-15 %, 48 to 63 Hz, cos φ = 1 (0.6)	
	5 (1.5) A	10 (3) A
Hysteresis	approx. 1.5% of the display range	1.5 to 3 % of the display range
Switching point accuracy	± 0.5% of the display range referring to the switch-off point with rising temperature	
Switching reliability	To ensure a high switching reliability, we recommend a minimum voltage of 24 V and a minimum current of 100 mA	
Electrical connection	Connection inlet: Cable cross section up to 2.5 mm^2, suitable for cable-Ø from 6.5 to 13 mm	

Note

Physical and toxic features of the expansion means, which could emerge in the event of a measuring system break.

Control range with scale limit value	Hazardous reactions	Fire and explosion hazard		hazardous to waters	Information about toxicology		
		Ignition temperature	Explosion limit		irritant	dangerous to health	toxic
≤ +200°C	no	+355°C	0.6 - 8V%	Yes	Yes	[a]	no
≥ +200°C ≤ +350°C		+490°C	- -				
> +350°C ≤ +500°C		no	0.6 - 8V%	no	no	no	

[a] There is currently no statement by the health authority concerning hazards to health in the event of short-term exposure and low concentration, e.g. measuring system break.

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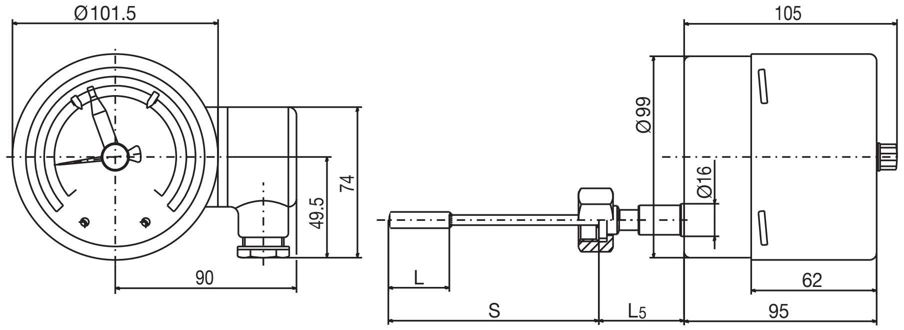
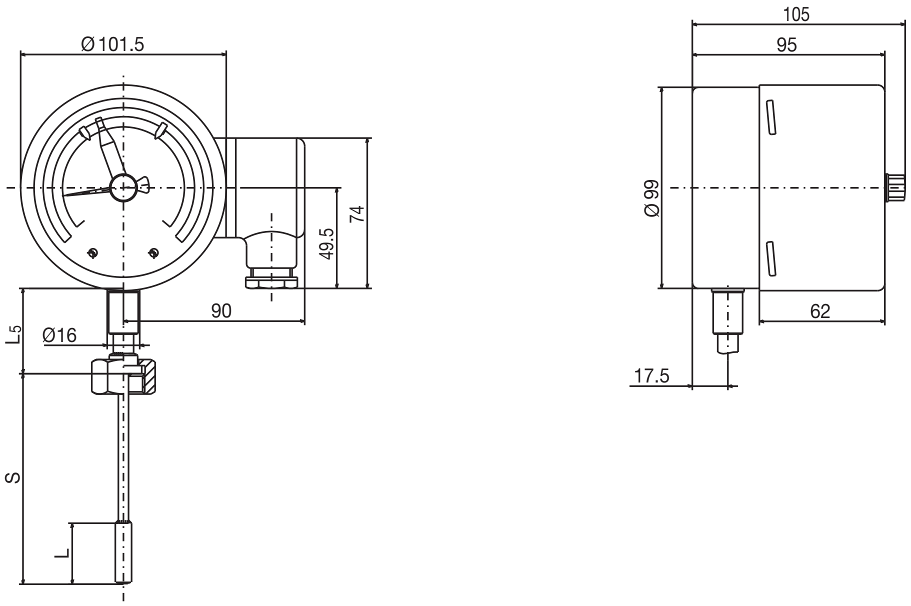
Dimensions

Type:
608523/0210



Type:
608523/1010



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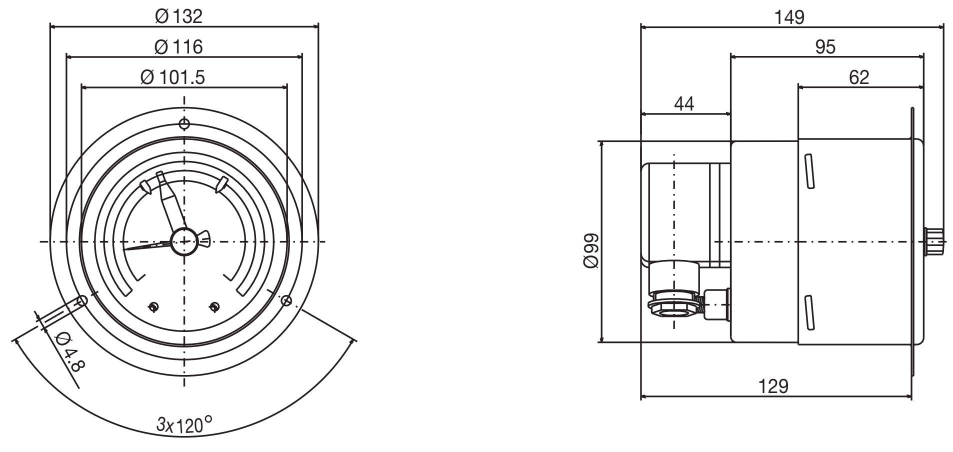
608523/2010



Panel cut-out Ø 105 $^{+0.5}_{0}$ mm

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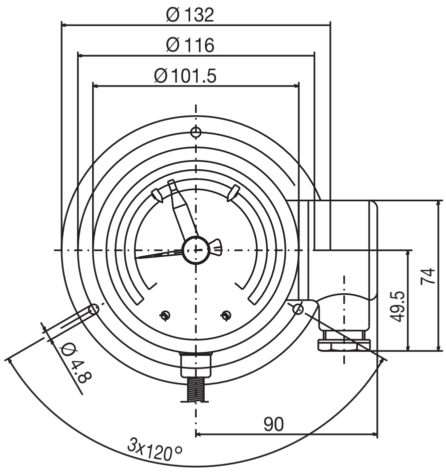
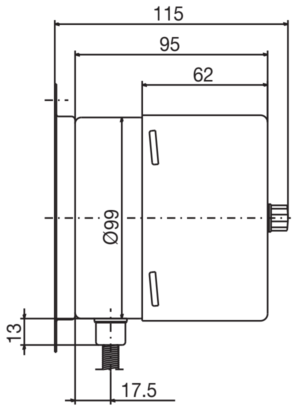
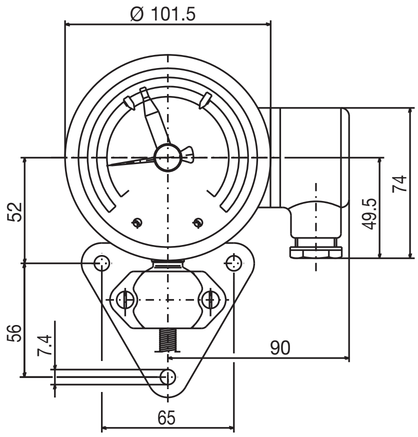
Type:
608523/2210



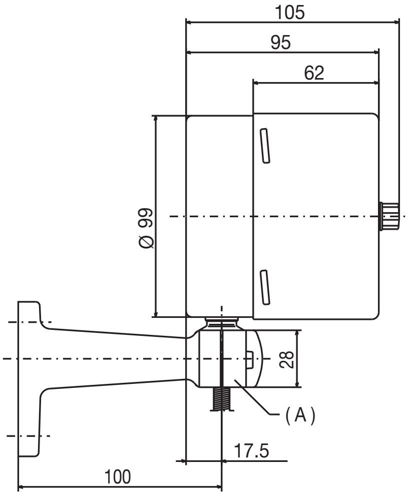


Panel cut-out Ø 105 $^{+0.5}_{0}$ mm

Type:
608523/2310



Holder for measuring device as per DIN 16281

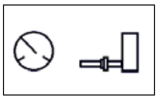
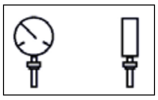
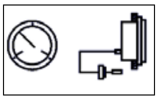
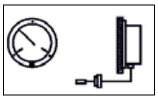
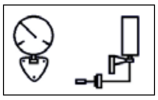


(A) Spigot-Ø 26 mm

L_5	Immersion tube connection type
40 mm	TA 03, TA 30
≤ 69 mm	TA 02
42.5 mm	TA 21
51.5 mm	TA 22, TA 31

Order details

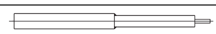
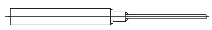
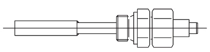
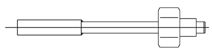
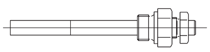
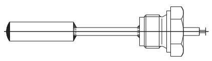
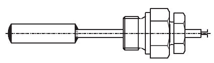
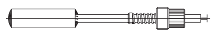
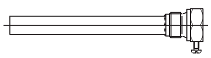
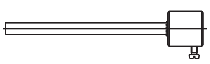
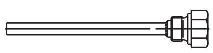
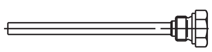
Order code	(1)	Basic type
608523		Mechanical contact dial thermometer, class 1.5

	(2)	Basic type extension		Case size Ø
0210		Design 02		100 mm
1010		Design 10		100 mm
2010		Design 20		100 mm
2210		Design 22		100 mm
2310		Design 23		100 mm

	(3)	Display range in °C
469		-40...+40
566		-30...+50
643		-20...+120
807		0...+60
810		0...+80
814		0...+100
818		0...+120
826		0...+160
832		0...+200
834		0...+250
926		+50...+250
840		0...+300
927		+50...+300
843		0...+350
932		+50...+350
848		0...+400
851		0...+450
854		0...+500
858		0...+600

Order code	(4)	Capillary type (FL) [a]
00		Without (with rigid connection)
02		FL 02 Cu capillary with Cu textile braiding, approx. Ø 2.5 mm (up to AB limit value +300°C)
11		FL 11 Cu capillary with PE jacketing, approx. Ø 3.5 mm (up to AB limit value +120°C)
17		FL 17 Stainless steel capillary, approx. Ø 1.5 mm
21		FL 21 Cu capillary, approx. Ø 1.0 mm (up to AB limit value +300°C)

	(5)	Capillary [b]
0		Without (with rigid connection)
1000		1000 mm
2000		2000 mm
3000		3000 mm
4000		4000 mm
5000		5000 mm
. . . .		Special length (specifications in plain text: 1000 mm steps, maximum length 10000 mm), further lengths on request

	(6)	Process connection (PA) [a]		
750		TF 01	Temperature probe with stepped support tube	
752		TF 11	Temperature probe without support tube	
843		TA 02	Immersion tube with union nut and loose screw-connection [b]	
161		TA 03	Immersion tube with loose screw-connection	
847		TA 06	Immersion tube with displaceable crimp screw-connection on support tube [b]	
311		TA 20	Immersion tube with loose screw-connection and connection collar [b]	
872		TA 21	Immersion tube with loose screw-connection and sealing cone (only G 3/8 possible)	
873		TA 22	Immersion tube with loose pressure screw, sealing cone and loose screw-connection [b]	
401		TA 23	Immersion tube with pressure screw and contact pressure spring (only M 10x1 possible)	
913		SH 07	Screw-in sheath, multi-part, with clamping piece and locking screw (suitable for TF 01 and TF 11)	
820		SH 09	Weld-in sheath, multi-part, with clamping piece and locking screw [b] (not for FL 21 - welding collar with steel 1.4515)	
876		SH 10	Screw-in sheath, multi-part [b] (suitable for TA 21)	
871		SH 11	Screw-in sheath, multi-part [b] (suitable for TA 21)	

[a] For the description and particularities, refer to data sheet 608730.
[b] Screw-in spigot as per DIN 3852, form A.

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Order code		
	(7)	**Ø Process connection (PA)** [a]
6		6 mm
8		8 mm
10		10 mm
11		11 mm
12		12 mm
	(8)	**Thread type of process connection (PA)** [a]
000		Without thread (for TA 01 and TF 11)
103		Screw connection G 3/8
104		Screw-connection G 1/2
105		Screw-connection G 3/4
114		Screw-connection M 10 x 1 (only for TA 23 and SH 11)
	(9)	Material, probe / support tube [a]
26		Stainless steel (CrNi, 1.4571)
96		Copper (Cu) / Brass (CuZn) (up to 200°C)
95		Stainless steel (CrNi, 1.4571) - probe / Brass (CuZn) - support tube from 250°C)
	(10)	**Material of process connection (PA)** [a]
00		Without (only TF 01 and TF 11)
26		Stainless steel (CrNi, 1.4571)
46		Brass (CuZn)
	(11)	**Fitting length, process connection (PA)** a **(dimension "EL" or "S")**
0		Minimum fitting length TF 11 (active probe dimension)
50		50 mm
100		100 mm
150		150 mm
200		200 mm
. . .		Special length (specifications in plain text - 50 mm steps)

[a] For the description and particularities, refer to data sheet 608730.

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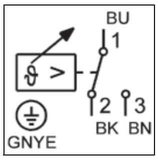
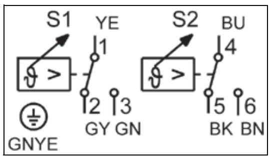
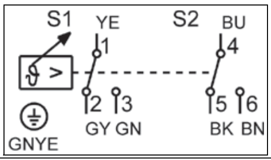
Order code	**(12)**	**Switching output**	
28		1 switch	
27		2 switches	
19		2 switches in fixed sequence	

	(13)	**Extra codes (TZ)**
000		Without extra codes
434		Fly back can be adjusted with a screwdriver, protected by a cover
650		Microswitch 10 (3) A (AC/DC 230 V, +10/-15 %, 48 to 63 Hz, cos φ = 1 (0.6))
518		Stop for Min. — or Max. — setpoint value limitation, factory set
522		Customized scale

Special versions on request !

Order code

(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)		(9)		(10)		(11)		(12)		(13)	
608523	/	. . . .	-	. . .	-	. .	-	. . . .	-	. . .	-	. .	-	. . .	-	. .	-	. .	-	. . .	-	. .	/	. . .	, . . .

Order example

608523	/	2010	-	818	-	21	-	2000	-	750	-	10	-	000	-	26	-	00	-	100	-	28	/	000[a]	, . . .

[a] List extra codes in sequence, separated by commas.

All stainless steel gas actuated thermometer
Model S5500

According EN 13190
Nominal size 100 mm or 160 mm
With or without capillary/contacts
Accuracy: Class 1 dry
Class 2 liquid filled

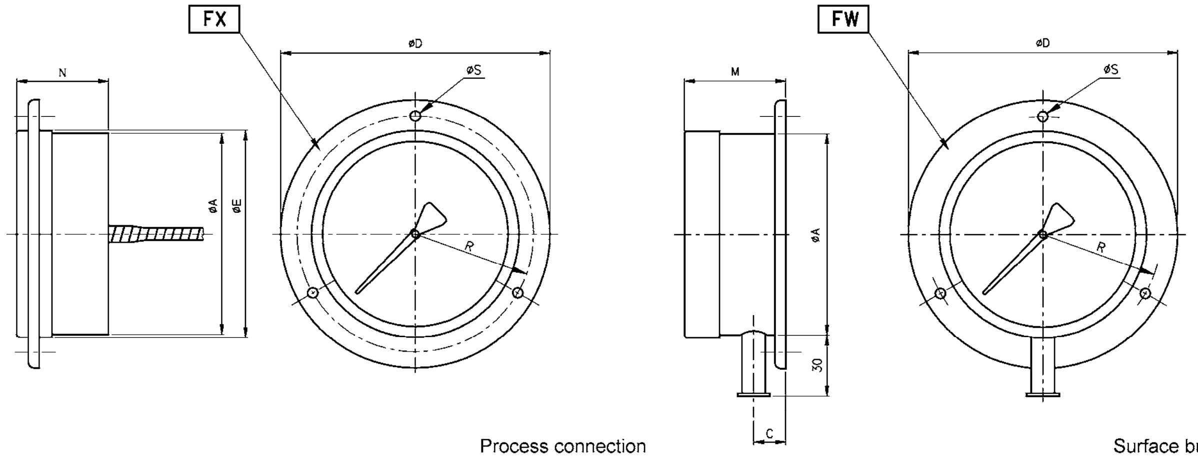
Features
- Rugged stainless steel construction
- Fast response
- Protection IP65
- High repeatability and small hysteresis
- Dry or liquid filled
- Rigid stem or bulb with capillary

Ranges
-200 ... 50 °C up to 0 ... 800 °C
-330 ... 120 °F up to 50 ... 1450 °F

Applications
Chemical and petrochemical industry
Machine and apparatus construction
Food and beverage industry
Pulp and paper industry

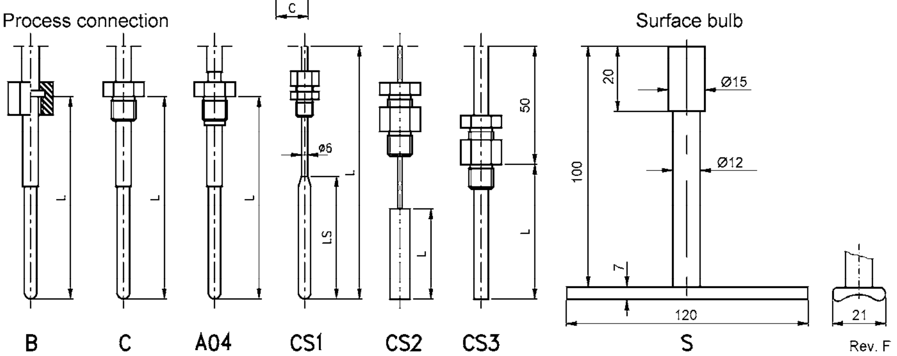
Technical specification	**Rigid stem**		**With capillary**	
Dial size in mm	100	160	100	160
Construction	Cylindrical case with bayonet ring			
Measuring principle Range in °C Overtemperature limit	Inert gas actuated 0/60 0/80 0/100 0/120 0/160 0/200 0/250 0/300 0/400 0/500 0/700 0/800 -10/50 -10/110 -20/40 -20/100 -20/120 -20/180 -30/50 -30/70 -30/170 -40/40 -40/60 -40/160 -50/50 -60/40 -80/40 -100/50 -120/40 -200/50 Ranges in °F and dual scales on request Max. 130 % F.S. but max. 800 °C, optional 210 % F.S. but max. 800 °C			
Stem or bulb diameter	6 mm, 8 mm, 9 mm, 10 mm, others on request			
Lengths	55 ... 4000 mm, other length on request, min. length depends on bulb and range			
Capillary length	N.A.		Max. 100 m	
Process connection	Plain G ½ B male, G ¾ B male, G 1 B male according ISO 228-1, ½ NPT male, ¾ NPT male, 1 NPT male according ANSI/ASME B1.20.1, M20x1,5 male, M24x1,5 male, M27x2 male according ISO 68-1, Others on request Fixed, adjustable union or with swivel nut			
Connection location	Back, lower, knee joint bendable (180°), knee joint bendable (360°)			
Material Connection Stem Case/ring	 Stainless steel 304 (1.4301) Stainless steel 321 (1.4541) Stainless steel 304 (1.4301), optional 316 (1.4401)			
Capillary Armor			Stainless steel 321 (1.4541) Flexible, 304 (1.4301), or 316 (1.4401) optional PVC covered	
Window Dial Pointer Movement	Instrument glass, optional laminated safety glass or acrylic glass Aluminum, black markings on white background Aluminum, black, optional micrometer pointer or maximum pointer Stainless steel 304/303 (1.4301/1.4305)			
Accuracy	Class 1 (dry) , Class 2 (liquid filled) according to EN 13190			
Zero adjustment	±6 % externally			
Protection according EN 60 529/IEC 529	IP65			
Filling liquids	Glycerin, silicone			
Weight dry/filled in kg	0,8/1,0 (stem length 100 mm)	1,2/3,0 (stem length 100 mm)	1,0/1,2 (stem length 100 mm, capillary 1,5 m)	1,4/3,2 (stem length 100 mm, capillary 1,5 m)
Accessories, options	Thermowells, dual scales, magnet spring- or inductive contacts, built in microswitch 1 or 2 SPDT, calibration certification			

General dimensions in mm



	A	C	D	E	M	N	R	S
NG 100	99	13	132	103	50	45	58	5
NG 160	159	13	196	164	50	45	89	6

minimum bulb length				
bulb diamter	6	8	9	10
direct mount or capillary up to 5 m	190	90	68	55
capillary over 5 m	on request	170	130	100



Order information

Size	Bulb diameter	Length of bulb/stem	Length of capillary	Process connection	Connection size	Connection orientation	Range	Engineering units	Options
(100) 100 mm **(160)** >160 mm	**(6)** 6 mm **(7)** 7 mm **(8)** 8 mm **(9)** 9 mm **(10)** 10 mm others on request	**55 to 4000 mm**	**length in mm** [1)] 1) for fixed bulb „0“ max. length: 100 m	**(B)** Turning nut **(C)** Single nipple **(A04)** Turning nipple **(CS1)** Adjustable union connection sliding on tube [1)] **(CS2)** Adjustable union connection sliding on capillary **(CS3)** Adjustable union connection sliding on stem **(S)** Surface bulb [2)] 1) length of bulb (LS) must be specified. 2) only for bulb diameter (7) others on request	**(50)** G ½ B **(75)** G ¾ B **(10)** G 1 B **(50N)** ½ NPT **(75N)** ¾ NPT **(10N)** 1 NPT **(M20)** M20x1,5 **(M24)** M24x1,5 **(M27)** M27x2 others on request	**(L)** Lower **(R)** Back **(E1)** Knee joint bendable (180°) **(E2)** Knee joint bendable (360°)	0/ 60 0/ 80 0/ 100 0/ 120 0/ 160 0/ 200 0/ 250 0/ 300 0/ 400 0/ 500 0/ 700 0/ 800 -10/ 50 -10/ 110 -20/ 40 -20/ 100 -20/ 120 -20/ 180 -30/ 50 -30/ 70 -30/ 170 -40/ 40 -40/ 60 -40/ 160 -50/ 50 -60/ 40 -80/ 40 -100/ 50 -120/ 40 -200/ 50	**°C** °F and dual scale on request	**(NH)** Tagging wired **(DA)** Dial marking **(CS)** Dual scale **(PD)** Acrylic glass **(SG)** Safety glass **(MP)** Micro pointer **(A4)** Capillary st. st. armored **(A5)** Capillary st. st. armored with PVC covering **(FX)** Front flange **(FW)** Back flange **(FH)** Surface mounting bracket L = 100 mm **(UC)** U-clamp **(EP)** Maximum pointer **(TM)** 2" pipe mounting bracket **(Q3)** 1 microswitch **(Q33)** 2 microswitches other options on request for contacts see data sheet K55

Order example

Size	Type	Bulb diameter	Length of bulb/stem	Length of capillary	Process connection	Connection size	Connection orientation	Range	Engineering unit	Options
100	S5500	8	100	1500	CS2	50N	L	0/100	C	FW

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Screwed Thermowells
Model SM, ST, RT and HT

Features

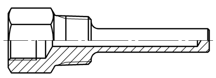
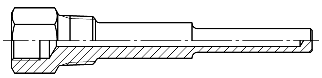
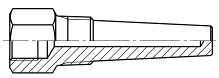
- Solid bore construction
- Materials according NACE MR 01-75/ISO 15156
- Selection of materials
- Standard and customer specifications
- ISO 228-1 and ANSI/ASME B1.20.1 connections

Ratings

from 620 bar at 20 °C
to 175 bar at 650 °C

Applications

Chemical and petrochemical industry
Machine and apparatus construction
Food and beverage industry
Pulp and paper industry

Technical specification		SM, ST	LSM, LST	RT	LRT	HT	LHT
Solid bore design							
Construction shank Lagging		Straight No	 Yes	Stepped No	 Yes	Tapered No	 Yes
Standard U-length	in inch in mm	1 5/8 2 ½ 4 ½ 41 63 114		7 ½ 10 ½ 13 ½ 191 267 343		16 ½ 22 ½ 419 572	
		Optional customer specification					
Bore diameter	in inch in mm	0,260 0,385 6,6 9,8 [1)] 7,0 10,5 [1)] 12,5 [1)] [1)] not for types RT and LRT Others on request, see coding table					
Pressure rating		Depending on process connection (½", ¾" or 1") and bore diameter (0,260"/6,6 mm) for standard thermowell material stainless steel 316L (1.4404) (These data don't apply to other materials)					

at process connection in inch		¾, 1				½		¾, 1	
°F	°C	PSI	BAR	PSI	BAR	PSI	BAR	PSI	BAR
70	21	6500	448	6000	413	6000	413	9000	620
200	93	5500	379	5200	358	5200	358	7700	531
400	204	5000	345	4500	310	4500	310	6700	462
600	316	4000	275	4000	275	4000	275	5800	400
800	427	3800	262	3500	241	3500	241	5300	365
1000	538	3500	241	3300	227	3300	227	5000	345
1200	649	2500	172	2500	172	2500	172	3700	255
						Bore 0,385 (9,8 mm) 40 % less			

Process connection	G ½ A male, G ¾ A male, G 1 A male according ISO 228-1 ½ NPT male, ¾ NPT male, 1 NPT male, 1 ¼ NPT male according ANSI/ASME B1.20.1 Others on request
Instrument connection	½ NPSM female standard, optional ½ NPT female or G ½ female
Material	Stainless steel 304 (1.4301), stainless steel 304L (1.4306), Stainless steel 316 (1.4401), stainless steel 316L (1.4404), stainless steel 316Ti (1.4571) Hastelloy B, Hastelloy C, Monel, Duplex, Nickel Other materials or coatings on request
Certifications & tests	Material certificate 3.1 to EN 10 204, hydrostatic test, dye penetration test, X-ray, hardness test, NACE/ISO 15156 certificate
Accessories, options	Thermometers, Pt-100, thermocouples

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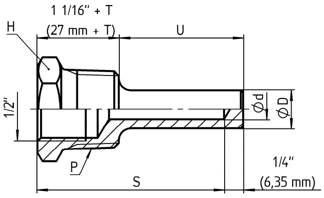
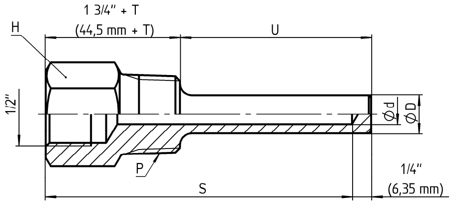
General dimensions in inch (mm)

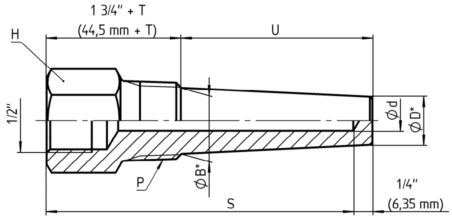
Type SM, LSM



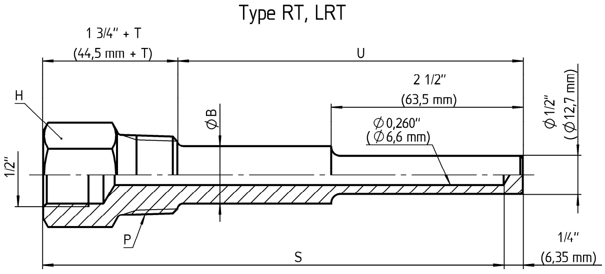
Type ST, LST



Type HT, LHT



Type RT, LRT



Lagging „T"		
T		**U**
inch	mm	inch
1-½	38	= 1-5/8
2	50	= 2-½
3	76	≥ 4-½

Rev. C

For all types

P (G, NPT)	**Ød**		**ØB / ØB***		**ØD / ØD***		**H** (G / NPT)	
	inch	mm	inch	mm	inch	mm	inch	mm
½	0,26	6,6	5/8 / 5/8	16 / 16	½ / ½	12,7 / 12,7	1-1/8 / 1-1/8	30 / 30
¾	0,26	6,6	¾ / 7/8	19 / 22	½ / 5/8	12,7 / 16	1-5/16 / 1-1/8	32 / 30
¾	0,385	9,8	- / 7/8	- / 22	49/64 / 49/64	19,5 / 19,5	1-5/16 / 1-1/8	32 / 30
1	0,26	6,6	7/8 / 1-1/16	22 / 27	½ / 5/8	12,7 / 16	1-5/8 / 1-3/8	41 / 36
1	0,385	9,8	- / 1-1/16	- / 27	49/64 / 49/64	19,5 / 19,5	1-5/8 / 1-3/8	41 / 36

- = not available

S		**U**		**P**	Type:
inch	mm	inch	mm	(G, NPT)	**SM**, **ST**, **RT**, **HT**
2-½	63	1-5/8	41	¾	SM, - - -
				1	SM, - - -
4	102	2-½	63	½	- ST, -, HT
				¾	- ST, -, HT
				1	- ST, -, HT
6	152	4-½	114	½	- *, RT, HT
				¾	- ST, RT, HT
				1	- ST, RT, HT
9	229	7-½	191	½	- *, RT, HT
				¾	- ST, RT, HT
				1	- ST, RT, HT
12	305	10-½	267	½	- *, RT, HT
				¾	- ST, RT, HT
				1	- ST, RT, HT
15	381	13-½	343	½	- *, RT, HT
				¾	- ST, RT, HT
				1	- ST, RT, HT
18	457	16-½	419	½	- *, RT, HT
				¾	- ST, RT, HT
				1	- ST, RT, HT
24	610	22-½	572	½	- *, RT, HT
				¾	- ST, RT, HT
				1	- ST, RT, HT

For **LRT**, **LST**, **LHT**: **S** = 1 ¾" + T + U - ¼"   * = on request
For **LSM**: **S** = 1 1/16" + T + U - ¼"

Order information

Process connection	**U-length**	**Instrument connection**	**Lagging**	**Shank type**	**Bore**	**Material**	**Options**
All connections are male **(50)** ½ NPT 1) **(51)** G ½ A 1) **(75)** ¾ NPT **(76)** G ¾ A **(10)** 1 NPT **(11)** G 1 A **(12)** 1-¼ NPT 1) not for SM and bore 0,385 inch/9,8 mm others on request	**Inch dimension** **(0162)** 1 5/8" (only type SM and LSM) **(0250)** 2 ½ " 1) **(0450)** 4 ½" 1) **(0750)** 7 ½" 1) **(1050)** 10 ½ " 1) **(1350)** 13 ½" 1) **(1650)** 16 ½" 1) **(2250)** 22 ½" 1) 1) not for type SM, LSM **MM dimension (... mm)** length in mm others on request	**All connections are female** **(=)** ½ NPSM **(2)** ½ NPT **(51)** G ½ others on request	**(=)** No lagging **(L)** With lagging (standard 1-½," 2" or 3" (38, 50 or 75 mm), see above table. Other lengths to be specified in inch or mm)	**(SM)** Limit space straight (only U = 1 5/8") 1) **(ST)** Straight **(RT)** Stepped 1) **(HT)** Tapered 1) only bore 0,260", 6,6 or 7 mm others on request	**Inch dimension** **(260)** 0,260" (6,6 mm) **(385)** 0,385" 1) (9,8 mm) others on request **MM dimension (... mm)** Standard available 6,6 mm 7,0 mm 8,5 mm 1) 9,8 mm 1) 10,5 mm 1) 12,5 mm 1) 1) not for type RT and LRT others on request	**(C)** 304 (1.4301) **(CL)** 304L (1.4306) **(S)** 316 (1.4401) **(SL)** 316L (1.4404) **(STI)** 316Ti (1.4571) **(M)** Monel **(H)** Hastelloy C **(G)** Hastelloy B **(N)** Nickel **(J)** Duplex others on request	**(NF)** Tagging stamped **(2)** Cap & chain stainless steel **(BP)** Buffed and polished **(CD5)** NACE certificate **(W2)** Dye penetration test **(MQ)** PMI test **(YR…)** X-ray photo **Material certificates acc. DIN EN 10 204** **(CD2)** 2.2 **(C3)** 3.1 **Hydrostatic internal pressure test** **(W9)** 100 bar 1 min. **(W4)** To customer specification

Order example

Process Connection	Type	U-length	Instrument connection	Lagging	Shank type	Bore diameter	Material	Options
75	W	0250	=	L	HT	260	SL	X NF

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Ausrichten des Gelenkanschluss

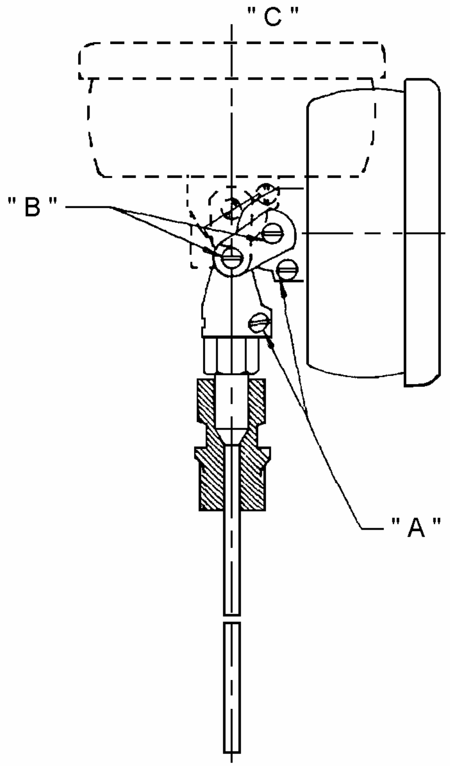
Thermometer MIT GELENKANSCHLUSS sollten im Gelenk nur dann verstellt werden, wenn es während der Montage oder des Abbaus notwendig ist (Gewährleistung der Lebensdauer).
Der Fühler sollte mittels Gelenk möglichst vor dem Einbau in die richtige Position gebracht werden, wobei wie folgt vorgegangen werden soll:
- Thermometer Anzeigenteil gerade stellen (Lage "C")
- Die mit "A" gekennzeichneten Schrauben lösen bis das Gelenk frei am Gehäuseunterteil und Fühler um 180° drehbar ist.
- Das Thermometergehäuse mit einer Hand festhalten, und mit der anderen Hand das Gelenkstück soweit verdrehen, bis die innere Seite des Gelenks in die gewünschte Biegerichtung zeigt.
- Die vorgenannten Schrauben "A" wieder fest anziehen.
- Die mit "B" gekennzeichneten Schrauben lösen und das Gelenk in die gewünschte Biegerichtung bringen.
- Die vorgenannten Schrauben "B" wieder fest anziehen.

Positioning of stem, Every-Angle execution

"Every-Angle style thermometers should be operated only when necessary during installation or removal to assure longest life time.
Positioning of the stem should be performed before installation, the stem and case should be set to the desired angle as follows:
- Thermometer head shall be putt in position "C".
- Loosen the screws labeled "A", until the harness and stem revolves freely through an angle of 180° with reference to the case.
- While holding the case revolve the harness and stem to place the harness in a position that will permit flexing the stem into the desired position.
- Lock screws labeled "A" again.
- Loosen the screws labeled "B" then flex the stem to the desired angle.
- Lock the screws labeled "B" again.

Positionnement de la tige, type Tous Angles

Pour obtenir la meilleure longévité du thermomètre "tous angles", l'articulation ne devra être actionnée que lorsque cela est indispensable; au montage et à la dépose par exemple. Avant l'installation, la tige devra être positionnée de la manière suivante:
- Placer la tête du thermomètre dans la position "C".
- Desserrer les vis repérées "A" jusqu'à ce que l'articulation tourne librement sans forcer, autour du soufflet.
- Tout en maintenant le boîtier, faire tourner l'articulation jusqu'à la position désirée.
- Resserrer les vis repérées "A".
- Desserrer les vis repérées "B" et plier la tête du thermomètre jusqu'à l'angle désiré.
- Resserrer les vis repérées "B".



ASHCROFT®

Betriebsanleitung
Thermometer

Operating Instruction
Thermometer

Instruction de Service
Thermomètre

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1. Montagebedingungen

- Die Thermometer müssen nach den in Betracht kommenden Anforderungen ausgewählt und montiert werden.
- Die max. Umgebungstemperaturen des Gehäuses für flüssigkeitsgefüllte Thermometer betragen - 40 °C (- 40 °F) oder + 60 °C (140 °F). Andere Temperaturgrenzen sind optional mit speziellen Serien möglich.

2. Montage

- Die Thermometer am Gehäuse oder am Prozessanschluss aus der Verpackung herausnehmen.
- Das Thermometer so montieren, dass das Fühlerende bei Bimetallen 50 mm und bei gasgefüllten Thermometern 75 mm im Messmedium eintaucht. Wird ein Thermometer in einer Schutzhülse montiert, so ist diese zuerst einzubauen. Der Fühler des Thermometers sollte dann mit einem wärmeübertragenden Stoff (z.B. Wärmeleitpaste) umgeben sein.
- Mit einem Gabelschlüssel am Sechskant des Gewindeanschlusses bis zur Dichtposition einschrauben und dann durch weiteres Anziehen die exakte Ableseposition einstellen. Bei Thermometern mit Kapillarleitung muss die Kapillarleitung so verlegt werden, dass diese nicht extremen Temperaturen ausgesetzt ist. Das Thermometersystem (Rohrfeder, Kapillarleitung und Fühler) darf in keinem Fall demontiert werden.

Achtung !

- Es darf keine Kraft (Moment) auf das Gehäuse ausgeübt werden.
- Die Gehäusetemperatur darf bei Bimetall - Thermometern +90 °C und bei gasgefüllten Thermometern +70 °C nicht überschreiten.
- Das Instrument grundsätzlich nicht am Fühler festhalten.
- Messbereich und zulässige Über- bzw. Untertemperatur nicht über- bzw. unterschreiten.
- Der minimale Kapillarradius beträgt 40 mm (1 1/2“). Wenn die Kapillarleitung zu lang ist, die Überlänge in einem Kreis von 20 - 25 cm Durchmesser aufwickeln, **jedoch nicht abschneiden**

3. Justierungen

- Falls die Anzeige verändert werden muss, wie folgt vorgehen:
  1. Bei Thermometern mit externer Verstellmöglichkeit diese mit einem Schraubendreher so lange verdrehen, bis der Zeiger die gewünschte Temperatur auf der Skala anzeigt.
  2. Bei Thermometern mit Bajonettring diesen abnehmen, mit zwei Fingern den Zeiger am breiteren Teil in der Nähe der Zeigerbuchse festhalten und mit einem kleinen Schraubendreher die Buchse um einen geschätzten Winkel verdrehen. Dann den Zeiger loslassen und den angezeigten Wert ablesen. Diesen Vorgang wiederholen, bis der gewünschte Wert angezeigt wird. Anschließend ist das Gehäuse mit Bajonettring, Glas und Dichtring dicht zu verschließen.

4. Wartung

- Die Geräte brauchen kaum oder keine Wartung. Das Gehäuse muss absolut dicht sein, damit keine Feuchtigkeit oder Schmutz eindringt.
- Falls der Fühler mit einem Messstoff in Berührung kommt, der eventuell aushärten kann, sollte das Thermometer des öfteren vom Messort entnommen und der Tauchschaft gereinigt werden.

5. Anmerkung

- Thermometer, die bei Umgebungstemperaturen unter 0 °C zum Einsatz kommen, müssen besonders gut abgedichtet sein, damit keine Feuchtigkeit eindringen kann. "Hermetisch dichte" Thermometer werden in trockener Atmosphäre verschlossen und bedürfen deshalb keiner Wartung. Thermometer mit Bajonettring sollten bei Umgebungstemperaturen < 0 °C nicht geöffnet werden. Falls sie geöffnet wurden, an einen trockenen und warmen Ort 24 bis 48 Stunden trocknen lassen. Danach sorgfältig verschließen.

Technische Änderungen vorbehalten

1. Installation requirements

- The Thermometer must be selected and installed this wise, that the possibility of failure resulting in injury or misapplication is minimized.
- The maximum ambient temperature for liquid filled thermometers shall not exceed -40 °C (-40 °F) or +60 °C (140 °F). Other temperature limits are available optionally in special series.

2. Mounting

- Remove the thermometer by the case or outlet out of the packing box.
- Mount thermometer at any convenient location (Thermowell) where the sensing portion of the stem will be at least 50 mm (2") for the bimetal or 75 mm (3") for gas-filled thermometer in the temperature to be measured. When a thermometer has to be inserted into a thermowell, install the thermowell first. The stem or bulb of the thermometer shall than be coated with a heat conducting medium, suitable for the required temperature (e.g. mixture of glycerine and graphite).
- To tighten always use a wrench applied to the hexagon head of the connection. Turn until the thermometer is reasonable tight, then tighten further until scale is in the desired position.
- For remote gas-filled thermometer the capillary should be laid so that it will not be exposed to extreme temperatures. The thermometer system (Bourdon tube, line and bulb) must not, under any circumstances be taken apart, or the capillary cut.

Attention !

- Do not tighten by turning the thermometer case.
- Install the thermometer so that the maximum case temperature does not exceed 90°C.
- (200 °F) for bimetals and 70 °C (16 °F) gas - filled thermometer.
- During all operations do not handle the thermometer by the stem.
- Do not exceed range or admissible overtemperature.
- The minimum capillary radius is 40 mm (1 1/2"), Should it be too long, coil the surplus neatly in a loop of 20 - 25 cm diameter at a convenient point but **do not cut it**

3. Adjustment

- If it is necessary to adjust the thermometer, proceed as follows:
  1. On the thermometers fitted with an "External Adjustment" use a screw driver to turn the slotted hexagon head in the back of the case until the pointer indicates the proper temperature on the dial.
  2. On the "Bayonet ring thermometers" after removal of the bayonet ring, hold the tail of the pointer close to the center with one hand and by using a small screw driver, turn the slotted center bushing. Release the pointer and check its reading. Repeat if necessary above operation until the pointer is brought to the proper reading on the scale. Replace the gasket, glass and ring and assure that the case is absolutely tight, after the adjustment has been made.

4. Maintenance

- The instruments need little or no maintenance. But be sure that the case is close at all times, so that no moisture or dirt can enter the case.
- If the thermometer is used in to a medium that may harden and built up, the thermometer should be removed occasionally to clean the stem.

5. Caution

- Thermometers operating below 0 °C (32 °F) must have a perfectly tight case to prevent entrance of moisture. "Hermetically sealed" thermometers are close in a dry, warm atmosphere and need no maintenance. "Bayonet ring type thermometers" may show for any reason sign of stickiness when indicating a low temperature they should be brought to a dry, warm location and allow them to dry out within 24 or 48 hours with an open case. Afterward close the cases carefully and reinstall them.

Modification reserved

1. Conditions de montage

- Le thermomètre doit être installé avec précaution afin d'éviter tout défaut provenant d'un mauvais montage.
- La température ambiante maximum pour les thermomètres à bain ne devra pas dépasser -40 °C (-40 °F) ou +60 °C (140 °F). D'autres limites de température sont possibles sur demande.

2. Montage

- Enlever le thermomètre de son emballage en le prenant par le boîtier ou au niveau du raccord.
- Monter le thermomètre (doigt de gant) de telle manière que l'extrémité de la tige soit au contact de la température à mesurer sur une longueur minimum de 50 mm (2") pour les bimétalliques et de 75 mm (3") pour ceux à gaz. Installer d'abord le doigt de gant. Il est conseillé d'enduire la tige ou le bulbe d'un produit conducteur adapté à la température (p. e. un mélange de glycérine et de graphite).
- Pour serrer, utiliser toujours une clé adaptée au raccord 6 pans. Serrer raisonnablement puis ajuster jusqu'à la position désirée.
- Pour les thermomètres à gaz, le capillaire doit être monté de manière à n'être pas exposé à des températures extrêmes. Le système du thermomètre (Tube Bourdon, bulbe, capillaire) ne doit dans aucun cas être démonté ou coupé.

Attention !

- Ne jamais serrer le thermomètre en le tournant par le boîtier.
- Installer le thermomètre de telle manière que la température au niveau du boîtier ne dépasse pas 90 °C pour les thermomètres bimétalliques et 70 °C pour les thermomètres à gaz.
- Ne jamais prendre le thermomètre par la tige.
- Ne pas dépasser l'échelle ou la température maximum admissible.
- Le radius minimum pour le capillaire est de 40 mm (1 1/2"). Si celui-ci est trop long, enrouler le surplus en formant une boucle de 20 - 25 cm de diamètre mais ne jamais couper le capillaire.

3. Réglage

- Si un réglage du thermomètre s'avère nécessaire, procéder comme suit:
  1. Sur le thermomètre "hermétique" à lunette sertie, utiliser un petit tournevis pour tourner la vis de réglage placée au dos de l'appareil jusqu'à ce que l'aiguille indique la bonne température.
  2. Sur le thermomètre à "baïonnette", enlever la lunette et en maintenant l'aiguille par son extrémité, tourner la bague centrale à l'aide d'un petit tournevis. Relâcher l'aiguille pour vérifier la position et répéter l'opération si nécessaire jusqu'à ce que la lecture soit correcte. Replacer la lunette, sa vitre et son joint et resserrer la lunette fermement.

4. Entretien

- Il n'y a pas d'entretien particulier. Cependant, s'assurer que la lunette est toujours parfaitement serrée afin qu'aucune humidité ou poussière n'entre à l'intérieur du boîtier.
- Si le thermomètre est utilisé sans doigt de gant et que des produits risquent de se déposer sur la tige, la tige du thermomètre devra être nettoyée régulièrement.

5. Information

- Les thermomètres soumis à des températures inférieures à 0 °C doivent être parfaitement étanches pour éviter l'introduction d'humidité. Les thermomètres "hermétiques" sont sertis en usine en atmosphère sèche et chaude et ne nécessitent aucun entretien. Les thermomètres à "baïonnette" peuvent présenter des signes d'adhérence à basse température. Déposer alors l'appareil, enlever la lunette et le laisser sécher de 24 à 48 heures. Puis le remonter au sec en s'assurant de la parfaite condition du joint avant de le réinstaller sur le site.

Sous réserve de modifications

14.2 Resistance thermometer

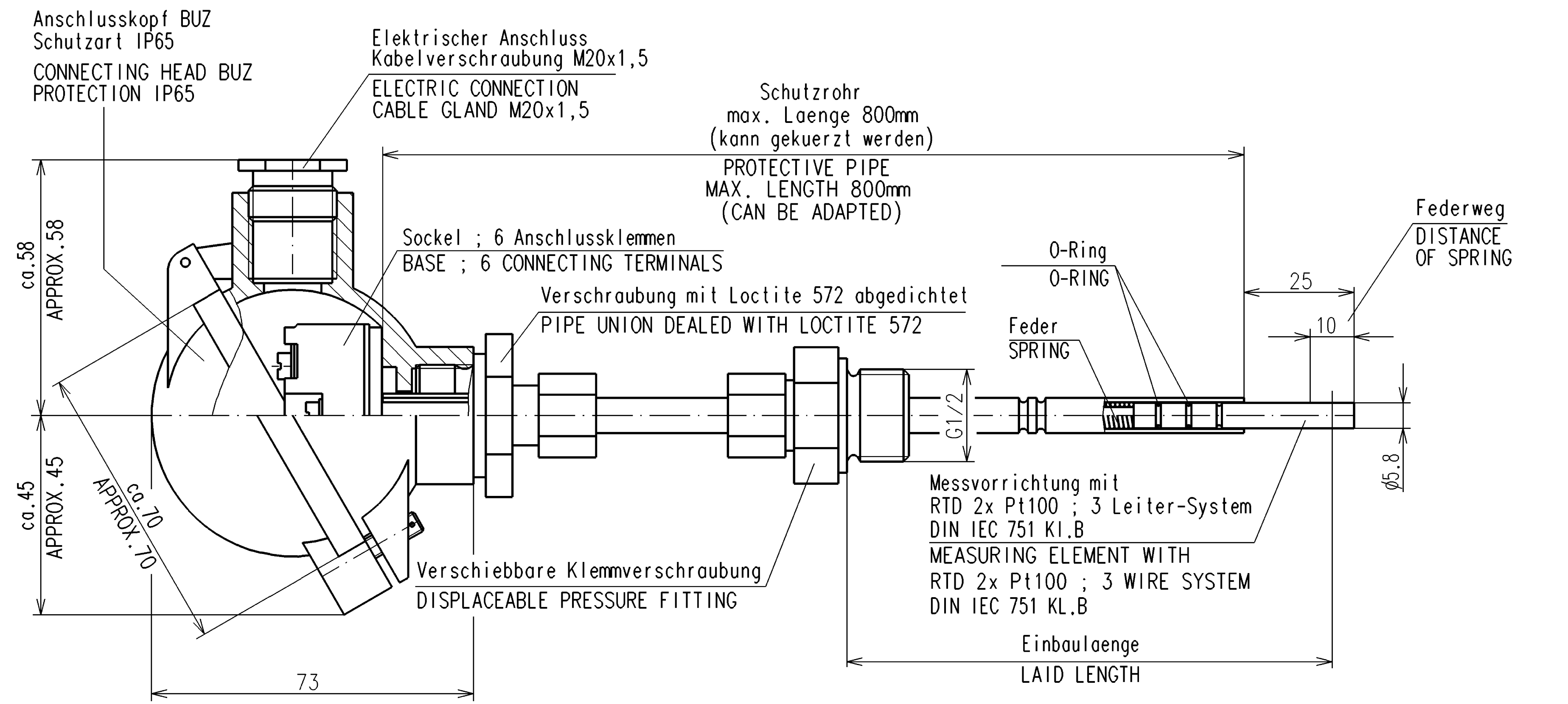
14.2.1 Resistance thermometer with connection head

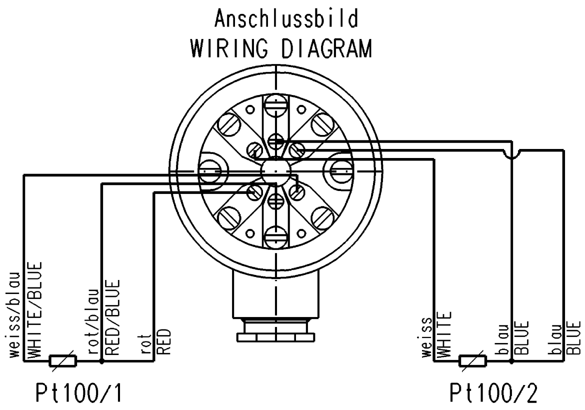
Voith Article No.: 4 221515 001
Voith Article No.: 4 203470 001

Type: JUMO (2xPt100, 3-Leiter)
Type: BUZ

Data sheet 4 203524 0

Description . . . . .JUMO





① Class I, Div.2, Group C & D;
Temperature Code T5

Vorhandene Sprachen / Available languages
de / en / fr / pl

Federbelastetes oeldichtes Widerstandsthermometer
2xPt100 ; 3 Leiter-System

* SPRING-LOADED OILTIGHT RESISTANCE THERMOMETER
2xPt100 ; 3 WIRE SYSTEM

Aend. Rev. Index	kommt vor Iss.	Aenderungs-Nr. Rev. No.	Aenderung Rev. descr. (shop and eng. Info only)	Index Index	Datum: Gez. Date: Dr.	Name Name	Ges. App.
1	1x	A6046/02	Text zugefuegt		02-01-29	Putz	Roeth

Passmass Dimension | Abmasse Tolerances

Kanten Chamfers DIN 6784; Innenkanten Inside +1,6; Aussenkanten Outside -0,2
Allg.Toleranzen Gen.Tolerances ISO 2768 mK
Tolerierung Tolerancing DIN 7167
Surface Quality acc. to R_a in/um ISO 1302

Freigabevermerk Released for microl.

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CAD

	Datum Date	Name Name
Gez. Dr.	2001-12-19	Putz
Gepr. Ch.	2001-12-19	vB
Abt. Dept.	crpe	Ges. App. Met
Norm Stand.		

VOITH TURBO ANTRIEBSTECHNIK

Urspr. Relar. 4 221772 0

Prueffforderungen in Zeichnungen nach VN 1631
VN
Bestell- und Liefervorschrift
Datum
Ges.

Massstab im Orig. Scale of Orig. 1 : 1
Masse (Gewicht) Weight Kg
Werkstoff / Werkstoff-Nr. Material/Material No.
Modell-, Gesenk-Nr. Pattern No. etc. (for internal use only)
Rohteil-Nr. mit Rohtz. Premachine Prt. No. with Drg. No

Benennung Title Widerstandsthermom.
* RESISTANCE THERMOM.

Zeichnungs-Nr. / Sach-Nr. Drawing No. / Art. No. deen
4 203524 0

Blatt Sheet 1
1 Bl.

Ers. f. Reply for
Ers. d. Repl. by

DIN A3

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Construction and application of resistance thermometers

Temperature-dependent resistance

The variation of the electrical resistance of metals with temperature is very often employed for the electrical measurement of temperature. Since the electrical resistance increases with increasing temperature, we speak of a **positive temperature coefficient** or **PTC** (in platinum temperature sensors, for example).

In order to employ this effect for temperature measurement, the electrical resistance of the metal must vary in a reproducible manner depending on temperature. The characteristics of the metal must not change during operation, as this would introduce measurement errors. The temperature coefficient should be as independent as possible of temperature, pressure and chemical effects.

Standardized platinum temperature sensors

Platinum has established itself as the resistance material of choice in industrial instrumentation. Its advantages include high chemical stability, relatively easy workability (especially in wire manufacture), its availability in highly pure form, and the good reproducibility of its electrical properties. In order to ensure universal interchangeability, these properties are defined in the standard EN 60751.

This standard lays down the electrical resistance and the permitted tolerances at different temperatures.

Additional definitions cover the nominal value of the temperature sensor and the temperature range. The calculation makes a distinction between the two temperature ranges -200 to 0°C and 0 to 850°C.

The range from -200 to 0°C is covered by the third-order polynomial:

$$R(t) = R_0(1 + A \times t + B \times t^2 + C \times (t - 100°C) \times t^3)$$

A second-order polynomial applies to the range 0 to 850°C …

$$R(t) = R_0(1 + A \times t + B \times t^2)$$

…with the coefficients:

$$A = 3{,}9083 \times 10^{-3} °C^{-1}$$
$$B = -5.775 \times 10^{-7} °C^{-2}$$
$$C = -4{,}183 \times 10^{-12} °C^{-4}$$

The term R_0 is referred to as the **nominal value,** and represents the resistance at 0°C.

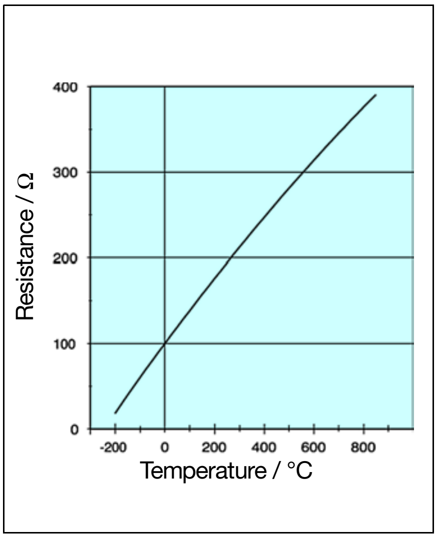

Fig. 1: Pt100 characteristic

According to EN 60751, the nominal value is 100.000 Ω at 0°C. We therefore speak of a Pt100 temperature sensor.

Temperature sensors with nominal values of 500 and 1000Ω are also available. Their advantage is a higher sensitivity, i.e. a larger variation of their resistance with temperature.

The resistance change in the temperature range up to 100°C is approximately:

0.4Ω/°C for Pt100 temperature sensors
2.0Ω/°C for Pt500 temperature sensors
4.0Ω/°C for Pt1000 temperature sensors

As an additional parameter, the standard defines a mean temperature coefficient between 0°C and 100°C. This represents the average change in resistance, referred to the nominal value at 0°C:

$$\alpha = \frac{R_{100} - R_0}{R_0 \times 100°C} = 3{,}850 \times 10^{-3} °C^{-1}$$

R_0 and R_{100} are the resistances at the temperatures 0°C and 100°C respectively.

Calculating the temperature from the resistance

In its application as a thermometer, the resistance of the temperature sensor is used to calculate the corresponding temperature. The formulae above represent the variation of electrical resistance with temperature.

For temperatures above 0°C it is possible to derive an explicit expression from the characteristic according to EN 60 751:

$$t = \frac{-R_0 \times A + [(R_0 \times A)^2 - 4 \times R_0 \times B \times (R_0 - R)]^{1/2}}{2 \times R_0 \times B}$$

R = measured resistance in Ω
t = calculated temperature in °C
R_0, A, B = parameter as per IEC 751

Tolerance limits

EN 60 751 distinguishes between two tolerance classes:

Class A: Δt = ± (0.15 + 0.002 x ltl)
Class B: Δt = ± (0.30 + 0.005 x ltl)

t = temperature in °C (without sign)

The formula for calculating the tolerance ΔR in Ω at a temperature of t > 0°C is:

$$\Delta R = R_0(A + 2 \times B \times t) \times \Delta t$$

For t < 0°C it is:

$$\Delta R = R_0(A + 2 \times B \times t - 300°C \times C \times t^2 + 4 \times C \times t^3) \times \Delta t$$

Tolerance Class A applies for temperatures between -200 and +600°C.

Tolerance Class B covers the entire definition range of -200 to +850°C.

Extended tolerance classes

It is frequently found that the two tolerance classes specified in the standard are not adequate to meet particular requirements. On the basis of the standard tolerances, **JUMO** have defined additional classes in order to meet the different requirements of the market.

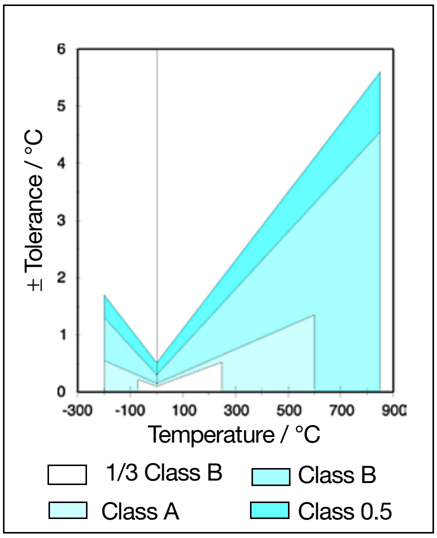

Fig. 2: Tolerance variation, depending on measurement temperature

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Tolerance class	Temperature range	Tolerance in °C	Tolerance at	
			t = 0°C	t = 100°C
1/3Class B	- 70 to +250°C	± (0.10 °C + 0.0017 x Itl)	± 0.10°C	± 0.27°C
Class A	-200 to +600°C	± (0.15°C + 0.020 x Itl)	± 0.15°C	± 0.35°C
Class B	-200 to +850°C	± (0.30°C + 0.0050 x Itl)	± 0.30°C	± 0.80°C
Class 0.5	-200 to +850°C	± (0.50°C + 0.0060 x Itl)	± 0.50°C	± 1.10°C

Table 1: Tolerance classes

Itl = measured temperature in °C, without sign

Construction of resistance thermometer probes

Apart from the virtually unlimited number of special models, there is also a series of probes whose components are completely defined by standard specifications.

Resistance thermometers with terminal head

These **resistance thermometers** are of modular construction, consisting of the measurement insert, protection tube, the terminal head and the terminal plate inside the head. A flange or a screw fitting can also be provided.

The **temperature sensor** is that part of the resistance thermometer which is directly affected by the measured temperature.

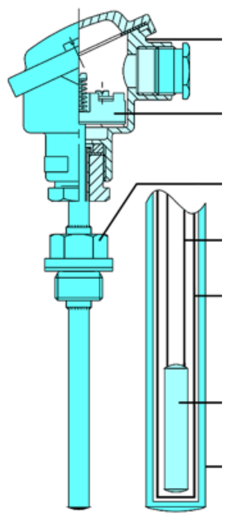

Fig. 3: Construction of an electrical thermometer

Measuring inserts are completely fabricated units, consisting of a temperature sensor and a terminal plate, with the sensor contained in an **insert tube** of 6 or 8mm diameter, made from bronze SnBz6 as per DIN 17 681 (up to 300°C) or nickel.

It is inserted into the actual **protection tube**, which is often made from stainless steel.

The tip of the insert tube is in full contact with the inside of the protection tube end plate, in order to ensure good heat transfer. The insert fixing screws are backed by springs so that bottom contact is maintained even with differential expansion between the insert tube and protection tube lengths. This arrangement makes it easy to replace the insert at a later date. The thermometers are available in single and twin versions. Their dimensions are specified in the standard DIN 43 762. Inserts with an integral 2-wire transmitter are also available.

If no insert is used, the temperature sensor is positioned directly inside the protection tube, embedded in aluminium oxide or a thermally conducting medium. After assembly, the terminal plate is mounted inside the terminal head and the connecting wires are soldered up.

In this arrangement, the sensor cannot be changed later; the complete resistance thermometer has to be replaced.

If a **pocket** is used, the thermometer can be removed without having to drain or depressurize the system.

The pocket is a type of protection tube which is mounted permanently at the measurement site, and in which the thermometer can be inserted and fixed in position. Other forms of pocket have an internal thread, so that a thermometer can be screwed in. The thermometer can then be made simply as an insert, or have its own protection tube. This, however, results in a much poorer response. The pocket itself is welded in position (which is not possible with a protection tube, because of the thin wall of the tube) or has an external thread, usually a pipe thread.

Since pockets are in direct contact with the fluid, they have to meet the same requirements for chemical resistance and mechanical robustness as protection tubes.

For the **terminal heads**, the DIN 43 729 standard defines two forms, A and B, which differ in size and also slightly in shape.

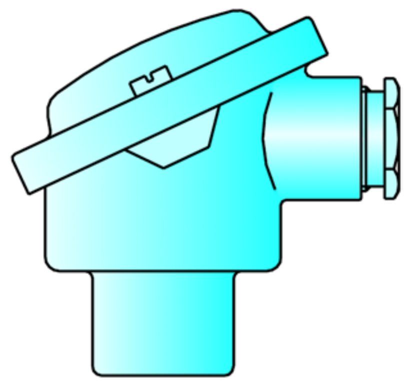

Fig. 4: Terminal head to DIN 43 729, Form B

The material used is cast iron, aluminium or plastic.

In addition, there are various other forms which are adapted to meet special requirements. The enclosure protection is not convered by the standard, it is usually a splashproof form (IP 54).

The nominal diameter of the bore in the terminal head, to take the protection tube, is:
for Form A: 22, 24 or 32mm.
for Form B: 15mm or
thread M 24 x 1.5.

The smaller terminal head (Form B) is the most widely used one, and the 2-wire transmitters are designed for this form.

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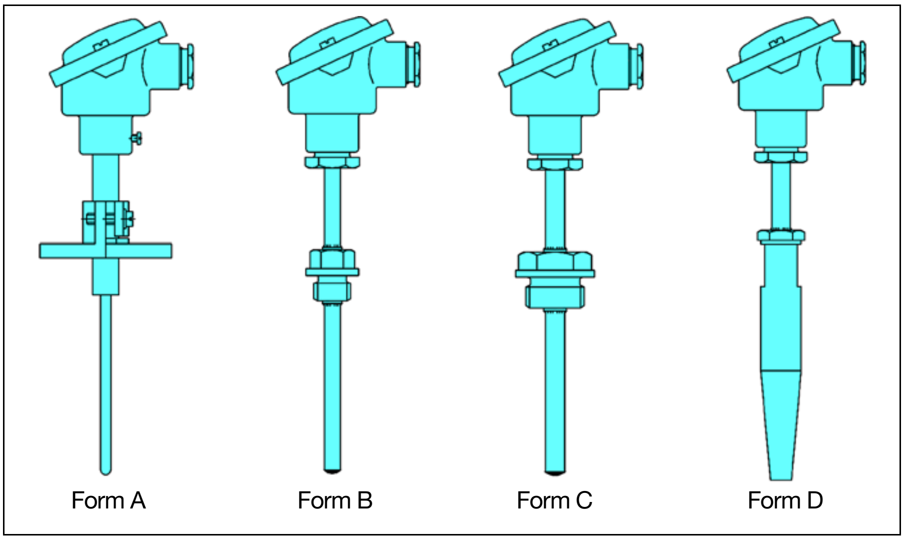

The standards DIN 43 764 to 43 769 define various protection tube designs for different resistance thermometers **and** thermocouples in different applications. They are all fitted with an insert and a terminal head Form B. The diameters and lengths of the protection tubes are also fixed.
The design of the protection tubes of these thermometers (with flange, taper, etc.) are identified by code letters A to G, which themselves are laid down in DIN 43 763.
Form A: enamelled tube for mounting by sliding stop flange, for flue gas measurement

Form B: tube with fixed external ½" pipe thread

Form C: tube with fixed external 1" pipe thread

Form D: pressure-resistant thick-walled tube, for welding into position

Form E: tube tapering at the tip, for rapid response and mounting by sliding stop flange

Form F: tube as Code E, but with fixed flange

Form G: tube as Code E, but with fixed external 1" pipe thread

The above-mentioned standard DIN 43 763 also lays down the materials and their abbreviations in the form of special codes. For instance: the designation “Protection tube DIN 43 763-B1-H“ identifies a tube to Form B, i.e. with a welded-on external ½" pipe thread, length 305mm (code number 1), in steel St 35.8 (code letter H). The standard also indicates the maximum pressure in air, water or steam as well as the maximum flow velocity. This makes it easy to select the protection tubes during the design phase of system construction.
There are also numerous special versions available, partly with standardized terminal heads and partly in highly specialized nonstandard forms with plug connectors or attached cable.

Resistance thermometers to DIN 3440

Resistance thermometers for use with temperature controllers or limiters for heating systems must meet the requirements of the standard DIN 3440. These are resistance thermometers, as described in the previous section, but with an additional TUV type approval.
The resistance thermometer must withstand temperatures which are 15% above the upper temperature limit for at least one hour, and must meet specific response times, depending on the fluid (e.g. in air: $t_{0.63}$ = 120 sec).
Furthermore, the thermometer must be designed to withstand mechanical loading caused by the external pressure and the flow rate of the medium, at the operating temperatures.
Alterations to such thermometers are not permitted without obtaining a fresh TUV approval!

Explosion-protected resistance thermometers

In all areas where flammable materials are stored, processed or manufactured, there is a possibility that, in combination with air, an explosive atmosphere may be formed which represents a hazard to the environment. The necessary conditions and requirements which electrical equipment has to meet in order that it can be used in an area exposed to an explosion hazard are summarized in the European Standards EN 50 014 … EN 50 020. Equipment that conforms to these standards can therefore be used throughout Europe.

Pressure-tight enclosure EEx “d”

Transducers in pressure-tight enclosures are designed so that all components which could ignite an explosive atmosphere are safely enclosed in the protective fitting or in the terminal head. Any explosion produced inside can therefore not be propagated to the outside. This is achieved by close tolerances, special cable glands and a particularly robust construction of the terminal head. Advantages of this version:

- an intrinsically safe power supply is not required
- connection in 2-wire, 3-wire or 4-wire circuit is possible
- also available with 2-wire transmitter

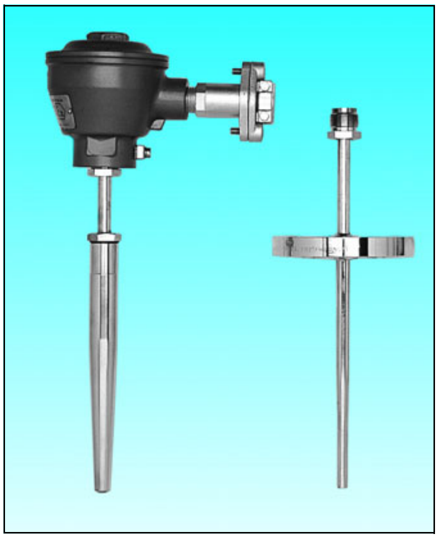

Fig. 6: Resistance thermometer in pressure-tight enclosure EEx “d”

Intrinsic safety EEx “i”

By contrast with protection “d”, which refers generally to the actual device, protection “i” always considers the complete circuit.

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In this form of resistance thermometer, the intrinsically safe 2-wire transmitter with a 4 — 20 mA output signal is located directly inside the enlarged terminal head of the thermometer, and is included in an intrinsically safe circuit.
This arrangement offers decisive advantages:
- interference-free output signal, directly from the thermometer
- low installation cost
- no lead compensation required
- signal can be transmitted over long distances
- installation and repair while the system is in operation

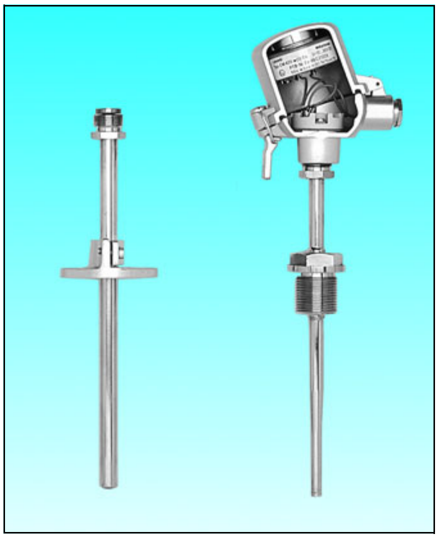

Fig. 7: Resistance thermometer with intrinsic safety EEx "i"

Resistance thermometers with 2-wire transmitters

Resistance thermometers with transmitter are used for measuring temperatures in liquids and gases when measurement signals have to be transmitted over considerable distances, free from interference. The transmitter converts the sensor signal into a standard 4 — 20mA current signal which is linear with temperature.
The supply for the transmitter is fed through the same connections, utilizing the quiescent current level of 4 mA. Because of the zero offset, this method is also referred to as "live zero". The 2-wire transmitter amplifies the signal and achieves a considerable reduction in its sensitivity to interference. In these styles, the 2-wire transmitter is encapsulated in epoxy resin and mounted directly inside the terminal head of the resistance thermometer.

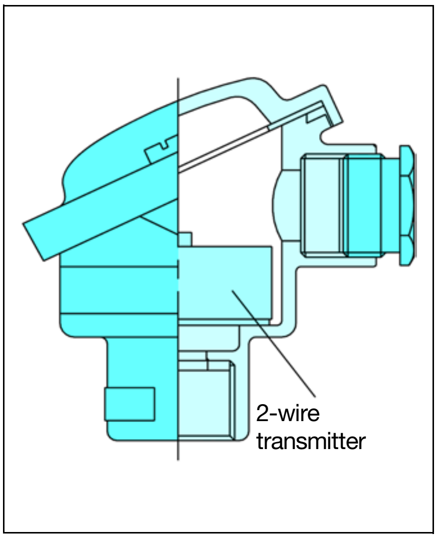

Fig. 8: Terminal head with a 2-wire transmitter

The transmitter is suitable for operating temperatures up to 90°C. Terminal heads are available in Forms BUZ, BBK and BUZH, as well as the standard Form B.

Resistance thermometers with connecting cable

On resistance thermometers with a connecting cable, the insert and terminal head are omitted. The temperature sensor is joined directly to the connecting cable, and placed in the protection tube. Strain relief is provided, for instance by grooving or compressing the end of the protection tube several times (enclosure IP65). The internal space between the protection tube and the temperature sensor is normally filled with thermally conductive material to improve the thermal contact to the fluid being measured. The maximum operating temperature is determined mainly by the temperature limit for the sheathing and insulating material of the connecting cable. The table shows some typical materials and their temperature limits.

Material	t_{max}/°C
PVC	80
PVC 105	105
Silicone	180
PTFE	260

The thermometers are available in many different styles, which are frequently designed to suit particular user requirements.

Some typical data values are:
- diameter: 2 — 8 mm
- protection tube length: 35 — 150 mm
- protection tube material: stainless steel, brass, coated steel
- circuit connection: 2, 3, or 4-wire
- mounting: flange with union connector, fixed nipple and clamping nipple

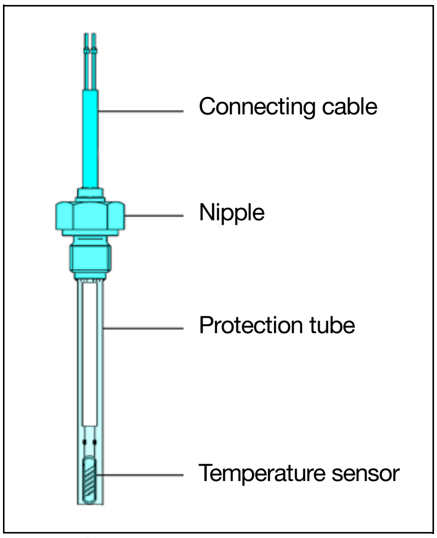

Fig. 9: Construction of a resistance thermometer with attached cable

Another type is **resistance thermometers for sterilizers.**
The temperature probes must have an especially high reliability, since these installations usually operate 24 hours a day.
The transition from the protection tube to the connecting cable is sealed steam-tight and can withstand absolute pressures of 0.1 to 4 bar at temperatures up to 150°C.
The basic versions are fitted with high-temperature PTFE-Teflon connecting cables and smooth protection tubes. Up to three Pt100 temperature sensors to EN 60 751 can be fitted in these temperature probes (see Data Sheet 90.2830).

Mineral-insulated resistance thermometers

Mineral-insulated resistance thermometers are constructed using a mineral-insulated cable. The thin stainless-steel cable sheath contains the copper conductors embedded in compressed, fire-resistant magnesium oxide. The temperature sensor (in 2-, 3- or 4-wire circuit) is connected to the internal conductors and fitted into the stainless steel protection tube, which is welded to the cable sheath. Diameters as small as 1.9 mm are available.

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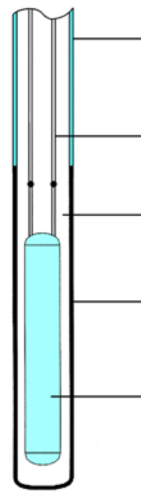

Fig. 10: Construction of a mineral-insulated resistance thermometer

The excellent heat transfer between the **protection tube** and the temperature sensor leads to a fast response ($t_{0.5}$ from 1.2 sec) and high accuracy. The shockproof construction ensures a long life. The flexible **mineral-insulated cable**, with a minimum bending radius of 5 x outside diameter (1.9/3/6mm), permits temperature measurement at relatively inaccessible locations. Because of their special properties, mineral-insulated resistance thermometers are used in chemical plant, power stations, pipelines, in engines, on test beds and in all locations where flexibility and problem-free installation are required.

Heat meter resistance thermometers

Resistance thermometers for heat meters have a federal type approval from the German Physikalisch-Technische-Bundesanstalt (PTB). The various styles meet the requirements of the Draft European Standard EN 1434 and are recommended by the German District Heating Association (AGFW = Arbeitsgemeinschaft für Fernwärme). **Thermometers with a terminal head** are available for direct temperature measurement as well as for use in suitable close-fitting pockets. The fitting length varies from 85 to 400mm. A variant is the **resistance thermometer with attached cable,** as a screw-in or push-in version. Screw-in resistance thermometers with an M 10x1 thread measure temperature directly inside the liquid, with the advantages of fast response and low heat conduction error. Using push-in thermometers in close-fitting pockets makes it unnecessary to drain the system when replacing the thermometer at the end of the certification period. The ideal locations for screw-in resistance thermometers with an attached cable are ball valves for 1/2", 3/4" and 1" pipes. The special design of the ball valves makes it unnecessary to drain the system when fitting or replacing the temperature probe. The small pipe diameters lead to a fitting length no greater than 30mm. This gives rise to a heat conduction error which affects the measurement. The optimized internal construction of **JUMO** resistance thermometers results in a negligible heat conduction error of less than 0.03°C, and is thus even lower than the PTB specification of 0.1°C.

Insertion resistance thermometers

The design is essentially a resistance thermometer with attached cable, which is fitted with a handle. Special features of this thermometer style are: it is unaffected by alternating temperatures, sealed against water (vapor), resistant to mechanical shock and vibration. The temperature sensor in 2-wire or 3-wire circuit is inserted into the protection tube which is then sealed. The stainless steel protection tube is 100 mm long and has a concentric point or angled tip. The handles in Teflon, PPS plastics or HTV silicone are resistant to a large number of aggressive media. The connecting cable has Teflon insulation for good heat resistance.

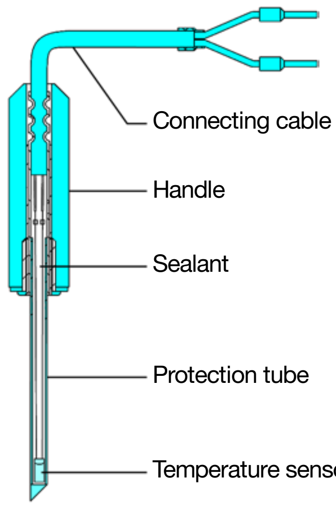

Fig. 11: Construction of an insertion resistance thermometer

A special feature of the internal construction is the sealing, which withstands high temperatures and prevents entry of water (vapor).

Surface resistance thermometers

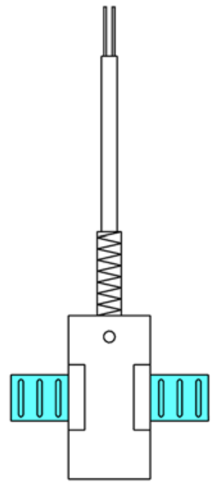

Fig. 12: Surface resistance thermometers

Surface resistance thermometers are used preferably for measuring temperatures on closed pipe systems and other round or flat surfaces. Simple installation by tension bands or hose clips avoids any mechanical preparation of the measurement location. Other versions have a mounting hole, for securing to any form of surface by a screw. Indirect temperature measurement avoids disturbing the flow of the liquid or gas. In addition, pressure and chemical effects do not influence the life of the resistance thermometer.

The object being measured is hardly affected by the small thermal mass. Heat-conductive paste can be used to improve the heat transfer. Large temperature differences between the gas/liquid and the surroundings have a direct effect on the measurement. In such cases, it is advisable to provide the thermometer with thermal insulation.

Indoor and outdoor resistance thermometers

Different versions are available for temperature measurement indoors and in the open. In the **domestic version,** the temperature sensor is enclosed in an elegant plastic housing with IP20 protection. On **outdoor thermometers for industrial use,** with IP65 protection, the temperature sensor is mounted outside the housing and enclosed by a protective cap.

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A further version is provided with a stainless steel protection tube, into which the temperature sensor is inserted.
Electrical connection is made through a Pg9 cable gland. The measuring range covers -30 to +80°C. Various versions can be fitted with a 2-wire transmitter having a 4 — 20mA output signal.

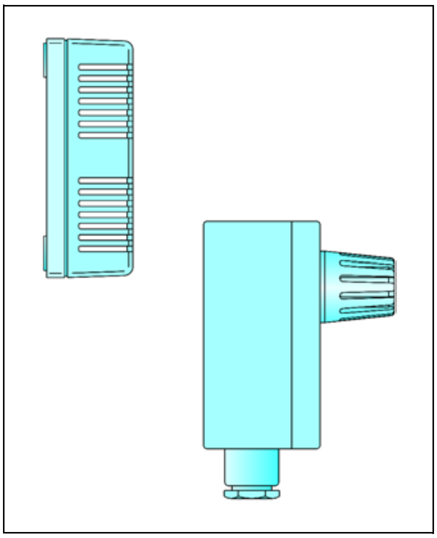

Fig. 13: Indoor and outdoor resistance thermometers

Precision resistance thermometers
For maximum stability, it is usual to arrange the resistance coil freely suspended inside the protection tube.

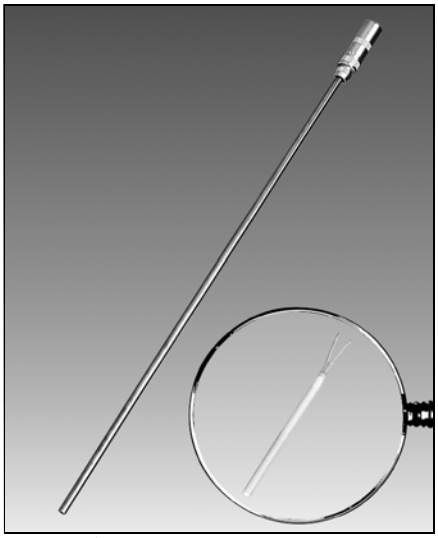

Fig. 14: Certifiable thermometer

This prevents mechanical loading under temperature, caused by differential expansion. But vibration can very easily result in a break in the coil. So, while these thermometers have excellent long-term stability, of the order of 0.001°C or less, the low mechanical strength means that they are unsuited for industrial use. For such applications **JUMO** employs a temperature sensor with a platinum coil that is secured in a ceramic sleeve. The leads to the connector are made as a 4-wire circuit. A stainless steel tube protects the sensor from mechanical influences. The temperature range covers -200 to +450°C, depending on the version. The measurement accuracy can be up to ±0.025°C.

Measurement

Connection of resistance thermometers
In a resistance thermometer, the electrical resistance varies with temperature. For evaluating the output signal, a constant current is passed through the thermometer and the voltage drop across it is measured. For this voltage drop, Ohm's Law states that:

$$V = R \times I$$

The measuring current should be as small as possible, in order to avoid heating of the sensor. It can be assumed that a measuring current of 1 mA does not introduce any appreciable errors. This current produces a voltage drop of 0.1 V in a Pt100 at 0°C. This signal voltage must now be transmitted through the connecting cables to the indicating or evaluation point, with a minimum of alteration.

Three different types of connecting circuit are used for this purpose:

2-wire circuit
The connection between the thermometer and the evaluation electronics is provided by a 2-core cable. Like any other electrical conductor, this cable has an electrical resistance which is in series with the temperature sensor. So the two resistances are added, and the result is a systematically higher temperature indication. For longer distances, the lead resistance may amount to a few ohms and produce an appreciable shift in the measured value. In order to avoid this error, the resistance is compensated electrically.
The instrument is designed to allow always for a lead resistance of, for instance, 10Ω. When the resistance thermometer is connected up, a compensating resistance is connected in one of the measurement lines and the sensor is replaced initially by a 100.00Ω resistor. The compensating resistance is then altered until a reading of 0°C appears on the instrument.
Because of the relative large amount of work involved and the fact that effects of temperature on the measurement cable are not covered, the use of the 2-wire circuit is becoming increasingly rare.

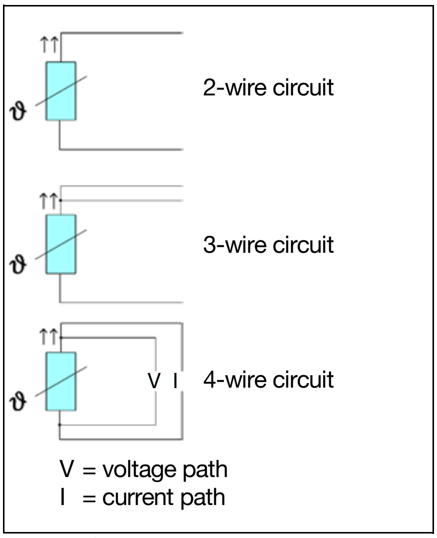

Fig. 15: Connection of resistance thermometers

3-wire circuit
The effects of the lead resistances and their fluctuation with temperature are reduced to a minimum in the 3-wire circuit. In this circuit, an additional lead is brought out to a contact on the resistance thermometer. This results in two measuring circuits, one of which is used as a reference.
The 3-wire circuit makes it possible to compensate for both the value and the temperature dependency of the lead resistance. But it is a requirement that all three cores have identical properties and are at the same temperature. In most cases, this is true to a sufficient degree of accuracy, so that the 3-wire circuit is the one most frequently used these days. No lead compensation is required.

4-wire circuit
The optimum form of connection for resistance thermometers is the 4-wire circuit. The measurement depends neither on the lead resistances nor on their variation due to temperature. No lead compensation is required. The thermometer receives the measuring current I through the supply connections. The voltage drop V across the temperature sensor is picked off by the measuring leads.

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If the input resistance of the electronics is many times greater than the lead resistance, then the latter can be neglected. The voltage drop determined in this way is independent of the properties of the connecting wires.

With both 3-wire and 4-wire circuits it must be remembered that the circuit is not always taken right up to the actual sensing element. The connection from the sensor to the terminal head of the fitting, the so-called internal connection, is frequently made in a 2-wire circuit. This results in similar problems to those discussed for the 2-wire circuit, although to a much smaller extent. The total resistance, consisting of the sum of internal connection and sensor, is defined by DIN 16160 as the **thermometer resistance**.

Insufficient insulation resistance
Because of the finite resistance between the connections and within the insulation material in which the sensor is embedded, there is a possibility of a further error due to poor insulation resistance which reduces the indicated temperature. Based on a Pt100 thermometer, an insulation resistance of 100 kΩ results in an error of 0.25°C, and 25 kΩ one of 1°C. Because of the variation of insulation resistance with temperature, it is possible for this error to vary with the measuring conditions.
For ceramic insulating materials in particular, the resistance decreases with increasing temperature.

In view of the relatively low maximum temperature of about 600°C, this effect is hardly noticeable for platinum temperature sensors. Much more important is any moisture which may penetrate the insulation, as this can cause a substantial measurement error. Sensors are therefore usually covered by a glaze or some other form of hermetic sealing. The measuring insert itself is also sealed, in order to prevent entry of moisture into the probe tube. Inserts are readily interchangeable, since they are completely enclosed units. For resistance thermometers without inserts, on the other hand, it is vital to ensure a reliable seal if they have to be repaired.

Self-heating
The output signal of a resistance thermometer can only be measured by passing a current through the sensor. This measurement current produces a power loss and therefore heats up the sensor, with the result that the temperature indication is increased. Self-heating depends on a number of factors, including the extent to which the heat generated can be removed by the fluid (or gas) being measured. Because the relationship for electrical power is $P = R \times I^2$, the effect depends also on the basic resistance of the temperature sensor. For the same measurement current, a Pt1000 temperature sensor is heated ten times as much as a Pt100. In addition, design features (thermometer size) and thermal conduction and capacity also determine the error. The thermal capacity of the fluid and its flow velocity also have a large influence on this effect.
Thermometer manufacturers often specify a self-heating coefficient, which represents a measure for the temperature increase through a defined power loss in the sensor. Such calorimetric measurements are carried out under standard conditions (in water at 0.5m/sec, or air at 2m/sec), but the information is somewhat theoretical and serves only for comparison between different designs.
In most cases, the measurement current is set at 1mA by the instrument manufacturer, since this value has been found appropriate in practice and produces no appreciable self-heating.
For example, a Pt100 temperature sensor is placed in a closed and fully insulated container with 10cm^3 of air, and this measurement current of 1 milliampere increases the air temperature by 39°C after one hour. With flowing gases and liquids the effect is very much less pronounced, because of the much greater heat dissipation.
Because of differences in measurement conditions it is necessary to measure the actual self-heating effect on site. The current is varied and the corresponding temperature is measured. The self-heating coefficient E is derived as:

$$E = \Delta t / (R \times I^2)$$

where
Δt = (indicated temperature) – (fluid temperature),
R = thermometer resistance
I = measurement current

The self-heating coefficient can be used to determine the maximum measurement current if an error Δt is permitted.

$$I = (\Delta t / E \times R)^{1/2}$$

Parasitic thermal voltages
The effect of thermo-electric voltages can also be seen during temperature measurement with resistance thermometers, in this case as a highly undesirable side effect. Thermal voltages can be generated at the junction of two different metals.
Such metal junctions occur at the lead connections in the resistance thermometer. The connecting wires of the sensor frequently consist of silver, with extensions of copper or nickel as internal conductors, for example.

Under normal conditions, it can be assumed that both junctions are at the same temperature and that the resulting thermal voltages cancel each other. Differences in heat conduction to the outside may however lead to the establishment of different temperatures; the resulting thermal voltage is interpreted by the electronics as a voltage drop, thus producing a measurement error.
This can take the form of an increase or a decrease, depending on the polarity of the thermal voltage which is produced.

The magnitude of the resulting error depends very much on the characteristics of the electronics, in particular on how the voltage is evaluated as a temperature.

A simple method for diagnosing such errors consists of performing two measurements with the measurement current in opposite directions. The larger the difference between the two measurements, the greater is the thermal voltage generated.

Transfer function
A sensor will never respond instantaneously, but always with a certain delay, because of the ever-present thermal resistances within the probe. The resulting measurement error, caused by the measurement or output signal lagging behind a change in the substance being measured, is known as the **dynamic error**.
As a simplification, it is possible to think of the probe as consisting of a combination of resistances and energy stores. The material masses and the corresponding thermal capacities form the energy stores. The materials have different thermal conductivities which cause the resistances. The components of the thermometer often have both characteristics simultaneously.

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The speed with which the thermometer responds depends in the first instance on the ratio of the thermal resistance to the thermal capacity of the probe. The larger this thermal resistance, the slower the probe heats up. So in order to achieve a fast response it is desirable to use small sensors and thin materials which conduct heat readily. A particularly unfavourable feature is the air gap between the measurement insert and its protection tube, since all gases are poor heat conductors. The remedy consists of embedding the insert in thermally conductive pastes or metal oxides. Thermocouples have essentially shorter reponse times than resistance thermometers, because of their lower thermal mass. This applies in particular to thin mineral-insulated thermocouples. However, in most cases the difference is largely outweighed by the comparatively high thermal capacity of the protective fitting. The response time generally increases with increasing protection tube diameter. It is therefore advisable to use thin-walled fittings of small diameter, as far as the mechanical circumstances allow.

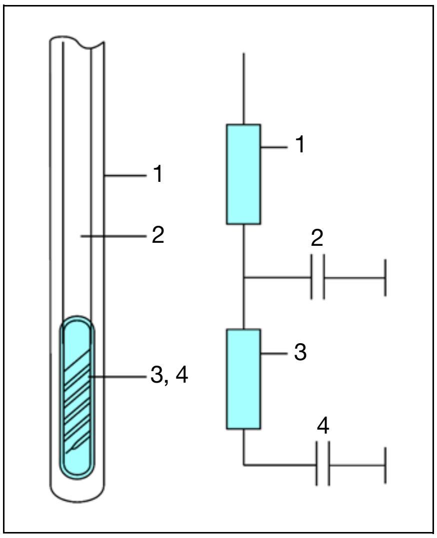

Fig. 16: Thermal resistances in a thermometer

The thermal conductivity of the protection tube material is also very important. Copper and iron are comparatively good heat conductors, but stainless steel and ceramics are not so good.

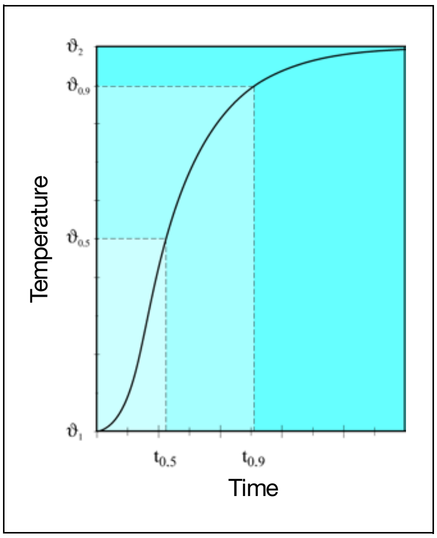

Fig. 17: The transfer function

The **transfer function**, i.e. the variation of the measured value following a sudden change in temperature, provides information on this effect. Tests to determine the transfer function of the thermometer are carried out in a flow of warm water or air, using special test set-ups, as specified for example in EN 60751. Two times (response periods) characterize the transfer function:

- **Half-value time $t_{0.5}$**
  The half-value time indicates the period during which the measured value reaches 50% of its final value.
- **90%-time $t_{0.9}$**
  The 90%-time indicates the period during which the measured value reaches 90% of its final value.

A time τ taken to reach 63.2% of the final value is not generally specified, because of possible confusion with the time constant of an exponential function. The heat transfer function of virtually all thermometers deviates clearly from such a function.

Errors in resistance thermometers

Effect of the cable

In measurements using resistance thermometers, the results may be falsified by design features or measurement effects. The following section explains the most important effects which may cause erroneous measurements.
As described elsewhere, the lead resistance enters into the measurement as a resistor in series with the sensor.

Particularly in large installations, with the resulting longer transmission distances, the lead resistance can reach the same order of magnitude as the sensor resistance itself. Compensation of the lead resistance is therefore absolutely essential, and usually consists of shifting the zero of the instrument connected to the sensor. However, such compensation does not take account of the changes in the lead resistance with temperature. If the connecting cable is subjected to fluctuating temperatures, this will lead to varying degrees of measurement error. The effect only becomes apparent with larger lead resistances, i.e. with longer cable lengths and small conductor cross-sections.

Heat conduction error

A thermometer is rarely used in the range of ambient temperatures. If the measured temperature is above or below the ambient temperature, a temperature gradient will result at the thermometer, between the measurement point and the surroundings.
This leads to an error in the temperature indication: heat flows through the protection tube and the internal components from the hotter to the cooler location. In addition, the sensor is connected to the cable, forming a direct metallic contact between the sensor and the surroundings – a thermal bridge which also causes an error. Good electrical conductors always have a low thermal resistance, so the requirement for a lower lead resistance is counteracted by a higher heat conduction error.
Furthermore, the design of the thermometer influences the heat conduction error. The sensor must have a good thermal connection to the protection tube, but at the same time be thermally decoupled from the connecting cable. The installation length of the thermometer must not be made too short, otherwise too much heat will be dissipated. The **immersion depth** (the length of the portion of the thermometer which is exposed to the medium being measured) depends on the type of medium and the rate at which it transports heat. For example, a fast-flowing liquid will transfer more heat than still air, and will therefore provide better compensation for the heat conduction of the thermometer.
Measurements in liquids only require about half of the installation length compared with that used with gases.

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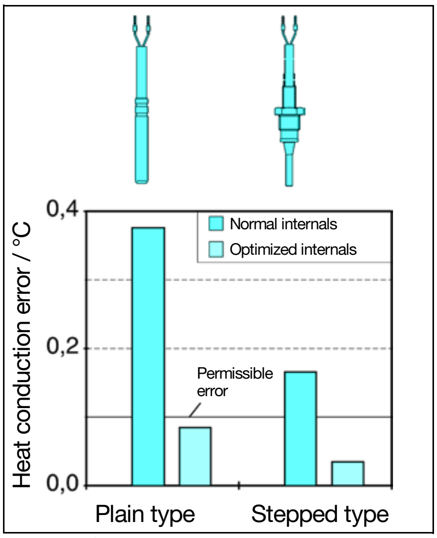

Fig. 18: Optimizing the heat conduction error, through protection tube geometry and internal layout

An example will demonstrate the effect of design on the heat conduction error. When used with heat meters, thermometers must have a heat conduction error not exceeding 0.1°C under the following conditions:

- Measured temperature: 80°C,
- Ambient temperature: 20°C,
- Measured medium: water, at a flow velocity of 0.1 to 0.2 m/sec

Particularly in short temperature probes with a fitting length less than 50mm, the achievement of the accuracy specified above raises problems which have to be solved through the design. The connecting cable is taken right up to the sensor and consists of copper. The thermal interface between sensor and protection tube is usually provided by heat conductive paste.

In the absence of any special precautions for thermal decoupling, there is a heat conduction error of about 0.3°C.

A 50% improvement is achieved by reducing the protection tube diameter in the region of the sensor. The error of 0.15°C for this probe version is still not adequate to meet the test criteria. Finally, a thermal decoupling of the connecting cable from the sensor reduces the heat conduction error to 0.03°C, which is now a factor of 10 better than the original version.

Measures for reducing the heat conduction error

It is not always possible to optimize the probe design for a particular measurement application so that the result is not affected by heat conduction errors. The publication “Electrical Temperature Measurement”, described on the last page, summarizes the most important selection criteria for a probe with regard to heat conduction errors.

Calibration

During its operational life, a thermometer experiences changes in its characteristic compared with its original ex-factory condition, because of chemical and mechanical effects, as well as through ageing phenomena such as recrystallization and diffusion. In order to allow for drift and to compensate for it, it is necessary to recalibrate the thermometer at regular intervals.

Fig. 19: Calibration certificate

Recalibration consists of checking the indicated temperature values and, where appropriate, recording the amounts by which they deviate from the true temperatures. By contrast, the concept of **adjustment**, which is often used in this connection, means altering the instrument to render the deviation small, at least to within the tolerance limits.

Calibration is identical with testing and measuring the accuracy for each individual thermometer. The manufacturer is, however, unable to provide any guarantee for the long-term stability of these values, since he cannot predict the future application and frequency of use, and the resulting stresses on the thermometer. It is advisable to recalibrate a thermometer initially every year and to compare the results with the previous calibration data. In the course of time, this produces a life history of the thermometer, from which its stability can be seen.

Depending on whether the reproducibility is adequate or not for the particular application, the recalibration period can then be extended or shortened.

The question concerning the actual details and the accuracy of a calibration cannot be answered in general terms. It is always subject to agreement between the user and the calibration laboratory, including temperature ranges and test points. The accuracy is determined by the type of measurement that is applied.

The German Calibration Service (Deutscher Kalibrierdienst, DKD)

The opening of the internal European trade boundaries after 1992, the new quality standards such as ISO 9001, and the more stringent product liability regulations make increasing demands on the documentation of processes and on the monitoring of measuring devices. In addition, there is an increasing demand from users for higher product quality standards. A particularly stringent requirement arises from the ISO 9001 standard, which describes the global concept of a quality assurance system.

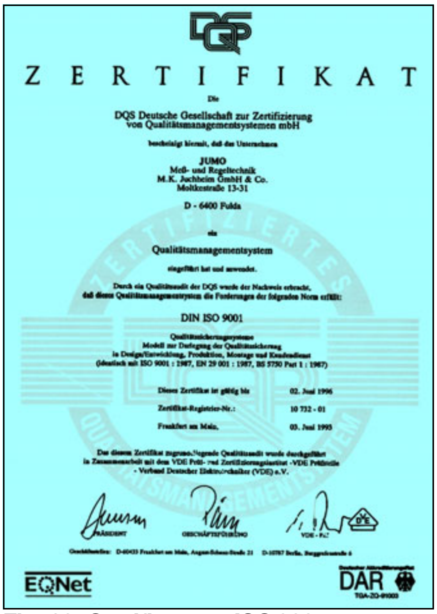

Fig. 20: Certificate to ISO 9001

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If a manufacturer wishes to issue certificates based on this standard, it is necessary that the testing devices involved in production can be traced back to recognized national standards.

Traceability to a national standard means that in the checking of a testing device, the actual measurements are documented so that they can be traced back to legal instrument standards. In Germany, the PTB (Physikalisch-Technische-Bundesanstalt) lays down the national standards and compares them with the results from other organizations so that the representation of important parameters such as temperature can be ensured uniformly by physical means throughout the world.

Primary standard — PTB

↑

Secondary standard — DKD laboratory

↑

Calibrated thermometer — Test laboratory

↑

Factory thermometer — Production

Fig. 21: Traceability

Because of the large demand for such calibrated devices, the government laboratories are found to have insufficient capacity and industry has therefore established and supports special calibration laboratories. These laboratories, including the **JUMO DKD Laboratory for Temperature 9501**, are linked to the German Calibration Service (DKD) and are subordinate to the national PTB laboratory for instrumental aspects. This ensures that the measuring devices used in a DKD laboratory can be traced back unequivocally to the national standards, and therefore also to the thermometers used there.

Safety note
All welded joints on thermometers and pockets are monitored through a fundamental quality assurance system according to DIN 8563, Part 113. Special safety regulations apply to the "Mandatory monitored area" (e.g. pressure vessels) according to Section 24 of the German Trade Regulations. In cases where the customer specifies such an application, the welding is monitored according to EN 287 and EN 288.

Pressure loading for temperature probes
The pressure resistance of protection fittings, such as are used for electric thermometers, depends largely on the different process parameters.
These include:
- temperature
- pressure
- flow velocity
- vibration

In addition, physical properties, such as material, fitting length, diameter and type of process connection have to be taken into account.

The diagrams below are taken from DIN 43 763 and show the load limit for the different basic types in relation to the temperature and the fitting length, as well as the flow velocity, temperature and medium.

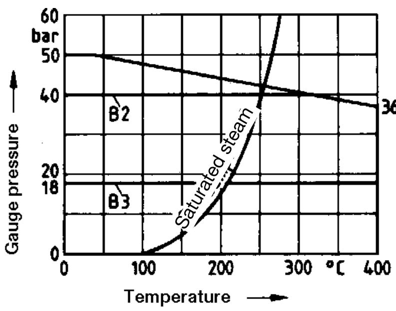

Fig. 22: Pressure loading for Form B protection tubes

stainless steel 1.4571
velocity up to 25m/sec in air
velocity up to 3m/sec in water

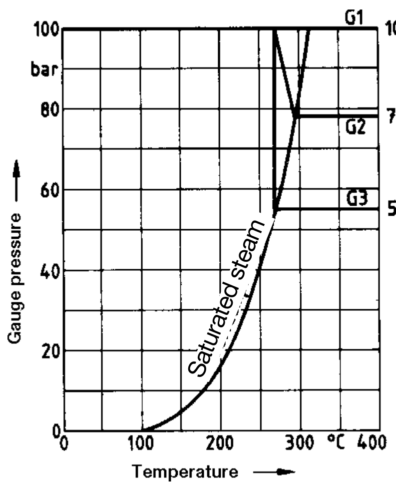

Fig. 23: Pressure loading for Form G protection tubes

stainless steel 1.4571
velocity up to 40m/sec in air
velocity up to 4m/sec in water

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As explained in the standard, the values indicated are guide values, which have to be individually examined for the specific application. Slight differences in the measurement conditions may suffice to destroy the protection tube.
If, when ordering an electric thermometer, it is required that the protection fitting be checked, the load type and the limit values have to be specified.

Fig. 24 shows the load limits (guide values) for different tube dimensions on a variety of additional thermometer designs. The maximum pressure loading of cylindrical protection tubes is shown in relation to the wall thickness with different tube diameters.
The data refer to protection tubes in stainless steel 1.4571, 100mm fitting length, 10m/sec flow velocity in air, or 4m/sec in water, and a temperature range from -20 to +100°C. A safety factor of 1.8 has been taken into account. For higher temperatures or different materials, the maximum pressure loading has to be reduced by the percentage values given in the table.

Material	Temperature	Reduction
CrNi 1.4571	up to +200°C	-10%
CrNi 1.4571	up to +300°C	-20%
CrNi 1.4571	up to +400°C	-25%
CrNi 1.4571	up to +500°C	-30%
CuZn 2.0401	up to +100°C	-15%
CuZn 2.0401	up to +175°C	-60%

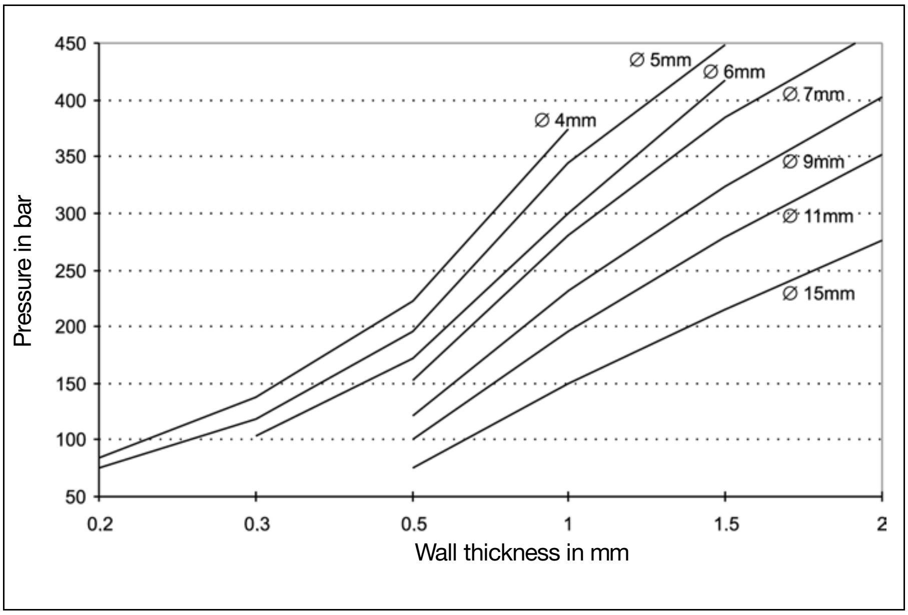

Fig. 24: Load limits on protection tubes, for various tube dimensions

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Pressure test for thermometer protection fittings

The welded protection fittings of JUMO thermometers are subjected to a leakage test or a pressure test, depending on the construction of the protection fitting.

Thermometers which are manufactured to DIN or to application-specific guidelines (chemical or petrochemical plant, pressure vessel regulation, steam boilers) require different pressure tests according to the specific application.

If the thermometers are to be manufactured to such standards or guidelines, then the required tests or standards and/or guidelines have to be specified when ordering.

Scope of test
Tests can be carried out on each individual protection fitting and documented with a test report or acceptance certificate to EN 10 204 (at extra cost).

Type of test
Tests can be performed on protection fittings up to a fitting length of 1050mm with flange connection DN25 or screw connection up to 1" thread size.

The following tests can be carried out:

Test type	Test medium	Pressure range	Test duration
Leakage test	helium	vacuum	10sec
Pressure test I	nitrogen	1 — 50bar	10sec
Pressure test II	water	50 — 300bar	10sec

Leakage test
A vacuum is produced inside the protection tube. From the outside, helium is applied to the protection fitting. If there is a leak in the protection tube, helium will penetrate and will be recognized through analysis. A leakage rate is determined by the rise in pressure (leakage rate > 1 x 10^{-6} l/bar).

Pressure test I
A positive pressure of nitrogen is applied to the protection tube from the outside. If there is a leak in the fitting, a volume flow will be produced inside the protection tube, which will be recognized.

Pressure test II
Water pressure is applied to the protection tube from the outside. The pressure must remain constant for a certain length of time. If this is not the case, the protection fitting has a leak.

Qualified welding processes for the production of protection tubes for thermometers

In addition to using perfect materials, it is the joining technique which, in the end, determines the mechanical stability and quality of the protection fittings. This is why the welding techniques at JUMO comply with the European Standards EN 287 and EN 288. Manual welding is carried out by qualified welders according to EN 287. Automatic welding processes are qualified by a WPS (welding instruction) to EN 288.

The following table provides an overview of the qualified welding processes:

	WIG welding	
Material	manual	automatic
W11, W11 with W01-W04 to EN 287	Tube diameter 2 — 30mm Wall thickness 0.75 — 5.6mm	Tube diameter 5 — 10mm Wall thickness 0.5 — 1.0mm

Table. 2: Qualified welding processes

Based on this experience, our welders can also join different materials and dimensions.

Laser beam welding is employed for wall thicknesses of less than 0.6mm, which is monitored by a laser beam specialist according to guideline DSV 1187.

On customers' request, material test certificates can be issued at extra cost. Likewise, special tests and treatments can be carried out, which are calculated according to the extent of the work, as set out in various application guidelines. This includes X-ray examinations, crack test (dye penetration test), thermal treatment, special cleaning processes and markings.

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Reference values according to EN 60 751 (ITS 90)

in ohms, for Pt100 temperature sensors, in 1°C steps

°C	-0	-1	-2	-3	-4	-5	-6	-7	-8	-9
-200	18.520	-	-	-	-	-	-	-	-	-
-190	22.825	22.397	21.967	21.538	21.108	20.677	20.247	19.815	19.384	18.952
-180	27.096	26.671	26.245	25.819	25.392	24.965	24.538	24.110	23.682	23.254
-170	31.335	30.913	30.490	30.067	29.643	29.220	28.796	28.371	27.947	27.552
-160	35.543	35.124	34.704	34.284	33.864	33.443	33.022	32.601	32.179	31.757
-150	39.723	39.306	38.889	38.472	38.055	37.637	37.219	36.800	36.382	35.963
-140	43.876	43.462	43.048	42.633	42.218	41.803	41.388	40.972	40.556	40.140
-130	48.005	47.593	47.181	46.769	46.356	45.944	45.531	45.117	44.704	44.290
-120	52.110	51.700	51.291	50.881	50.470	50.060	49.649	49.239	48.828	48.416
-110	56.193	55.786	55.378	54.970	54.562	54.154	53.746	53.337	52.928	52.519
-100	60.256	59.850	59.445	59.039	58.633	58.227	57.821	57.414	57.007	56.600
- 90	64.300	63.896	63.492	63.088	62.684	62.280	61.876	61.471	61.066	60.661
- 80	68.325	67.924	67.552	67.120	66.717	66.315	65.912	65.509	65.106	64.703
- 70	72.335	71.934	71.534	71.134	70.733	70.332	69.931	69.530	69.129	68.727
- 60	76.328	75.929	75.530	75.131	74.732	74.333	73.934	73.534	73.134	72.735
- 50	80.306	79.909	79.512	79.114	78.717	78.319	77.921	77.523	77.125	76.726
- 40	84.271	83.875	83.479	82.083	82.687	82.290	81.894	81.497	81.100	80.703
- 30	88.222	87.827	87.432	87.038	86.643	86.248	85.853	85.457	85.062	84.666
- 20	92.160	91.767	91.373	90.980	90.586	90.192	89.798	89.404	89.010	88.616
- 10	96.086	95.694	95.302	94.909	94.517	94.124	93.732	93.339	92.946	92.553
0	100.000	99.609	99.218	98.827	98.436	98.044	97.653	97.261	96.870	96.478

°C	0	1	2	3	4	5	6	7	8	9
0	100.000	100.391	100.781	101.172	101.562	101.953	102.343	102.733	103.123	103.513
10	103.903	104.292	104.682	105.071	105.460	105.849	106.238	106.627	107.016	107.405
20	107.794	108.182	108.570	108.959	109.347	109.735	110.123	110.510	110.898	111.286
30	111.673	112.060	112.447	112.835	113.221	113.608	113.995	114.382	114.768	115.155
40	115.541	115.927	116.313	116.699	117.085	117.470	117.856	118.241	118.627	119.012
50	119.397	119.782	120.167	120.552	120.936	121.321	121.705	122.090	122.474	122.858
60	123.242	123.626	124.009	124.393	124.777	125.160	125.543	125.926	126.309	126.692
70	127.075	127.458	127.840	128.223	128.605	128.987	129.370	129.752	130.133	130.515
80	130.897	131.278	131.660	132.041	132.422	132.803	133.184	133.565	133.946	134.326
90	134.707	135.087	135.468	135.848	136.228	136.608	136.987	137.367	137.747	138.126
100	138.506	138.885	139.264	139.643	140.022	140.400	140.779	141.158	141.536	141.914
110	142.293	142.671	143.049	143.426	143.804	144.182	144.559	144.937	145.314	145.691
120	146.068	146.445	146.822	147.198	147.575	147.951	148.328	148.704	149.080	149.456
130	149.832	150.208	150.583	150.959	151.334	151.710	152.085	152.460	152.865	153.210
140	153.584	153.959	154.333	154.708	155.082	155.456	155.830	156.204	156.578	156.952
150	157.325	157.699	158.072	158.445	158.818	159.191	159.564	159.937	160.309	160.682
160	161.054	161.427	161.799	162.171	162.543	162.915	163.286	163.658	164.030	164.401
170	164.772	165.143	165.514	165.885	166.256	166.627	166.997	167.368	167.738	168.108
180	168.478	168.848	169.218	169.588	169.958	170.327	170.696	171.066	171.435	171.804
190	172.173	172.542	172.910	173.279	173.648	174.016	174.384	174.752	175.120	175.488
200	175.856	176.224	176.591	176.959	177.326	177.693	178.060	178.427	178.794	179.161
210	179.528	179.894	180.260	180.627	180.993	181.359	181.725	182.091	182.456	182.822
220	183.188	183.553	183.918	184.283	184.648	185.013	185.378	185.743	186.107	186.472
230	186.836	187.200	187.564	187.928	188.292	188.656	189.019	189.383	189.746	190.110
240	190.473	190.836	191.199	191.562	191.924	192.287	192.649	193.012	193.374	193.736
250	194.098	194.460	194.822	195.183	195.545	195.906	196.268	196.629	196.990	197.351
260	197.712	198.073	198.433	198.794	199.154	199.514	199.875	200.235	200.595	200.954
270	201.314	201.674	202.033	202.393	202.752	203.111	203.470	203.829	204.188	204.546
280	204.905	205.263	205.622	205.980	206.338	206.696	207.054	207.411	207.769	208.127
290	208.484	208.841	209.198	209.555	209.912	210.269	210.626	210.982	211.339	211.695
300	212.052	212.408	212.764	213.120	213.475	213.831	214.187	214.542	214.897	215.252

The reference values have been calculated according to the International Temperature Scale ITS 90.
(The reference values must be multiplied by the factor 5 or 10 for Pt500 or Pt1000 temperature sensors).

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Reference values according to EN 60 751 (ITS 90)

in ohms, for Pt100 temperature sensors, in 1°C steps

°C	0	1	2	3	4	5	6	7	8	9
310	215.608	215.962	216.317	216.672	217.027	217.381	217.736	218.090	218.444	218.798
320	219.152	219.506	219.860	220.213	220.567	220.920	221.273	221.626	221.979	222.332
330	222.685	223.038	223.390	223.743	224.095	224.447	224.799	225.151	225.503	225.855
340	226.206	226.558	226.909	227.260	227.612	227.963	228.314	228.664	229.015	229.366
350	229.716	230.066	230.417	230.767	231.117	231.467	231.816	232.166	232.516	232.865
360	233.214	233.564	233.913	234.262	234.610	234.959	235.308	235.656	236.005	236.353
370	236.701	237.049	237.397	237.745	238.093	238.440	238.788	239.135	239.482	239.829
380	240.176	240.523	240.870	241.217	241.563	241.910	242.256	242.602	242.948	243.294
390	243.640	243.986	244.331	244.677	245.022	245.367	245.713	246.058	246.403	246.747
400	247.092	247.437	247.781	248.125	248.470	248.814	249.158	249.502	249.845	250.189
410	250.533	250.876	251.219	251.562	251.906	252.248	252.591	252.934	253.277	253.619
420	253.962	254.304	254.646	254.988	255.330	255.672	256.013	256.355	256.696	257.038
430	257.379	257.720	258.061	258.402	258.743	259.083	259.424	259.764	260.105	260.445
440	260.785	261.125	261.465	261.804	262.144	262.483	262.823	263.162	263.501	263.840
450	264.179	264.518	264.857	265.195	265.534	265.872	266.210	266.548	266.886	267.224
460	267.562	267.900	268.237	268.574	268.912	269.249	269.586	269.923	270.260	270.597
470	270.933	271.270	271.606	271.942	272.278	272.614	272.950	273.286	273.622	273.957
480	274.293	274.628	274.963	275.298	275.633	275.968	276.303	276.638	276.972	277.307
490	277.641	277.975	278.309	278.643	278.977	279.311	279.644	279.978	280.311	280.644
500	280.978	281.311	281.643	281.976	282.309	282.641	282.974	283.306	283.638	283.971
510	284.303	284.634	284.966	285.298	285.629	285.961	286.292	286.623	286.954	287.285
520	287.616	287.947	288.277	288.608	288.938	289.268	289.599	289.929	290.258	290.588
530	290.918	291.247	291.577	291.906	292.235	292.565	292.894	293.222	293.551	293.880
540	294.208	294.537	294.865	295.193	295.521	295.849	296.177	296.505	296.832	297.160
550	297.487	297.814	298.142	298.469	298.795	299.122	299.449	299.775	300.102	300.428
560	300.754	301.080	301.406	301.732	302.058	302.384	302.709	303.035	303.360	303.685
570	304.010	304.335	304.660	304.985	305.309	305.634	305.958	306.282	306.606	306.930
580	307.254	307.578	307.902	308.225	308.549	308.872	309.195	309.518	309.841	310.164
590	310.487	310.810	311.132	311.454	311.777	312.099	312.421	312.743	313.065	313.386
600	313.708	314.029	314.351	314.672	314.993	315.314	315.635	315.956	316.277	316.597
610	316.918	317.238	317.558	317.878	318.198	318.518	318.838	319.157	319.477	319.796
620	320.116	320.435	320.754	321.073	321.391	321.710	322.029	322.347	322.666	322.984
630	323.302	323.620	323.938	324.256	324.573	324.891	325.208	325.526	325.843	326.160
640	326.477	326.794	327.110	327.427	327.744	328.060	328.376	328.692	329.008	329.324
650	329.640	329.956	330.271	330.587	330.902	331.217	331.533	331.848	332.162	332.477
660	332.792	333.106	333.421	333.735	334.049	334.363	334.677	334.991	335.305	335.619
670	335.932	336.246	336.559	336.872	337.185	337.498	337.811	338.123	338.436	338.748
680	339.061	339.373	339.685	339.997	340.309	340.621	340.932	341.244	341.555	341.867
690	342.178	342.489	342.800	343.111	343.422	343.732	344.043	344.353	344.663	344.973
700	345.284	345.593	345.903	346.213	346.522	346.832	347.141	347.451	347.760	348.069
710	348.378	348.686	348.995	349.303	349.612	349.920	350.228	350.536	350.844	351.152
720	351.460	351.768	352.075	352.382	352.690	352.997	353.304	353.611	353.918	354.224
730	354.531	354.837	355.144	355.450	355.756	256.062	356.368	356.674	356.979	357.285
740	357.590	357.896	358.201	358.506	358.811	359.116	359.420	359.725	360.029	360.334
750	360.638	360.942	361.246	361.550	361.854	362.158	362.461	362.765	363.068	363.371
760	363.674	363.977	364.280	364.583	364.886	365.188	365.491	365.793	366.095	366.397
770	366.699	367.001	367.303	367.604	367.906	368.207	368.508	368.810	369.111	369.412
780	369.712	370.013	370.314	370.614	370.914	371.215	371.515	371.815	372.115	372.414
790	372.714	373.013	373.313	373.612	373.911	374.210	374.509	374.808	375.107	375.406
800	375.704	376.002	376.301	376.599	376.897	377.195	377.493	377.790	378.088	378.385
810	378.683	378.980	379.277	379.574	379.871	380.167	380.464	380.761	381.057	381.353
820	381.650	381.946	382.242	382.537	382.833	383.129	383.424	383.720	384.015	384.310
830	384.605	384.900	385.195	385.489	385.784	386.078	386.373	386.667	386.961	387.255
840	387.549	387.843	388.136	388.430	388.723	389.016	389.310	389.603	389.896	390.188
850	390.481	-	-	-	-	-	-	-	-	-

The reference values have been calculated according to the International Temperature Scale ITS 90.
(The reference values must be multiplied by the factor 5 or 10 for Pt500 or Pt1000 temperature sensors).

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Electrical Temperature Measurement

with Thermocouples and Resistance Thermometers

D. Weber and M. Nau

Electrical temperature sensors have become indispensable components in modern automation, domestic engineering and production technology. As a result of the rapid expansion of automation during recent years, they have become firmly established in industrial engineering.

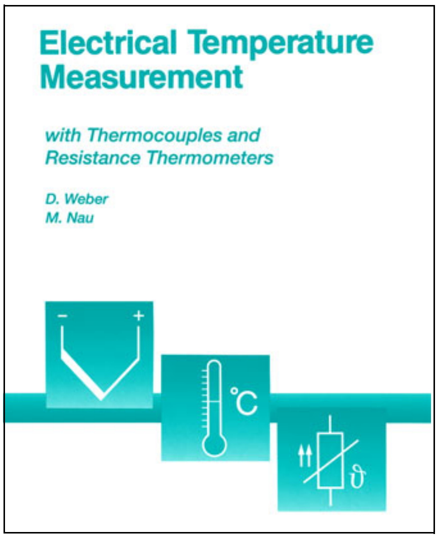

Fig. 25: Publication Electrical Temperature Measurement with Thermocouples and Resistance Thermometers

In view of this large spectrum of available products for temperature measurement it is becoming ever more important for the user to select the one suitable for his application.

On 128 pages this publication deals with the theoretical fundamentals of electrical temperature measurement, the practical construction of temperature sensors, their standardization, electrical connection, tolerances and types of construction.

In addition, it describes in detail the different fittings for electrical thermometers, their classification according to DIN standards, and the great variety of applications. An extensive series of tables for voltage and resistance series according to DIN and EN makes the book a valuable guide, both for the experienced practical engineer and also for the novice in the field of electrical temperature measurement.

To be ordered under Sales No. 90/00085081, price 15 DM net.
Schools, institutes and universities are asked to order in bulk, in view of the high handling costs.

Control Engineering

A guide for beginners

F. Blasinger

On 137 pages this publication covers the essential principles of measurement and control engineering. It offers the reader an opportunity to become familiar with the different types and applications of electronic controllers, assists in selecting the one most suitable for a particular application from the large number of different models, and ensures that it is adjusted correctly.

Mathematics has been avoided where possible, and the emphasis has been placed on practical control principles.

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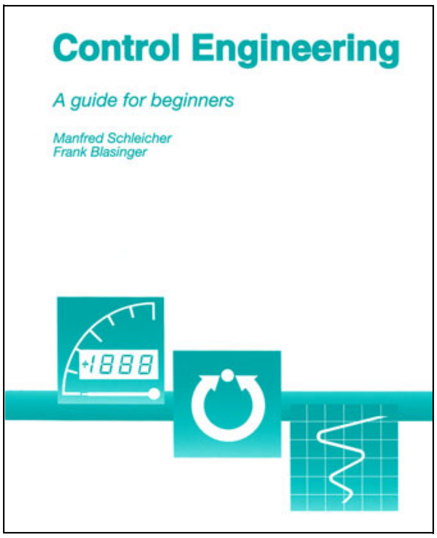


Fig. 26: Publication Control Engineering A guide for beginners

To be ordered under Sales No. 70/00323761, price 25 DM. net
Schools, institutes and universities are asked to order in bulk, in view of the high handling costs.

German Calibration Service (DKD) at JUCHHEIM

Certification laboratory for temperature

Raised quality expectations, improved measurement technology and, of course, quality assurance systems, such as DIN ISO 9000, make increasing demands on the documentation of processes and the monitoring of measuring devices.
In addition, there are increasing calls from customers for high product quality standards. Particularly stringent demands arise from the ISO 9001/9004 standard “Test devices monitoring”. This provides the legal basis for obliging suppliers and manufacturers (of products that are subject to processes where temperature is relevant) to check testing devices which can affect the product quality before use, or at certain intervals. Generally, this is done by calibrating or adjusting with certified devices. Because of the high demand for calibrated instruments and the large number of instruments to be calibrated, the state laboratories have insufficient capacity.
The industry has therefore established and supports special calibration laboratories which are linked to the German Calibration Service (DKD) and subordinate to the PTB (Physikalisch-Technische-Bundesanstalt) for all aspects of instrumentation.

The certification laboratory of the German Calibration Service at JUMO has carried out calibration certification for temperature since 1992. This service provides fast and economical certification for everyone.
DKD calibration certificates can be issued for resistance thermometers, thermocouples, measurement sets, data loggers and temperature block calibrators within the range -80 to +1100°C. The traceability of the reference standard is the central issue here. All DKD calibration certificates are recognized as documents of traceability, without any further specifications. In addition, calibrated precision platinum resistance thermometers or complete measurement sets with indicator in a service case can be obtained.

14.3 Pressure gauge

Voith Article No.: 4 201477 018

Type: 100-T5500 (0-1 bar)

Description . . . . ASHCROFT

All stainless steel process gauge open or solid front
Model T5500 and T6500

According EN 837-1
Nominal size 100 mm or 160 mm
Accuracy: Class 1 (EN)

Features

- Rugged stainless steel construction
- Socket and case welded
- Protection IP65/IP67
- Optional ATEX approved CE Ex II 2 GD c
- Usable to full scale
- Overload protection 130 %
- Dry, liquid filled or liquid less (*PLUS!* gauge)
- Measuring system stainless steel or Monel

Ranges

-1 ... 0 bar up to 0 ... 1000 bar
-30 in. Hg ... 0 psi up to 0 ... 15.000 psi

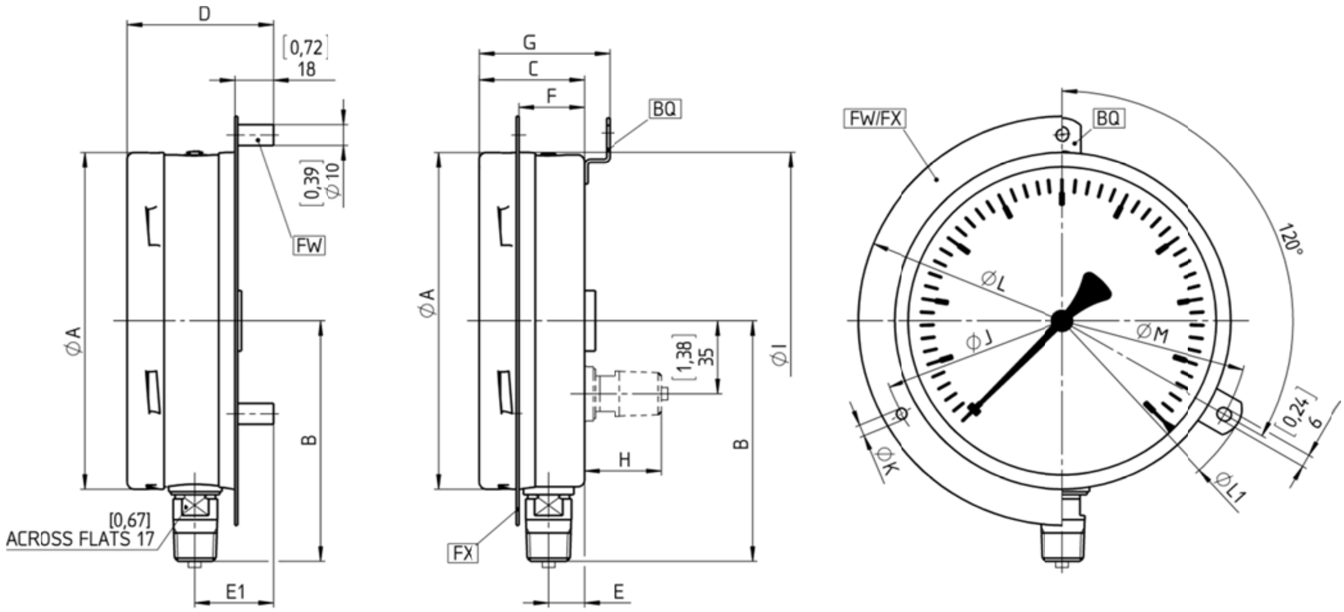
Applications

Chemical and petrochemical industry
Machine and apparatus construction
Food and beverage industry
Pulp and paper industry

Technical specification	T5500		T6500	
Dial size in mm	100	160	100	160
Construction	Open front cylindrical case with blow out disc at the back		Solid front safety pattern cylindrical case with blow out at the back	
Measuring principle Range in bar Overpressure limit Pressure type	Bourdon tube 0,6 1 1,6 2,5 4 6 10 16 25 40 60 100 160 250 400 600 1000 -1/0 -1/0,6 -1/1,5 -1/3 -1/5 -1/9 -1/15 -1/24 130 % F.S., short time Gauge, vacuum and compound			
Process connection	G ¼ B male, G ½ B male, G 3/8 B male according EN 837-1, M20x1,5 male, R ½ male tapered (DIN 2999), ½" male straight (JIS, BSP), 3/8" male straight (JIS, BSP), ¼ NPT male, ½ NPT male according ANSI/ASME B1.20.1, 9/16-18 UNF-2B Aminco (high pressure), Others on request (for pressure limitations see order information)			
Connection location	Lower, back		Lower only	
Material Pressure connection Tube Case/bayonet ring Window Dial Pointer Movement	 Stainless steel 316L (1.4404), optional Monel 400 Stainless steel 316L (1.4404), optional Monel K-500 Stainless steel 304 (1.4301), optional 316L (1.4404) Instrument glass, optional safety glass or acrylic glass Aluminum, black markings on white background Aluminum, black, optional micrometer adjustment, red set hand or maximum pointer Stainless steel 304/303 (1.4301/1.4305)		 Safety glass, optional acrylic glass	
Accuracy	Class 1 (1 % F.S.), optional 0,5 % F.S. for preferred ranges			
Permissible Ambient temperature Medium temperature Storage temperature Effect	 -25 ... 60 °C Max. 200 °C (dry), max. 100 °C (liquid filled) -40 ... 60 °C Max. 0,3 % / 10 K			
Protection according EN 60 529/IEC 529	IP67, IP65 for T6500 dry execution			
Conformity according to RL 94/9/EC appendix X for mechanical equipment in potential hazardous areas	Optional, Marking CE Ex II 2 GD c IIC Tx File no. 35134582 at notified body 0044, TÜV NORD CERT (only with safety glass or acrylic glass)			
Filling liquids	Glycerin, silicone, halocarbon, others on request Optional dampened movement (liquid less gauge), functions as liquid filled gauge (*PLUS!* gauge)			
Mounting	Standard stem, optional flush or surface, others on request			
Weight dry/filled in kg	0,8/1,0	1,2/2,0	0,8/1,0	1,2/2,0
Accessories, options	Diaphragm seals, valves, gauges with integrated contacts (see data sheet G1.T5500-KF), gauges with integrated pressure transducer (see data sheet G1.T55E)			

General dimensions in mm

T5500 open front with blow out compensation plug



NG	A	B	C	D	E	E1	F	G	H	I	J	K	L	L1	M
100 mm	[3,97] 101	[3,36] 85	[2,01] 51	[2,72] 69	[0,73] 18,5	[1,44] 36,5	[1,26] 32	[2,48] 63	[1,38] 35	[4,00] 102	[4,57] 116	[0,19] 4,8	[5,20] 132	[5,28] 134	[4,69] 119
160 mm	[6,35] 161	[4,54] 115	[1,96] 50	[2,76] 70	[0,67] 17	[1,47] 37	[1,22] 31	[2,43] 62	[1,46] 37	[6,36] 162	[7,01] 178	[0,22] 5,5	[7,72] 196	[7,64] 194	[7,05] 179

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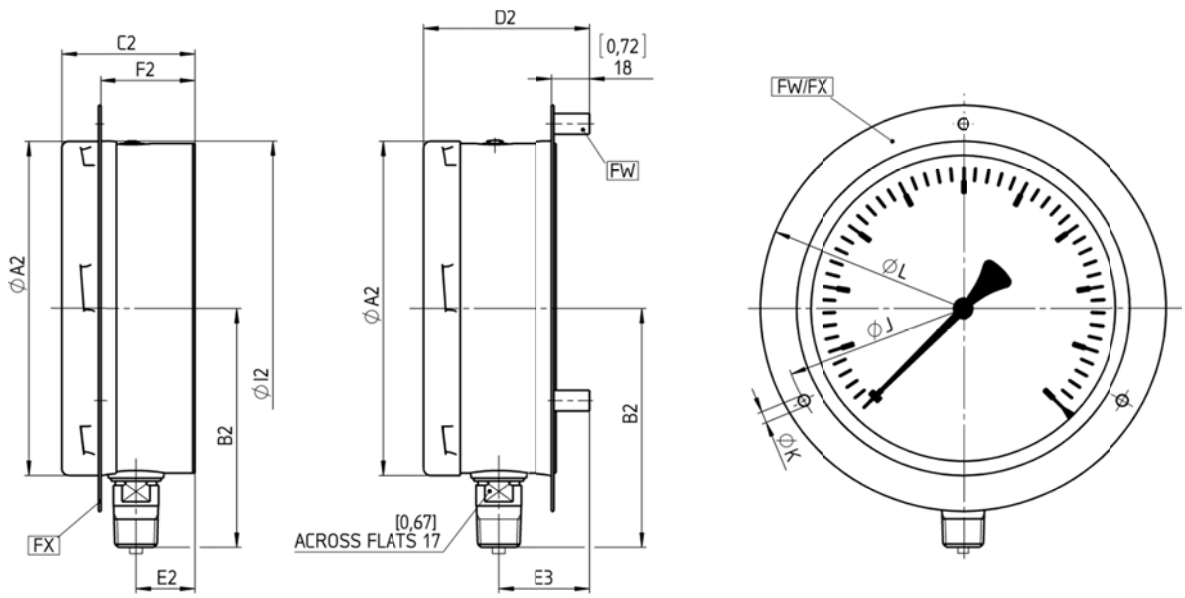
T6500 solid front with blow out back wall



NG	A2	B2	C2	D2	E2	E3	F2	I2	J	K	L
100 mm	[3,97] 101	[3,36] 85	[2,38] 61	[2,91] 74	[1,02] 26	[1,55] 39	[1,63] 42	[4,00] 102	[4,57] 116	[0,19] 4,8	[5,20] 132
160 mm	[6,35] 161	[4,54] 115	[2,52] 64	[3,15] 80	[1,11] 28	[1,74] 44	[1,78] 45	[6,36] 162	[7,01] 178	[0,22] 5,5	[7,72] 196

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Order information

Size	Type	System material	Execution	Process connection	Connection orientation	Range	Engineering unit	Filling/Case material	Options
(100) 100 mm **(160)** 160 mm	**T5500** **T6500**	**(S)** 316L (1.4404) ≤ 1000 bar **(P)** Monel ≤ 1000 bar	**(D)** Dry **(L)** Liquid filled	**(04)** ½ NPT male 1) **(02)** ¼ NPT male 1) **(09)** 9/16-18 UNF-2B Aminco **(13)** G ¼ B male 1) **(14)** G 3/8 B male 1) **(15)** G ½ B male 1) **(16)** M20x1,5 male 1) **(KQ)** R½ male tapered DIN 2999 1) **(KN)** ½" male straight (JIS, BSP)1) **(KP)** 3/8" male straight (JIS, BSP)1)	**(L)** Lower **(B)** Back 1)	**-1/ 0** 1) **-1/ 1,5** **-1/ 3** **-1/ 5** **-1/ 9** **-1/ 15** **-1/ 24** **0/ 0,6** 2) **0/ 1** 1) **0/ 1,6** **0/ 2,5** **0/ 4** **0/ 6** **0/ 10** **0/ 16** **0/ 25** **0/ 40** **0/ 60** **0/ 100** **0/ 160** **0/ 250** **0/ 400** **0/ 600** **0/1000**	**(BAR)**	**(=)** Standard no filling **(GV)** Silicone **(GV3)** Silicone 3 cst **(GR)** Glycerin **(GX)** Halocarbon 1) **(LJ)** Field fillable (only for execution D) **(YW)** Case material 316L (1.4404)	**(NH)** Tagging wired **(CS)** Dual scale (Outer scale is dominant) **(DA)** Dial Marking **(TU)** Throttle plug stainless steel **(6B)** Cleaned for Oxygen service (not for T5500 (open front) acc. EN 837-1) **(6W)** Cleaned free of oil and grease **(MP)** Micrometer pointer **(PD)** Acrylic glass **(SG)** Safety glass **(BQ)** Wall mounting brackets **(FX)** Front flange **(FW)** Back flange **(UF)** U-clamp (not for T6500) **(AJ)** Calibration 0,5 % F.S. (not for ranges < 1 bar (dry) or < 4 bar (liquid filled)) **(LL)** Liquid less gauges (Halocarbon filling not allowed) **(NZ)** Liquid less gauges, silicon free (not for execution L) **(PR)** Receiver gauge **(OS)** Overload stop **(VS)** Vacuum stop **(ATEX)** ATEX approval **(C3)** Material test report acc. to DIN EN 10204 3.1 **(C4)** Calibration certificate **(HY)** Hydrostatic test 130% **(MQ)** PMI test
				1) max. 1000 bar	1) not for type T6500	1) not allowed with liquid less (LL or NS) option 2) not allowed with execution L or with liquid less (LL or NS) option	psi and others on request	1) not allowed in combination with liquid less (LL) option	Option listing starts with "X", followed by options separated by "=" Example: X=NH=SG=FW

Order example

Size	Type	System material	Execution	Process connection	Connection Orientation	Range	Engineering unit	Filling/Case material	Options
100	T5500	S	D	15	L	0/16	BAR	YW	NH

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- Si la température du process au niveau du mano est supérieure à la température maximum admissible, alors il sera nécessaire de monter un siphon, un séparateur ou un capillaire suffisamment long. Utilisez toujours clefs adaptées au plats du mano. Ne jamais appliquer de forces sur le boîtier.

3. Mise en service
- L'échelle d'opération correspond à la pleine échelle sinon se référer à la marque ▼ indiquant la limite de pression. Pour les mano's différentiels, vérifier la pression statique maxi. Pendant les essais d'étanchéité des tuyaux, les mano's ne doivent pas être exposés hors limites indiquées. La température d'étalonnage est de +20 °C, chaque déviation de ±30 °C ajoute ± une classe de la valeur pleine échelle à la précision. Les tuyaux vers les mano's doivent avoir un diamètre interne entre 4 et 9 mm, en fonction de la pression et de la longueur.
- Après l'installation de mano's différentiels, les lignes de mesure doivent être ventilées (purgées pour liquides).
- Jusqu'à la mise en service définitive, la vanne d'isolement doit rester fermée et la vanne d'équilibrage ouverte. Faire attention aux charges unidirectionnels.
- Au démarrage pour les mano's ouvrir la vanne d'isolement lentement.
- Pour les mano's différentiels, suivre les instructions suivantes pour:
- Mise en service: 1. Ouvrir la vanne d'équilibrage
  2. Ouvrir les vannes d'isolement
  3. Fermer la vanne d'équilibrage.
  La pression différentielle est indiquées sur le cadran
- Mise hors service: 1. Ouvrir la vanne d'équilibrage
  . 2. Fermer les vannes d'isolement.
- Service en zone dangereuse (model T5500/T6500):
  Ambiance: -20 … 60 °C
  Le "Process": Les températures maxi des fluides, gaz et vapeurs en contact avec l'instrument dépendent de la construction de l'appareil ainsi que la température d'inflammation des gaz, vapeurs ou poussières dans l'ambiance (voir tableau 1):
  Attention: Pour les gaz, la température peut augmenter à cause de la compression; ceci limite la fréquence maxi admissible (pas les pulsations) jusqu'à 0,1 Hz. Ce n'est pas applicable pour les manomètres remplis d'un bain d'huile amortisseur.
  Tableau 1: Température du "process" maxi.

Classe de température	Température du "process" maxi
T6	+55 °C
T5	+70 °C
T4	+100 °C
T3	+100 °C
T2	+100 °C
T1	+100 °C

Pendant les essais de chocs le degré de risque mécanique à été classifié comme léger.

4. Zéro ou test de fonctionnement
- La vanne d'isolement du mano fermée, la pression doit être amenée à la pression atmosphérique. L'aiguille doit rester à zéro.
- Vérification pour les mano's différentiels. Fermer l'ensemble des vannes à la prise de pression en même temps. L'aiguille doit reste dans l'échelle. Si l'aiguille descend, la partie haute pression a des fuites ou la vanne d'équilibrage est restée ouverte. En cas montée de l'aiguille, la partie basse pression a des fuites. Si le mano ne montre aucune indication, fermer la coté basse pression et ouvrir la haute pression. Si l'aiguille ne bouge pas, l'instrument est défectueux.

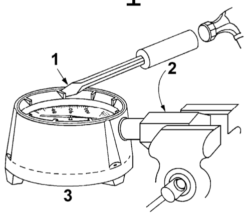
5. Maintenance
- L'instrument ne demande pas une maintenance particulière.
- En cas de défaut, demander l'assistance de nos agents ou la nôtre. Nous vous apporterons conseil et service.

6. Réglage du zéro
- Pour les instrument à lunette amovible ou munis d'une système de remise à zéro externe, le zéro peut être. Pour les instruments munis d'un système de réglage interne du zéro, la lunette à baïonnette ou articulée peut être aisément enlevée, pour les manomètres lunette visée, voir le schéma pour retirer la lunette.
  1. Tenir la manomètre solidement fixé. il est important de le tenir étroitement sinon les ergots de la lunette pourraient être endommagés.
  2. Pour retirer la lunette, tapoter dans le sens inverse des aiguilles d'une montre comme indiqué en utilisant un marteau et un tournevis à bout plat.
  3. Pour installer la lunette, la serrer à fond à la main. Tourner comme indiqué sur le schéma d'1/8 de tour pour l'étanchéité et d'1/3 de tour pour les boîtiers à bain ou hermétique.
- Les manomètres différentiels ont un ajustement externe sur le côte du boîtier.
- Les manomètres étalons à lunette amovible sont équipés d'une vis de remise à zéro sur la façade (voir schéma 2).
  1. Desserrer la bague de verrouillage „A"
  2. Faire tourner le bouton „B" pour ajuster le zéro.
  3. Serrer la vis „A" sur le bouton „B".
- L'aiguille ne peut être remise à zéro qu'après avoir libéré l'élément sensible de tout pression.

Sous réserve de modifications !

Bild / sketch / schéma

1



2

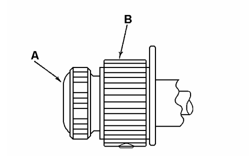


Tabelle / table / tableau 2

max. Umgebungstemperatur / ambient temperature limits / température ambiante maximum

Ausführung execution type de boîtier		°C	°F
hermetisch dicht hermetically sealed hermétique	Luft / air / air	- 25 ... 50	- 10 ... 125
Flüssigkeitsgefüllt liquid filled à bain	Glycerin / glycerin / glycérine	- 18 ... 65	0 ... 150
	Silikon / silicon / silicone	- 45 ... 65	- 50 ... 150

- Füllflüssigkeit und Messstoff müssen kompatibel sein.
- Be sure filling liquid is compatible with process fluid
- S'assurer que le liquide de remplissage est compatible avec le fluide de service.

GAUGE - BA Rev. N 12/04/2006

ASHCROFT®

Betriebsanleitung
Druck- und Differenzdruckmanometer

Operating Instruction
Pressure- and DP gauge

Instruction de Service
Manomètre et Manomètre différentiel

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1. Montagebedingungen
- Die Manometer müssen nach den in Betracht kommenden Anforderungen ausgewählt und montiert werden.
- Zulässige Umgebungstemperatur siehe Tabelle 2. Andere Temperaturgrenzen sind optional mit speziellen Serien möglich.

2. Montage
- Der Einbau des Messgerätes sollte in der Nähe des Messpunktes erfolgen. Der Einbauort sollte zugänglich und frei von Erschütterungen sein.
- Die Betriebsstellung muss mit der auf dem Zifferblatt angegebenen Gebrauchsstellung übereinstimmen. Ohne Angabe auf dem Zifferblatt ist die Gebrauchslage 90° ±5° (Zifferblatt in vertikaler Lage).
- Bei extremen Bedingungen (Druckspitzen, Vibrationen) Schutzelemente verwenden (Dämpfungselemente, Füllflüssigkeiten).
- Das Messgerät ist vor schädlichen Umwelteinflüssen, Beschädigungen, großen Temperaturschwankungen und, bei Differenzdruckmessgeräten, vor einseitiger Wärmestrahlung zu schützen.
- Differenzdruckmessgeräte müssen frostsicher eingebaut werden.
- Überschreitet die Temperatur des Messstoffes die zulässige Betriebstemperatur, so muss eine ausreichend lange Messleitung, ein Wassersackrohr oder ein Druckmittler mit Kapillarrohr vorgeschaltet werden.
- Beim Montieren ist ein entsprechender Maulschlüssel zu verwenden. Es darf keine Kraft (Moment) auf das Gehäuse ausgeübt werden.

3. Inbetriebnahme
- Ist auf dem Zifferblatt keine Begrenzungsmarke ▼ aufgedruckt, so ist der Verwendungsbereich gleich dem Anzeigebereich. Bei Differenzdruckmessgeräten ist der maximale statische Druck zu berücksichtigen.
- Beim Abdrücken von Rohrleitungen und Kesseln darf das Messgerät nicht höher als die vorgenannten Begrenzungen belastet werden.
- Die Bezugstemperatur beträgt +20 °C (Normaltemperatur bei betrieblicher Eichung). Abweichend von der Bezugstemperatur ergibt sich je ±30 °C Betriebstemperaturzunahme bzw. Abnahme ein zusätzlicher Anzeigefehler von ±1 % bezogen auf den M. E..
- Die Anschlussleitung sollte, in Abhängigkeit von Druck und Länge, einen Innendurchmesser von 4 ... 9 mm haben.
- Nach der Montage eines Differenzdruckmessgerätes sind die Anschlussleitungen auszublasen, bzw. bei flüssigen Medien zu entlüften. Bis zum Einsatz bleibt das Anschlussventil geschlossen und das Ausgleichsventil geöffnet. Einseitige Druckbelastungen sind zu vermeiden.
- Absperrventile immer langsam öffnen.
- Bei Inbetriebnahme von Differenzdruckmessgeräten wie folgt vorgehen:
  1. Ausgleichsventil öffnen 2. Anschlussventil öffnen.
  3. Ausgleichsventil schließen. Der Differenzdruck wird angezeigt.
- Bei Außerbetriebnahme wie folgt vorgehen:
  1. Ausgleichsventil öffnen. 2. Anschlussventil schließen.
- Einsatz in explosionsfähiger Atmosphäre (Modell T5500/T6500):
  Umgebung: -20 … 60 °C
  Messstoff: Die zulässige Messstofftemperatur hängt außer von der Gerätebauart auch von der Zündtemperatur der umgebenden Gas, Dämpfe bzw. Stäube ab (siehe Tabelle 1):
  Achtung: Bei gasförmigen Stoffen kann sich die Temperatur durch Kompressionswärme erhöhen. Auf Grund dessen darf die Frequenz von 0,1 Hz (nicht Pulsation) nicht überschritten werden. Dies trifft nicht bei gefüllten Geräten zu.
  Tabelle 1: Zulässige Messstofftemperaturen

Temperaturklasse	Max. Messstofftemperatur
T6	+55 °C
T5	+70 °C
T4	+100 °C
T3	+100 °C
T2	+100 °C
T1	+100 °C

Bei der Stoßprüfung wurde der Grad der mechanischen Gefahr als niedrig angesehen.

4. Nullpunktprüfung/Funktionstest
- Nach dem Schließen der Absperrventile und erfolgtem Druckausgleich muss der Zeiger im, als Nullpunkt, gekennzeichneten Bereich stehen.
- Bei Differenzdruckmessgeräten steht der Zeiger bei gleichzeitigem Schließen der Ventile innerhalb des Anzeigebereiches. Fällt der Zeiger, ist die Plusleitung undicht oder das Ausgleichsventil nicht geschlossen. Steigt der Zeiger, ist die Minusleitung undicht. Zeigt das Differenzdruckmessgerät nichts an, Minusleitung schließen und Plusleitung öffnen. Bewegt sich der Zeiger nicht, so ist das Gerät defekt.

5. Wartung
- Das Gerät ist wartungsfrei.
- Lassen sich Störungen nicht beheben, wenden Sie sich bitte an unsere Niederlassungen und Vertretungen, die Ihnen mit Beratung und Service zur Verfügung stehen.

6. Nullpunktkorrektur
- Bei Messgeräten mit abnehmbaren Frontring oder externer Verstellmöglichkeit kann der Nullpunkt eingestellt werden.
- Bei Messgeräten mit interner Nullpunktverstellung muss der Bajonett-Ring bzw. der klappbare Ring vorsichtig entfernt werden. Messgeräte mit geschraubtem Ring werden wie in Bild 1 dargestellt geöffnet.
  1. Gerät (3) mit einer Schutzhülse (2) im Schraubstock einspannen.
  2. Schraubring vorsichtig mit einem Hammer und einem großen Schraubendreher (1) gegen den Uhrzeigersinn lösen.
  3. Nach der Nullpunktkorrektur Schraubring von Hand fest andrehen. Bei wetterfester Ausführung eine 1/8 Umdrehung, bei hermetisch dichter und gefüllter Ausführung eine 1/3 Umdrehung nachziehen.
- Differenzdruckmessgeräte haben eine externe Verstellmöglichkeit an der Gehäuseseite.
- Feinmessgeräte mit klappbarem Ring haben eine frontseitige Nullpunktkorrektur (siehe Bild 2).
  1. Feststellschraube A lösen.
  2. Mit der Justierschraube B den Nullpunkt einstellen.
  3. Feststellschraube A in Justierschraube B eindrehen.
- Vor der Nullpunktkorrektur ist ein Druckausgleich erforderlich.

Technische Änderungen vorbehalten !

1. Installation requirements
- The pressure gauges must be selected and installed this wise, that the possibility of failure, resulting in injury or misapplication, is minimized.
- For the maximum ambient temperature see table 2. Other limits are possible at special series.

2. Mounting
- The mounting of measuring instruments shall be in proximity of measuring point, easily accessible and safe from vibrations and always coincide with the position as indicated on the dial. If no such statement is printed on the dial, the gauges must be mounted in a 90° ±5° position with the vertical dial. If the instrument can not protected against shock or vibration, use an additional movement damping feature (liquid filled or pulsation dampener). The measuring instrument must be protect against damages, great pollution, high fluctuation of temperature and one-sided heat radiation for the dp gauge. Please note the freezing point of media and choose a frost-protected place for the dp gauges.
- If the process temperature at the gauge is in excess of the max. allowable operation temperature, than depending of the application a syphon, diaphragm seal or sufficient length of pipe/capillary has to be mounted between the pressure tap and the instrument.
- When installing always use a wrench suitable for the flats on the instrument. Do never apply mechanical torque's to the case.

3. Operation
- The operating range corresponds to the scale range or see static pressure limit mark ▼ printed on the dial. For dp gauges look for the max. allowable static pressure. When carrying out pressure test of process pipes and vessels, the instrument may not exposed to the above limits as mentioned before. The calibration temperature is +20 °C, each ±30 °C deviation of this temperature adds ± one class of full scale value to the accuracy.
  The instruments piping shall be between 4 and 9 mm ID, depending on the pressure and the lengths.
- After installation of the dp gauges the measuring lines must be blowed through. When using liquid media, the measuring lines must be bled.
- Until definitive operation the connection valve remains closed and the compensation valve remains open. Please avoid one-sided charge.
- On start up for pressure gauges open the shut off valve slowly.
- For dp gauges follow the following sequence for:
- Operation: 1. Open balancing valve. 2. Open connection valves.
  3. Close balancing valve.
  Differential pressure is indicated on dial
- Out of operation: 1. Open balancing valve. 2. Close connection valves.
- Service in hazardous area (model T5500/T6500):
  Ambiance: -20 … 60 °C
  Process media: The admissible temperature of the process media depends on the instrument construction as well as the ignition temperature of the surrounding gases, vapors or dusts (see table 1):
  Attention: For gaseous media the temperature can rise as result of compression. Therefore the maximum admissible frequency (not pulsation) is 0,1 Hz. This does not apply to liquid filled gauges.
  Table 1: Maximum admissible process media temperature

Temperature class	Max. process media temperature
T6	+55 °C
T5	+70 °C
T4	+100 °C
T3	+100 °C
T2	+100 °C
T1	+100 °C

During choc tests the degree of mechanical hazard was classified as low.

4. Zero or functional test
- The shut off valve(s) at the pressure tap(s) for the instrument has to be closed and the pressure has to be released to atmosphere. The pointer tip must stay within the zero mark.
- Check for dp gauges: Close both valves at the pressure taps at the same time. The pointer must rest within the scale range. If pointer drops the plus line leaks or the balancing valve is still open. In case of rising pointer the minus line leaks. If the dp gauge shows no indication, close the minus line and open the plus line. In case the pointer doesn't move the instrument is damaged.

5. Maintenance
- The instrument require no special maintenance.
- In case of any default apply for assistance from ourselves or our agents. We will assist you with advice and service.

6. Zero adjustment
For instruments with a removable ring, bezel or external zero adjust feature the zero can be adjusted. For the instruments with internal zero adjustments the bayonet ring or hinged ring bezel must be removed, for gauges with screwed ring see sketch 1 to remove the ring.
  1. Hold gauge in vise with threaded nut. it is important to hold the gauge rigidly otherwise ring lugs may be damaged.
  2. To remove ring-tap counter wise as shown using hammer and large screw driver with flat tip
  3. To install ring tighten snugly by hand. Turn as per sketch 1/8 turn for weatherproof and 1/3 turn for liquid filled and hermetically sealed.
The differential pressure gauges have an external adjustment on the side of the case.
- Testgauges with hinged ring are equipped with a front mounted zero adjustment (see sketch 2).
  1. Loosen ring locking screw A.
  2 Rotated knob B until required adjustment.
  3 Tighten screw A down on knob B.
The pointer can be adjusted to zero after releasing the pressure element against atmosphere.

Modification reserved !

1. Conditions de montage
- Les manomètres doivent être choisis et montés de manière à minimiser les possibilités d'erreurs, résultant d'un mauvais montage d'une mauvaise application.
- Pour la température ambiante maximum, se référer au tableau 2. D'autres limites sont possibles dans des modèles particuliers.

2. Montage
- Le montage de mano's doit être fait à proximité du point de mesure, facilement accessible, exempt de vibrations et toujours coïncider avec la position indiquée sur cadran. En standard, les manomètres doivant être montés à 90° ±5° par rapport au cadran à la verticale. Protéger les mano's contre les chocs ou les vibrations ou utiliser un système d'amortissement supplémentaire (remplissage ou amortisseur). Le mano doit être protégé contre avaries, pollution, hautes fluctuations de température et chaleur d'un côté de l'appareil pour le mano différentiel. Noter la point de gel du fluide et choisir une place protégée du gel pour les mano's différentiels.

14.4 Differential pressure gauge

Voith Article No.: 4 201595 002

Type: 100-F5509 (0-1,6 bar)

Description . . . . ASHCROFT

Stainless steel differential pressure gauge
Model F5509 and F6509

Max. static pressure 25 bar

Nominal size 100 mm or 160 mm
Accuracy: Class 2,5, optional class 1,6 (EN)

Features

- Stainless steel case and wetted parts
- Static pressure 10 bar or 25 bar
- Protection IP54 or IP65
- Chamber purge and bleed connection available
- High corrosive resistance
- Dry or liquid filled
- Optional solid front

Ranges

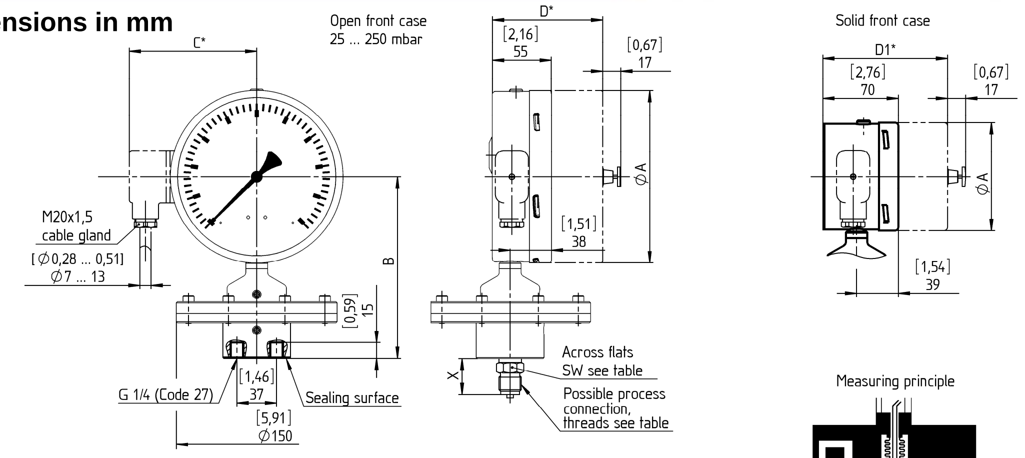
0 ... 25 mbar up to 0 ... 250 mbar (max. static pressure 10 bar)
0 ... 400 mbar up to 0 ... 25 bar (max. static pressure 25 bar)

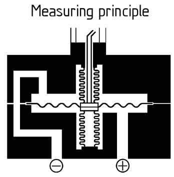
Applications

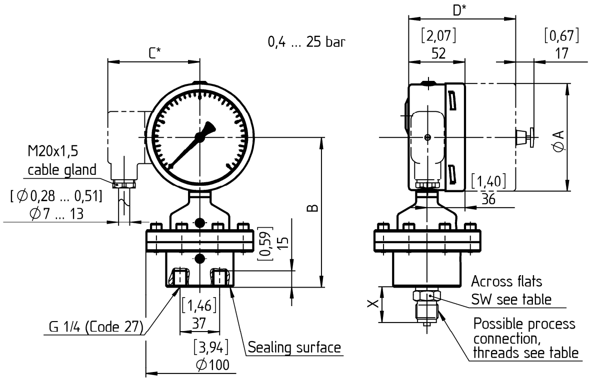
Chemical and petrochemical industry
Machine and apparatus construction
Food and beverage industry
Pulp and paper industry

Technical specification	**F5509**		**F6509**	
Dial size in mm	100	160	100	160
Construction	Open front cylindrical case with blow out disc at the back		Solid front safety pattern cylindrical case with blow out at the back	
Zero adjustment	Externally, at the top of the case			
Measuring principle	Diaphragm (see back side)			
Range in mbar	25 40 60 100 160 250 400			
in bar	0,6 1 1,6 2,5 4 6 10 16 25			
Max. static pressure	Range < 400 mbar static pressure = 10 bar (10 times F.S. load at one side) Range ≥ 400 mbar static pressure = 25 bar (10 times F.S. load at one side)			
Pressure type	Differential			
Process connection	G ¼ B male, G ¼ female, G ½ B male, G ½ female ¼ NPT male, ¼ NPT female, ½ NPT male, ½ NPT female, others on request			
Connection location	Lower			
Material				
Pressure connection	Stainless steel 316L (1.4404)			
Pressure chamber	Stainless steel 316L (1.4404), Viton O-ring, EPDM on request			
Measuring diaphragm	≤ 400 mbar stainless steel 316Ti (1.4571) ≥ 0,6 bar Duratherm 2.4781 (NiCrCo alloy)			
Bellows	Stainless steel 316Ti (1.4571)			
Case/bayonet ring	Stainless steel 304 (1.4301)			
Window	Laminated safety glass			
Dial	Aluminum, black markings on white background			
Pointer	Aluminum, black, optional red set hand or maximum pointer			
Movement	Stainless steel 304/303 (1.4301/1.4305)			
Accuracy	Class 2,5 (2,5 % F.S.), optional (for ranges ≥ 60 mbar) class 1,6 (1,6 % F.S.)			
Permissible				
Ambient temperature	-25 ... 85 °C			
Medium temperature	Max. 100 °C			
Storage temperature	-40 ... 60 °C			
Effect	Max. 0,3 % / 10 K			
Protection according EN 60 529/IEC 529	IP54 (dry), IP65 (liquid filled), optional IP65 for dry gauges			
Filling liquids	Glycerin, silicone, others on request			
Mounting	Direct, optional wall or 2" pipe mounting, others on request			
Weight dry/filled in kg range	≤ 400 mbar 9/9,5 ≥ 600 mbar 4/4,5	≤ 400 mbar 9,4/10 ≥ 600 mbar 4,4/5	≤ 400 mbar 9/9,5 ≥ 600 mbar 4/4,5	≤ 400 mbar 9,4/10 ≥ 600 mbar 4,4/5
Accessories, options	3 or 5 way manifolds, valves, gauges with contacts (see data sheet G1.K55/E)			

General dimensions in mm



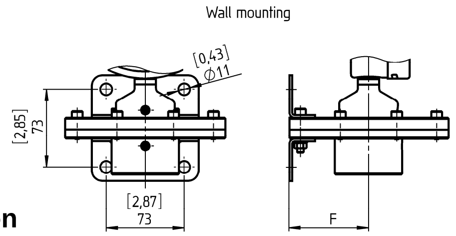


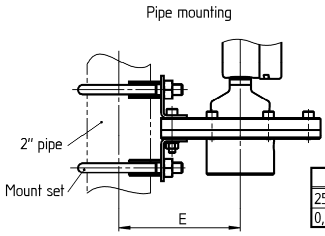


Threads	Code	X	SW
1/4-18 NPT male; DIN EN 837	02	30 [1,18]	19 [0,75]
1/2-14 NPT male; DIN EN 837	04	37 [1,46]	22 [0,87]
G 1/4 B male; DIN EN 837	13	25 [0,98]	19 [0,75]
G 1/2 B male; DIN EN 837	15	34 [1,34]	22 [0,87]
1/4-18 NPT female	25	20 [0,79]	19 [0,75]
1/2-14 NPT female	50	26 [1,02]	27 [1,06]
G 1/2 female; DIN EN 837	51	26 [1,02]	27 [1,06]

* with integrated contacts

Dial size	∅A	B	C*	D*	D1*
100	101 [3,98]	140 [5,51]	86 [3,39]	100 [3,94]	116 [4,57]
160	161 [6,34]	170 [6,69]	120 [4,72]	102 [4,02]	118 [4,65]





Range	E	F
25 ... 250 mbar	114 [4,47]	74 [2,91]
0,4 ... 25 bar	91 [3,59]	51 [2,01]

Rev. G

Order information

Size	Type	System material	Execution	Process connection	Connection orientation	Range	Engineer-in unit	Filling/contacts	Options
(100) 100 mm **(160)** 160 mm	**F5509** **F6509**	**(S) Pressure compartment** 316L (1.4404) **Diaphragm** ≤ 400 mbar 316Ti (1.4571), ≥ 0,6 bar Duratherm **Bellows** 316Ti (1.4571)	**(=)** IP54 standard case **(L)** Liquid filled IP65	**(27)** G ¼ female **(02)** ¼ NPT male **(04)** ½ NPT male **(13)** G ¼ B male **(15)** G ½ B male **(25)** ¼ NPT female **(50)** ½ NPT female **(51)** G ½ female	**(L)** Lower	**0/ 25** **0/ 40** **0/ 60** **0/ 100** **0/ 160** **0/ 250** **0/ 400** **0/ 0,6** **0/ 1** **0/ 1,6** **0/ 2,5** **0/ 4** **0/ 6** **0/ 10** **0/ 16** **0/ 25** max. static pressure for < 400 mbar 10 bar for ≥ 400 mbar 25 bar	**MBAR** **BAR** psi and others on request compound ranges on request	**(=)** Standard no filling **(GV)** Silicone (admissible for inductive contacts) **(GT)** Napvis (admissible for magnetic spring contacts) **(GR)** Glycerin **( )** Contact type and function (see data sheet G1.K55/E)	**(NH)** Tagging wired **(DA)** Dial marking **(FW)** Wall mounting bracket **(TM)** 2" pipe mounting bracket **(EP)** Maximum pointer adjustable **(LJ)** Field fillable IP65 (only for execution "=")

Order example

Size	Type	System material	Execution	Process connection	Connection orientation	Range	Engineering unit	Filling/contacts	Options
100	F5509	S	L	27	L	0/16	BAR	GV	TM

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- Si la température du process au niveau du mano est supérieure à la température maximum admissible, alors il sera nécessaire de monter un siphon, un séparateur ou un capillaire suffisamment long. Utilisez toujours clefs adaptées au plats du mano. Ne jamais appliquer de forces sur le boîtier.

3. Mise en service
- L'échelle d'opération correspond à la pleine échelle sinon se référer à la marque ▼ indiquant la limite de pression. Pour les mano's différentiels, vérifier la pression statique maxi. Pendant les essais d'étanchéité des tuyaux, les mano's ne doivent pas être exposés hors limites indiquées. La température d'étalonnage est de +20 °C, chaque déviation de ±30 °C ajoute ± une classe de la valeur pleine échelle à la précision. Les tuyaux vers les mano's doivent avoir un diamètre interne entre 4 et 9 mm, en fonction de la pression et de la longueur.
- Après l'installation de mano's différentiels, les lignes de mesure doivent être ventilées (purgées pour liquides).
- Jusqu'à la mise en service définitive, la vanne d'isolement doit rester fermée et la vanne d'équilibrage ouverte. Faire attention aux charges unidirectionnels.
- Au démarrage pour les mano's ouvrir la vanne d'isolement lentement.
- Pour les mano's différentiels, suivre les instructions suivantes pour:
- Mise en service: 1. Ouvrir la vanne d'équilibrage
  2. Ouvrir les vannes d'isolement
  3. Fermer la vanne d'équilibrage.
  La pression différentielle est indiquées sur le cadran
- Mise hors service: 1. Ouvrir la vanne d'équilibrage
  . 2. Fermer les vannes d'isolement.
- Service en zone dangereuse (model T5500/T6500):
  Ambiance: -20 … 60 °C
  Le "Process": Les températures maxi des fluides, gaz et vapeurs en contact avec l'instrument dépendent de la construction de l'appareil ainsi que la température d'inflammation des gaz, vapeurs ou poussières dans l'ambiance (voir tableau 1):
  Attention: Pour les gaz, la température peut augmenter à cause de la compression; ceci limite la fréquence maxi admissible (pas les pulsations) jusqu'à 0,1 Hz. Ce n'est pas applicable pour les manomètres remplis d'un bain d'huile amortisseur.
  Tableau 1: Température du "process" maxi.

Classe de température	Température du "process" maxi
T6	+55 °C
T5	+70 °C
T4	+100 °C
T3	+100 °C
T2	+100 °C
T1	+100 °C

Pendant les essais de chocs le degré de risque mécanique à été classifié comme léger.

4. Zéro ou test de fonctionnement
- La vanne d'isolement du mano fermée, la pression doit être amenée à la pression atmosphérique. L'aiguille doit rester à zéro.
- Vérification pour les mano's différentiels. Fermer l'ensemble des vannes à la prise de pression en même temps. L'aiguille doit reste dans l'échelle. Si l'aiguille descend, la partie haute pression a des fuites ou la vanne d'équilibrage est restée ouverte. En cas montée de l'aiguille, la partie basse pression a des fuites. Si le mano ne montre aucune indication, fermer la coté basse pression et ouvrir la haute pression. Si l'aiguille ne bouge pas, l'instrument est défectueux.

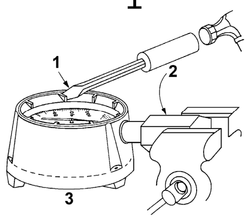
5. Maintenance
- L'instrument ne demande pas une maintenance particulière.
- En cas de défaut, demander l'assistance de nos agents ou la nôtre. Nous vous apporterons conseil et service.

6. Réglage du zéro
- Pour les instrument à lunette amovible ou munis d'une système de remise à zéro externe, le zéro peut être. Pour les instruments munis d'un système de réglage interne du zéro, la lunette à baïonnette ou articulée peut être aisément enlevée, pour les manomètres lunette visée, voir le schéma pour retirer la lunette.
  1. Tenir la manomètre solidement fixé. il est important de le tenir étroitement sinon les ergots de la lunette pourraient être endommagés.
  2. Pour retirer la lunette, tapoter dans le sens inverse des aiguilles d'une montre comme indiqué en utilisant un marteau et un tournevis à bout plat.
  3. Pour installer la lunette, la serrer à fond à la main. Tourner comme indiqué sur le schéma d'1/8 de tour pour l'étanchéité et d'1/3 de tour pour les boîtiers à bain ou hermétique.
- Les manomètres différentiels ont un ajustement externe sur le côte du boîtier.
- Les manomètres étalons à lunette amovible sont équipés d'une vis de remise à zéro sur la façade (voir schéma 2).
  1. Desserrer la bague de verrouillage „A"
  2. Faire tourner le bouton „B" pour ajuster le zéro.
  3. Serrer la vis „A" sur le bouton „B".
- L'aiguille ne peut être remise à zéro qu'après avoir libéré l'élément sensible de tout pression.

Sous réserve de modifications !

Bild / sketch / schéma

1



2

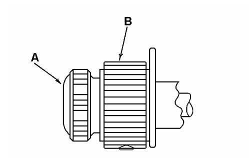


Tabelle / table / tableau 2

max. Umgebungstemperatur / ambient temperature limits / température ambiante maximum

Ausführung execution type de boîtier		°C	°F
hermetisch dicht hermetically sealed hermétique	Luft / air / air	- 25 ... 50	- 10 ... 125
Flüssigkeitsgefüllt liquid filled à bain	Glycerin / glycerin / glycérine	- 18 ... 65	0 ... 150
	Silikon / silicon / silicone	- 45 ... 65	- 50 ... 150

- Füllflüssigkeit und Messstoff müssen kompatibel sein.
- Be sure filling liquid is compatible with process fluid
- S'assurer que le liquide de remplissage est compatible avec le fluide de service.

ASHCROFT®

Betriebsanleitung
Druck- und Differenzdruckmanometer

Operating Instruction
Pressure- and DP gauge

Instruction de Service
Manomètre et Manomètre différentiel

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1. Montagebedingungen
- Die Manometer müssen nach den in Betracht kommenden Anforderungen ausgewählt und montiert werden.
- Zulässige Umgebungstemperatur siehe Tabelle 2. Andere Temperaturgrenzen sind optional mit speziellen Serien möglich.

2. Montage
- Der Einbau des Messgerätes sollte in der Nähe des Messpunktes erfolgen. Der Einbauort sollte zugänglich und frei von Erschütterungen sein.
- Die Betriebsstellung muss mit der auf dem Zifferblatt angegebenen Gebrauchsstellung übereinstimmen. Ohne Angabe auf dem Zifferblatt ist die Gebrauchslage 90° ±5° (Zifferblatt in vertikaler Lage).
- Bei extremen Bedingungen (Druckspitzen, Vibrationen) Schutzelemente verwenden (Dämpfungselemente, Füllflüssigkeiten).
- Das Messgerät ist vor schädlichen Umwelteinflüssen, Beschädigungen, großen Temperaturschwankungen und, bei Differenzdruckmessgeräten, vor einseitiger Wärmestrahlung zu schützen.
- Differenzdruckmessgeräte müssen frostsicher eingebaut werden.
- Überschreitet die Temperatur des Messstoffes die zulässige Betriebstemperatur, so muss eine ausreichend lange Messleitung, ein Wassersackrohr oder ein Druckmittler mit Kapillarrohr vorgeschaltet werden.
- Beim Montieren ist ein entsprechender Maulschlüssel zu verwenden. Es darf keine Kraft (Moment) auf das Gehäuse ausgeübt werden.

3. Inbetriebnahme
- Ist auf dem Zifferblatt keine Begrenzungsmarke ▼ aufgedruckt, so ist der Verwendungsbereich gleich dem Anzeigebereich. Bei Differenzdruckmessgeräten ist der maximale statische Druck zu berücksichtigen.
- Beim Abdrücken von Rohrleitungen und Kesseln darf das Messgerät nicht höher als die vorgenannten Begrenzungen belastet werden.
- Die Bezugstemperatur beträgt +20 °C (Normaltemperatur bei betrieblicher Eichung). Abweichend von der Bezugstemperatur ergibt sich je ±30 °C Betriebstemperaturzunahme bzw. Abnahme ein zusätzlicher Anzeigefehler von ±1 % bezogen auf den M. E..
- Die Anschlussleitung sollte, in Abhängigkeit von Druck und Länge, einen Innendurchmesser von 4 ... 9 mm haben.
- Nach der Montage eines Differenzdruckmessgerätes sind die Anschlussleitungen auszublasen, bzw. bei flüssigen Medien zu entlüften. Bis zum Einsatz bleibt das Anschlussventil geschlossen und das Ausgleichsventil geöffnet. Einseitige Druckbelastungen sind zu vermeiden.
- Absperrventile immer langsam öffnen.
- Bei Inbetriebnahme von Differenzdruckmessgeräten wie folgt vorgehen:
  1. Ausgleichsventil öffnen 2. Anschlussventil öffnen.
  3. Ausgleichsventil schließen. Der Differenzdruck wird angezeigt.
- Bei Außerbetriebnahme wie folgt vorgehen:
  1. Ausgleichsventil öffnen. 2. Anschlussventil schließen.
- Einsatz in explosionsfähiger Atmosphäre (Modell T5500/T6500):
  Umgebung: -20 … 60 °C
  Messstoff: Die zulässige Messstofftemperatur hängt außer von der Gerätebauart auch von der Zündtemperatur der umgebenden Gas, Dämpfe bzw. Stäube ab (siehe Tabelle 1):
  Achtung: Bei gasförmigen Stoffen kann sich die Temperatur durch Kompressionswärme erhöhen. Auf Grund dessen darf die Frequenz von 0,1 Hz (nicht Pulsation) nicht überschritten werden. Dies trifft nicht bei gefüllten Geräten zu.
  Tabelle 1: Zulässige Messstofftemperaturen

Temperaturklasse	Max. Messstofftemperatur
T6	+55 °C
T5	+70 °C
T4	+100 °C
T3	+100 °C
T2	+100 °C
T1	+100 °C

Bei der Stoßprüfung wurde der Grad der mechanischen Gefahr als niedrig angesehen.

4. Nullpunktprüfung/Funktionstest
- Nach dem Schließen der Absperrventile und erfolgtem Druckausgleich muss der Zeiger im, als Nullpunkt, gekennzeichneten Bereich stehen.
- Bei Differenzdruckmessgeräten steht der Zeiger bei gleichzeitigem Schließen der Ventile innerhalb des Anzeigebereiches. Fällt der Zeiger, ist die Plusleitung undicht oder das Ausgleichsventil nicht geschlossen. Steigt der Zeiger, ist die Minusleitung undicht. Zeigt das Differenzdruckmessgerät nichts an, Minusleitung schließen und Plusleitung öffnen. Bewegt sich der Zeiger nicht, so ist das Gerät defekt.

5. Wartung
- Das Gerät ist wartungsfrei.
- Lassen sich Störungen nicht beheben, wenden Sie sich bitte an unsere Niederlassungen und Vertretungen, die Ihnen mit Beratung und Service zur Verfügung stehen.

6. Nullpunktkorrektur
- Bei Messgeräten mit abnehmbaren Frontring oder externer Verstellmöglichkeit kann der Nullpunkt eingestellt werden.
- Bei Messgeräten mit interner Nullpunktverstellung muss der Bajonett-Ring bzw. der klappbare Ring vorsichtig entfernt werden. Messgeräte mit geschraubtem Ring werden wie in Bild 1 dargestellt geöffnet.
  1. Gerät (3) mit einer Schutzhülse (2) im Schraubstock einspannen.
  2. Schraubring vorsichtig mit einem Hammer und einem großen Schraubendreher (1) gegen den Uhrzeigersinn lösen.
  3. Nach der Nullpunktkorrektur Schraubring von Hand fest andrehen. Bei wetterfester Ausführung eine 1/8 Umdrehung, bei hermetisch dichter und gefüllter Ausführung eine 1/3 Umdrehung nachziehen.
- Differenzdruckmessgeräte haben eine externe Verstellmöglichkeit an der Gehäuseseite.
- Feinmessgeräte mit klappbarem Ring haben eine frontseitige Nullpunktkorrektur (siehe Bild 2).
  1. Feststellschraube A lösen.
  2. Mit der Justierschraube B den Nullpunkt einstellen.
  3. Feststellschraube A in Justierschraube B eindrehen.
- Vor der Nullpunktkorrektur ist ein Druckausgleich erforderlich.

Technische Änderungen vorbehalten !

1. Installation requirements
- The pressure gauges must be selected and installed this wise, that the possibility of failure, resulting in injury or misapplication, is minimized.
- For the maximum ambient temperature see table 2. Other limits are possible at special series.

2. Mounting
- The mounting of measuring instruments shall be in proximity of measuring point, easily accessible and safe from vibrations and always coincide with the position as indicated on the dial. If no such statement is printed on the dial, the gauges must be mounted in a 90° ±5° position with the vertical dial. If the instrument can not protected against shock or vibration, use an additional movement damping feature (liquid filled or pulsation dampener). The measuring instrument must be protect against damages, great pollution, high fluctuation of temperature and one-sided heat radiation for the dp gauge. Please note the freezing point of media and choose a frost-protected place for the dp gauges.
- If the process temperature at the gauge is in excess of the max. allowable operation temperature, than depending of the application a syphon, diaphragm seal or sufficient length of pipe/capillary has to be mounted between the pressure tap and the instrument.
- When installing always use a wrench suitable for the flats on the instrument. Do never apply mechanical torque's to the case.

3. Operation
- The operating range corresponds to the scale range or see static pressure limit mark ▼ printed on the dial. For dp gauges look for the max. allowable static pressure. When carrying out pressure test of process pipes and vessels, the instrument may not exposed to the above limits as mentioned before. The calibration temperature is +20 °C, each ±30 °C deviation of this temperature adds ± one class of full scale value to the accuracy.
  The instruments piping shall be between 4 and 9 mm ID, depending on the pressure and the lengths.
- After installation of the dp gauges the measuring lines must be blowed through. When using liquid media, the measuring lines must be bled.
- Until definitive operation the connection valve remains closed and the compensation valve remains open. Please avoid one-sided charge.
- On start up for pressure gauges open the shut off valve slowly.
- For dp gauges follow the following sequence for:
- Operation: 1. Open balancing valve. 2. Open connection valves.
  3. Close balancing valve.
  Differential pressure is indicated on dial
- Out of operation: 1. Open balancing valve. 2. Close connection valves.
- Service in hazardous area (model T5500/T6500):
  Ambiance: -20 … 60 °C
  Process media: The admissible temperature of the process media depends on the instrument construction as well as the ignition temperature of the surrounding gases, vapors or dusts (see table 1):
  Attention: For gaseous media the temperature can rise as result of compression. Therefore the maximum admissible frequency (not pulsation) is 0,1 Hz. This does not apply to liquid filled gauges.
  Table 1: Maximum admissible process media temperature

Temperature class	Max. process media temperature
T6	+55 °C
T5	+70 °C
T4	+100 °C
T3	+100 °C
T2	+100 °C
T1	+100 °C

During choc tests the degree of mechanical hazard was classified as low.

4. Zero or functional test
- The shut off valve(s) at the pressure tap(s) for the instrument has to be closed and the pressure has to be released to atmosphere. The pointer tip must stay within the zero mark.
- Check for dp gauges: Close both valves at the pressure taps at the same time. The pointer must rest within the scale range. If pointer drops the plus line leaks or the balancing valve is still open. In case of rising pointer the minus line leaks. If the dp gauge shows no indication, close the minus line and open the plus line. In case the pointer doesn't move the instrument is damaged.

5. Maintenance
- The instrument require no special maintenance.
- In case of any default apply for assistance from ourselves or our agents. We will assist you with advice and service.

6. Zero adjustment
For instruments with a removable ring, bezel or external zero adjust feature the zero can be adjusted. For the instruments with internal zero adjustments the bayonet ring or hinged ring bezel must be removed, for gauges with screwed ring see sketch 1 to remove the ring.
  1. Hold gauge in vise with threaded nut. it is important to hold the gauge rigidly otherwise ring lugs may be damaged.
  2. To remove ring-tap counter wise as shown using hammer and large screw driver with flat tip
  3. To install ring tighten snugly by hand. Turn as per sketch 1/8 turn for weatherproof and 1/3 turn for liquid filled and hermetically sealed.

The differential pressure gauges have an external adjustment on the side of the case.
- Testgauges with hinged ring are equipped with a front mounted zero adjustment (see sketch 2).
  1. Loosen ring locking screw A.
  2 Rotated knob B until required adjustment.
  3 Tighten screw A down on knob B.

The pointer can be adjusted to zero after releasing the pressure element against atmosphere.

Modification reserved !

1. Conditions de montage
- Les manomètres doivent être choisis et montés de manière à minimiser les possibilités d'erreurs, résultant d'un mauvais montage d'une mauvaise application.
- Pour la température ambiante maximum, se référer au tableau 2. D'autres limites sont possibles dans des modèles particuliers.

2. Montage
- Le montage de mano's doit être fait à proximité du point de mesure, facilement accessible, exempt de vibrations et toujours coïncider avec la position indiquée sur cadran. En standard, les manomètres doivant être montés à 90° ±5° par rapport au cadran à la verticale. Protéger les mano's contre les chocs ou les vibrations ou utiliser un système d'amortissement supplémentaire (remplissage ou amortisseur). Le mano doit être protégé contre avaries, pollution, hautes fluctuations de température et chaleur d'un côté de l'appareil pour le mano différentiel. Noter la point de gel du fluide et choisir une place protégée du gel pour les mano's différentiels.

14.5 Pressure transmitter / Differential pressure transmitter

14.5.1 Pressure transmitter

Voith Article No.: 4 190372 024

Type: 3051 TG (0-4 bar; 4-20 mA)

14.5.2 Differential pressure transmitter

Voith Article No.: 4 190372 071

Type: 3051 CD (0-1,6 bar; 4-20 mA)

Description . . . . Emerson - Rosemount

Product Data Sheet
00813-0100-4001, Rev HA
Catalog 2008 - 2009

Rosemount 3051 Pressure Transmitter

THE PROVEN INDUSTRY LEADER IN PRESSURE MEASUREMENT

- *Best-in-Class performance with 0.04% High Accuracy option*
- *Industry first installed five-year stability*
- *Unmatched Dynamic Performance*
- *Coplanar™ platform enables integrated pressure, flow, and level solutions*
- *Advanced PlantWeb® Functionality to increase plant productivity*

Contents

Setting the Standard for Pressure Measurement

Industry's best total performance, a flexible *Coplanar* platform, and installed five-year stability, has made the Rosemount 3051 the standard in pressure measurement.

Industry's best-in-class total performance of ±0.15%
Total performance is the true measure of "real-world" transmitter performance. Using superior sensor technology and engineered for optimal performance, the 3051 delivers unprecedented ±0.04% reference accuracy, resulting in total operating performance of ±0.15%. Superior total performance equates to reduced variability and improved plant safety.

Installed five-year stability of ±0.125%
Transmitter stability is a critical measure of transmitter performance over time. Through aggressive simulation testing beyond standard IEC 770 testing, the 3051 has proven its ability to maintain performance over a five year period under the most demanding process conditions. Superior transmitter stability reduces calibration frequency to save operation and maintenance costs.

Unmatched dynamic performance
In dynamic applications, speed of measurement is as important as repeatability. The 3051 responds up to eight times faster than the typical pressure transmitter to detect and control variations quickly and efficiently. Superior dynamic response yields more accurate measurements to reduce variability and increase profitability.

***Coplanar* platform enables complete point solutions**
The versatile *Coplanar* platform design enables the best process connection for pressure, flow and level applications. Right out of the box, the solution arrives factory calibrated, pressure-tested, and ready to install. Only the 3051 has a flexible design to reduce engineering and inventory costs.

Advanced *PlantWeb* Functionality
The 3051 powers the PlantWeb architecture by delivering the best sensor and transmitter, best installation practices, and best in class field intelligence. One component is the enhanced diagnostic capabilities in FOUNDATION fieldbus that provide an increase in process visibility, enabling proactive maintenance, improving process availability and plant productivity.

Rosemount Pressure Solutions

Rosemount 3051S Series of Instrumentation
Scalable pressure, flow and level measurement solutions improve installation and maintenance practices.

Rosemount 3095MV Mass Flow Transmitter
Accurately measures differential pressure, static pressure and process temperature to dynamically calculate fully compensated mass flow.

Rosemount 305 and 306 Integral Manifolds
Factory-assembled, calibrated and seal-tested manifolds reduce on-site installation costs.

Rosemount 1199 Diaphragm Seals
Provides reliable, remote measurements of process pressure and protects the transmitter from hot, corrosive, or viscous fluids.

Orifice Plate Primary Element Systems: Rosemount 1495 and 1595 Orifice Plates, 1496 Flange Unions and 1497 Meter Sections
A comprehensive offering of orifice plates, flange unions and meter sections that is easy to specify and order. The 1595 Conditioning Orifice provides superior performance in tight fit applications.

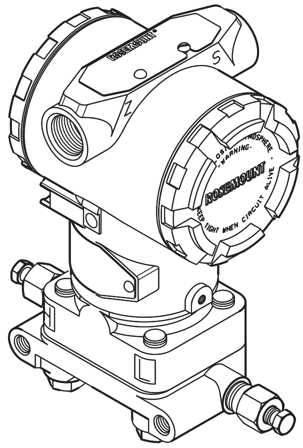
***Annubar®* Flowmeter Series: Rosemount 3051SFA, 3095MFA, and 485**
The state-of-the-art, fifth generation Rosemount 485 *Annubar* combined with the 3051S or 3095MV MultiVariable transmitter creates an accurate, repeatable and dependable insertion-type flowmeter.

Compact Orifice Flowmeter Series: Rosemount 3051SFC, 3095MFC, and 405
Compact Orifice Flowmeters can be installed between existing flanges, up to a Class 600 (PN100) rating. In tight fit applications, a conditioning orifice plate version is available, requiring only two diameters of straight run upstream.

***ProPlate®* Flowmeter Series: Rosemount *ProPlate*, Mass *ProPlate*, and 1195**
These integral orifice flowmeters eliminate the inaccuracies that become more pronounced in small orifice line installations. The completely assembled, ready to install flowmeters reduce cost and simplify installation.

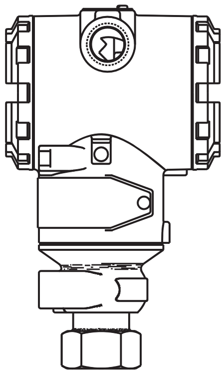
Product Offering

Rosemount 3051C Differential, Gage, and Absolute



See ordering information on page Pressure-25.

- Performance up to 0.04% accuracy
- Installed five-year stability of 0.125%
- *Coplanar* platform enables integrated manifold, primary element and diaphragm seal solutions
- Calibrated spans/ranges from 0.1 inH_2O to 4000 psi (0,25 mbar to 276 bar)
- 316L SST, *Hastelloy*® C276, *Monel*®, Tantalum, Gold-plated *Monel*, or Gold-plated 316L SST process isolators

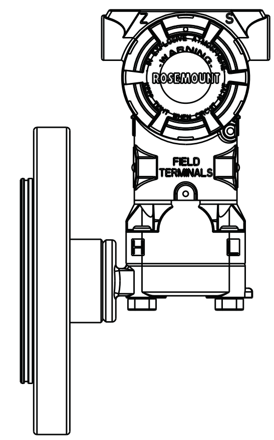


Rosemount 3051T Gage and Absolute

See ordering information on page Pressure-29.

- Performance up to 0.04% accuracy
- Installed five-year stability of 0.125%
- Calibrated spans from 0.3 to 10000 psi (10,3 mbar to 689 bar)
- Multiple process connections available
- 316L SST and *Hastelloy* C276 process isolators

Rosemount 3051L Liquid Level



See ordering information on page Pressure-31.

- Performance up to 0.075% accuracy
- Welded fill fluid system provides best-in-class system reliability
- Flush and extended diaphragms
- Multiple fill fluids and wetted materials available

Specifications

PERFORMANCE SPECIFICATIONS

Total Performance is based on combined errors of reference accuracy, ambient temperature effect, and static pressure effect.

This product data sheet covers both HART and fieldbus protocols unless specified.

Conformance To Specification (±3σ (Sigma))

Technology leadership, advanced manufacturing techniques and statistical process control ensure specification conformance to at least ±3σ.

Reference Accuracy(1)

Models	Standard	High Accuracy Option
3051CD, 3051CG		
Range 0 (CD)	±0.10% of span For spans less than 2:1, accuracy = ±0.05% of URL	
Range 1	±0.10% of span For spans less than 15:1, accuracy = $\pm\left[0.025 + 0.005\left(\frac{URL}{Span}\right)\right]$% of Span	
Ranges 2-5	±0.065% of span For spans less than 10:1, accuracy = $\pm\left[0.015 + 0.005\left(\frac{URL}{Span}\right)\right]$% of Span	Ranges 2-4 High Accuracy Option, P8 ±0.04% of span For spans less than 5:1, accuracy = $\pm\left[0.015 + 0.005\left(\frac{URL}{Span}\right)\right]$% of Span
3051T		
Ranges 1-4	±0.065% of span For spans less than 10:1, accuracy = $\pm\left[0.0075\left(\frac{URL}{Span}\right)\right]$% of Span	Ranges 2-4 High Accuracy Option, P8 ±0.04% of span For spans less than 5:1, accuracy = $\pm\left[0.0075\left(\frac{URL}{Span}\right)\right]$% of Span
Range 5	±0.075% of span For spans less than 10:1, accuracy = $\pm\left[0.0075\left(\frac{URL}{Span}\right)\right]$% of Span	
3051CA		
Ranges 1-4	±0.065% of span For spans less than 10:1, accuracy = $\pm\left[0.0075\left(\frac{URL}{Span}\right)\right]$% of Span	Ranges 2-4 High Accuracy Option, P8 ±0.04% of span For spans less than 5:1, accuracy = $\pm\left[0.0075\left(\frac{URL}{Span}\right)\right]$% of Span
3051H/3051L		
All Ranges	±0.075% of span For spans less than 10:1, accuracy = $\pm\left[0.025 + 0.005\left(\frac{URL}{Span}\right)\right]$% of Span	

(1) *For FOUNDATION fieldbus transmitters, use calibrated range in place of span. For zero based spans, reference conditions, silicone oil fill, SST materials, Coplanar flange (3051C) or $^1/_2$ in. - 18 NPT (3051T) process connections, digital trim values set to equal range points.*

Total Performance

For ±50 °F (28 °C) temperature changes, up to 1000 psi (6,9 MPa) line pressure (CD only), from 1:1 to 5:1 rangedown.

Models		Total Performance
3051C		
	Ranges 2-5	±0.15% of span
3051T		
	Ranges 1-4	±0.15% of span

Long Term Stability

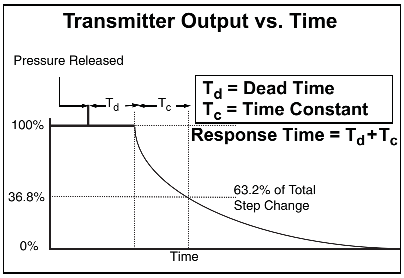
Models		Long Term Stability
3051C		
	Ranges 2-5	±0.125% of URL for 5 years ±50 °F (28 °C) temperature changes, and up to 1000 psi (6,9 MPa) line pressure.
3051CD Low/Draft Range		
	Ranges 0-1	±0.2% of URL for 1 year
3051T		
	Ranges 1-4	±0.125% of URL for 5 years ±50 °F (28 °C) temperature changes, and up to 1000 psi (6,9 MPa) line pressure.
Rosemount 3051H		
	Ranges 2-3	±0.1% of URL for 1 year
	Ranges 4-5	±0.2% of URL for 1 year

Dynamic Performance

	4 - 20 mA (*HART* protocol)(1)	Fieldbus protocol(3)
Total Response Time ($T_d + T_c$)(2):		
3051C, Ranges 2-5:	100 ms	152 ms
Range 1:	255 ms	307 ms
Range 0:	700 ms	752 ms
3051T:	100 ms	152 ms
3051H/L:	Consult factory	Consult factory
Dead Time (Td)	45 ms (nominal)	97 ms
Update Rate	22 times per second	22 times per second

(1) Dead time and update rate apply to all models and ranges; analog output only
(2) Nominal total response time at 75 °F (24 °C) reference conditions.
(3) Transmitter fieldbus output only, segment macro-cycle not included.

Typical HART Transmitter Response Time



Line Pressure Effect per 1000 psi (6,9 MPa)

For line pressures above 2000 psi (13,7 MPa) and Ranges 4-5, see user manual (Rosemount publication number 00809-0100-4001).

Models		Line Pressure Effect
3051CD		Zero Error(1)
	Range 0	±0.125% of URL/100 psi (6,89 bar)
	Range 1	±0.25% of URL/1000 psi (68,9 bar)
	Ranges 2-3	±0.05% of URL/1000 psi (68,9 bar) for line pressures from 0 to 2000 psi (0 to 13,7 MPa)
		Span Error
	Range 0	±0.15% of reading/100 psi (6,89 bar)
	Range 1	±0.4% of reading/1000 psi (68,9 bar)
	Ranges 2-3	±0.1% of reading/1000 psi (68,9 bar)
3051HD		Zero Error(1)
	All Ranges	±0.1% of URL/1000 psi (68,9 bar) for line pressures from 0 to 2000 psi (0 to 13,7 MPa)
		Span Error
	All Ranges	±0.1% of reading/1000 psi (68,9 bar)

(1) Can be calibrated out at line pressure.

Ambient Temperature Effect per 50°F (28°C)

Models		Ambient Temperature Effect
3051CD/CG		
	Range 0	±(0.25% URL + 0.05% span)
	Range 1	±(0.1% URL + 0.25% span)
	Ranges 2-5	±(0.0125% URL + 0.0625% span) from 1:1 to 5:1 ±(0.025% URL + 0.125% span) from 5:1 to 100:1
3051T		
	Range 1	±(0.025% URL + 0.125% span) from 1:1 to 10:1 ±(0.05% URL + 0.125% span) from 10:1 to 100:1
	Range 2-4	±(0.025% URL + 0.125% span) from 1:1 to 30:1 ±(0.035% URL + 0.125% span) from 30:1 to 100:1
	Range 5	±(0.1% URL + 0.15% span)
3051CA		
	All Ranges	±(0.025% URL + 0.125% span) from 1:1 to 30:1 ±(0.035% URL + 0.125% span) from 30:1 to 100:1
3051H		
	All Ranges	±(0.025% URL + 0.125% span + 0.35 inH_2O) from 1:1 to 30:1 ±(0.035% URL + 0.125% span + 0.35 inH_2O) from 1:1 to 30:1
3051L		See Rosemount Inc. Instrument Toolkit® software.

Mounting Position Effects

Models	Mounting Position Effects
3051C	Zero shifts up to ±1.25 inH_2O (3,11 mbar), which can be calibrated out. No span effect.
3051H	Zero shifts up to ±5 inH_2O (12,43 mbar), which can be calibrated out. No span effect.
3051L	With liquid level diaphragm in vertical plane, zero shift of up to 1 inH_2O (2,49 mbar). With diaphragm in horizontal plane, zero shift of up to 5 inH_2O (12,43 mbar) plus extension length on extended units. All zero shifts can be calibrated out. No span effect.
3051T/CA	Zero shifts up to 2.5 inH_2O (6,22 mbar), which can be calibrated out. No span effect.

Vibration Effect

All Models

Measurement effect due to vibrations is negligible except at resonance frequencies. When at resonance frequencies, vibration effect is less than ±0.1% of URL per g when tested between 15 and 2000 Hz in any axis relative to pipe-mounted process conditions.

Power Supply Effect

All Models

Less than ±0.005% of calibrated span per volt.

RFI Effects

All Models

±0.1% of span from 20 to 1000 MHz and for field strength up to 30 V/m.

Transient Protection (Option Code T1)

All Models:

Meets IEEE C62.41, Category B

6 kV crest (0.5 µs - 100 kHz)
3 kV crest (8 × 20 microseconds)
6 kV crest (1.2 × 50 microseconds)

Meets IEEE C37.90.1, Surge Withstand Capability

SWC 2.5 kV crest, 1.25 MHz wave form

General Specifications:

Response Time: < 1 nanosecond
Peak Surge Current: 5000 amps to housing
Peak Transient Voltage: 100 V dc
Loop Impedance: < 25 ohms
Applicable Standards: IEC61000-4-4, IEC61000-4-5

NOTE:
Calibrations at 68 °F (20 °C) per ASME Z210.1 (ANSI)

FUNCTIONAL SPECIFICATIONS

Range and Sensor Limits

TABLE 1. 3051CD, 3051CG, 3051L, and 3051H Range and Sensor Limits

Range	Minimum Span	Range and Sensor Limits						
			Lower (LRL)					
	3051CD(1), CG, L, H	Upper (URL)	3051C Differential	3051C/ Gage	3051L Differential	3051L Gage	3051H Differential	3051H Gage
0	0.1 inH_2O (0,25 mbar)	3.0 inH_2O (7,47 mbar)	–3.0 inH_2O (-7,47 mbar)	NA	NA	NA	NA	NA
1	0.5 inH_2O (1,2 mbar)	25 inH_2O (62,3 mbar)	–25 inH_2O (–62,1 mbar)	–25 inH_2O (–62,1 mbar)	NA	NA	NA	NA
2	2.5 inH_2O (6,2 mbar)	250 inH_2O (0,62 bar)	–250 inH_2O (–0,62 bar)	–250 inH_2O (–0,62 bar)	–250 inH_2O (–0,62 bar)	–250 inH_2O (–0,62 bar)	–250 inH_2O (–0,62 bar)	–250 inH_2O (–0,62 bar)
3	10 inH_2O (24,9 mbar)	1000 inH_2O (2,49 bar)	–1000 inH_2O (–2,49 bar)	0.5 psia (34,5 mbar abs)	–1000 inH_2O (–2,49 bar)	0.5 psia (34,5 mbar abs)	–1000 inH_2O (–2,49 bar)	0.5 psia (34,5 mbar abs)
4	3 psi (0,20 bar)	300 psi (20,6 bar)	–300 psi (–20,6 bar)	0.5 psia (34,5 mbar abs)	–300 psi (–20,6 bar)	0.5 psia (34,5 mbar abs)	–300 psi (–20,6 bar)	0.5 psia (34,5 mbar abs)
5	20 psi (1,38 bar)	2000 psi (137,9 bar)	– 2000 psi (–137,9 bar)	0.5 psia (34,5 mbar abs)	NA	NA	– 2000 psi (–137,9 bar)	0.5 psia (34,5 mbar abs)

(1) Range 0 only available with 3051CD. Range 1 only available with 3051CD or 3051CG.

TABLE 2. Range and Sensor Limits

Range	3051CA Minimum Span	Range and Sensor Limits Upper (URL)	Lower (LRL)
1	0.3 psia (20,6 mbar)	30 psia (2,07 bar)	0 psia (0 bar)
2	1.5 psia (0,103 bar)	150 psia (10,3 bar)	0 psia (0 bar)
3	8 psia (0,55 bar)	800 psia (55,2 bar)	0 psia (0 bar)
4	40 psia (2,76 bar)	4000 psia (275,8 bar)	0 psia (0 bar)

Range	3051T Minimum Span	Range and Sensor Limits Upper (URL)	Lower (LRL)	Lower(1) (LRL) (Gage)
1	0.3 psi (20,6 mbar)	30 psi (2,07 bar)	0 psia (0 bar)	–14.7 psig (–1,01 bar)
2	1.5 psi (0,103 bar)	150 psi (10,3 bar)	0 psia (0 bar)	–14.7 psig (–1,01 bar)
3	8 psi (0,55 bar)	800 psi (55,2 bar)	0 psia (0 bar)	–14.7 psig (–1,01 bar)
4	40 psi (2,76 bar)	4000 psi (275,8 bar)	0 psia (0 bar)	–14.7 psig (–1,01 bar)
5	2000 psi (137,9 bar)	10000 psi (689,4 bar)	0 psia (0 bar)	–14.7 psig (–1,01 bar)

(1) Assumes atmospheric pressure of 14.7 psig.

Zero and Span Adjustment Requirements (*HART* and Low Power)

Zero and span values can be set anywhere within the range limits stated in Table 1 and Table 2.

Span must be greater than or equal to the minimum span stated in Table 1 and Table 2.

Service

Liquid, gas, and vapor applications

4–20 mA (Output Code A)

Output

Two-wire 4–20 mA, user-selectable for linear or square root output. Digital process variable superimposed on 4–20 mA signal, available to any host that conforms to the *HART* protocol.

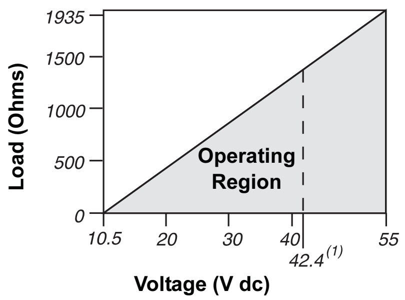
Power Supply

External power supply required. Standard transmitter (4–20 mA) operates on 10.5 to 55 V dc with no load.

Load Limitations

Maximum loop resistance is determined by the voltage level of the external power supply, as described by:

Max. Loop Resistance = 43.5 (Power Supply Voltage – 10.5)



Communication requires a minimum loop resistance of 250 ohms.

(1) For CSA approval, power supply must not exceed 42.4 V.

Foundation fieldbus (output code F) and Profibus (output code W)

Power Supply

External power supply required; transmitters operate on 9.0 to 32.0 V dc transmitter terminal voltage.

Current Draw

17.5 mA for all configurations (including LCD display option)

Foundation fieldbus Function Block Execution Times

Block	Execution Time
Resource	-
Transducer	-
LCD Block	-
Analog Input 1, 2	30 milliseconds
PID	45 milliseconds
Input Selector	30 milliseconds
Arithmetic	35 milliseconds
Signal Characterizer	40 milliseconds
Integrator	35 milliseconds

Foundation fieldbus Parameters

Schedule Entries	7 (max.)
Links	20 (max.)
Virtual Communications Relationships (VCR)	12 (max.)

Standard Function Blocks

Resource Block

Contains hardware, electronics, and diagnostic information.

Transducer Block

Contains actual sensor measurement data including the sensor diagnostics and the ability to trim the pressure sensor or recall factory defaults.

LCD Block

Configures the local display.

2 Analog Input Blocks

Processes the measurements for input into other function blocks. The output value is in engineering units or custom and contains a status indicating measurement quality.

PID Block

Contains all logic to perform PID control in the field including cascade and feedforward.

Backup Link Active Scheduler (LAS)

The transmitter can function as a Link Active Scheduler if the current link master device fails or is removed from the segment.

Advanced Control Function Block Suite (Option Code A01)

Input Selector Block

Selects between inputs and generates an output using specific selection strategies such as minimum, maximum, midpoint, average or first “good.”

Arithmetic Block

Provides pre-defined application-based equations including flow with partial density compensation, electronic remote seals, hydrostatic tank gauging, ratio control and others.

Signal Characterizer Block

Characterizes or approximates any function that defines an input/output relationship by configuring up to twenty X, Y coordinates. The block interpolates an output value for a given input value using the curve defined by the configured coordinates.

Integrator Block

Compares the integrated or accumulated value from one or two variables to pre-trip and trip limits and generates discrete output signals when the limits are reached. This block is useful for calculating total flow, total mass, or volume over time.

Foundation fieldbus Diagnostics Suite (Option Code D01)

The 3051C *Foundation* fieldbus Diagnostics provide Abnormal Situation Prevention (ASP) indictation. The integral statistical process monitoring (SPM) technology calculates the mean and standard deviation of the process variable 22 times per second. The 3051C ASP algorithm uses these values and highly flexible configuration options for customization to many user-defined or application specific abnormal situations. The detection of plugged impulse lines is the first available predefined application.

Low Power (Output Code M)

Output

Three wire 1–5 V dc or 0.8–3.2 V dc (Option Code C2) user-selectable output. Also user selectable for linear or square root output configuration. Digital process variable superimposed on voltage signal, available to any host conforming to the *HART* protocol. Low-power transmitter operates on 6–12 V dc with no load.

Power Consumption

3.0 mA, 18–36 mW

Minimum Load Impedance

100 kΩ (V_{out} wiring)

Indication

Optional 5-digit LCD display

Overpressure Limits

Rosemount 3051CD/CG

- Range 0: 750 psi (51,7 bar)
- Range 1: 2000 psig (137,9 bar)
- Ranges 2–5: 3626 psig (250 bar)
  4500 psig (310,3 bar) for option code P9

Rosemount 3051CA

- Range 1: 750 psia (51,7 bar)
- Range 2: 1500 psia (103,4 bar)
- Range 3: 1600 psia (110,3 bar)
- Range 4: 6000 psia (413,7 bar)

Rosemount 3051H

- All Ranges: 3626 psig (25 MPa)

Rosemount 3051TG/TA

- Range 1: 750 psi (51,7 bar)
- Range 2: 1500 psi (103,4 bar)
- Range 3: 1600 psi (110,3 bar)
- Range 4: 6000 psi (413,7 bar)
- Range 5: 15000 psi (1034,2 bar)

For 3051L or Level Flange Option Codes FA, FB, FC, FD, FP, and FQ, limit is 0 psia to the flange rating or sensor rating, whichever is lower.

TABLE 3. 3051L and Level Flange Rating Limits

Standard	Type	CS Rating	SST Rating
ANSI/ASME	Class 150	285 psig	275 psig
ANSI/ASME	Class 300	740 psig	720 psig
ANSI/ASME	Class 600	1480 psig	1440 psig
At 100 °F (38 °C), the rating decreases with increasing temperature.			
DIN	PN 10–40	40 bar	40 bar
DIN	PN 10/16	16 bar	16 bar
DIN	PN 25/40	40 bar	40 bar
At 248 °F (120 °C), the rating decreases with increasing temperature.			

Static Pressure Limit

Rosemount 3051CD Only

Operates within specifications between static line pressures of 0.5 psia and 3626 psig (4500 psig (310, 3 bar) for Option Code P9).

Range 0: 0.5 psia and 750 psig (3, 4 bar and 51, 7 bar)

Range 1: 0.5 psia and 2000 psig (3, 4 bar and 137, 9 bar)

Burst Pressure Limits

Burst pressure on *Coplanar*, traditional, or 3051H process flange is 10000 psig (69 MPa).

Burst pressure for the 3051T is

Ranges 1–4: 11000 psi (75,8 MPa)

Range 5: 26000 psig (179 MPa)

Failure Mode Alarm

Output Code A

If self-diagnostics detect a gross transmitter failure, the analog signal will be driven either below 3.75 mA or to 21.75 mA to alert the user. NAMUR-compliant values are available, option code C4. High or low alarm signal is user-selectable by internal jumper.

Output Code M

If self-diagnostics detect a gross transmitter failure, the analog signal will be driven either below 0.94 V or above 5.4 V to alert the user (below 0.75 V or above 4.4 V for Option C2). High or low alarm signal is user-selectable by internal jumper.

Output Code F and W

If self-diagnostics detect a gross transmitter failure, that information gets passed as a status along with the process variable.

Temperature Limits

Ambient

–40 to 185 °F (–40 to 85 °C)

With LCD display(1): –4 to 175 °F (–20 to 80 °C)

Storage

–50 to 230 °F (–46 to 110 °C)

With LCD display: –40 to 185 °F (–40 to 85 °C)

Process

At atmospheric pressures and above. See Table 4

(1) LCD display may not be readable and LCD updates will be slower at temperatures below -4 °F (-20 °C).

TABLE 4. 3051 Process Temperature Limits

3051CD, 3051CG, 3051CA	
Silicone Fill Sensor(1)	
with *Coplanar* Flange	–40 to 250 °F (–40 to 121 °C)(2)
with Traditional Flange	–40 to 300 °F (–40 to 149 °C)(2)(3)
with Level Flange	–40 to 300 °F (–40 to 149 °C)(2)
with 305 Integral Manifold	–40 to 300 °F (–40 to 149 °C)(2)
Inert Fill Sensor(1)	0 to 185 °F (–18 to 85 °C)(4)(5)
3051H (Process Fill Fluid)	
D.C.® Silicone 200(1)	–40 to 375 °F (–40 to 191 °C)
Inert(1)	–50 to 350 °F (–45 to 177 °C)
Neobee M-20®(1)	0 to 375 °F (–18 to 191 °C)
3051T (Process Fill Fluid)	
Silicone Fill Sensor(1)	–40 to 250 °F (–40 to 121 °C)(2)
Inert Fill Sensor(1)	–22 to 250 °F (–30 to 121 °C)(2)
3051L Low-Side Temperature Limits	
Silicone Fill Sensor(1)	–40 to 250 °F (–40 to 121 °C)(2)
Inert Fill Sensor(1)	0 to 185 °F (–18 to 85 °C)(2)
3051L High-Side Temperature Limits (Process Fill Fluid)	
Syltherm® XLT	–100 to 300 °F (–73 to 149 °C)
D.C. Silicone 704®	32 to 400 °F (0 to 205 °C)
D.C. Silicone 200	–40 to 400 °F (–40 to 205 °C)
Inert	–50 to 350 °F (–45 to 177 °C)
Glycerin and Water	0 to 200 °F (–18 to 93 °C)
Neobee M-20	0 to 400 °F (–18 to 205 °C)
Propylene Glycol and Water	0 to 200 °F (–18 to 93 °C)

(1) *Process temperatures above 185 °F (85 °C) require derating the ambient limits by a 1.5:1 ratio (0.6:1 ratio for the 3051H).*

(2) *220 °F (104 °C) limit in vacuum service; 130 °F (54 °C) for pressures below 0.5 psia.*

(3) *3051CD0 process temperature limits are* –40 to 212 °F (–45 to 100 °C)

(4) *160 °F (71 °C) limit in vacuum service.*

(5) *Not available for 3051CA.*

Humidity Limits

0–100% relative humidity

Turn-On Time

Performance within specifications less than 2.0 seconds (10.0 s for Profibus protocol) after power is applied to the transmitter

Volumetric Displacement

Less than 0.005 in^3 (0,08 cm^3)

Damping

Analog output response to a step input change is user-selectable from 0 to 36 seconds for one time constant. This software damping is in addition to sensor module response time.

PHYSICAL SPECIFICATIONS

Electrical Connections

1/2–14 NPT, PG 13.5, G1/2, and M20 × 1.5 (CM20) conduit. *HART* interface connections fixed to terminal block.

Process Connections

All Models except 3051L and 3051T

1/4–18 NPT on 21/8-in. centers

1/2–14 NPT on 2-, 21/8-, or 21/4-in. centers

Rosemount 3051L

High pressure side: 2-, 3-, or 4-in., ASME B 16.5 (ANSI) Class 150, 300 or 600 flange; 50, 80 or 100 mm, PN 40 or 10/16 flange

Low pressure side: 1/4–18 NPT on flange 1/2–14 NPT on adapter

Rosemount 3051T

1/2–14 NPT female. A DIN 16288 Male (available in SST for Range 1–4 transmitters only), or Autoclave type F-250-C (Pressure relieved 9/16–18 gland thread; 1/4 OD high pressure tube 60° cone; available in SST for Range 5 transmitters only).

Process-Wetted Parts

Drain/Vent Valves

316 SST, *Hastelloy* C276, or *Monel* material (*Monel* not available with 3051L or 3051H)

Process Flanges and Adapters

Plated carbon steel, SST cast CF-8M (cast version of 316 SST, material per ASTM-A743), C-Type cast alloy CW12MW, or *Monel* cast alloy M30C

Wetted O-rings

Glass-filled PTFE or Graphite-filled PTFE

Process Isolating Diaphragms

Isolating Diaphragm Material	3051CD/CG	3051T	3051CA	3051H
316L SST	•	•	•	•
Hastelloy C276	•	•	•	•
Monel	•		•	
Tantalum	•			•
Gold-plated *Monel*	•		•	
Gold-plated SST	•		•	

Rosemount 3051L Process Wetted Parts

Flanged Process Connection (Transmitter High Side)

Process Diaphragms, Including Process Gasket Surface

- 316L SST, *Hastelloy* C276, or Tantalum

Extension

- CF-3M (Cast version of 316L SST, material per ASTM-A743), or *Hastelloy* C276. Fits schedule 40 and 80 pipe.

Mounting Flange

- Zinc-cobalt plated CS or SST

Reference Process Connection (Transmitter Low Side)

Isolating Diaphragms

- 316L SST or *Hastelloy* C276

Reference Flange and Adapter

- CF-8M (Cast version of 316 SST, material per ASTM-A743)

Non-Wetted Parts

Electronics Housing

Low-copper aluminum or CF-3M (Cast version of 316L SST, material per ASTM-A743). NEMA 4X, IP 65, IP 66

Coplanar Sensor Module Housing

CF-3M (Cast version of 316L SST, material per ASTM-A743)

Bolts

ASTM A449, Type 1 (zinc-cobalt plated carbon steel)
ASTM F593G, Condition CW1 (Austenitic 316 SST)
ASTM A193, Grade B7M (zinc plated alloy steel)
Monel K-500

Sensor Module Fill Fluid

Silicone oil (D.C. 200) or Fluorocarbon oil (Halocarbon or Fluorinert® FC-43 for 3051T)

Process Fill Fluid (3051L and 3051H only)

3051L: Syltherm XLT, D.C. Silicone 704,
D.C. Silicone 200, inert, glycerin and water, Neobee M-20 or propylene glycol and water

3051H: inert, Neobee M-20, or D.C. Silicone 200

Paint

Polyurethane

Cover O-rings

Buna-N

Shipping Weights

Refer to “Shipping Weights” on page 38

Product Certifications

Approved Manufacturing Locations

Rosemount Inc. — Chanhassen, Minnesota USA
Emerson Process Management GmbH & Co. — Wessling, Germany
Emerson Process Management Asia Pacific
Private Limited — Singapore
Beijing Rosemount Far East Instrument Co., LTD — Beijing, China

European Directive Information

The EC declaration of conformity for all applicable European directives for this product can be found on the Rosemount website at www.rosemount.com. A hard copy may be obtained by contacting an Emerson Process Management representative.

ATEX Directive (94/9/EC)
All 3051 transmitters comply with the ATEX Directive.

European Pressure Equipment Directive (PED) (97/23/EC)
3051CA4; 3051CG2, 3, 4, 5; 3051CD2, 3, 4, 5
(also with P9 option); 3051HD2, 3, 4, 5; 3051HG2, 3, 4, 5;
3051PD2, 3; and 3051PG2, 3, 4, 5 Pressure Transmitters
— QS Certificate of Assessment - EC No. PED-H-100
Module H Conformity Assessment

All other 3051/3001 Pressure Transmitters
— Sound Engineering Practice

Transmitter Attachments: Diaphragm Seal - Process Flange - Manifold
— Sound Engineering Practice

Electro Magnetic Compatibility (EMC) (2004/108/EC)
All 3051 Pressure Transmitters meet all of the requirements of EN61326: 1997 - A1, A2, and A3 and NAMUR NE-21

Ordinary Location Certification for Factory Mutual
As standard, the transmitter has been examined and tested to determine that the design meets basic electrical, mechanical, and fire protection requirements by FM, a nationally recognized testing laboratory (NRTL) as accredited by the Federal Occupational Safety and Health Administration (OSHA).

HART PROTOCOL

Hazardous Locations Certifications

North American Certifications

FM Approvals

E5 Explosion-Proof for Class I, Division 1, Groups B, C, and D. Dust-Ignition-Proof for Class II, Division 1, Groups E, F, and G. Dust-Ignition-Proof for Class III, Division 1.
Factory Sealed, Enclosure Type 4X

I5 Intrinsically Safe for use in Class I, Division 1, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III, Division 1 when connected per Rosemount drawing 03031-1019; Non-incendive for Class I, Division 2, Groups A, B, C, and D.
Temperature Code:T4 (Ta = 40 °C), T3 (Ta = 85 °C), Enclosure Type 4X
For input parameters see control drawing 03031-1019.

Canadian Standards Association (CSA)

E6 Explosion-Proof for Class I, Division 1, Groups B, C, and D. Dust-Ignition-Proof for Class II and Class III, Division 1, Groups E, F, and G. Suitable for Class I, Division 2 Groups A, B, C, and D for indoor and outdoor hazardous locations. Enclosure type 4X, factory sealed

C6 Explosion-Proof and intrinsically safe approval. Intrinsically safe for Class I, Division 1, Groups A, B, C, and D when connected in accordance with Rosemount drawings 03031-1024. Temperature Code T3C.
Explosion-Proof for Class I, Division 1, Groups B, C, and D. Dust-Ignition-Proof for Class II and Class III, Division 1, Groups E, F, and G. Suitable for Class I, Division 2 Groups A, B, C, and D hazardous locations. Enclosure type 4X, factory sealed
For input parameters see control drawing 03031-1024.

European Certifications

I1 ATEX Intrinsic Safety and Dust
Certification No.: BAS 97ATEX1089X Ex II 1 GD
EEx ia IIC T4 (–60 ≤ T_a ≤ +70 °C)
Dust Rating: T80 °C (–20 ≤ T_a ≤ 40 °C) IP66
CE 1180

TABLE 5. Input Parameters

U_i = 30V
I_i = 200 mA
P_i = 0.9W
C_i = 0.012 μF

Special Conditions for Safe Use (X):
When the optional transient protection terminal block is installed, the apparatus is not capable of withstanding the 500V insulation test required by Clause 6.4.12 of EN50020:1994. This must be taken into account when installing the apparatus.

N1 ATEX Type n and Dust
Certification No.: BAS 00ATEX3105X Ex II 3 GD
U_i = 55 Vdc max
EEx nL T5 (–40°C ≤ T_{amb} ≤ 70 °C)
Dust rating: T80 °C (–20 ≤ T_a ≤ 40 °C) IP66
CE

Special Conditions for Safe Use (X):
When the optional transient protection terminal block is installed, the apparatus is not capable of withstanding a 500V r.m.s. test to case. This must be taken into account on any installation in which it is used, for example by assuring that the supply to the apparatus is galvanically isolated.

E8 ATEX Flame-Proof and Dust
Certification No.: KEMA 00ATEX2013X Ex II 1/2 GD
EEx d IIC T6 (–50 ≤ T_a ≤ 65 °C)
Dust rating T90 °C, IP66
CE 1180
Vmax = 55 V dc

Special Conditions for Safe Use (X):
This device contains a thin wall diaphragm. Installation, maintenance, and use shall take into account the environmental conditions to which the diaphragm will be subjected. The manufacturer's instructions for installation and maintenance shall be followed in detail to assure safety during its expected lifetime.

Japanese Certifications

E4 TIIS Flame-Proof
Ex d IIC T6

Certificate	Description
C15850	3051C/D/1 4–20 mA *HART* — no display
C15851	3051C/D/1 4–20 mA *HART* — with display
C15854	3051T/G/1 4–20 mA *HART*, SST, Silicon — no display
C15855	3051T/G/1 4–20 mA *HART*, *Hastelloy* C276, Silicon — no display
C15856	3051T/G/1 4–20 mA *HART*, SST, Silicon — with display
C15857	3051T/G/1 4–20 mA *HART*, *Hastelloy* C276, Silicon — with display

I4 TIIS Intrinsic Safety
Ex ia IIC T4

Certificate	Description
C16406	3051CD/CG

Australian Certifications

I7 SAA Intrinsic Safety
Certification No.: AUS Ex 1249X
Ex ia IIC T4 (T_{amb} = 70 °C)
IP66
When connected per Rosemount drawing 03031-1026

TABLE 6. Input Parameters

U_i = 30V
I_i = 200 mA
I_i = 160 mA (output code A with T1)
P_i = 0.9W
C_i = 0.01 μF
C_i = 0.042 μF (output code M)
L_i = 10 μH
L_i = 1.05 mH (output code A with T1)
L_i = 0.75 mH (output code M with T1)

Special Conditions for Safe Use (X):
The apparatus may only be used with a passive current limited power source Intrinsic Safety application. The power source must be such that Po ≤ (Uo * Io) / 4. Modules using transient protection in the terminal assembly (T1 transient protection models) the apparatus enclosure is to be electrically bonded to the protective earth. The conductor used for the connection shall be equivalent to a copper conductor of 4 mm^2 minimum cross-sectional area.

E7 SAA Explosion-Proof (Flame-Proof)
Certification No.: AUS Ex 03.1347X
Ex d IIC T6 (T_{amb} = 40 °C)
DIP A21 T6 (T_{amb} = 40 °C)
IP66

Special Conditions for Safe Use (X):
It is a condition of safe use for transmitter enclosures having cable entry thread other than metric conduit thread that the equipment be utilized with an appropriate certified thread adaptor.

N7 SAA Type n (Non-sparking)
Certification No.: AUS Ex 1249X
Ex n IIC T4 (T_{amb} = 70 °C)
IP66

Special Conditions for Safe Use (X):
Where the equipment is installed such that there is an unused conduit entry, it must be sealed with a suitable blanking plug to maintain the IP66 degree of protection. Any blanking plug used with the equipment shall be of a type which requires the use of a tool to effect its removal. Voltage source shall not exceed 55V dc.

Combinations of Certifications

Stainless steel certification tag is provided when optional approval is specified. Once a device labeled with multiple approval types is installed, it should not be reinstalled using any other approval types. Permanently mark the approval label to distinguish it from unused approval types.

K5 **E5** and **I5** combination
KB **K5** and **C6** combination
KD **K5**, **C6**, **I1**, and **E8** combination
K6 **C6**, **I1**, and **E8** combination
K8 **E8** and **I1** combination
K7 **E7**, **I7**, and **N7** combination

FIELDBUS PROTOCOL

Hazardous Locations Certifications

North American Certifications

FM Approvals

E5 Explosion-Proof for Class I, Division 1, Groups B, C, and D. Dust-Ignition-Proof for Class II, Division 1, Groups E, F, and G. Dust-Ignition-Proof for Class III, Division 1.

I5 Intrinsically Safe for use in Class I, Division 1, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III, Division 1 when connected per Rosemount drawing 03031-1019; Non-incendive for Class I, Division 2, Groups A, B, C, and D.

Temperature Code:T4 (Ta = 60 °C), T3 (Ta = 85 °C),
Enclosure Type 4X
For input parameters see control drawing 03031-1019.

Canadian Standards Association (CSA)

E6 Explosion-Proof for Class I, Division 1, Groups B, C, and D. Dust-Ignition-Proof for Class II and Class III, Division 1, Groups E, F, and G. Suitable for Class I, Division 2 Groups A, B, C, and D for indoor and outdoor hazardous locations. Enclosure type 4X, factory sealed

C6 Explosion-Proof and intrinsically safe approval. Intrinsically safe for Class I, Division 1, Groups A, B, C, and D when connected in accordance with Rosemount drawings 03031-1024. Temperature Code T3C.
Explosion-Proof for Class I, Division 1, Groups B, C, and D. Dust-Ignition-Proof for Class II and Class III, Division 1, Groups E, F, and G. Suitable for Class I, Division 2 Groups A, B, C, and D hazardous locations. Enclosure type 4X, factory sealed
For input parameters see control drawing 03031-1024.

European Certifications

I1 ATEX Intrinsic Safety and Dust
Certification No.: BAS 98ATEX1355X Ex II 1 GD
EEx ia IIC T4 (T_{amb} = –60 to +60 °C)
Dust Rating: T70 °C (T_{amb} –20 to 40 °C) IP66
CE 1180

TABLE 7. Input Parameters

U_i = 30V
I_i = 300 mA
P_i = 1.3 W
C_i = 0 μF

Special Conditions for Safe Use (X):
The device is not capable of withstanding the 500V insulation test required by Clause 6.4.12 of EN50020:1994. This must be taken into account when installing the apparatus.

IA ATEX FISCO Intrinsic Safety
Certification No.: BAS 98ATEX1355X Ex II 1 G
EEx ia IIC T4 (T_{amb} = –60 to +60 °C)
IP66
CE 1180

TABLE 8. Input Parameters

U_i = 17.5 V
I_i = 380 mA
P_i = 5.32 W
C_i = ≤ 5 μF
L_i = ≤ 10 μH

Special Conditions for Safe Use (X):
The device is not capable of withstanding the 500V insulation test required by Clause 6.4.12 of EN50020:1994. This must be taken into account when installing the apparatus.

N1 ATEX Type n and Dust
Certification No.: BAS 98ATEX3356X Ex II 3 GD
U_i = 40 Vdc max
EEx nL IIC T5 (T_a = –40°C to 70 °C)
Dust rating: T80 °C (T_{amb} = –20 to 40 °C) IP66

Special Conditions for Safe Use (X):
The device is not capable of withstanding the 500V insulation test required by Clause 6.4.12 of EN50020:1994. This must be taken into account when installing the apparatus.

E8 ATEX Flame-Proof and Dust
Certification No.: KEMA 00ATEX2013X Ex II 1/2 GD
EEx d IIC T6 (T_{amb} = –50 to 65 °C)
Dust rating T90 °C, IP66
CE 1180
Vmax = 55 V dc

Special Conditions for Safe Use (X):
This device contains a thin wall diaphragm. Installation, maintenance, and use shall take into account the environmental conditions to which the diaphragm will be subjected. The manufacturer's instructions for installation and maintenance shall be followed in detail to assure safety during its expected lifetime.

Japanese Certifications

E4 TIIS Flame-Proof
Ex d IIC T6

Certificate	Description
C15852	3051C/D/1 *FOUNDATION* Fieldbus — no display
C15853	3051C/D/1 *FOUNDATION* Fieldbus — with display
C15858	3051T/G/1 *FOUNDATION* Fieldbus, SST, Silicon — no display
C15859	3051T/G/1 *FOUNDATION* Fieldbus, *Hastelloy* C276, Silicon — no display
C15860	3051T/G/1 *FOUNDATION* Fieldbus, SST, Silicon — with display
C15861	3051T/G/1 *FOUNDATION* Fieldbus, *Hastelloy* C276, Silicon — with display

Australian Certifications

I7 SAA Intrinsic Safety
Certification No.: AUS Ex 1249X
Ex ia IIC T4 (T_{amb} = 60 °C)
IP66
When connected per Rosemount drawing 03031-1026.

TABLE 9. Input Parameters

U_i = 30 V
I_i = 300 mA
P_i = 1.3 W
C_i = 0 μF
L_i = 0 μH

Special Conditions for Safe Use (X):
The apparatus may only be used with a passive current limited power source Intrinsic Safety application. The power source must be such that Po ≤ (Uo * Io) / 4. Modules using transient protection in the terminal assembly (T1 transient protection models) the apparatus enclosure is to be electrically bonded to the protective earth. The conductor used for the connection shall be equivalent to a copper conductor of 4 mm2 minimum cross-sectional area.

E7 SAA Explosion-Proof (Flame-Proof)
Certification No.: AUS Ex 1347X
Ex d IIC T6 (T_{amb} = 40 °C)
DIP A21 T6 (T_{amb} = 40 °C)
IP66

Special Conditions for Safe Use (X):
It is a condition of safe use for transmitter enclosures having cable entry thread other than metric conduit thread that the equipment be utilized with an appropriate certified thread adaptor.

N7 SAA Type n (Non-sparking)
Certification No.: AUS Ex 1249X
Ex n IIC T4 (T_{amb} = 70 °C)
IP66

Special Conditions for Safe Use (X):
Where the equipment is installed such that there is an unused conduit entry, it must be sealed with a suitable blanking plug to maintain the IP40 degree of protection. Any blanking plug used with the equipment shall be of a type which requires the use of a tool to effect its removal. Voltage source shall not exceed 35V dc.

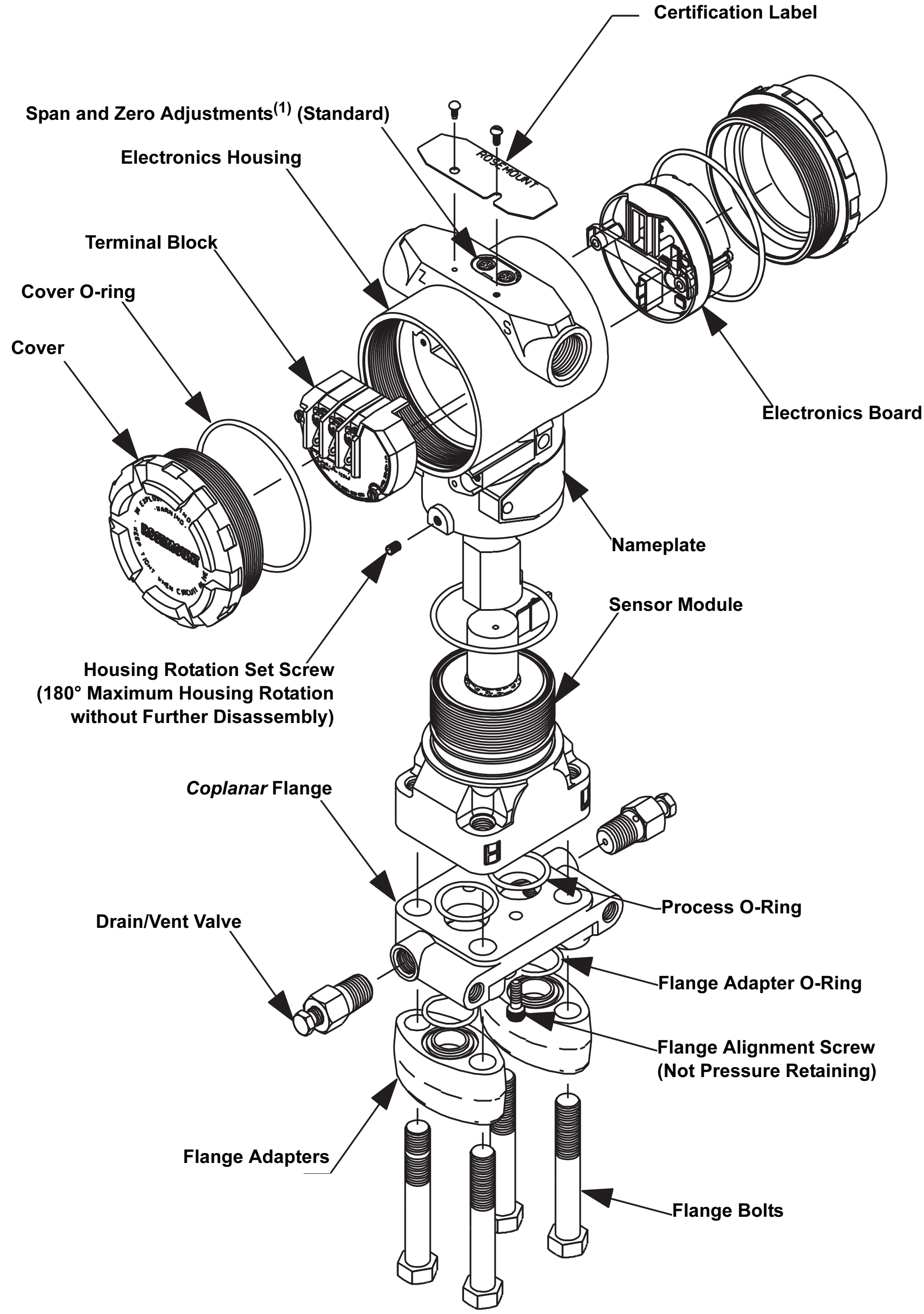
Combinations of Certifications

Stainless steel certification tag is provided when optional approval is specified. Once a device labeled with multiple approval types is installed, it should not be reinstalled using any other approval types. Permanently mark the approval label to distinguish it from unused approval types.

K5 **E5** and **I5** combination
KB **K5** and **C6** combination
KD **K5**, **C6**, **I1**, and **E8** combination
K6 **C6**, **I1**, and **E8** combination
K8 **E8** and **I1** combination
K7 **E7**, **I7**, and **N7** combination

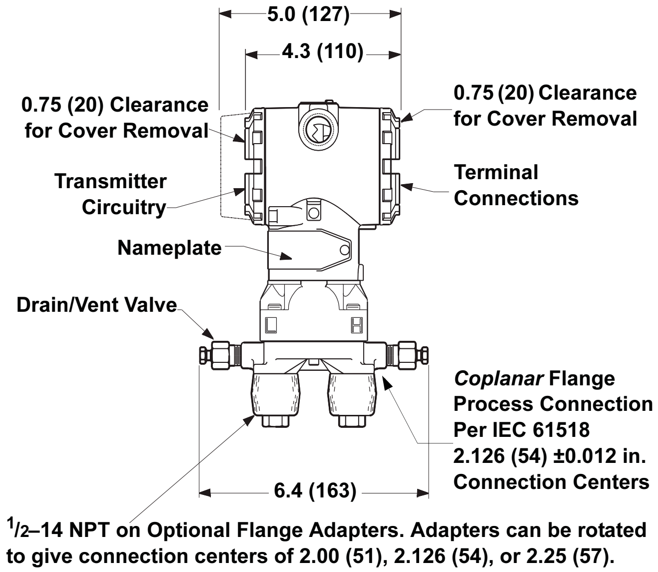
Dimensional Drawings

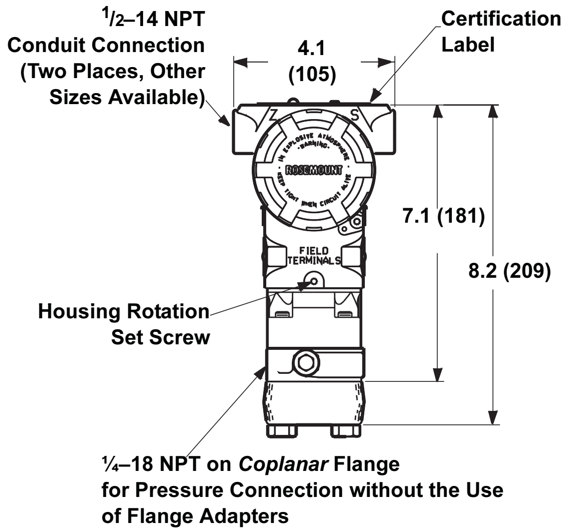
3051 Exploded View



1) Span and Zero Adjustments are not available with fieldbus or profibus protocols.

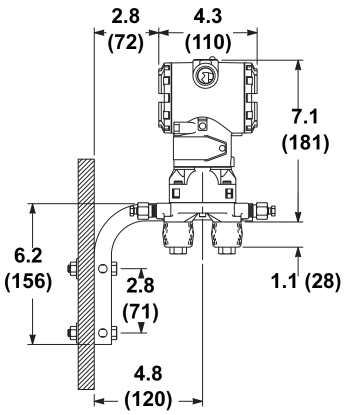
3051C *Coplanar* Flange Dimensional Drawing (Differential Pressure Transmitter Shown)

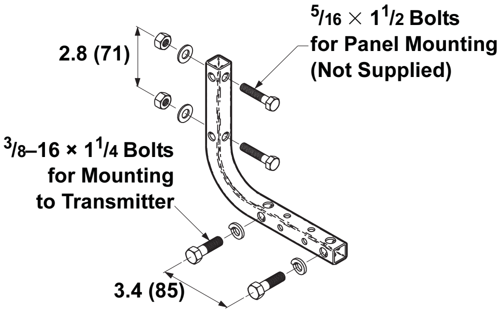




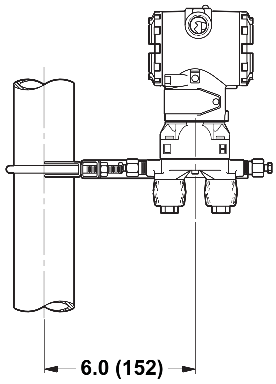
Coplanar Flange Mounting Configurations with Optional Bracket (B4) for 2-in. Pipe or Panel Mounting

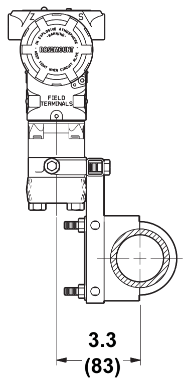
PANEL MOUNTING

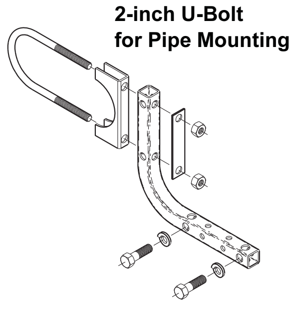




PIPE MOUNTING



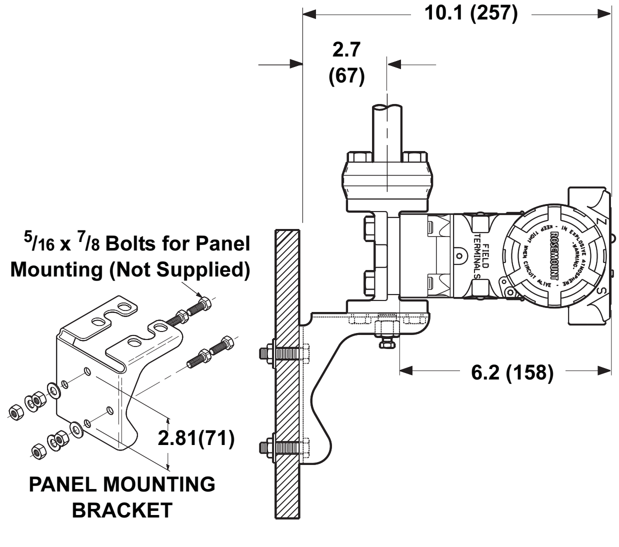




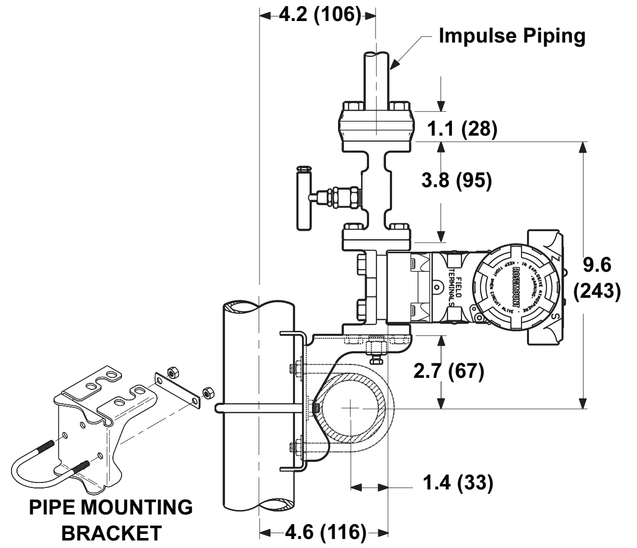
Dimensions are in inches (millimeters)

Traditional Flange Mounting Configurations with Optional Brackets for 2-in. Pipe or Panel Mounting

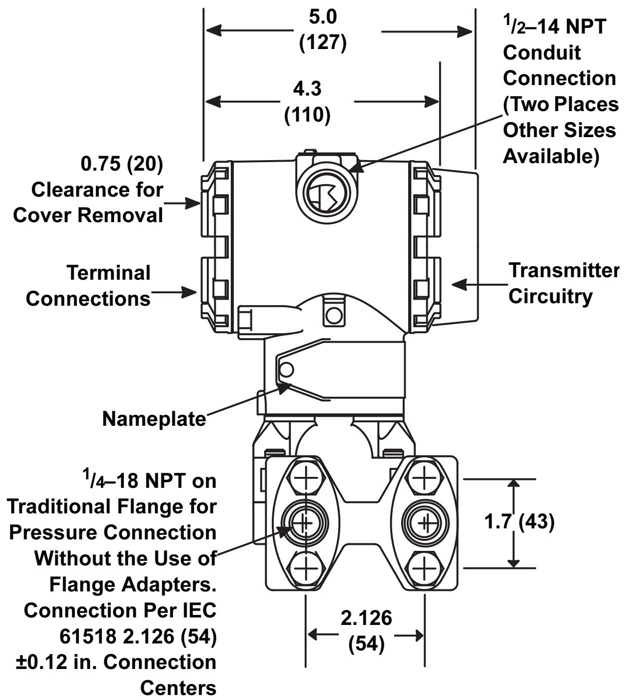
Traditional Flange Panel Mounting Bracket (option B2/B8)

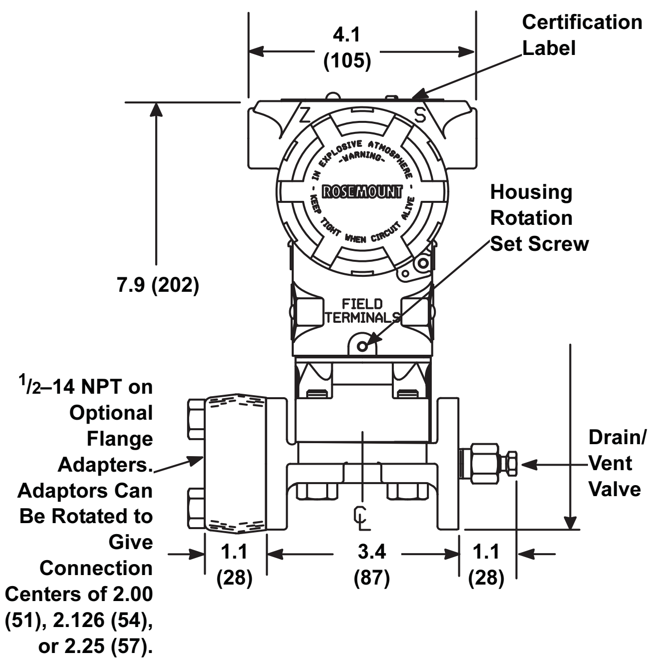


Traditional Flange 2-in. Pipe Mounting Bracket (option B1/B7/BA)



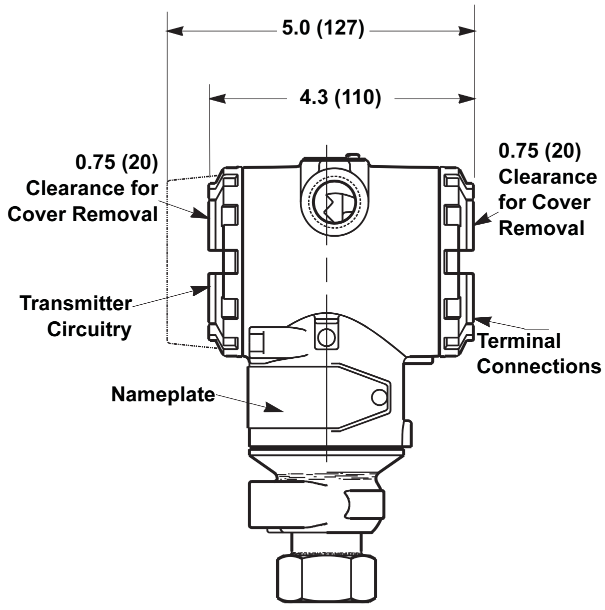
Traditional Flange (Options H2–H7) Dimensional Drawing

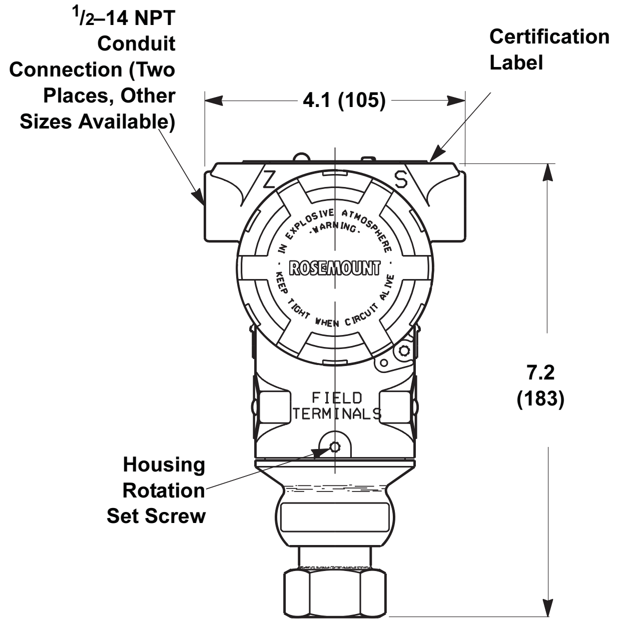




Dimensions are in inches (millimeters)

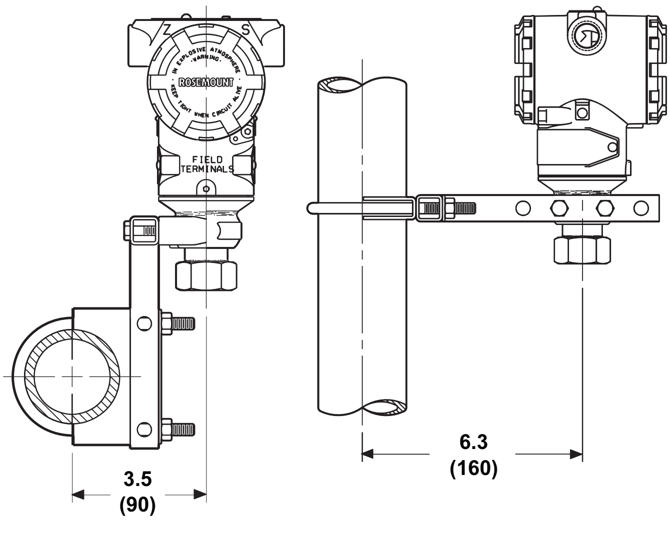
3051T Dimensional Drawings



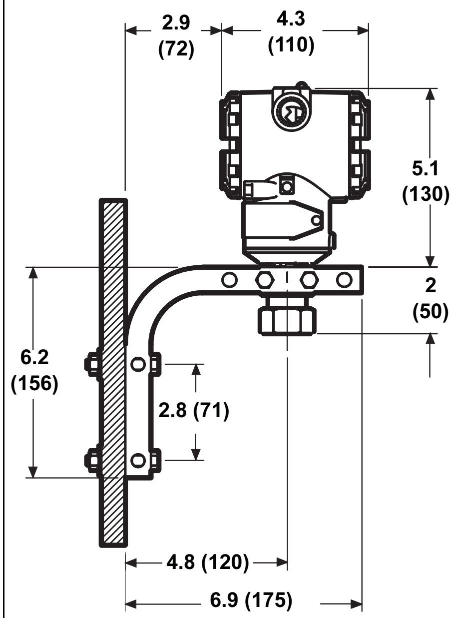


3051T Typical Mounting Configurations with Optional Mounting Bracket

Pipe Mounting

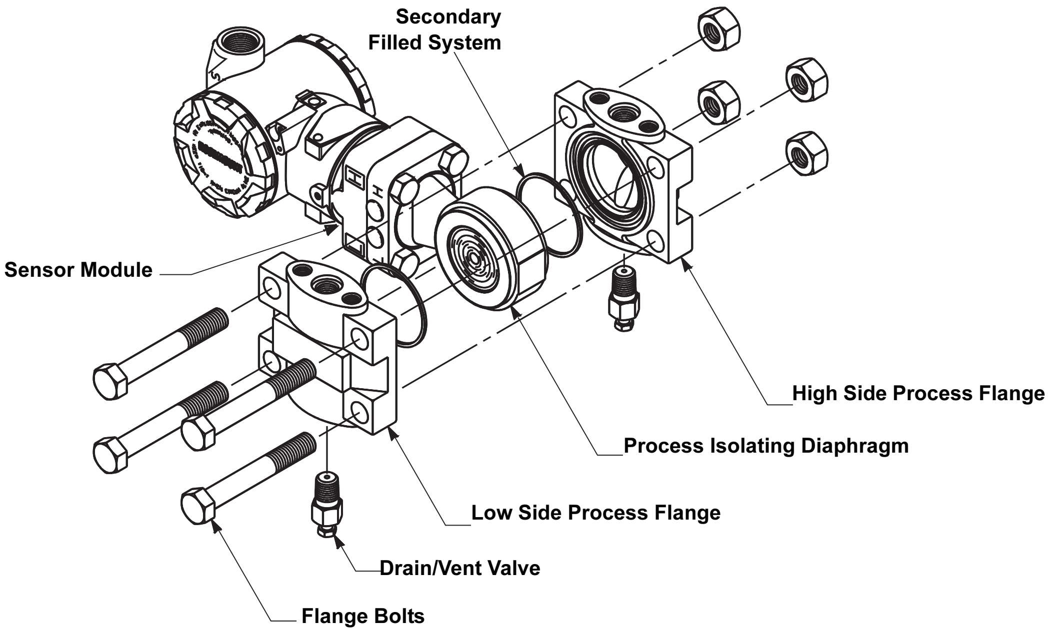


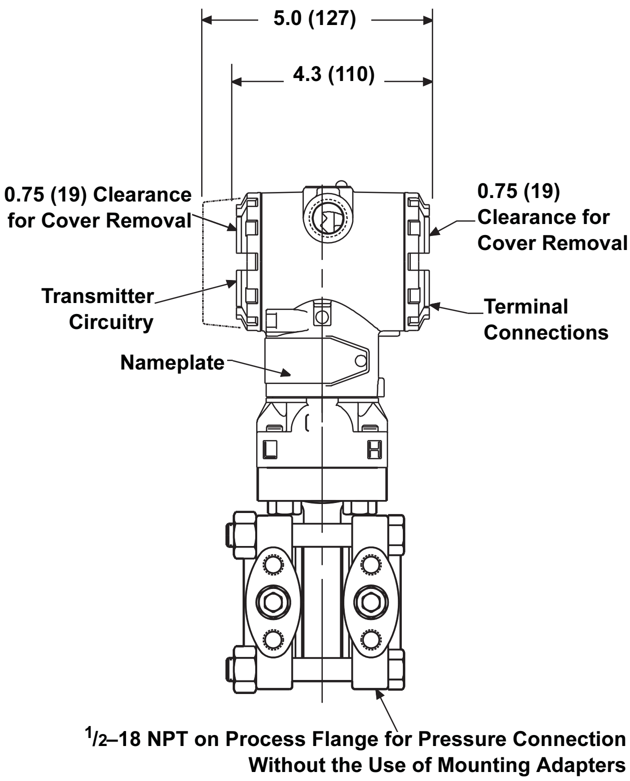
Panel Mounting

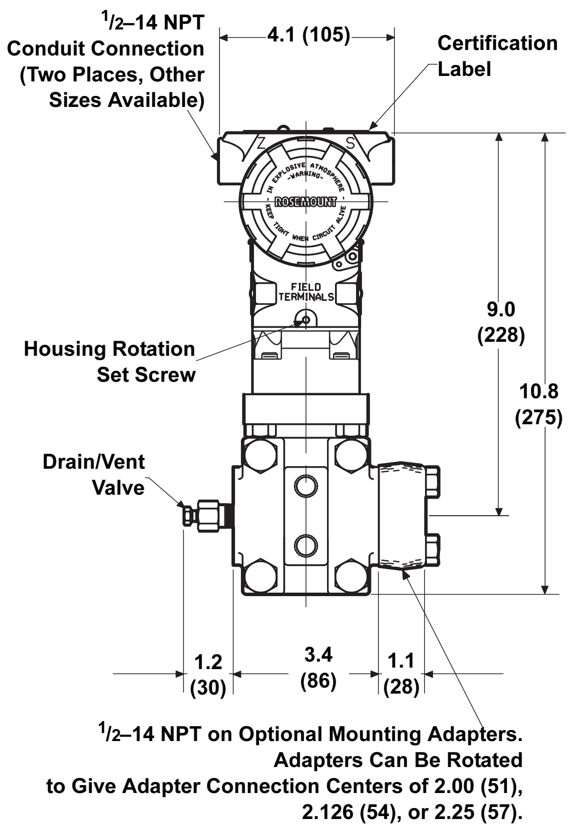


Dimensions are in inches (millimeters)

3051H Pressure Transmitter Exploded View and Dimensional Drawings



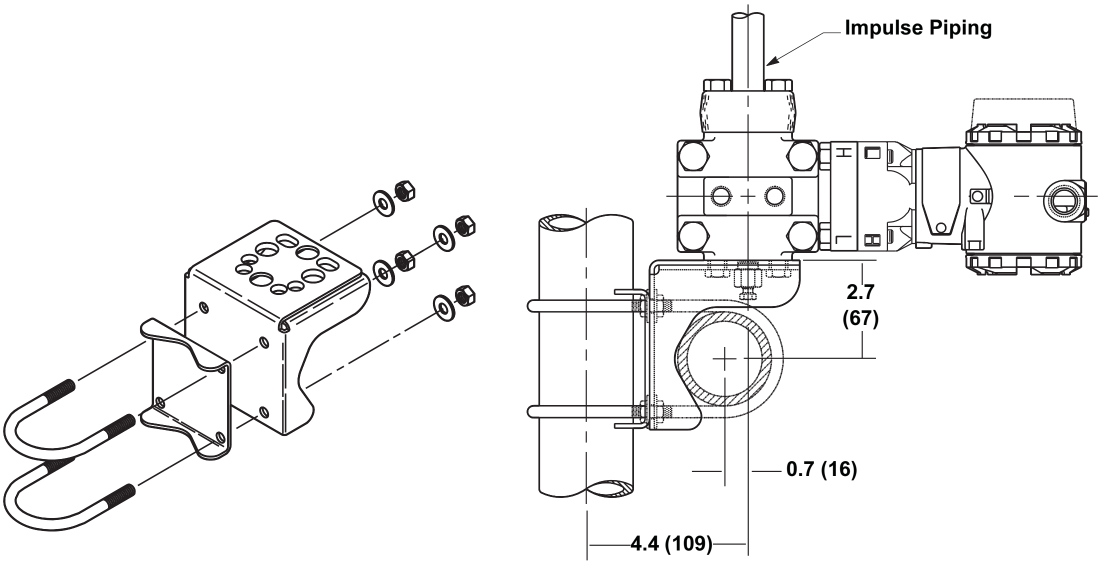




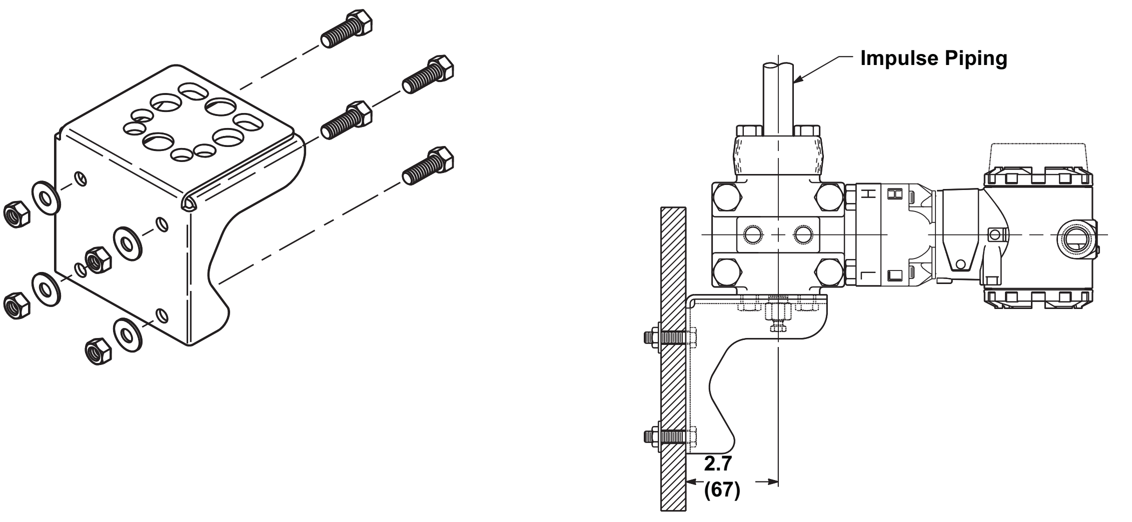
Dimensions are in inches (millimeters)

3051H Mounting Brackets for 2-in. Pipe and Panel Mount (Option Code B5/B6)

PIPE MOUNTING CONFIGURATION



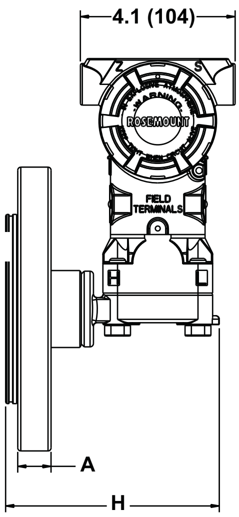
PANEL MOUNTING CONFIGURATION
$^{7}/_{16}$–20×$^{3}/_{4}$ Bolts Supplied for Attaching Bracket to Transmitter



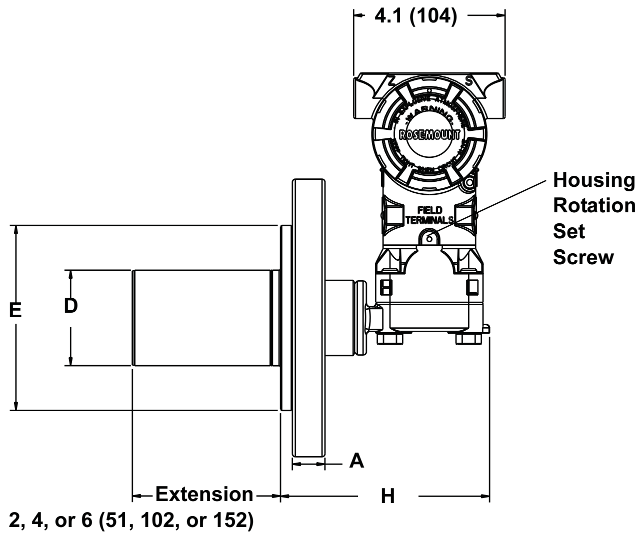
Dimensions are in inches (millimeters)

3051L Dimensional Drawings

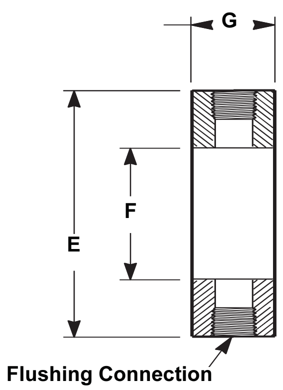
2-in. Flange Configuring (Flush Mount Only)



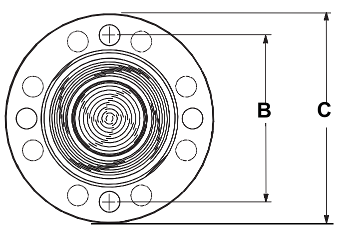
3- and 4-in. Flange Configuration

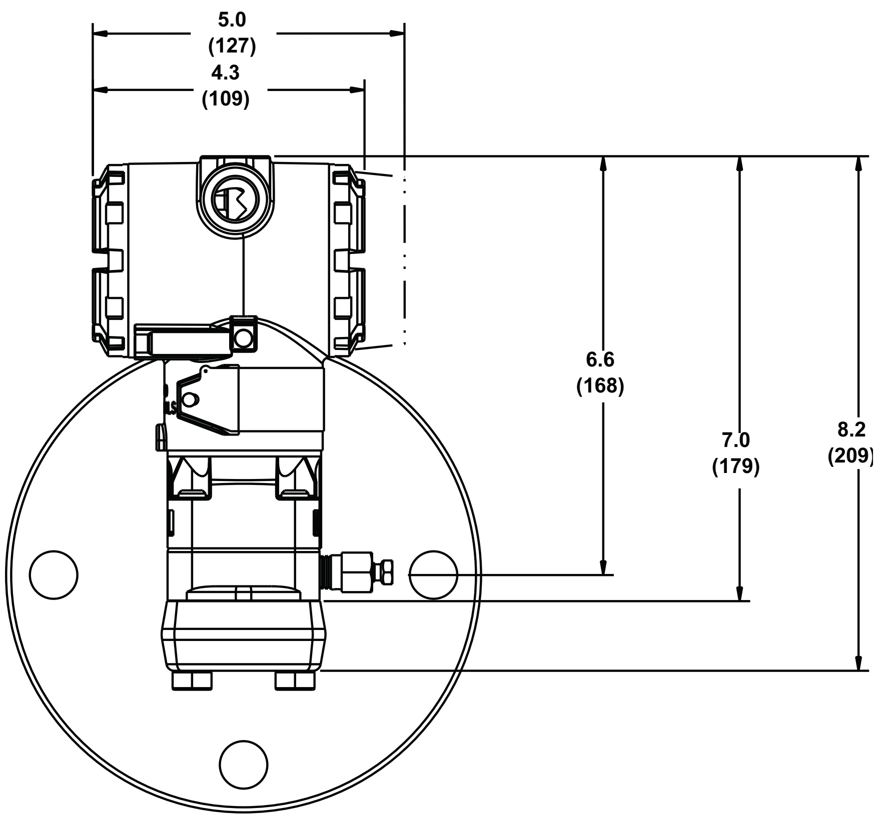


Optional Flushing Connection Ring (Lower Housing)



Diaphragm Assembly and Mounting Flange





Dimensions are in inches (millimeters)

TABLE 10. 3051L Dimensional Specifications

Except where indicated, dimensions are in inches (millimeters).

Class	Pipe Size	Flange Thickness A	Bolt Circle Diameter B	Outside Diameter C	No. of Bolts	Bolt Hole Diameter	Extension Diameter(1) D	O.D. Gasket Surface E
ASME B16.5 (ANSI) 150	2 (51)	0.69 (18)	4.75 (121)	6.0 (152)	4	0.75 (19)	NA	3.6 (92)
	3 (76)	0.88 (22)	6.0 (152)	7.5 (191)	4	0.75 (19)	2.58 (66)	5.0 (127)
	4 (102)	0.88 (22)	7.5 (191)	9.0 (229)	8	0.75 (19)	3.5 (89)	6.2 (158)
ASME B16.5 (ANSI) 300	2 (51)	0.82 (21)	5.0 (127)	6.5 (165)	8	0.75 (19)	NA	3.6 (92)
	3 (76)	1.06 (27)	6.62 (168)	8.25 (210)	8	0.88 (22)	2.58 (66)	5.0 (127)
	4 (102)	1.19 (30)	7.88 (200)	10.0 (254)	8	0.88 (22)	3.5 (89)	6.2 (158)
ASME B16.5 (ANSI) 600	2 (51)	1.00 (25)	5.0 (127)	6.5 (165)	8	0.75 (19)	NA	3.6 (92)
	3 (76)	1.25 (32)	6.62 (168)	8.25 (210)	8	0.88 (22)	2.58 (66)	5.0 (127)
DIN 2501 PN 10–40	DN 50	20 mm	125 mm	165 mm	4	18 mm	NA	4.0 (102)
DIN 2501 PN 25/40	DN 80	24 mm	160 mm	200 mm	8	18 mm	65 mm	5.4 (138)
	DN 100	24 mm	190 mm	235 mm	8	22 mm	89 mm	6.2 (158)
DIN 2501 PN 10/16	DN 100	20 mm	180 mm	220 mm	8	18 mm	89 mm	6.2 (158)

Class	Pipe Size	Process Side F	Lower Housing G		H
			1/4 NPT	1/2 NPT	
ASME B16.5 (ANSI) 150	2 (51)	2.12 (54)	0.97 (25)	1.31 (33)	5.65 (143)
	3 (76)	3.6 (91)	0.97 (25)	1.31 (33)	5.65 (143)
	4 (102)	3.6 (91)	0.97 (25)	1.31 (33)	5.65 (143)
ASME B16.5 (ANSI) 300	2 (51)	2.12 (54)	0.97 (25)	1.31 (33)	5.65 (143)
	3 (76)	3.6 (91)	0.97 (25)	1.31 (33)	5.65 (143)
	4 (102)	3.6 (91)	0.97 (25)	1.31 (33)	5.65 (143)
ASME B16.5 (ANSI) 600	2 (51)	2.12 (54)	0.97 (25)	1.31 (33)	7.65 (194)
	3 (76)	3.6 (91)	0.97 (25)	1.31 (33)	7.65 (194)
DIN 2501 PN 10–40	DN 50	2.4 (61)	0.97 (25)	1.31 (33)	5.65 (143)
DIN 2501 PN 25/40	DN 80	3.6 (91)	0.97 (25)	1.31 (33)	5.65 (143)
	DN 100	3.6 (91)	0.97 (25)	1.31 (33)	5.65 (143)
DIN 2501 PN 10/16	DN 100	3.6 (91)	0.97 (25)	1.31 (33)	5.65 (143)

(1) Tolerances are 0.040 (1,02), –0.020 (0,51).

Ordering Information

TABLE 11. 3051C Differential, Gage, and Absolute Pressure Transmitters — = Not Applicable • = Applicable

Model	Transmitter Type (Select One)			CD	CG	CA
3051CD	Differential Pressure Transmitter			•	—	—
3051CG	Gage Pressure Transmitter			—	•	—
3051CA	Absolute Pressure Transmitter			—	—	•
Code	**Pressure Ranges (Range/Min. Span)**			**CD**	**CG**	**CA**
	3051CD	**3051CG**[1]	**3051CA**			
0[2]	–3 to 3 inH_2O/0.1 inH_2O (–7,5 to 7,5 mbar/0,25 mbar)	Not Applicable	Not Applicable	•	—	—
1	–25 to 25 inH_2O/0.5 inH_2O (–62,2 to 62,2 mbar/1,2 mbar)	–25 to 25 inH_2O/0.5 inH_2O (–62,1 to 62,2 mbar/1,2 mbar)	0 to 30 psia/0.3 psia (0 to 2,1 bar/20,7 mbar)	•	•	•
2	–250 to 250 inH2O/2.5 inH_2O (–623 to 623 mbar/6,2 mbar)	–250 to 250 inH_2O/2.5 inH_2O (–621 to 623 mbar/6,2 mbar)	0 to 150 psia/1.5 psia (0 to 10,3 bar/0,1 bar)	•	•	•
3	–1000 to 1000 inH_2O/10 inH_2O (–2,5 to 2,5 bar/25 mbar)	–393 to 1000 inH_2O/10in H_2O (–0,98 to 2,5 bar/25 mbar)	0 to 800 psia/8 psia (0 to 55,2 bar/0,55 bar)	•	•	•
4	–300 to 300 psi/3 psi (–20,7 to 20,7 bar/0,2 bar)	–14.2 to 300 psi/3 psi (–0,98 to 20,7 bar/0,2 bar)	0 to 4000 psia/40 psia (0 to 275,8 bar/2,8 bar)	•	•	•
5	–2000 to 2000 psi/20 psi (–137,9 to137,9 bar/1,4 bar)	–14.2 to 2000 psig/20 psi (–0,98 to 137,9 bar/1,4 bar)	Not Applicable	•	•	—
Code	**Output**			**CD**	**CG**	**CA**
A	4–20 mA with Digital Signal Based on *HART* Protocol			•	•	•
M[3]	Low-Power, 1–5 V dc with Digital Signal Based on *HART* Protocol *(See Option C2 for 0.8–3.2 V dc)*			•	•	•
F	FOUNDATION fieldbus Protocol			•	•	•
W	Profibus — PA			•	•	•
Code	**Materials of Construction**			**CD**	**CG**	**CA**
	Process Flange Type	**Flange Material**	**Drain/Vent**			
2	*Coplanar*	SST	SST	•	•	•
3[4]	*Coplanar*	*Alloy C*	*Hastelloy* C276	•	•	•
4	*Coplanar*	*Monel*	*Monel*	•	•	•
5	*Coplanar*	Plated CS	SST	•	•	•
7[4]	*Coplanar*	SST	*Hastelloy* C276	•	•	•
8[4]	*Coplanar*	Plated CS	*Hastelloy* C276	•	•	•
0	Alternate Flange—See Options on page Pressure-26			•	•	•
Code	**Isolating Diaphragm**			**CD**	**CG**	**CA**
2[4]	316L SST			•	•	•
3[4]	*Hastelloy* C276			•	•	•
4	*Monel*			•	•	•
5	Tantalum *(Available on 3051CD and CG, Ranges 2–5 only. Not available on 3051CA)*			•	•	—
6	Gold-plated *Monel (Use in combination with O-ring Option Code B.)*			•	•	•
7	Gold-plated SST			•	•	•
Code	**O-ring**					
A	Glass-filled PTFE			•	•	•
B	Graphite-filled PTFE			•	•	•
Code	**Fill Fluid**			**CD**	**CG**	**CA**
1	Silicone			•	•	•
2	Inert fill (Halocarbon)			•	•	—

TABLE 11. 3051C Differential, Gage, and Absolute Pressure Transmitters — = Not Applicable • = Applicable

Code	Housing Material	Conduit Entry Size	CD	CG	CA
A	Polyurethane-covered Aluminum	½–14 NPT	•	•	•
B	Polyurethane-covered Aluminum	M20 × 1.5 (CM20)	•	•	•
C	Polyurethane-covered Aluminum	PG 13.5	•	•	•
D	Polyurethane-covered Aluminum	G½	•	•	•
J	SST	½–14 NPT	•	•	•
K	SST	M20 × 1.5 (CM20)	•	•	•
L	SST	PG 13.5	•	•	•
M	SST	G½	•	•	•
Code	***PlantWeb* Functionality (Optional)**		**CD**	**CG**	**CA**
A01	Advanced Control Function Block Suite		•	•	•
D01	FOUNDATION fieldbus Diagnostics Suite		•	•	•
Code	**Alternate Flange Options (Requires Materials of Construction Code 0)**		**CD**	**CG**	**CA**
H2	Traditional Flange, 316 SST, SST Drain/Vent		•	•	•
H3(4)	Traditional Flange, *Alloy C*, *Hastelloy* C276 Drain/Vent		•	•	•
H4	Traditional Flange, *Monel*, *Monel* Drain/Vent		•	•	•
H7(4)	Traditional Flange, 316 SST, *Hastelloy* C276 Drain/Vent		•	•	•
HJ	DIN Compliant Traditional Flange, SST, $^{1}/_{16}$ in. Adapter/Manifold Bolting		•	•	•
HK	DIN Compliant Traditional Flange, SST, 10 mm Adapter/Manifold Bolting		•	•	•
HL	DIN Compliant Traditional Flange, SST, 12mm Adapter/Manifold Bolting *(Not available on 3051CD0)*		•	•	•
FA	Level Flange, SST, 2 in., ANSI Class 150, Vertical Mount		•	•	•
FB	Level Flange, SST, 2 in., ANSI Class 300, Vertical Mount		•	•	•
FC	Level Flange, SST, 3 in., ANSI Class 150, Vertical Mount		•	•	•
FD	Level Flange, SST, 3 in., ANSI Class 300, Vertical Mount		•	•	•
FP	DIN Level Flange, SST, DN 50, PN 40, Vertical Mount		•	•	•
FQ	DIN Level Flange, SST, DN 80, PN 40, Vertical Mount		•	•	•
Code	**Integral Mount Manifold Options (Requires Materials of Construction Code 0)**		**CD**	**CG**	**CA**
S5(5)	Assemble to Rosemount 305 Integral Manifold (specified separately, see the Rosemount 305 and 306 Integral Manifolds PDS (document number 00813-0100-4733))		•	•	•
S6(5)	Assemble to Rosemount 304 Manifold or connection system		•	•	•
Code	**Integral Mount Primary Elements (Optional)**		**CD**	**CG**	**CA**
S4(5)	Factory Assembly to Rosemount Primary Element (Rosemount *Annubar* or Rosemount 1195 Integral Orifice) *(With the primary element installed, the maximum operating pressure will equal the lesser of either the transmitter or the primary element. Option is available for factory assembly to range 1–4 transmitters only)*		•	—	—
S3(5)	Factory Assembly to Rosemount 405 Primary Element		•	—	—
Code	**Diaphragm Seal Assemblies (Optional)** ***NOTE: Standard flange and adapter bolts are austenitic 316 SST.***		**CD**	**CG**	**CA**
S1(5)	One Diaphragm Seal (Direct Mount or Capillary Connection Type)		•	•	•
S2(5)	Two Diaphragm Seals (Direct Mount or Capillary Connection Type)		•	—	—
Code	**Optional All Welded Diaphragm Seal Systems (for high vacuum applications)** ***NOTE: Standard flange and adapter bolts are austenitic 316 SST.***		**CD**	**CG**	**CA**
S7(5)	One Diaphragm Seal, All-Welded System (Capillary Connection Type)		•	•	•
S8(5)	Two Diaphragm Seals, All-Welded System (Capillary Connection Type)		•	—	—
S0(5)	One Diaphragm Seal, All-Welded System (Direct Mount Connection Type)		•	•	•
S9(5)	Two Diaphragm Seals, All-Welded System (One Direct Mount and One Capillary Connection Type)		•	—	—

TABLE 11. 3051C Differential, Gage, and Absolute Pressure Transmitters — = Not Applicable • = Applicable

Code	Mounting Bracket Options	CD	CG	CA
B4	*Coplanar* Flange Bracket for 2-in. Pipe or Panel Mounting, all SST	•	•	•
B1	Traditional Flange Bracket for 2-in. Pipe Mounting, CS Bolts	•	•	•
B2	Traditional Flange Bracket for Panel Mounting, CS Bolts	•	•	•
B3	Traditional Flange Flat Bracket for 2-in. Pipe Mounting, CS Bolts	•	•	•
B7	B1 Bracket with Series 300 SST Bolts	•	•	•
B8	B2 Bracket with Series 300 SST Bolts	•	•	•
B9	B3 Bracket with Series 300 SST Bolts	•	•	•
BA	SST B1 Bracket with Series 300 SST Bolts	•	•	•
BC	SST B3 Bracket with Series 300 SST Bolts	•	•	•
Code	**Hazardous Locations Certification Options**	**CD**	**CG**	**CA**
E5	FM Explosionproof Approval	•	•	•
I5	FM Non-incendive and Intrinsic Safety Approval	•	•	•
IE	FM FISCO Intrinsically Safe; for FOUNDATION fieldbus protocol only	•	•	•
K5	FM Explosionproof and Intrinsic Safety Approval	•	•	•
I1(6)	ATEX Intrinsic Safety	•	•	•
N1(6)	ATEX Type N and Dust Certification	•	•	•
E8	ATEX Flame-proof and Dust Certification	•	•	•
E4(6)	TIIS Flame-proof Certification	•	•	•
I4	TIIS Intrinsic Safety Certification *(Only available with HART Option Code A)*	•	•	—
C5(7)	Measurement Canada Accuracy Approval *(Limited availability depending on transmitter type and range. Contact an Emerson Process Management representative)*	•	•	•
C6	CSA Explosion-proof and Intrinsic Safety Approval	•	•	•
K6(6)	CSA and ATEX Explosion-proof and Intrinsic Safety Approval (combination of C6 and K8)	•	•	•
KB	FM and CSA Explosion-proof and Intrinsic Safety Approvals (combination of K5 and C6)	•	•	•
K7	SAA Flame-proof and Intrinsic Safety Approvals (combination of I7, N7, and E7)	•	•	•
K8(6)	ATEX Flame-proof and Intrinsic Safety Approvals (combination of I1 and E8)	•	•	•
KD(6)	FM, CSA, and ATEX Explosion-proof and Intrinsically Safe combination of K5, C6, I1, and E8	•	•	•
I7	SAA Intrinsic Safety Certification	•	•	•
E7	SAA Flame-proof Certification	•	•	•
N7	SAA Type N Certification	•	•	•
IA	ATEX Intrinsic Safety for FISCO; for *FOUNDATION* fieldbus protocol only	•	•	•
Code	**Bolting Options**	**CD**	**CG**	**CA**
L4	Austenitic 316 SST Bolts	•	•	•
L5	ASTM A 193, Grade B7M Bolts	•	•	•
L6	*Monel* Bolts	•	•	•
Code	**Display Options**	**CD**	**CG**	**CA**
M5	LCD display for Aluminum Housing (Housing Codes A, B, C, and D only)	•	•	•
M6	LCD display for SST Housing (Housing Codes J, K, L, and M only)	•	•	•

TABLE 11. 3051C Differential, Gage, and Absolute Pressure Transmitters — = Not Applicable • = Applicable

Code	Other Options	CD	CG	CA
Q4	Calibration Data Sheet	•	•	•
Q8	Material Traceability Certification per EN 10204 3.1.B *(Only available for the sensor module housing and Coplanar or traditional flanges and adapters (3051C), and for the sensor module housing and low-volume Coplanar flange and adapter (3051C with Option Code S1))*	•	•	•
Q16	Surface finish certification for sanitary remote seals	•	•	•
QZ	Remote Seal System Performance Calculation Report	•	•	•
QP	Calibration certification and tamper evident seal	•	•	•
QS	Certificate of FMEDA Data	•	•	•
J1(7)(8)	Local Zero Adjustment Only	•	•	•
J3(7)(8)	No Local Zero or Span Adjustment	•	•	•
T1	Transient Protection Terminal Block	•	•	•
C1(7)	Custom Software Configuration (Completed CDS 00806-0100-4001 required with order)	•	•	•
C2(7)	0.8–3.2 V dc Output with Digital Signal Based on *HART* Protocol (Output Code M only)	•	•	•
C3	Gage Calibration (3051CA4 only)	—	—	•
C4(7)(9)	Analog Output Levels Compliant with NAMUR Recommendation NE 43	•	•	•
CN(7)(9)	Analog Output Levels Compliant with NAMUR Recommendation NE 43 Alarm Configuration–Low	•	•	•
P1	Hydrostatic Testing with Certificate	•	•	•
P2	Cleaning for Special Service	•	•	•
P3	Cleaning for <1 PPM Chlorine/Fluorine	•	•	•
P4	Calibrate at line pressure *(Specify Q48 on order for corresponding certificate)*	•	•	•
DF	1/2 -14 NPT flange adapter(s)— Material determined by flange material	•	•	•
D7	*Coplanar* Flange Without Drain/Vent Ports	•	•	•
D8	Ceramic Ball Drain/Vents	•	•	•
D9	JIS Process Connection—RC ¼ Flange with RC ½ Flange Adapter	•	•	•
P8	0.04% accuracy to 5:1 turndown (Range 2-4)	•	•	•
P9	4500 psig Static Pressure Limit (3051CD Ranges 2–5 only)	•	—	—
V5(10)	External Ground Screw Assembly	•	•	•
Typical Model Number:	**3051CD 2 A 2 2 A 1 A B4**			

(1) 3051CG lower range limit varies with atmospheric pressure.

(2) 3051CD0 is available only with Output Code A, Process Flange Code 0 (Alternate Flange H2, H7, HJ, or HK), Isolating Diaphragm Code 2, O-ring Code A, and Bolting Option L4.

(3) Not available with hazardous locations certification Options Codes I1, N1, E4, K6 and K8.

(4) Materials of Construction comply with recommendations per NACE MR0175/ISO 15156 for sour oil field production environments. Environmental limits apply to certain materials. Consult latest standard for details. Selected materials also conform to NACE MR0103 for sour refining environments.

(5) "Assemble-to" items are specified separately and require a completed model number.

(6) Not available with Low Power code M.

(7) Not available with Fieldbus (output code F) or Profibus (output code W).

(8) Local zero and span adjustments are standard unless Option Code J1 or J3 is specified

(9) NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.

(10) The V5 option is not needed with the T1 option; external ground screw assembly is included with the T1 option.

TABLE 12. 3051T Gage and Absolute Pressure Transmitter

Model	Transmitter Type	
3051T	Pressure Transmitter	
Code	**Pressure Type**	
G	Gage	
A	Absolute	
Code	**Pressure Ranges (Range/Min. Span)** **3051TG(1)**	**3051TA**
1	–14.7 to 30 psi/0.3 psi (–1,01 to 2,1 bar/20,7 mbar)	0 to 30 psia/0.3 psia (0 to 2,1 bar/20,7 mbar)
2	–14.7 to 150 psi/1.5 psi (–1,01 to 10,3 bar/103,4 mbar)	0 to 150 psia/1.5 psia (0 to 10,3 bar/103,4 mbar)
3	–14.7 to 800 psi/8 psi (–1,01 to 55,2 bar/0,55 bar)	0 to 800 psia/8 psia (0 to 55,2 bar/0,55 bar)
4	–14.7 to 4000 psi/40 psi (–1,01 to 275,8 bar/2,8 bar)	0 to 4000 psia/40 psia (0 to 275,8 bar/2,8 bar)
5	–14.7 to 10000 psi/2000 psi (–1,01 to 689,5 bar/138 bar)	0 to 10000 psia/2000 psia (0 to 689,5 bar/138 bar)
Code	**Output**	
A	4–20 mA with Digital Signal Based on *HART* Protocol	
M	Low-Power 1–5 V dc with Digital Signal Based on *HART* Protocol (See Option Code C2 for 0.8–3.2 V dc Output) (*Not available with hazardous certification Option Codes I1, N1, E4, K6 or K8)*	
F	*FOUNDATION* fieldbus Protocol	
W	Profibus — PA	
Code	**Process Connection Style**	
2B	1/2–14 NPT Female	
2C	G½ A DIN 16288 Male (Available in SST for Range 1–4 only)	
2F	Coned and Threaded, Compatible with Autoclave Type F-250-C *(Only available in SST for Range 5)*	
Code	**Isolating Diaphragm**	**Process Connection Wetted Parts Material**
2(2)	316L SST	316L SST
3(2)	*Hastelloy* C276	*Hastelloy* C276
Code	**Fill Fluid**	
1	Silicone	
2	Inert (Fluorinert® FC-43)	
Code	**Housing Material**	**Conduit Entry Size**
A	Polyurethane-covered Aluminum	½–14 NPT
B	Polyurethane-covered Aluminum	M20 × 1.5 (CM20)
C	Polyurethane-covered Aluminum	PG 13.5
D	Polyurethane-covered Aluminum	G½
J	SST	½–14 NPT
K	SST	M20 × 1.5 (CM20)
L	SST	PG 13.5
M	SST	G½
Code	***PlantWeb* Functionality (Optional)**	
A01	Advanced Control Function Block Suite	
D01	*FOUNDATION* fieldbus Diagnostics Suite	
Code	**Integral Mount Manifold (Optional)**	
S5(3)	Assemble to Rosemount 306 Integral Manifold (specified separately, see the Rosemount 305 and 306 Integral Manifolds PDS (document number 00813-0100-4733)) (*Requires 1/2-in. process connection code 2B)*	
Code	**Remote Diaphragm Seals Assemblies (Optional)**	
S1(3)	One remote diaphragm seal (Direct Mount or Capillary Connection Type) (Requires Process Connection Style code 2B)	
Code	**Mounting Brackets (Optional)**	
B4	Bracket for 2-in. Pipe or Panel Mounting, All SST	

TABLE 12. 3051T Gage and Absolute Pressure Transmitter

Code	Hazardous Locations Certifications (Optional)
E5	FM Explosion-proof Approval
I5	FM Non-incendive and Intrinsic Safety Approval
IE	FM FISCO Intrinsically Safe; for FOUNDATION fieldbus protocol only
K5	FM Explosion-proof and Intrinsic Safety Approval
C5	Measurement Canada accuracy approval *(Limited availability depending on transmitter type and range. Contact an Emerson Process Management representative)*
C6	CSA Explosion-proof and Intrinsic Safety Approval
K6(4)	CSA and ATEX Explosion-proof and Intrinsic Safety Approval (combination of C6 and K8)
KB	FM and CSA Explosion-proof and Intrinsic Safety Approvals (combination of K5 and C6)
K7	SAA Flame-proof and Intrinsic Safety Approvals (combination of I7, N7, and E7)
K8(4)	ATEX Flame-proof and Intrinsic Safety Approvals (combination of I1 and E8)
KD(4)	CSA, FM, and ATEX Explosion-proof and Intrinsic Safety Approval (combination of K5, C6, I1, and E8)
I7	SAA Intrinsic Safety Certification
E4(4)	TIIS Flame-proof Certification
E7	SAA Flame-proof Certification
N7	SAA Type N Certification
I1(4)	ATEX Intrinsic Safety and Dust Certification
N1(4)	ATEX Type N and Dust Certification
E8	ATEX Flame-proof and Dust Certification
DW	NSF drinking water approval
IA	ATEX Intrinsic Safety for FISCO; for *FOUNDATION* fieldbus protocol only
Code	**Other Options**
Q4	Calibration Data Sheet
Q8	Material Traceability Certification per EN 10204 3.1.B *NOTE: This option applies to the process connection only.*
Q16	Surface finish certification for sanitary remote seals
QZ	Remote Seal System Performance Calculation Report
QP	Calibration certification and tamper evident seal
QS	Certificate of FMEDA Data
J1(5)(6)	Local Zero Adjustment Only
J3(5)(6)	No Local Zero or Span Adjustment
M5	LCD display for Aluminum Housing (Housing Codes A, B, C, and D only)
M6	LCD display for SST Housing (Housing Codes J, K, L and M only)
T1	Transient Protection Terminal Block
C1(5)	Custom Software Configuration (Completed CDS 00806-0100-4001 required with order)
C2(5)	0.8–3.2 V dc Output with Digital Signal Based on *HART* Protocol (Output Code M only)
C4(5)(7)	Analog Output Levels Compliant with NAMUR Recommendation NE 43, 27-June-1996.
CN(5)(7)	Analog Output Levels Compliant with NAMUR Recommendation NE 43: Low Alarm Configuration
P1	Hydrostatic Testing with Certificate
P2	Cleaning for Special Service
P3	Cleaning for <1 PPM Chlorine/Fluorine
P8	0.04% accuracy to 5:1 turndown (Range 1-4)
V5(8)	External Ground Screw Assembly
Typical Model Number: 3051T G 5 F 2A 2 1 A B4	

(1) 3051TG lower range limit varies with atmospheric pressure.

(2) Materials of Construction comply with recommendations per NACE MR0175/ISO 15156 for sour oil field production environments. Environmental limits apply to certain materials. Consult latest standard for details. Selected materials also conform to NACE MR0103 for sour refining environments.

(3) "Assemble-to" items are specified separately and require a completed model number.

(4) Not available with low-power Option Code M.

(5) Not available with fieldbus (output code F) or Profibus protocols (output code W).

(6) Local zero and span adjustments are standard unless Option Code J1 or J3 is specified.

(7) NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.

(8) The V5 option is not needed with T1 option; external ground screw assembly is included with the T1 option.

TABLE 13. 3051L Flange-Mounted Liquid Level Transmitter

Model	Transmitter Type		
3051L	Flange-Mounted Liquid Level Transmitter		
Code	**Pressure Ranges (Range/Min. Span)**		
2	–250 to 250 inH_2O/2.5 inH_2O (–0,6 to 0,6 bar/6,2 mbar)		
3	–1000 to 1000 inH_2O/10 inH_2O (–2,5 to 2,5 bar/25 mbar)		
4	–300 to 300 psi/3 psi (–20,7 to 20,7 bar/0,2 bar)		
Code	**Output**		
A	4–20 mA with Digital Signal Based on *HART* Protocol		
M	Low-Power 1–5 V dc with Digital Signal Based on *HART* Protocol (See Option Code C2 for 0.8–3.2 V dc Output) *(Not available with hazardous certification Option Codes I1, N1, E4, K6, and K8)*		
F	*FOUNDATION* fieldbus Protocol		
W	Profibus – PA		
High Pressure Side			
Code	**Diaphragm Size**	**Material**	**Extension Length**
G0	2 in./DN 50	316L SST	Flush Mount Only
H0	2 in./DN 50	*Hastelloy* C276	Flush Mount Only
J0	2 in./DN 50	Tantalum	Flush Mount Only
A0	3 in./DN 80	316L SST	Flush Mount
A2	3 in./DN 80	316L SST	2 in./50 mm
A4	3 in./DN 80	316L SST	4 in./100 mm
A6	3 in./DN 80	316L SST	6 in./150 mm
B0	4 in./DN 100	316L SST	Flush Mount
B2	4 in./DN 100	316L SST	2 in./50 mm
B4	4 in./DN 100	316L SST	4 in./100 mm
B6	4 in./DN 100	316L SST	6 in./150 mm
C0	3 in./DN 80	*Hastelloy* C276	Flush Mount
C2	3 in./DN 80	*Hastelloy* C276	2 in./50 mm
C4	3 in./DN 80	*Hastelloy* C276	4 in./100 mm
C6	3 in./DN 80	*Hastelloy* C276	6 in./150 mm
D0	4 in./DN 100	*Hastelloy* C276	Flush Mount
D2	4 in./DN 100	*Hastelloy* C276	2 in./50 mm
D4	4 in./DN 100	*Hastelloy* C276	4 in./100 mm
D6	4 in./DN 100	*Hastelloy* C276	6 in./150 mm
E0	3 in./DN 80	Tantalum	Flush Mount Only
F0	4 in./DN 100	Tantalum	Flush Mount Only

TABLE 13. 3051L Flange-Mounted Liquid Level Transmitter

Code	Mounting Flange			
	Size	**ASME B 16.5 (ANSI) or DIN Flange Rating**	**Material**	
M	2 in.	Class 150	CS	
A	3 in.	Class 150	CS	
B	4 in.	Class 150	CS	
N	2 in.	Class 300	CS	
C	3 in.	Class 300	CS	
D	4 in.	Class 300	CS	
P	2 in.	Class 600	CS	
E	3 in.	Class 600	CS	
X	2 in.	Class 150	SST	
F	3 in.	Class 150	SST	
G	4 in.	Class 150	SST	
Y	2 in.	Class 300	SST	
H	3 in.	Class 300	SST	
J	4 in.	Class 300	SST	
Z	2 in.	Class 600	SST	
L	3 in.	Class 600	SST	
Q	DN 50	PN 10-40	CS	
R	DN 80	PN 40	CS	
S	DN 100	PN 40	CS	
V	DN 100	PN 10/16	CS	
K	DN 50	PN 10-40	SST	
T	DN 80	PN 40	SST	
U	DN 100	PN 40	SST	
W	DN 100	PN 10/16	SST	
Code	**Process Fill-High Pressure Side**		**Temperature Limits**	
A	*Syltherm* XLT		–100 to 300 °F (–73 to 135 °C)	
C	*D. C. Silicone 704*		60 to 400 °F (15 to 205 °C)	
D	*D. C. Silicone 200*		–40 to 400 °F (–40 to 205 °C)	
H	Inert (Halocarbon)		–50 to 350 °F (–45 to 177 °C)	
G	Glycerine and Water		0 to 200 °F (–17 to 93 °C)	
N	*Neobee M-20*		0 to 400 °F (–17 to 205 °C)	
P	Propylene Glycol and Water		0 to 200 °F (–17 to 93 °C)	
Low Pressure Side				
Code	**Configuration**	**Flange Adapter**	**Diaphragm Material**	**Sensor Fill Fluid**
11	Gage	SST	316L SST	Silicone
21	Differential	SST	316L SST	Silicone
22	Differential	SST	*Hastelloy* C276	Silicone
2A	Differential	SST	316L SST	Inert (Halocarbon)
2B	Differential	SST	*Hastelloy* C276	Inert (Halocarbon)
31	Remote Seal	SST	316L SST	Silicone *(Requires Option Code S1)*
Code	**O-ring Material**			
A	Glass-filled PTFE			

TABLE 13. 3051L Flange-Mounted Liquid Level Transmitter

Code	Housing Material	Conduit Entry Size
A	Polyurethane-covered Aluminum	½–14 NPT
B	Polyurethane-covered Aluminum	M20 × 1.5 (CM20)
C	Polyurethane-covered Aluminum	PG 13.5
D	Polyurethane-covered Aluminum	G½
J	SST	½–14 NPT
K	SST	M20 × 1.5 (CM20)
L	SST	PG 13.5
M	SST	G½
Code	***PlantWeb* Functionality (Optional)**	
A01	Advanced Control Function Block Suite	
D01	*FOUNDATION* fieldbus Diagnostics Suite	
Code	**Diaphragm Seal Assemblies (Optional)**	
S1(1)	One Diaphragm Seal *(requires low pressure side Option Code 31 capillary connection type)*	
Code	**Hazardous Locations Certification Options**	
E5	FM Explosion-proof Approval	
I5	FM Non-incendive and Intrinsic Safety Approval	
IE	FM FISCO Intrinsically Safe; for FOUNDATION fieldbus protocol only	
K5	FM Explosion-proof and Intrinsic Safety Approval	
I1(2)	ATEX Intrinsic Safety and Dust Certification	
N1(2)	ATEX Type N and Dust Certification	
E8	ATEX Flame-proof and Dust Certification	
E4(2)	TIIS Flame-proof Certification	
C6	CSA Explosion-proof and Intrinsic Safety Approval	
K6(2)	CSA and ATEX Explosion-proof and Intrinsic Safety Approval (combination of C6 and K8)	
KB	FM and CSA Explosion-proof and Intrinsic Safety Approvals (combination of K5 and C6)	
K7	SAA Flame-proof and Intrinsic Safety Approvals (combination of I7, N7, and E7)	
K8(2)	ATEX Flame-proof and Intrinsic Safety Approvals (combination of I1 and E8)	
KD(2)	CSA, FM, and ATEX Explosion-proof and Intrinsic Safety Approval (combination of K5, C6, I1, and E8)	
I7	SAA Intrinsic Safety Certification	
E7	SAA Flame-proof Certification	
N7	SAA Type N Certification	
IA	ATEX Intrinsic Safety for FISCO; for *FOUNDATION* fieldbus protocol only	
Code	**Bolt for Flange and Adapters (Optional)**	
L5	ASTM A 193, Grade B7M Bolts	
Code	**Display Options**	
M5	LCD display for Aluminum Housing *(Available with Housing codes A, B, C, and D only)*	
M6	LCD display for SST Housing *(Available with Housing codes J, K, L, and M only)*	

TABLE 13. 3051L Flange-Mounted Liquid Level Transmitter

Code	Other Options
Q4	Calibration Data Sheet
Q8	Material Traceability Certification per EN 10204 3.1.B (*Available with the diaphragm, upper housing, Coplanar flange, adapter, sensor module housing, lower housing/flushing connection, and extension)*
QZ	Remote Seal System Performance Calculation Report
QP	Calibration certification and tamper evident seal
J1(3)(4)	Local Zero Adjustment Only
J3(3)(4)	No Local Zero or Span Adjustment
T1	Transient Protection Terminal Block
C1(3)	Custom Software Configuration (*Completed CDS 00806-0100-4001 required with order)*
C2(3)	0.8–3.2 V dc Output with Digital Signal Based on *HART* Protocol *(Available with Output code M only)*
C4(3)(5)	Analog Output Levels Compliant with NAMUR Recommendation NE 43
CN(3)(5)	Analog Output Levels Compliant with NAMUR Recommendation NE 43: Alarm Configuration–Low
D8	Ceramic Ball Drain/Vents
V5(6)	External Ground Screw Assembly

Code	Lower Housing Flushing Connections Options					
	Ring Material	**Number**	**Size**	**2 in.**	**3 in.**	**4 in.**
F1	SST	1	1/4	•	•	•
F2	SST	2	1/4	•	•	•
F3(7)	*Hastelloy* C276	1	1/4	•	•	•
F4(7)	*Hastelloy* C276	2	1/4	•	•	•
F7	SST	1	1/2	•	•	•
F8	SST	2	1/2	•	•	•
F9	*Hastelloy* C276	1	1/2	•	•	•
F0	*Hastelloy* C276	2	1/2	•	•	•

Typical Model Number: 3051L 2 A A0 D 21 A A F1

(1) "Assemble-to" items are specified separately and require a completed model number.

(2) Not available with low-power Option Code M

(3) Not available with fieldbus (output code F) or profibus protocols (output code W).

(4) Local zero and span adjustments are standard unless Option Code J1 or J3 is specified.

(5) NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.

(6) The V5 option is not needed with the T1 option; external ground screw assembly is included with the T1 option.

(7) Not available with Option Codes A0, B0, and G0.

TABLE 14. 3051H Pressure Transmitter for High-Temperature Processes — = Not Applicable • = Applicable

Model	Transmitter Type (Select One)		HD	HG
3051HD	Differential Pressure Transmitter for High-Temperature Processes		•	—
3051HG	Gage Pressure Transmitter for High-Temperature Processes		—	•
Code	**Pressure Ranges (Range/ Min. Span)**			
	3051HD	**3051HG**		
2	–250 to 250 inH_2O/2.5 inH_2O (–0,62 to 0,62 bar/6,2 mbar)	–250 to 250 inH_2O/2.5 inH_2O (–0,62 to 0,62 bar/6,2 mbar)		
3	–1000 to 1000 inH_2O/10 inH_2O (–2,5 to 2,5 bar/25 mbar)	–407 to 1000 inH_2O/10in H_2O (–1,01 to 2,5 bar/25 mbar)		
4	–300 to 300 inH_2O/3 psi (–747 to 747 mbar/0,2 bar)	–14.7 to 300 psi/3 psi (–1,01 to 20,7 bar/0,2 bar)		
5	–2000 to 2000 psi/20 psi (–138 to 138 bar/1,4 bar)	–14.7 to 2000 psig/20 psi (–1,01 to 138 bar/1,4 bar)		
NOTE: 3051HG lower range limit varies with atmospheric pressure.				
Code	**Output**		**HD**	**HG**
A	4–20 mA with Digital Signal Based on *HART* Protocol		•	•
M	Low-Power 1–5 V dc with Digital Signal Based on *HART* Protocol (See Option Code C2 for 0.8–3.2 V dc Output) *(Not available with hazardous certification Option Codes I1, N1, E4, K6, and K8)*		•	•
F	FOUNDATION fieldbus Protocol		•	•
W	Profibus – PA		•	•
Code	**Process Connection**		**HD**	**HG**
	Process Flange Material	**Drain/Vent**		
2	SST	SST	•	•
7(1)	SST	*Hastelloy* C276	•	•
Code	**Process Isolating Diaphragm**		**HD**	**HG**
2	316L SST		•	•
3(1)	*Hastelloy* C276		•	•
5	Tantalum		•	•
Code	**O-ring Material**		**HD**	**HG**
A	Glass-Filled PTFE		•	•
Code	**Process Fill Fluid**		**HD**	**HG**
D	*D.C. 200* Silicone		•	•
H	Inert		•	•
N	*Neobee M-20*		•	•
Code	**Sensor Module Isolator Material**		**HD**	**HG**
2	SST		•	•
Code	**Sensor Module Fill Fluid**		**HD**	**HG**
1	Silicone		•	•
2	Inert (Halocarbon)		•	•
Code	**Housing Material**	**Conduit Entry Size**	**HD**	**HG**
A	Polyurethane-covered Aluminum	½–14 NPT	•	•
B	Polyurethane-covered Aluminum	M20 × 1.5 (CM20)	•	•
C	Polyurethane-covered Aluminum	PG 13.5	•	•
D	Polyurethane-covered Aluminum	G½	•	•
J	SST	½–14 NPT	•	•
K	SST	M20 × 1.5 (CM20)	•	•
L	SST	PG 13.5	•	•
M	SST	G½	•	•
Code	***PlantWeb* Functionality (Optional)**			
A01	Advanced Control Function Block Suite			
D01	FOUNDATION fieldbus Diagnostics Suite			
Code	**Integral Mount Primary Elements (Optional)**		**HD**	**HG**
S4(2)	Factory Assembly to Rosemount Primary Element (Rosemount *Annubar* or Rosemount 1195 Integral Orifice) *(With the primary element installed, the maximum operating pressure will equal the lesser of either the transmitter or the primary element. Option is available for factory assembly to range 1–4 transmitters only)*		•	—

TABLE 14. 3051H Pressure Transmitter for High-Temperature Processes — = Not Applicable • = Applicable

Code	Mounting Bracket Options	HD	HG
B5	Universal Mounting Bracket for 2-in. Pipe or Panel Mount, CS Bolts	•	•
B6	Universal Mounting Bracket for 2-in. Pipe or Panel Mount, SST Bolts	•	•
Code	**Hazardous Locations Certification Options**	**HD**	**HG**
E5	FM Explosion-proof Approval	•	•
I5	FM Non-incendive and Intrinsic Safety Approval	•	•
K5	FM Explosion-proof and Intrinsic Safety Approval	•	•
I1(3)	ATEX Intrinsic Safety and Dust Certification	•	•
N1(3)	ATEX Type N and Dust Certification	•	•
E8	ATEX Flame-proof and Dust Certification	•	•
E4(3)	TIIS Flame-proof Certification	•	•
C6	CSA Explosion-proof and Intrinsic Safety Approval	•	•
K6(3)	CSA and ATEX Explosion-proof and Intrinsic Safety Approval (combination of C6 and K8)	•	•
KB	FM and CSA Explosion-proof and Intrinsic Safety Approvals (combination of K5 and C6)	•	•
K7	SAA Flame-proof and Intrinsic Safety Approvals (combination of I7, N7, and E7)	•	•
KB(3)	ATEX Flame-proof and Intrinsic Safety Approvals (combination of I1 and E8)	•	•
KD(3)	CSA, FM, and ATEX Explosion-proof and Intrinsic Safety Approval (combination of K5, C6, I1, and E8)	•	•
I7	SAA Intrinsic Safety Certification	•	•
E7	SAA Flame-proof Certification	•	•
N7	SAA Type N Certification	•	•
IA	ATEX Intrinsic Safety for FISCO; for FOUNDATION fieldbus protocol only	•	•
IE	FM FISCO Intrinsic Safety; for FOUNDATION fieldbus protocol only	•	•
Code	**Bolt for Flange and Adapter Options**	**HD**	**HG**
L4	Austenitic 316 SST Bolts	•	•
Code	**Display Options**	**HD**	**HG**
M5	LCD display for Aluminum Housing *(Available with Housing codes A, B, C, and D only)*	•	•
M6	LCD display for SST Housing *(Available with Housing codes J, K, L, and M only)*	•	•
Code	**Other Options**	**HD**	**HG**
Q4	Calibration Data Sheet	•	•
Q8	Material traceability certification per EN 10204 3.1.B	•	•
QP	Calibration certification and tamper evident seal	•	•
J1(4)	Local Zero Adjustment Only *(Local zero and span adjustments are standard unless Option Code J1 or J3 is specified.)*	•	•
J3(4)	No Local Zero or Span Adjustment *(Local zero and span adjustments are standard unless Option Code J1 or J3 is specified)*	•	•
T1	Transient Protection Terminal Block	•	•
C1(4)	Custom Software Configuration (Completed CDS 00806-0100-4001 required with order)	•	•
C2(4)	0.8–3.2 V dc Output with Digital Signal Based on *HART* Protocol *(Output Code M only)*	•	•
C4(4)(5)	Analog Output Levels Compliant with NAMUR Recommendation NE 43	•	•
CN(4)(5)	Analog Output Levels Compliant with NAMUR Recommendation NE 43: Alarm Configuration–Low	•	•
P1	Hydrostatic Testing with Certificate	•	•
P2	Cleaning for Special Service	•	•
P3	Cleaning for <1 PPM Chlorine/Fluorine	•	•
DF	1/2–14 NPT flange adapters—SST	•	•
D8	Ceramic Ball Drain/Vents	•	•
V5(6)	External Ground Screw Assembly	•	•
Typical Model Number: 3051HG 2 A 2 2 A H 2 1 A B5			

(1) Materials of Construction comply with recommendations per NACE MR0175/ISO 15156 for sour oil field production environments. Environmental limits apply to certain materials. Consult latest standard for details. Selected materials also conform to NACE MR0103 for sour refining environments.

(2) "Assemble-to" items are specified separately and require a completed model number.

(3) Not available with low-power Option Code M.

(4) Not available with fieldbus (output code F) or profibus protocols (output code W).

(5) NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.

(6) The V5 option is not needed with the T1 option; external ground screw assembly is included with the T1 option.

OPTIONS

Standard Configuration

Unless otherwise specified, transmitter is shipped as follows:

ENGINEERING UNITS	
Differential/Gage:	inH_2O (Range 0, 1, 2, and 3) psi (Range 4 and 5)
Absolute/3051T:	psi (all ranges)
4 mA (1 V dc)[(1)]:	0 (engineering units above)
20 mA (5 V dc):	Upper range limit
Output:	Linear
Flange type:	Specified model code option
Flange material:	Specified model code option
O-ring material:	Specified model code option
Drain/vent:	Specified model code option
Integral meter:	Installed or none
Alarm[(1)]:	Upscale
Software tag:	(Blank)

(1) Not applicable to fieldbus.

Custom Configuration *HART* protocol only[(1)]

If Option Code C1 is ordered, the customer may specify the following data in addition to the standard configuration parameters.

- Output Information
- Transmitter Information
- LCD display Configuration
- Hardware Selectable Information
- Signal Selection

Refer to the “HART Protocol C1 Option Configuration Data Sheet” document number 00806-0100-4001.

Tagging (3 options available)

- Standard SST hardware tag is wired to the transmitter. Tag character height is 0.125 in. (3,18 mm), 56 characters maximum.
- Tag may be permanently stamped on transmitter nameplate upon request, 56 characters maximum.
- Tag may be stored in transmitter memory (30 characters maximum). Software tag is left blank unless specified.

Commissioning tag (fieldbus only)

A temporary commissioning tag is attached to all transmitters. The tag indicates the device ID and allows an area for writing the location.

Optional Rosemount 304, 305 or 306 Integral Manifolds

Factory assembled to 3051C and 3051T transmitters. Refer to the following Product Data Sheet (document number 00813-0100-4839 for Rosemount 304 and 00813-0100-4733 for Rosemount 305 and 306) for additional information.

Optional Diaphragm and Sanitary Seals

Refer to Product Data Sheet 00813-0100-4016 or 00813-0201-4016. for additional information.

Output Information[(1)]

Output range points must be the same unit of measure. Available units of measure include:

inH2O	inH2O@4 °C[(1)]	psi	Pa
inHg	ftH2O	bar	kPa
mmH2O	mmH2O@4 °C[(1)]	mbar	torr
mmHg	g/cm2	kg/cm2	atm

(1) Not available on low power or previous versions.

LCD display

M5 Digital Display, 5-Digit, 2-Line LCD

- Direct reading of digital data for higher accuracy
- Displays user-defined flow, level, volume, or pressure units
- Displays diagnostic messages for local troubleshooting
- 90-degree rotation capability for easy viewing

M6 Digital Display with 316 Stainless Steel Cover

- For use with stainless steel housing option (housing codes J, K, and L)

Local Span and Zero Adjustment[(2)]

Transmitters ship with local span and zero adjustments standard unless otherwise specified.

- Non-interactive external zero and span adjustments ease calibration
- Magnetic switches replace standard potentiometer adjustments to optimize performance

J1 Local Zero Adjustment Only[(1)]

J3 No Local Zero or Span Adjustment[(1)]

Transient Protection

T1 Integral Transient Protection Terminal Block

- Integral transient protection terminal block
- Meets IEEE Standard 587, Category B
  1 kV crest (10 × 1 000 microseconds)
  3 kV crest (8 × 20 microseconds)
  6 kV crest (1.2 × 50 microseconds)
- Meets IEEE Standard 472,
  Surge Withstand Capability
  SWC 2,5 kV crest, 1 MHz wave form
- Applicable standards: IEC 801-4, 801-5

Bolts for Flanges and Adapters

- Options permit bolts for flanges and adapters to be obtained in various materials
- Standard material is plated carbon steel per ASTM A449, Type 1

L4 Austenitic 316 Stainless Steel Bolts

L5 ASTM A 193, Grade B7M Bolts

L6 *Monel* Bolts

(1) Not applicable to fieldbus.

(2) Not applicable to fieldbus.

Rosemount 3051C *Coplanar* Flange and 3051T Bracket Option

B4 Bracket for 2-in. Pipe or Panel Mounting

- For use with the standard *Coplanar* flange configuration
- Bracket for mounting of transmitter on 2-in. pipe or panel
- Stainless steel construction with stainless steel bolts

Rosemount 3051H Bracket Options

B5 Bracket for 2-in. Pipe or Panel Mounting

- For use with the 3051H Pressure Transmitter for high process temperatures
- Carbon steel construction with carbon steel bolts

B6 B5 Bracket with SST Bolts

- Same bracket as the B5 option with Series 300 stainless steel bolts.

Traditional Flange Bracket Options

B1 Bracket for 2-in. Pipe Mounting

- For use with the traditional flange option
- Bracket for mounting on 2-in. pipe
- Carbon steel construction with carbon steel bolts
- Coated with polyurethane paint

B2 Bracket for Panel Mounting

- For use with the traditional flange option
- Bracket for mounting transmitter on wall or panel
- Carbon steel construction with carbon steel bolts
- Coated with polyurethane paint

B3 Flat Bracket for 2-in. Pipe Mounting

- For use with the traditional flange option
- Bracket for vertical mounting of transmitter on 2-in. pipe
- Carbon steel construction with carbon steel bolts
- Coated with polyurethane paint

B7 B1 Bracket with SST Bolts

- Same bracket as the B1 option with Series 300 stainless steel bolts

B8 B2 Bracket with SST Bolts

- Same bracket as the B2 option with Series 300 stainless steel bolts

B9 B3 Bracket with SST Bolts

- Same bracket as the B3 option with Series 300 stainless steel bolts

BA Stainless Steel B1 Bracket with SST Bolts

- B1 bracket in stainless steel with Series 300 stainless steel bolts

BC Stainless Steel B3 Bracket with SST Bolts

- B3 bracket in stainless steel with Series 300 stainless steel bolts

Shipping Weights

TABLE 15. Transmitter Weights without Options

Transmitter	Add Weight In lb (kg)
3051C	6.0 (2,7)
3051L	Table 16 on page 38
3051H	13.6 (6,2)
3051T	3.0 (1,4)

TABLE 16. 3051L Weights without Options

Flange	Flush lb. (kg)	2-in. Ext. lb (kg)	4-in. Ext. lb (kg)	6-in. Ext. lb (kg)
2-in., 150	12.5 (5,7)	—	—	—
3-in., 150	17.5 (7,9)	19.5 (8,8)	20.5 (9,3)	21.5 (9,7)
4-in., 150	23.5 (10,7)	26.5 (12,0)	28.5 (12,9)	30.5 (13,8)
2-in., 300	17.5 (7,9)	—	—	—
3-in., 300	22.5 (10,2)	24.5 (11,1)	25.5 (11,6)	26.5 (12,0)
4-in., 300	32.5 (14,7)	35.5 (16,1)	37.5 (17,0)	39.5 (17,9)
2-in., 600	15.3 (6,9)	—	—	—
3-in., 600	25.2 (11,4)	27.2 (12,3)	28.2 (12,8)	29.2 (13,2)
DN 50/PN 40	13.8 (6,2)	—	—	—
DN 80/PN 40	19.5 (8,8)	21.5 (9,7)	22.5 (10,2)	23.5 (10,6)
DN 100/ PN 10/16	17.8 (8,1)	19.8 (9,0)	20.8 (9,5)	21.8 (9,9)
DN 100/ PN 40	23.2 (10,5)	25.2 (11,5)	26.2 (11,9)	27.2 (12,3)

TABLE 17. Transmitter Options Weights

Code	Option	Add lb (kg)
J, K, L, M	Stainless Steel Housing(T)	3.9 (1,8)
J, K, L, M	Stainless Steel Housing (C, L, H, P)	3.1 (1,4)
M5	LCD display for Aluminum Housing	0.5 (0,2)
M6	LCD display for SST Housing	1.25 (0,6)
B4	SST Mounting Bracket for *Coplanar* Flange	1.0 (0,5)
B1 B2 B3	Mounting Bracket for Traditional Flange	2.3 (1,0)
B7 B8 B9	Mounting Bracket for Traditional Flange	2.3 (1,0)
BA, BC	SST Bracket for Traditional Flange	2.3 (1,0)
B5 B6	Mounting Bracket for 3051H	2.9 (1,3)
H2	Traditional Flange	2.4 (1,1)
H3	Traditional Flange	2.7 (1,2)
H4	Traditional Flange	2.6 (1,2)
H7	Traditional Flange	2.5 (1,1)
FC	Level Flange—3 in., 150	10.8 (4,9)
FD	Level Flange—3 in., 300	14.3 (6,5)
FA	Level Flange—2 in., 150	10.7 (4,8)
FB	Level Flange—2 in., 300	14.0 (6,3)
FP	DIN Level Flange, SST, DN 50, PN 40	8.3 (3,8)
FQ	DIN Level Flange, SST, DN 80, PN 40	13.7 (6,2)

3051C Differential/Gage Pressure Transmitter Range Limits										
	Range 1 Span		Range 2 Span		Range 3 Span		Range 4 Span		Range 5 Span	
Units	min	max	min	max	min	max	min	max	min	max
inH_2O	0.5	25	2.5	250	10	1000	83.040	8304	553.60	55360
inHg	0.03678	1.8389	0.18389	18.389	0.73559	73.559	6.1081	610.81	40.720	4072.04
ftH_2O	0.04167	2.08333	0.20833	20.8333	0.83333	83.3333	6.9198	691.997	46.13	4613.31
mmH_2O	12.7	635.5	63.553	6355	254	25421	2110.95	211095	14073	1407301
mmHg	0.93416	46.7082	4.67082	467.082	18.6833	1868.33	155.145	15514.5	1034.3	103430
psi	0.01806	0.903	0.0902	9.03183	0.36127	36.127	3	300	20	2000
bar	0.00125	0.06227	0.00623	0.62272	0.02491	2.491	0.20684	20.6843	1.37895	137.895
mbar	1.2454	62.2723	6.22723	622.723	24.9089	2490.89	206.843	20684.3	1378.95	137895
g/cm^2	1.26775	63.3875	6.33875	633.875	25.355	2535.45	210.547	21054.7	1406.14	140614
kg/cm^2	0.00127	0.0635	0.00635	0.635	0.0254	2.54	0.21092	21.0921	1.40614	140.614
Pa	124.545	6227.23	622.723	62160.6	2490.89	249089	20684.3	2068430	137895	13789500
kPa	0.12545	6.2272	0.62272	62.2723	2.49089	249.089	20.6843	2068.43	137.895	13789.5
torr	0.93416	46.7082	4.67082	467.082	18.6833	1868.33	155.145	15514.5	1034.3	103430
atm	0.00123	0.06146	0.00615	0.61460	0.02458	2.458	0.20414	20.4138	1.36092	136.092

When using a HART communicator, ±5% adjustment is allowed on the sensor limit to allow for unit conversions.

3051L/3051H Pressure Transmitter Range Limits								
	Range 2 Span		Range 3 Span		Range 4 Span		Range 5 Span	
Units	min	max	min	max	min	max	min	max
inH_2O	2.5	250	10	1000	83.040	8304	553.60	55360
inHg	0.18389	18.389	0.73559	73.559	6.1081	610.81	40.720	4072.04
ftH_2O	0.20833	20.8333	0.83333	83.3333	6.9198	691.997	46.13	4613.31
mmH_2O	63.553	6355	254	25421	2110.95	211095	14073	1407301
mmHg	4.67082	467.082	18.6833	1868.33	155.145	15514.5	1034.3	103430
psi	0.0902	9.03183	0.36127	36.127	3	300	20	2000
bar	0.00623	0.62272	0.02491	2.491	0.20684	20.6843	1.37895	137.895
mbar	6.22723	622.723	24.9089	2490.89	206.843	20684.3	1378.95	137895
g/cm^2	6.33875	633.875	25.355	2535.45	210.547	21054.7	1406.14	140614
kg/cm^2	0.00635	0.635	0.0254	2.54	0.21092	21.0921	1.40614	140.614
Pa	622.723	62160.6	2490.89	249089	20684.3	2068430	137895	13789500
kPa	0.62272	62.2723	2.49089	249.089	20.6843	2068.43	137.895	13789.5
torr	4.67082	467.082	18.6833	1868.33	155.145	15514.5	1034.3	103430
atm	0.00615	0.61460	0.02458	2.458	0.20414	20.4138	1.36092	136.092

When using a HART communicator, ±5% adjustment is allowed on the sensor limit to allow for unit conversions.

3051T Gage and Absolute Pressure Transmitter Range Limits										
	Range 1 Span		Range 2 Span		Range 3 Span		Range 4 Span		Range 5 Span	
Units	min	max	min	max	min	max	min	max	min	max
inH_2O	8.30397	831.889	41.5198	4159.45	221.439	22143.9	1107.2	110720	55360	276799
inHg	0.61081	61.0807	3.05403	305.403	16.2882	1628.82	81.441	8144.098	4072.04	20360.2
ftH_2O	0.69199	69.3241	3.45998	345.998	18.4533	1845.33	92.2663	9226.63	4613.31	23066.6
mmH_2O	211.10	21130	1054.60	105460.3	5634.66	563466	28146.1	2814613	1407301	7036507
mmHg	15.5145	1551.45	77.5723	7757.23	413.72	41372	2068.6	206860.0	103430	517151
psi	0.3	30	1.5	150	8	800	40	4000	2000	10000
bar	0.02068	3.06843	0.10342	10.3421	0.55158	55.1581	2.75791	275.7905	137.895	689.476
mbar	20.6843	2068.43	103.421	10342.11	551.581	55158.1	2757.91	275790.5	137895	689476
g/cm^2	21.0921	2109.21	105.461	10546.1	561.459	56145.9	2807.31	280730.6	140614	703067
kg/cm^2	0.02109	2.10921	0.10546	10.5461	0.56246	56.2456	2.81228	281.228	140.614	701.82
Pa	2068.43	206843	10342.1	1034212	55158.1	5515811	275791	27579054	13789500	68947600
kPa	2.06843	206.843	10.3421	1034.21	55.1581	5515.81	275.791	27579.05	13789.5	68947.6
torr	15.5145	1551.45	77.5726	7757.26	413.721	413721	2068.6	206859.7	103430	517151
atm	0.02041	2.04138	0.10207	10.2069	0.54437	54.4368	2.72184	272.1841	136.092	680.46

When using a HART communicator, ±5% adjustment is allowed on the sensor limit to allow for unit conversions.

3051C Absolute Pressure Transmitter Range Limits								
	Range 1 Span		Range 2 Span		Range 3 Span		Range 4 Span	
Units	min	max	min	max	min	max	min	max
inH_2O	8.30397	831.889	41.5198	4151.98	221.439	22143.9	1107.2	110720
inHg	0.61081	61.0807	3.05403	305.403	16.2882	1628.82	81.441	8144.098
ftH_2O	0.69199	69.3241	3.45998	345.998	18.4533	1845.33	92.2663	9226.63
mmH_2O	211.10	21130	6.35308	635.308	5634.66	563466	28146.1	2814613
mmHg	15.5145	1551.45	1055.47	105547	413.72	41372	2068.6	206860.0
psi	0.3	30	1.5	150	8	800	40	4000
bar	0.02068	2.06843	0.10342	10.342	0.55158	55.1581	2.75791	275.7905
mbar	20.6843	2068.43	103.421	10342.1	551.581	55158.1	2757.91	275790.5
g/cm^2	21.0921	2109.21	105.27	105.27	561.459	56145.9	2807.31	280730.6
kg/cm^2	0.02109	2.10921	0.10546	10.546	0.56246	56.2456	2.81228	281.228
Pa	2068.43	206843	10342.1	1034210	55158.1	5515811	275791	27579054
kPa	2.06843	206.843	10.3421	1034.21	55.1581	5515.81	275.791	27579.05
torr	15.5145	1551.45	77.5726	7757.26	413.721	413721	2068.6	206859.7
atm	0.02041	2.04138	0.10207	10.207	0.54437	54.4368	2.72184	272.1841

When using a HART communicator, ±5% adjustment is allowed on the sensor limit to allow for unit conversions.

Emerson Process Management

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Singapore 128461
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F (65) 6777 0947
Enquiries@AP.EmersonProcess.com

EMERSON
Process Management

14.6 Liquid level indicator

Voith Article No.: 2 124123 0

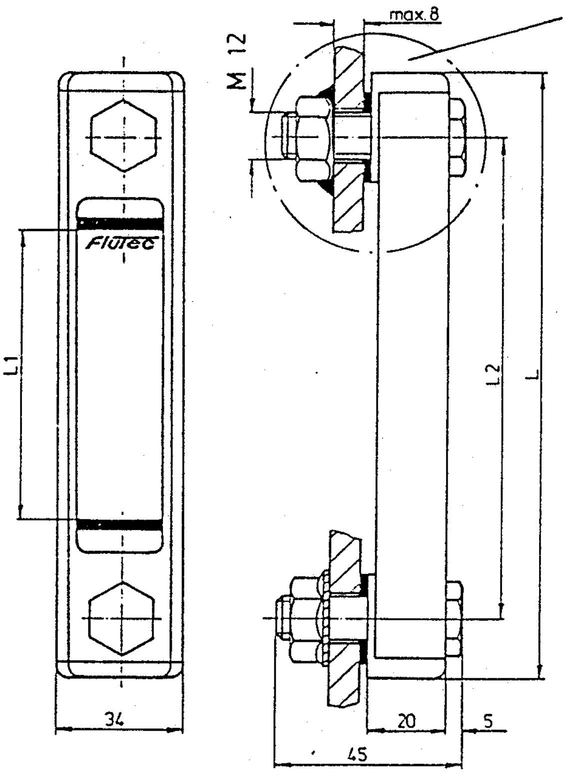
Type: FSA 254.2.0/12

Description 3626-9710

VOITH

FLUID LEVEL GAUGE FSA

FSA



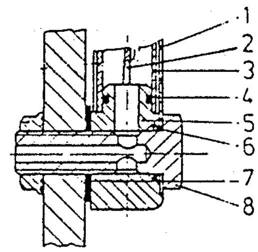
Voith design

Screw tightening torque
10 Nm max.

NG	L	L1	L2	Type	Voith part no.
76	108	37	76	FSA 76.2.0/12	521241210
127	159	76	127	FSA 127.2.0/12	521241220
254	286	203	254	FSA 254.2.0/12	521241230

SPARE PARTS

FSA



Item	Description
1	Housing
2	Name plate
3	Tube
4	O-ring 13 x 2.5
5	End cap
6	O-ring, 12.3 x 2.4
7	Washer
8	Banjo bolt

VOITH TURBO GMBH & Co. KG - D 7180 CRAILSHEIM
Postfach 15 55 - Telefon (07951) 320 - Telex 074338

14.7 Vent filter

Voith Article No.: 4 188931 002

Type: TLF I 3-40 G 25

Description . . . . Bosch / Rexroth

Breather filter

RE 51415/02.09
Replaces: 08.08
RE 51416

Types TLF I…; TLF II…; TLF III…

Nominal size: TLF I; II; III 1 - 25 to 8 - 250
Connections up to DN 250
Operating temperature –20 °C to +100 °C

H7623

Table of contents

Application

– Filtration and dehumidification of the intake air of industrial systems.
– Avoidance of initial damage in pumps and bearings and system components.

Design

Dismountable filter housing for ventilation with internal, exchangeable filter element. Filter elements H10XL up to a filtration rating of 10 µm with glass fiber mat and P… up to 25 µm with paper mat.
Materials as per spare parts list.

Designs:

TLF I…: with internal screw-in thread,

TLF II…: with external screw-in thread,

TLF III…: with external screw-in thread and filling filter (screen basket 130 µm).

TLF I 7-125: with DIN flange,

TLF I 8-250: with DIN flange,

TLF III 7-125: with DIN flange and filling filter (screen basket 130 µm).

Maintenance intervals

Fields of application of the filter	Environmental conditions average dust content	Maintenance interval
General mechanical engineering	9…25 mg/m^3	4,000 h
Heavy industry	50…80 mg/m^3	3,000 h
Mobile hydraulics	30…100 mg/m^3	3,000 h

Spare parts nominal sizes 1-25 to 6-80

Part	Piece	Size Description	Material	TLF I, TLF II, TLF III 1-25	2-32	3-40	4-50	5-65	6-80
1	1	Cover	Steel	Please indicate ordering information “Filter”					
2	1	Wing nut	Steel	Part No. 4349					
3	1	Filter element	various	Please indicate ordering information “Filter Element”					
4	1	Lower housing part	various	Please indicate ordering information “Filter”					
5	1	Filling piece	Al	Part No. 3650	Part No. 3658	Part No. 3659	Part No. 3660	Part No. 3661	Part No. 3662
6	1	Filling screen	Steel	Part No. 3651	Part No. 3663	Part No. 3664	Part No. 3665	Part No. 3666	Part No. 3667

All part nos. BRFS.specific. Filling piece and filling screen only available as unit.

Spare parts nominal sizes 7-125, 8-250

Part	Piece	Size Description	Material	TLF I/TLF III 7-125	TLF I 8-250
1	1	Cover	Steel	Please indicate ordering information “Filter”	
2	1	Wing nut	Steel	Part No. 5233	
3	1	Filter element	various	Please indicate ordering information “Filter Element”	
4	1	Lower housing part	various	Please indicate ordering information “Filter”	
6	1	Filling screen	various	Part no. 5784	—
7	1	Seal	NBR	Please indicate ordering information “Filter”	
8	1	Seal	NBR	Please indicate ordering information “Filter”	
			Weight (in kg)	8.0	33.0

All part numbers. BRFS specific.

Ordering details of the filter nominal sizes 1-25 to 6-80

		– S	– 0	0	0 – 00		0	0

Design
Tank breather filter...
with internal thread connection = **TLF I…**
with external thread connection = **TLF II…**
with external thread connection and filling screen = **TLF III…**

Nom. size
TLF I, II, III… = **1-25 2-32 3-40 4-50 5-65 6-80**

Filtration rating in µm
nominal
Paper, non-cleanable
P10, P25 = **P…**
absolute (ISO 16889)
Micro glass, non-cleanable
H10XL = **H10XL**

Pressure differential
Max. admissible pressure differential of the filter element
Standard = **S**

Element model
Standard adhesive T = 80 °C = **0…**
Standard material = **…0**

Solenoid
without = **0**

Complementary details
0 = without

Material
0 = Standard

Seal
0 = Polyurethane adhesive
M = NBR seal

Connection
00 = Standard

Clogging indicator
0 = without

Bypass valve
0 = without

Ordering example:
TLF III 3 - 40 P10-S00-000-00M00

Ordering details of the filter element nominal size 1-25 to 6-80

7.		– S	– 0 –	

Filter element
Design = **7.**

Filter element size
NG1-25, 2-32 = **002**
NG3-40, 4-50, 5-65 = **004**
NG6-80 = **006**

Filtration rating in µm
nominal
Paper, non-cleanable
P10, P25 = **P…**
absolute (ISO 16889)
Micro glass, non-cleanable
H10XL = **H10XL**

Pressure differential
Max. admissible pressure differential of the filter element
Standard = **S**

Seal
0 = Polyurethane adhesive
M = NBR seal

Bypass valve
0 = without

Element model
0… = Standard adhesive T = 80 °C
…0 = Standard material

Ordering example:
7.004 P10-S00-0-M

Ordering details of the filter nominal sizes 7-125, 8-250

		– S	– 0	0	0 – 00	M	0	0

Design
Tank breather filter with DIN flange connection **= TLF I…**
Tank breather filter with DIN flange connection and filling screen **= TLF III…**

Nom. size
TLF I, III **= 7-125**
TLF I **= 8-250**

Filtration rating in µm
nominal
Paper, non-cleanable
P10, P25 **= P…**
absolute (ISO 16889)
Micro glass, non-cleanable
H10XL **= H10XL**

Pressure differential
Max. admissible pressure differential of the filter element
Standard **= S**

Element model
Standard adhesive T = 80 °C **= 0…**
Standard material **= …0**

Solenoid
without **= 0**

Bypass valve
0 = without

Clogging indicator
0 = without

Connection
00 = Standard

Seal
M = NBR seal

Material
0 = Standard

Complementary details
0 = without

Ordering example:
TLF III 7 - 125 P10-S00-000-00M00

Ordering details of the filter element nominal sizes 7-125, 8-250

7.		– S	– 0	– M

Filter element
Design **= 7.**

Filter element size
NG7-125 **= 007**
NG8-250 **= 008**

Filtration rating in µm
nominal
Paper, non-cleanable
P10, P25 **= P…**
absolute (ISO 16889)
Micro glass, non-cleanable
H10XL **= H10XL**

Pressure differential
Max. admissible pressure differential of the filter element
Standard **= S**

Element model
0… = Standard adhesive T = 80 °C
…0 = Standard material

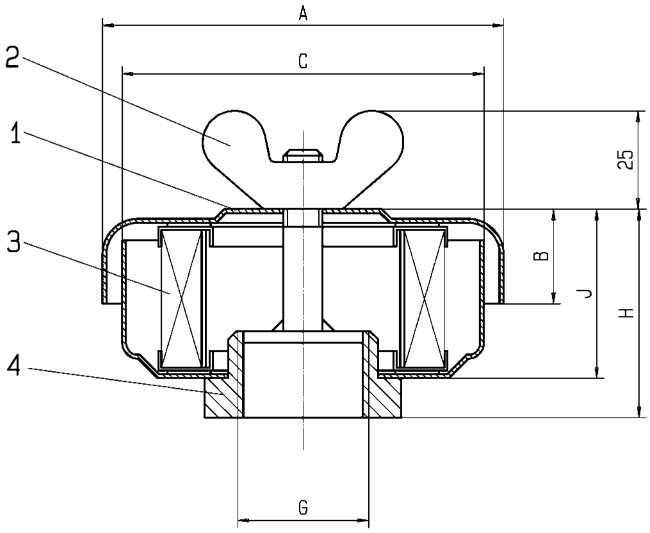
Bypass valve
0 = without

Seal
M = NBR seal

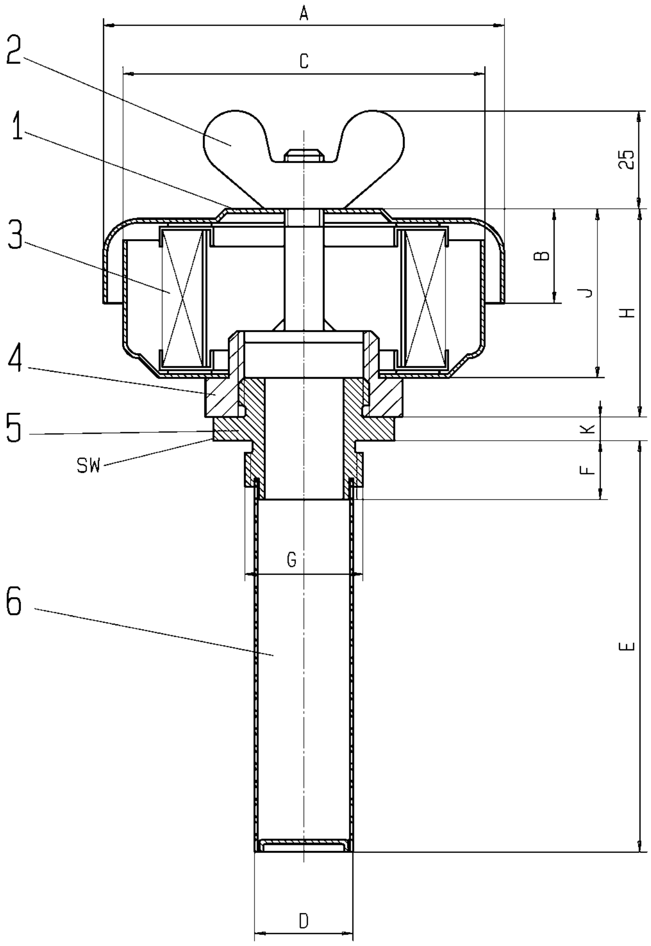
Ordering example:
7.007 P10-S00-0-M

Unit dimensions nominal sizes 1-25 to 6-80

TLF I…

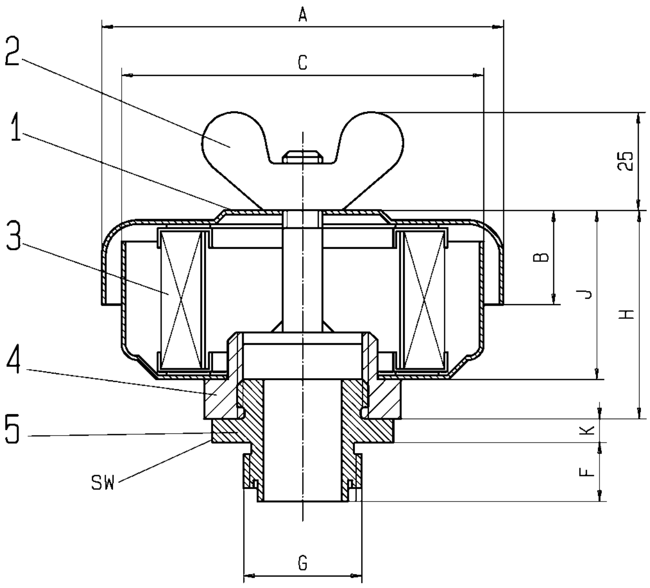


TLF III…



Design with filling piece
and filling screen

TLF II…



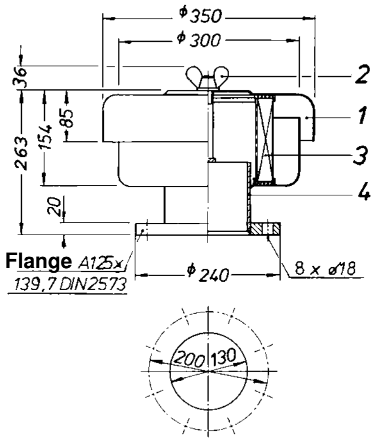
Design with filling piece

Unit dimensions nominal sizes 1-25 to 6-80 (dimensions in mm)

Size	Weight in kg	A	B	C	D	E	F	G	H	J	K	SW
TLF I 1-25	0.5	Ø 104	24	Ø 92	—	—	—	G 1	53	43	—	—
TLF I 2-32	0.6							G 1¼	63			
TLF I 3-40	2.1	Ø 177	46	Ø 162				G 1½	90	80		
TLF I 4-50	2.1							G 2				
TLF I 5-65	2.1							G 2½				
TLF I 6-80	2.4	Ø 210	45	Ø 190				G 3	88	78		
TLF II 1-25	0.6	Ø 104	24	Ø 92	—	—	25	G 1	53	43	6	46
TLF II 2-32	0.7							G 1¼	63			55
TLF II 3-40	2.3	Ø 177	46	Ø 162			26	G 1½	90	80	7	60
TLF II 4-50	2.3							G2				75
TLF II 5-65	2.3						28	G2½			8	90
TLF II 6-80	2.7	Ø 210	45	Ø 190			30	G 3	88	78	9	105
TLF III 1-25	0.7	Ø 104	24	Ø 92	Ø 28	107	25	G 1	53	43	6	46
TLF III 2-32	0.8				Ø 34	131		G 1¼	63			55
TLF III 3-40	2.5	Ø 177	46	Ø 162	Ø 42	155	26	G 1½	90	80	7	60
TLF III 4-50	2.5				Ø 53	185		G 2				75
TLF III 5-65	2.5				Ø 67	217	28	G 2½			8	90
TLF III 6-80	2.8	Ø 210	45	Ø 190	Ø 82	254	30	G 3	88	78	9	105

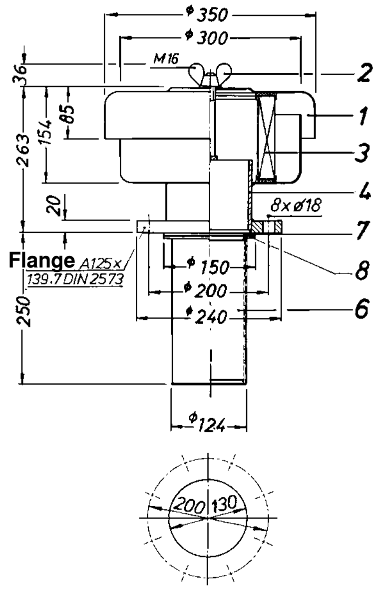
Unit dimensions nominal sizes 7-125, 8-250

TLF I 7-125



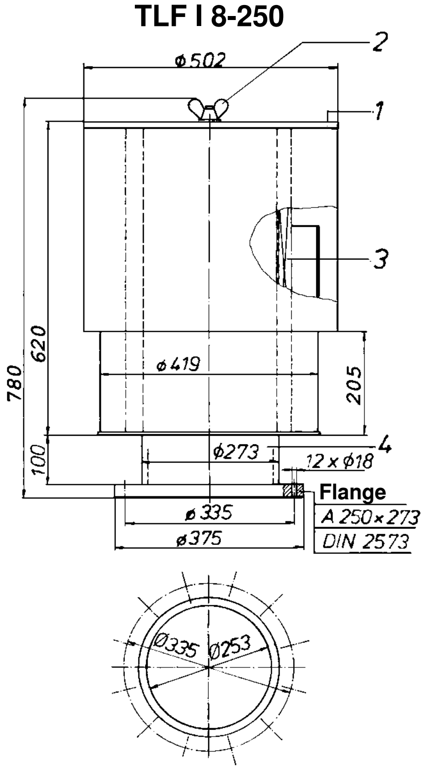
Hole pattern

TLF III 7-125



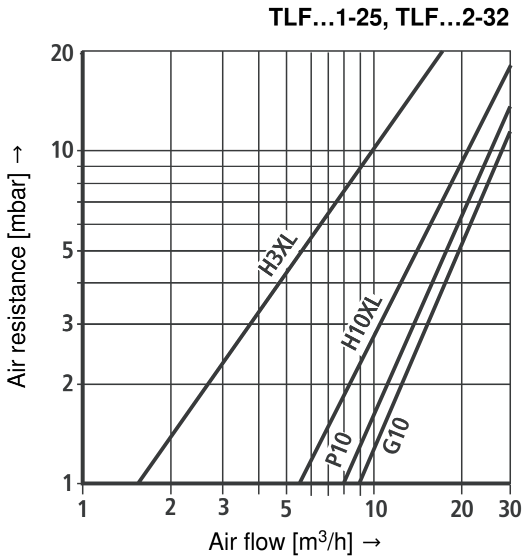
Hole pattern

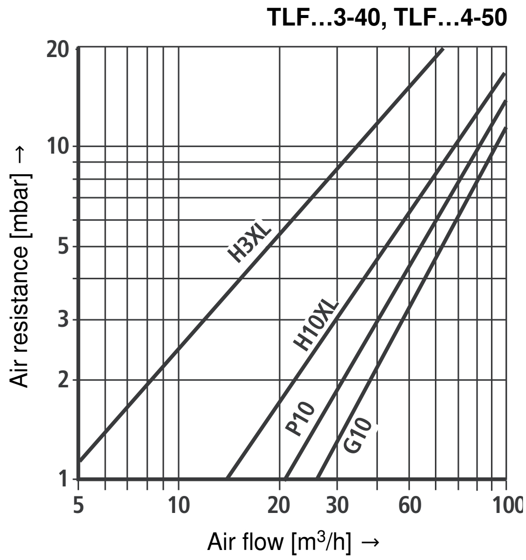
TLF I 8-250

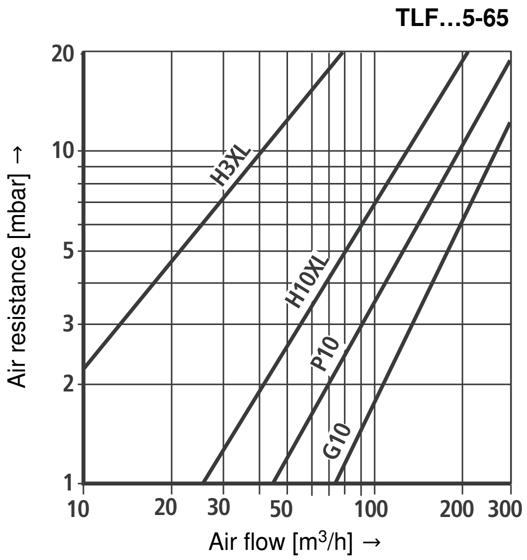


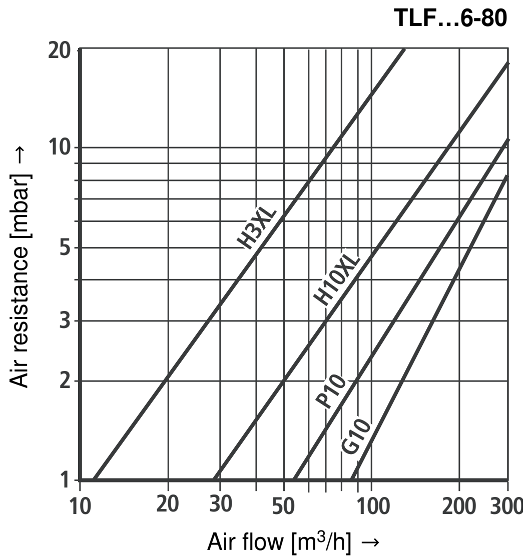
Hole pattern

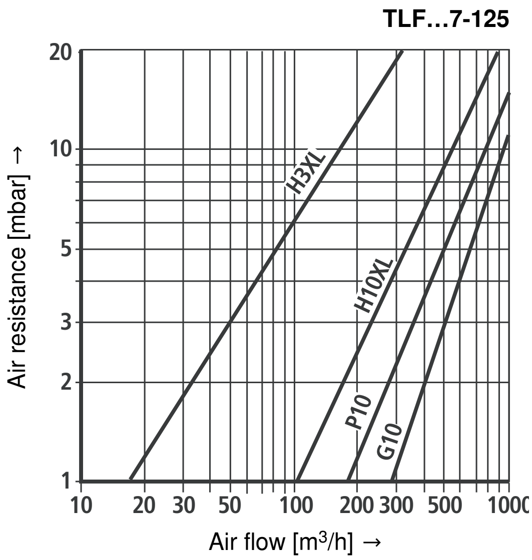
Characteristic curves (measured at test temperature = 20 °C)

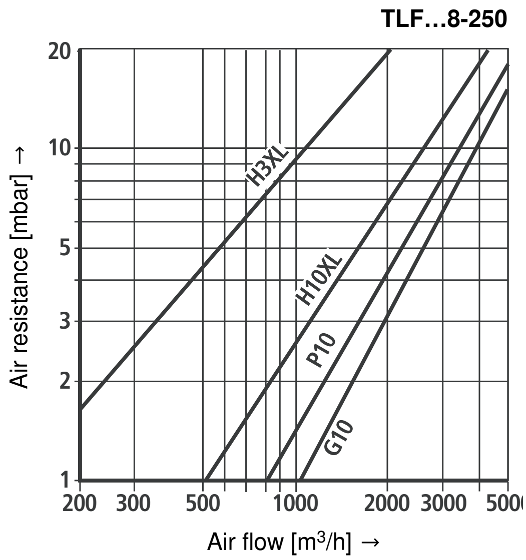












Notes

Notes

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Phone +49 (0) 62 02 / 6 03-0
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brfs-support@boschrexroth.de
www.eppensteiner.de

14.8 Valves

14.8.1 Valve blocks

Voith Article No.: 4 201528 001
Voith Article No.: 4 223859 0

Type: N 342.44.483.21
Type: N 342.42.482.01

Description . . . . .Schneider

Description . . . . .Schneider

14.8.2 Check valves

Voith Article No.: 4 134975 0
Voith Article No.: 4 203312 0
Voith Article No.: 4 246798 0

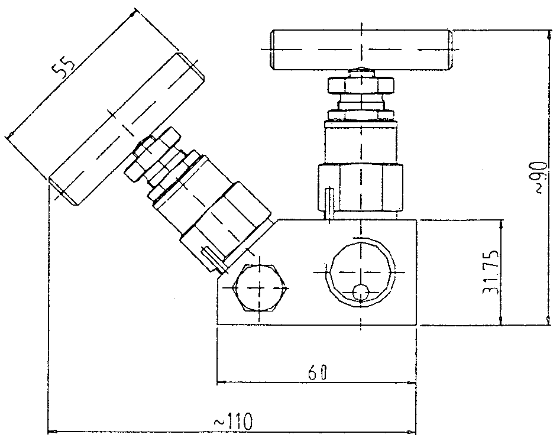
Type: RK 44 NW40 (D3)
Type: RK 44 NW40 (D2)
Type: RK 80A NW80

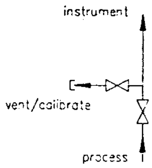
Data sheet . . . . Gestra

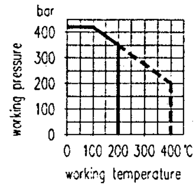
Data sheet . . . . Gestra

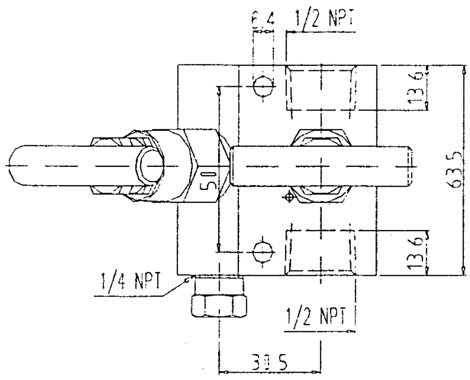
2 valve manifold PN 420 DN 5

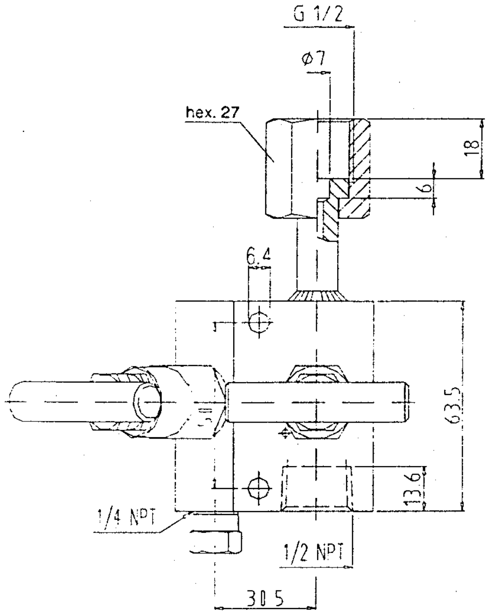
for pressure instruments with 1/2 NPT and G 1/2 male











MOUNTING ACCESSORIES see section 8 and 10

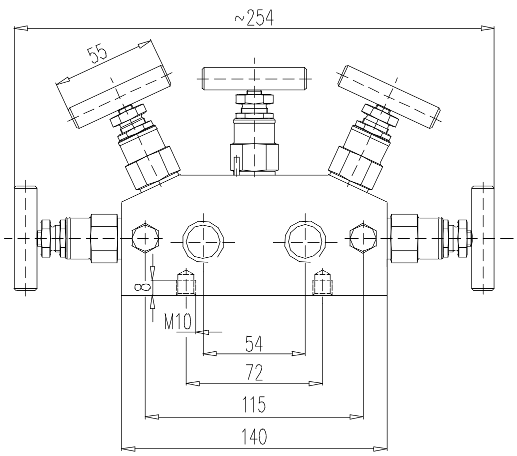
Material	Connections: Inlet	Connections: Outlet	Connections: Vent / Calibrate connection	Part no.
steel st. st.	1/2 NPT female		1/4 NPT female with screw plug	N 342.44.183.21 N 342.44.483.21
steel st. st.	1/2 NPT female	swivel nut G 1/2		N 342.44.183.22 N 342.44.483.22

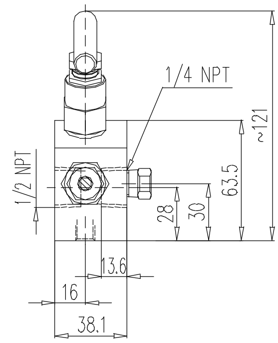
Components	Steel	Stainless steel [1]
	DIN - Material Number	
Body [2]	1.0460	1.4404
Bonnet	1.0501	1.4571
Valve stem	1.4104	1.4571
Needle tip [3]	1.4122 [4]	1.4571
Packing	PTFE up to 200°C special packing up to 400°C	
Gland nut	1.0501	1.4301
T-handle	stainless steel	
Screw plug	1.0501	1.4404

- Surface: steel phosphatized
- External stem thread
- Stem with cold rolled surface, back seat and non-rotating needle tip
- Special types are available
- The manifolds can be supplied according to NACE-standard

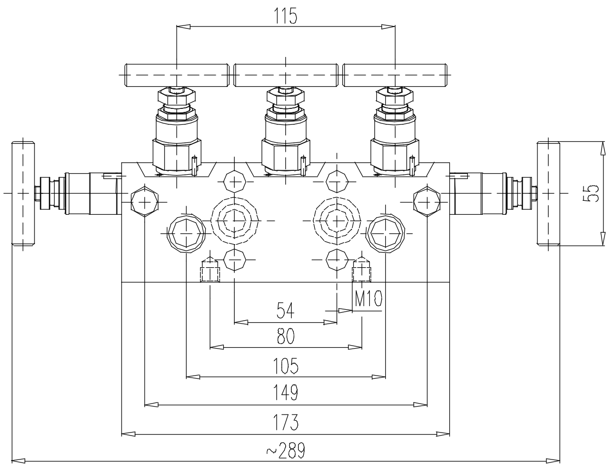
1) Can also be supplied for oxygen service. Please notice order instruction B 3!
2) Available with inspection certificate 3.1.B acc. to EN 10 204
3) Also available with soft tip in KEL-F (PCTFE) or Delrin (POM)
4) 1.4122 quenched and tempered

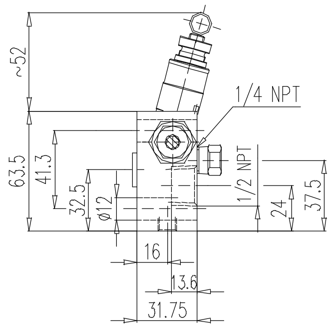
Type 1 (for remote mounting)



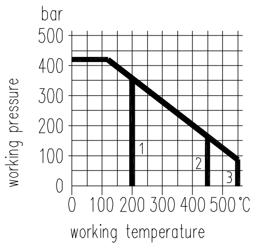


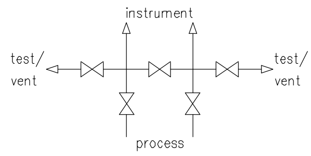
Type 2 (for direct mounting)





1 PTFE packing
2 graphite packing - 1.0460
3 graphite packing - 1.4404





MOUNTING ACCESSORIES see section 8

Type	Material	Connections: Inlet	Connections: Outlet	Test / Vent	Part no.
1	steel st. st.	1/2 NPT female		1/4 NPT female with screw plug	N342.42.182.01 N342.42.482.01
2	steel st. st.	1/2 NPT female	IEC Type A 4)		N542.48.180.01 N542.48.480.01

Components	Steel	Stainless steel 1)
	DIN - Material Number	
Body 2)	1.0460	1.4404 / 316L
Bonnet	1.4401 / 316	
Valve stem	1.4404	
Needle tip 3)	1.4122 5)	1.4571
Packing	PTFE up to 200°C (graphite up to 550°C)	
Gland nut	1.4301	
T-handle	stainless steel	
Screw plug	1.0501	1.4404

- Surface: steel phosphatized
- External stem thread
- Stem with cold rolled surface, back seat and non-rotating needle tip
- Special types are available
- The manifolds can be supplied according to NACE-standard

1) Can also be supplied for oxygen service. Please notice order instruction B 3!
2) Available with inspection certificate 3.1.B acc. to EN 10 204
3) Also available with soft tip in KEL-F® (PCTFE) or Delrin® (POM)
4) Dimensions acc. to IEC 61518 / DIN EN 61518 see order instruction B 4
5) 1.4122 quenched and tempered

Proper use

Shut-off valves assembled with „E-series“ valve head units are used to connect instruments to the impulse lines or to shut off the impulse lines in chemical plants, power stations or similar facilities.

The max. permissible operating pressure depends on the temperature of the medium and on the used materials of the parts and gaskets. Please pay attention to the pressure-temperature-diagram of the valve or manifold.

Any other use or any modification are not allowed and exclude the manufacturer from any liability.

General warning

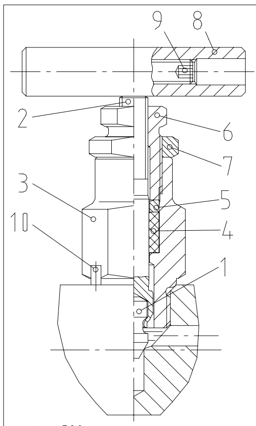
Shut-off valves with „E-series“ valve head units are used to shut off various media. These can be **poisonous, explosive, irritating, very hot or very cold**. Mounting, disassembling, operation and maintenance may only be done by experienced staff, which is familiar with the secure handling of the used medium.

In addition to these instructions also the common safety regulations and the instructions of the complete installation and of the measuring device have to be considered.

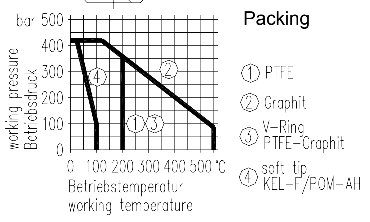
Suitability of material:

Protection against improper use of the shut-off valve:
In particular, it has to be ensured that the chosen materials of the wetted parts of the valve are suitable for the used media.
The manufacturer is not responsible for damages at the shut-off valve caused by corrosive media.
The disregard of these precautions can mean danger for the user and it can also cause damages in the piping system.

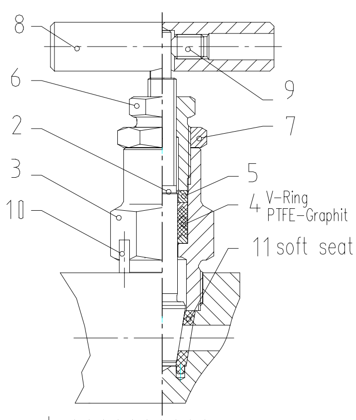
Types

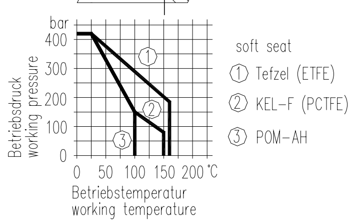


1	valve tip
2	stem
3	bonnet
4	packing
5	gland
6	gland nut
7	lock nut
8	handle
9	set screw
10	lock pin

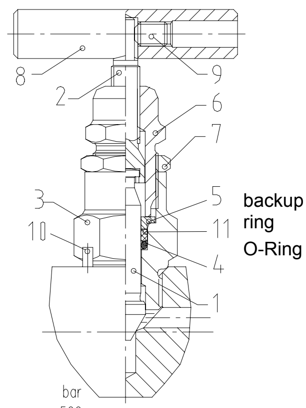


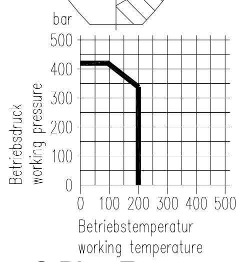
E-series standard





E-series soft seat
S011.42_20.__(__)





O-Ring-Type

Installation / Disassembling

Mounting and disassembling may only be done at depressurized systems!

Even at depressurized systems the parts can be very hot or very cold for a reasonable period of time!
Small volumes of the medium can penetrate during disassembling.
Wear protective gloves and safety glasses!

Operating

The valves are operated by T-handles or socket wrench.

Close clockwise.

1. Adjustment of packing

The packing (4; stem sealing against atmosphere) is pre-set at 1.5 times the nominal pressure. In case of long storage, the packing may lose it's tightness as it isn't under pressure. In this case it should be adjusted as follows:

Open the stem (2) and release the lock nut (7). Tighten the gland nut (6) ¼ turn until the valve feels not too slack or difficult to operate. Then tighten down the lock nut.

Required tools: engineer's wrench A/F 19 and A/F 14

2. Relieving of packing

Open the valve by turning the T-handle or socket wrench in an anti clockwise direction until it stops (back seat).

3. Replacing the head unit

Required tools: hexagon socket wrench A/F 3mm, flat-nose pliers, torque ring spanner A/F 22mm, hammer, drift punch

a) Depressurize the impulse line.
b) Open the stem up to the stop. Then dismount the T-handle.
c) Remove the lock pin (10).
d) Unscrew the valve head unit (3) counter-clockwise.
e) Lubricate the threads of the new head unit (valves for oxygen service require special approved lubricants). Open the stem completely up to the stop (back seat).
f) Screw in the new valve head unit and tighten it with a torque of 100 Nm (70 Nm for soft seat type).
g) Drive in the lock pin (10).
h) Mount the T-handle.
i) Pressurize the impulse line.
j) Check the packing for tightness and whether the valve feels not too slack or difficult to operate.

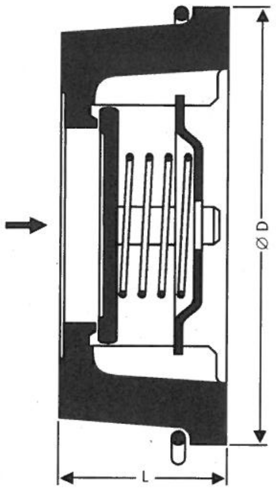
4. Oxygen service

For degreased valves for oxygen service please consider the applicable accident prevention regulations.

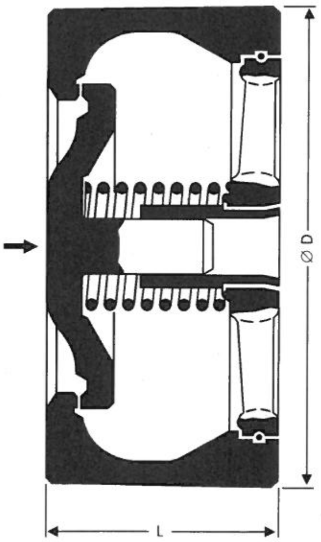
Our products are manufactured to ISO9001 levels of quality assurance.

Non-Return Valves RK
PN 6 to PN 40

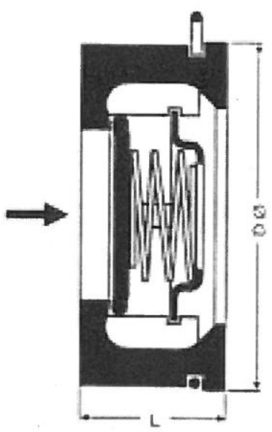
GESTRA



RK 41/RK 44
DN 15 – 100 mm



RK 41/RK 44
DN 125 – 200 mm



RK 76
DN 15 – 100 mm

Application

Type	PN	
RK 41 **RK 44** **RK 76**	16 16 40	For liquids, gases, vapours. Application as gravity circulation check, vacuum breaker, breather, foot valve, pressure-maintaining valve, check valve. RK 41 especially suited for heating installations RK 44 for sea water and drinking water RK 76 for industrial applications

Body Material

Type	Nominal sizes (DN)	DIN reference	ASTM equivalent
RK 41	15 – 100 mm	2.0540	Special Brass
	125 – 200 mm	0.6025	A 126 Class A
RK 44	15 – 200 mm	2.1050	B 584 C 90 500
RK 76	15 – 100 mm	1.4008	A 217-CA 15

Physical and chemical properties comply with DIN grade. ASTM nearest equivalent is stated for guidance only.

Dimensions

	DN	[mm]	15	20	25	32	40	50	65	80	100	125	150	200
		[in]	½	¾	1	1¼	1½	2	2½	3	4	5	6	8
	L	[mm]	16	19	22	28	31.5	40	46	50	60	90	106	140
RK 41	D	[mm]	40	47	56	72	82	95	115	132	152	184	209	264
RK 44	D	[mm]	42	49	58	74	84	97	117	132	152	184	209	264
RK 76	D	[mm]	45	55	65	75	85	98	118	134	154	–	–	–

Pressure/Temperature Ratings

Type	PN	Nominal sizes (DN)	PMA / TMA / [bar] / [°C]		
RK 41	16	15 – 100 mm	16 / -60	14 / 200	13 / 250
	16	125 – 200 mm	16 / -10	13 / 200	13 / 300
RK 44	16	15 – 100 mm	16 / -200	14 / 200	13 / 250
	16	125 – 200 mm	16 / -10	14 / 200	13 / 250
RK 76	40	15 – 100 mm	40 / -10	32 / 200	28 / 300

Non-Return Valves RK – PN 6 to PN 40

Short overall length according to DIN EN 558-1, table 11, series 49 (≙ DIN 3202, part 3, series K4)

GESTRA

Pressure Drop Charts

The curves given in the chart are valid for water at 20 °C. To read the pressure drop for other fluids the equivalent water volume flowrate must be calculated and used in the graph.

The values indicated in the chart are applicable to spring-loaded valves with horizontal flow. With vertical flow insignificant deviations occur only within the range of partial opening.

$$\dot{V}_W = \dot{V} \cdot \sqrt{\frac{\rho}{1000}}$$

$\dot{V}_W$ = Equivalent water volume flow in [l/s] or [m³/h]

ρ = Density of fluid (operating condition) in [kg/m³]

$\dot{V}$ = Volume of fluid (operating condition) in [l/s] or [m³/h]

Opening Pressures

Differential pressures at zero volume flow.

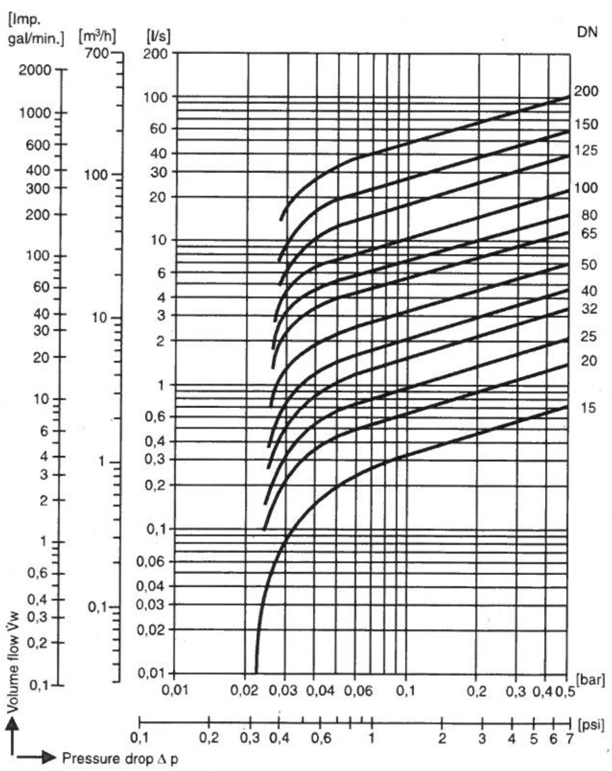
RK 41, RK 44, RK 76*)

DN	Opening pressures [mbar]			
	Direction of flow			
	without spring ↑	with spring ↑	with spring →	with spring ↓
15	2.5	25	22.5	20
20	2.5	25	22.5	20
25	2.5	25	22.5	20
32	3.5	27	23.5	20
40	4.0	28	24.0	20
50	4.5	29	24.5	20
65	5.0	30	25.0	20
80	5.5	31	25.5	20
100	6.5	33	26.5	20
125	12.5	35	22.5	10
150	14.0	38	24.0	10
200	13.5	37	23.5	10

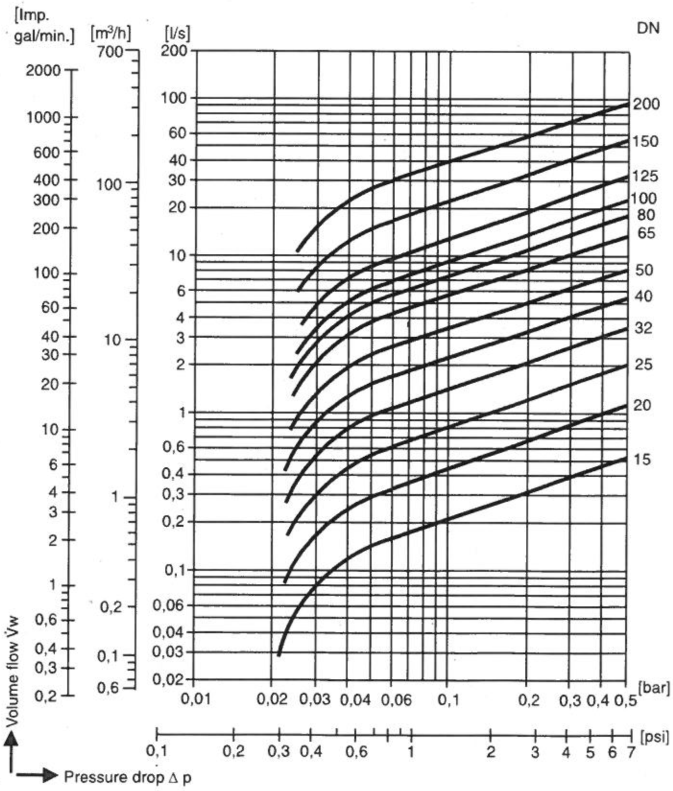
***) RK 76 not available with special springs.**

A2

RK 41/44



RK 76



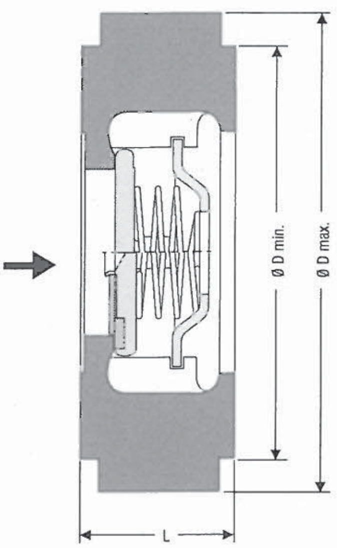
DISCO Non-Return Valves RK
PN 6 to PN 40

GESTRA

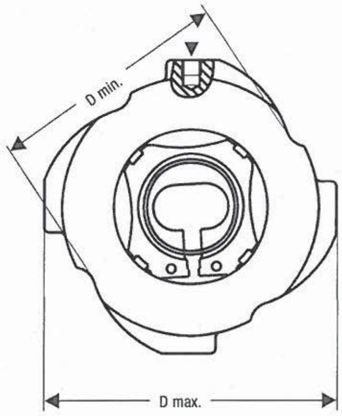
Stock Code

Type	PN	DN [mm]	Stock code
RK 41	6/10/16	15	1021200
	6/10/16	20	1021400
	6/10/16	25	1021500
	6/10/16	32	1021600
	6/10/16	40	1021700
	6/10/16	50	1021800
	6/10/16	65	1021900
	6/10/16	80	1022000
	6/10/16	100	1022100
	6/10/16	125	1022200
	6/10/16	150	1022300
	6/10/16	200	1022500
RK 44	6/10/16	15	1031200
	6/10/16	20	1031400
	6/10/16	25	1031500
	6/10/16	32	1031600
	6/10/16	40	1031700
	6/10/16	50	1031800
	6/10/16	65	1031900
	6/10/16	80	1032000
	6/10/16	100	1032100
	6/10/16	125	1032200
	6/10/16	150	1032300
	6/10/16	200	1032500
RK 76*)	6/10/16/25/40	15	1201200
	6/10/16/25/40	20	1201400
	6/10/16/25/40	25	1201500
	6/10/16/25/40	32	1201600
	6/10/16/25/40	40	1201700
	6/10/16/25/40	50	1201800
	6/10/16/25/40	65	1201900
	6/10/16/25/40	80	1202000
	6/10/16/25/40	100	1202100

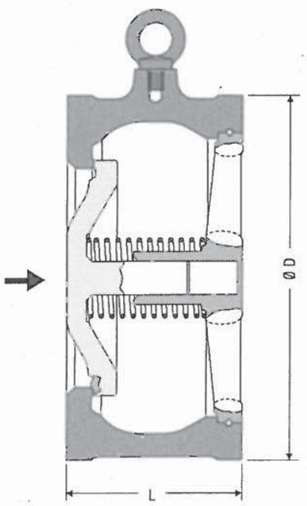
***) RK 76 not available with soft seat or special spring.**



RK 86 / RK 86 A
DN 15 bis 100



RK 86 / RK 86 A
DN 15 bis 100



RK 86 / RK 86 A
DN 125 bis 200

RK 86 und RK 86 A – Die Allrounder im Programm

Verwendung

Typ	PN	
RK 86 RK 86 A	40/class 300 40/class 300	Für Flüssigkeiten, Gase, Dämpfe. Einsatz als Schwerkraft-umlaufsperre, Kurzschlusssperre, Rückflusssperre, Vakuumbrecher, Ansaugfußventil oder Überströmventil. RK 86 A besonders geeignet für tiefe Temperaturen, aggressive Medien, Kesselspeisewasserleitungen und andere industrielle Anwendungen.

Werkstoffe

Typ		DN	EN	ASTM [1])
RK 86	Gehäuse	15 – 100	Chromstahl, 1.4317	A743-CA6-NM
	Ventilplatte		1.4571	AISI 316 Ti
	Gehäuse	125 – 200	GP240GH (1.0619)	A216 WCB
	Kegel		1.4006	A182 F6 A
RK 86A	Gehäuse	15 – 100	1.4408	A351 CF 8M
	Ventilplatte		1.4571	AISI 316 Ti
	Gehäuse	125 – 200	1.4408	A351 CF 8M
	Kegel		1.4404	A182 F316 L

[1]) ASTM-Werkstoff vergleichbar mit dem EN-Werkstoff!
Unterschiede der chemischen und physikalischen Eigenschaften beachten!

Maße

Nennweite	[mm]	15	20	25	32	40	50	65	80	100	125	150	200
	[Inch]	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	5	6	8
Baumaße [mm]	L	16	19	22	28	31,5	40	46	50	60	90	106	140
	Ø D_{min}	44	53	64	73	83	96	110	128	151	–	–	–
	Ø D_{max}	67	76	82	93	104	118	136	158	186	–	–	–
Ø D	PN 10/16	–	–	–	–	–	–	–	–	–	194	220	275
	PN 25	–	–	–	–	–	–	–	–	–	194	226	286
	PN 40	–	–	–	–	–	–	–	–	–	194	226	293
	Class 125/150	–	–	–	–	–	–	–	–	–	194	220	275
	Class 300	–	–	–	–	–	–	–	–	–	216	251	308
Gewicht	[kg]	0,27	0,38	0,52	0,8	1,12	1,78	2,43	3,37	5,34	11	14	25

Einsatzgrenzen bei metallischem Abschluss

Typ	PN	DN	p / T / [bar] / [°C]		
RK 86	40/class 300	15 – 100	51 / -10	43,9 / 200	36,9 / 350
	40/class 300	125 – 200	51 / -10	43,9 / 200	34,5 / 400
RK 86 A	40/class 300	15 – 200	49,6 / -200	35,8 / 200	24 / 550

Ausführungen

Typ	Sitzdichtung				Schließfedern			Erdungs-anschluss
	metallisch	EPDM (–40 bis 150 °C)[2])	FPM (–25 bis 200 °C)[2])	PTFE [3])	ohne Feder	Sonder-federn	Nimonic-feder [4])	
RK 86	X	0	0	0	0	0	0	X
RK 86A	X	0	0	0	0	0	0	X

[2]) Geräte-Einsatzgrenzen beachten!
[3]) DN 15-100 -190 °C bis 250 °C; DN 125-200 -60 bis 200 °C
[4]) Bei Temperaturen über 300 °C erforderlich

X : Standard
0 : optional

Druckverlustdiagramm

Werte für Wasser bei 20 °C. Zum Ablesen der Druckverluste bei anderen Medien ist der äquivalente Wasservolumenstrom zu berechnen.

Diagrammwerte basieren auf Messungen an Ventilen mit Feder bei waagerechtem Einbau. Bei senkrechtem Einbau ergeben sich nur im Bereich der Teilöffnung unbedeutende Abweichungen.

$$\dot{V}_W = \dot{V} \cdot \sqrt{\frac{\rho}{1000}}$$

$\dot{V}_W$ = äquivalenter Wasservolumenstrom in [l/s] oder [m³/h]

ρ = Dichte des Mediums (Betriebszustand) in [kg/m³]

$\dot{V}$ = Volumenstrom des Mediums (Betriebszustand) in [l/s] oder [m³/h]

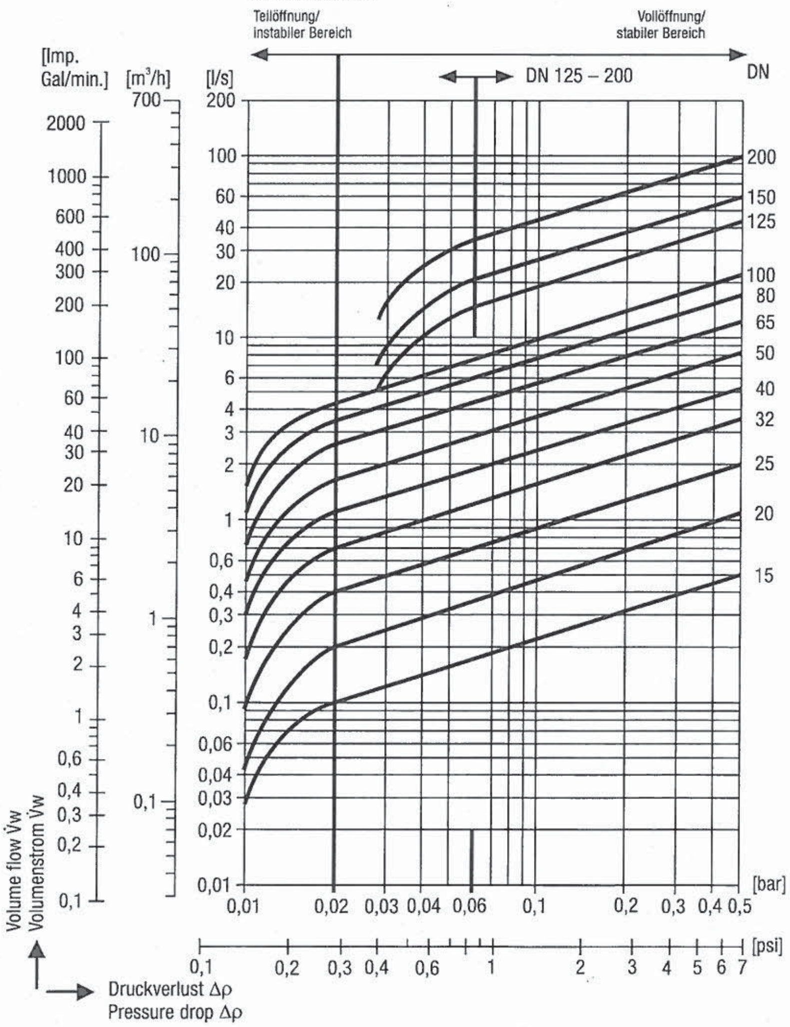
Öffnungsdrücke

Druckdifferenzen bei Volumenstrom Null.

RK 86, RK 86 A

DN	Öffnungsdrücke [mbar]			
	Durchflussrichtung der Ventile			
	ohne Feder ↑	mit Feder ↑	mit Feder →	mit Feder ↓
15	2,5	10	7,5	5
20	2,5	10	7,5	5
25	2,5	10	7,5	5
32	3,5	12	8,5	5
40	4,0	13	9	5
50	4,5	14	9,5	5
65	5,0	15	10	5
80	5,5	16	10,5	5
100	6,5	18	11,5	5
125	12,5	35	22,5	10
150	14,0	38	24,0	10
200	13,5	37	23,5	10

RK 86, 86A



14.9 Duplex filter

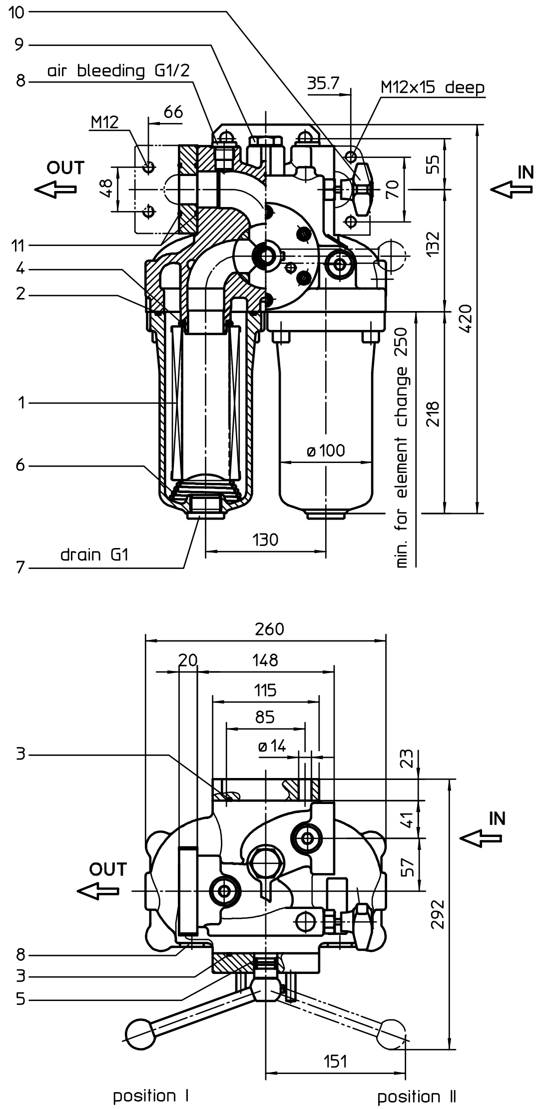
Voith Article No.: 204.00207800

Type: DSF.176.43838.10VG

Description . . . . Internormen

PRESSURE FILTER, change-over
Series DSF 176.43838 DN 40/32 PN 25

Sheet No.
43838-4



Pos. I: left filter side in operation
Pos. II: right filter side in operation

1. Type index:

1.1. Complete filter: (ordering example)

DSF.	176.	43838.	10VG.	16.	E.	P.	-.	FS.	7.	FW.	02.	-
1	2	3	4	5	6	7	8	9	10	11	12	13

1 **series:**
DSF = duplex filter

2 **nominal size:** 176

3 **execution** according to sheet-no. 43838

4 **filter-material and filter-fineness:**
25 G = 25 µm stainless steel wire mesh
10VG = 10 $\mu m_{(c)}$ Interpor fleece (glass fibre)

5 **resistance of pressure difference for filter element:**
16 = Δp 16 bar

6 **filter element design:**
E = without by-pass valve

7 **sealing material:**
P = Nitrile (NBR)

8 **filter element specification:**
\- = standard

9 **connection „IN“:**
FS = SAE-flange 3000 PSI

10 **connection size „IN“:**
7 = 1 ½“

11 **connection „OUT“:**
FW = flange according to INTERNORMEN factory specification

12 **connection size „OUT“:**
02 = DN32

13 **filter housing specification:**
\- = standard

1.2. Filter element: (ordering example)

01E.	175.	10VG.	16.	E.	P.	-
1	2	4	5	6	7	8

1 **series:**
01E = filter element according to INTERNORMEN factory specification

2 **nominal size:** 175

4 - 8 see type index-complete filter

weight: approx. 36 kg

Changes of measures and design are subject to alteration!

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2. Spare parts:

item	qty.	designation	dimension	article-no.
1	2	filter element	01E.175.10VG.16.E.P.-	300156
	2	filter element	01E.175.25G.16.E.P.-	300161
2	2	O-ring	98 x 4	301914 (NBR)
3	2	O-ring	75 x 3	302215 (NBR)
4	2	O-ring	44 x 6	302222 (NBR)
5	2	O-ring	18 x 3	304359 (NBR)
6	2	pressure spring	d=4,0 Da=80/60 Lo=50,0 if=2,5	304989
7	2	screw plug	G 1	305303
8	4	screw plug	G ½	304678
9	1	screw plug	20913-4	309817
10	1	pressure balance valve		
11	2	O-ring	50 x 3	307398 (NBR)

3. Description:

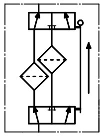
Duplex filters change-over of the series DSF 176.43838 are suitable for a working pressure up to 25 bar
Pressure peaks can be absorbed with a sufficient margin of safety.
A three-way-change-over valve which is integrated in the middle of the housing makes it possible to switch from the dirty filter-side to the clean filter-side without interruting operation.
The filters can be installed as suction filter, pressure filter or return-line filter.
The filter element consist of star-shaped, pleated filter material which is supported on the inside by a perforated core tube and is bonded to the end caps with a high-quality adhesive. The flow direction is from outside to the inside. Filter finer than 40 µm should use throw-away elements made of paper or Interpor fleece (glass fibre). Filter elements as fine as 5 $\mu m_{(c)}$ are available; finer filter elements on request.
INTERNORMEN-Filter elements are known as elements with a high intrinsic stability and an excellent filtration capability, a high dirt-retaining capacity and a long service life.
INTERNORMEN-Filter are suitable for all petroleum based fluids, HW-emulsions, most synthetic hydraulic fluids and lubrication oils.
Approvals according to TÜV, and the major „Shipyard Classification Societies“ D.N.V.; B.V.; G.L.; L.R.S.; R.I.N.A.; A.B.S.; P.R.S.;USS.R.S. and others are possible.

4. Technical data:

temperature range:	- 10°C to + 80°C (for a short time + 100°C)
operating medium:	mineral oil, other media on request
max. operating pressure:	25 bar
test pressure:	50 bar
connection:	SAE-flange 3000 PSI, flange INTERNORMEN factory specification DN32
housing material:	EN-GJS-400-18-LT
sealing material:	Nitrile (NBR)
installation position:	vertical
bleeder connections:	G ½
evacuation connections:	G 1
volume tank:	2x 1,2 l

Classified under the Pressure Vessel Directive 97/23/EC for mineral oil (fluid group 2), Article 3, Para. 3.
Classified under ATEX Directive 94/9/EC according to specific application (see questionnaire sheet-no. 34279-4).

5. Symbol:



6. Pressure drop flow curves:

Precise flow rates see 'INT-Expert-System Filter', respectively ∆p-curves; depending on filter fineness and viscosity.

7. Test methods:

Filter elements are tested according to the following ISO standards:

ISO 2941	Verification of collapse/burst resistance
ISO 2942	Verification of fabrication integrity
ISO 2943	Verification of material compatibility with fluids
ISO 3723	Method for end load test
ISO 3724	Verification of flow fatigue characteristics
ISO 3968	Evaluation of pressure drop versus flow characteristics
ISO 16889	Multi-pass method for evaluating filtration performance

Manual and maintenance instructions

for INTERNORMEN pressure filters, change-over
DSF 175, 176, 330, 331, related specifications

This manual is effective for all filters of the type DSF 175, 176, 330, 331 and related specifications. It contains certain requirements and instructions which ensure unobjectionable operation of the filter. It can be completed with specific additional instructions by the operator himself if necessary.

1. Safety instructions

- Prior to operating the filter, manual and maintenance instructions have to be read carefully.
- Follow the instructions of this manual under any circumstances!
- The manufacturer does not assume liability for any damage, which occurs due to disregarding these instructions.
- If operations are carried out differently, the safety of the pressurized device can not be assured!
- Operating conditions given in the data sheet, especially excess pressure, temperature range and operating fluid, have to be followed unconditionally. Variation of these parameters can cause damage to important pressure holding parts and sealing. Also take in consideration the compatibility of filter components with the operating fluid.
- Under working conditions the filter housing is pressurized. Do not try to loosen or remove any part of the filter or the filter housing during operation. The operating fluid could escape at high pressure and high temperatures.
  This does not apply for parts of the decompressed or the turned off side of the filter.
- Leaking operating fluid always bears the danger of injuries and burns!
- Do not open the filter housing until you made sure it is not pressurized any more!
- Touching parts of the filter may cause burning, depending on the operating temperature.
- When exchanging the filter keep in mind that it might have operating temperature. Danger of burning!
- Always wear safety goggles and gloves when working on the filter!
- If you come into contact with the operating fluid please follow the instructions of the fluid manufacturer!!
- Only use original spare parts.

For filters being used in hazardous locations the INTERNORMEN documentation N° 41269 "Supplementation of the Operating Manual for the use of filters in potential explosive areas.

2. Installation

Note safety instructions!

When removing a new filter from its box it is ready for installation. The filter is fixed with 2 screws M12 at a vertical mounting surface.

When installing the filter please make sure, that:
- sufficient fixation of the filter is assured
- the clogging indicator is accessible and can be checked easily.
- the connections for draining, air-bleeding and pressure measurements can be accessed easily.
- there is enough room above the filter to remove and replace elements.
- no dirt, particles, other contamination or fluids enter the filter.
- both inlet and outlet of the filter are connected to the pipe work correctly.
- counterflanges or screw joints of the pipe system and the filter have to be angled precisely and connected that same way (if counterflanges or pipe joints are canted or under tension switching filters can be aggravated and it might harm pressure tightness)

3. Commissioning

Prior to the commissioning of the filter the completeness (filter elements, seals) has to be controlled.
Then the filter has to be bleeded as follows :

- Set the shift lever of the reversing valve into middle position
- Open the screw plugs G ½" at the air-bleed bore holes and connect suitable air bleeding tubes with collecting pan for the operating fluid flowing out
- Connection of the volume flow until bubble-free operating fluid flow out of the air-bleeding tubes
- Disconnection of the volume flow
- Remove the air-bleeding tubes and close the air-bleed bore holes
- Connection to the required filter side at the positioning pin of the selector shaft

The shift lever of the selector shaft always points at the operating filter side.

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4. Change of Elements

The change of filter elements is necessary when reaching the unit specific pressure difference, respectively the maximum pressure difference shown on the clogging indicator. If there is no unit specific definition, the change of elements should be done at a maximum pressure of Δp 6 bar.

The elements can be changed as follows:

- Open the pressure balance valve
- Set the positioning pin from the operating side to the other side
- Closing the pressure balance valve
- Open the screw plug for the bleeding at the filter side to be serviced (G ½" at operating filter side), respectively close the bleeding according to data sheet 1650 and open the drain screw G 1" at the filter bowl
- Unscrew the filter bowl
- Remove the filter elements
- Clean the filter bowl (pressure spring Item 8 (DSF175-330) and item 6 (DSF176-331) must be there)
- Install the new or cleaned filter element
- Screw the filter bowl to the filter housing
- Closing of the drain bore (G 1") at the filter bowl
- Air-bleeding of the serviced filter side (see Item 5)

In general take care of the absolute cleanness during the change of elements in order to prevent from any penetration of dirt, respectively of impurities. The new elements should be taken out of their package shortly before they are replaced, and they should be protected against mechanical damages.
When changing the filter elements the availability and quality of the sealing elements should be controlled. Worn-out sealing elements should be replaced by new ones.

5. Air-bleeding of the Filter

The air-bleeding of the filter during the change of elements is different to the air-bleeding of commissioning. For the change of elements there is an air-bleeding required only at the filter side to be serviced. The air-bleeding is done during the operation of the unit.

- Open the bleeding screw plug G ½" at the operating side of the filter head, respectively connect the bleeding device according to data sheet 1650
- Open the bleeding screw plug G ½" at the operating side of the filter head, respectively connect the bleeding device according to data sheet 1650
- Close the pressure balance valve and the bleeding bore hole. From filters equipped with a bleeding device according to data sheet 1650 this is to be removed.

6. Cleaning of the Filter Element

Filter elements with filter materials of glass fibre (VG) or paper (P) are not cleanable. They have to be replaced when having reached the dirt retention capacity . Filter elements with filter materials of wire mesh (G) are cleanable and can be used again.
The cleaning ost ehese filter elements has to be carried out according to the cleaning specification for INTERNORMEN-filter elements (metal), sheet-no. 21070-4 and 39448-4.

7. Pressure Difference Measuring

In case of filters installed with clogging indicators a permanent measuring of the pressure difference takes place. The indication corresponds to the kind of clogging indicators; either visual or visual and electrical respectively electronic.
In addition the air-bleeding connections III and IV can be used for the connection of external pressure gauges.
Recommended are the measuring connections according to data sheet 1650.

8. Service

The service will be performed by

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Special questions about the operation of the filter will also be answered within this area.
Spare parts respectively wearing parts have to be ordered according to the spare part list of the filter-data-sheet.

14.10 Voith Electro-Hydraulic Positioning Control (VEHS)

14.10.1 VEHS 4/3-way valve with control magnet

Voith Article No.: 9 186769 0

Type: VEHS BOX-L

VEHS Description - Instruction Manual . . . . 3626-015310 en

14.10.2 Position sensor

Voith Article No.: 4 220827 0

Type: BTL-P-1013-4R

14.10.3 Positions pickup

Voith Article No.: 204.01123210

Type: BTL 7-E100-M0175-B-KA05

Description . . . . BALLUF

Overall wiring. . . . . „Terminal Plan Sheet 1-6/ 215001154-0040“

Voith **E**lectro **H**ydraulic Po**s**itioning Control

VEHS

Description

5	2001-03-21	R. Schott
6	2006-08-02	R. Schott
6.3	2008-02-13	R. Schott
Revision	Datum	Name

PC

Voith Turbo GmbH & Co. KG - D-74555 Crailsheim
P.O Box 1555 · Telephone (07951) 32-0 · Fax 32-500

Contents

1. General

The **V**oith **E**lectro **H**ydraulic Po**s**itioning Control serves to provide an exact and continuous positioning. The VEHS is used for positioning the scoop tube for geared variable speed couplings and for positioning the guide vane for torque converters. The VEHS is a compact unit consisting of an electromagnetic actuator, a double-acting cylinder and the electronic position pickup.
The actual position is recorded by the electronic position pickup on the double-acting cylinder. The *electromagnetic actuator* consists of a *control magnet* with integrated PD controller with subordinated magnetic force control and a hydraulic *4/3-way valve*. The excellent control quality of positioning control circuit results from the high sensitivity/responsiveness and accuracy in case of short positioning times.

2. Operation

The VEHS unit is a positioner with PD action. The actuator (e.g. scoop tube, guide vanes) is positioned as a function of the position setpoint of a master controller (control circuit).
The internal position control circuit compares the actual position value (position pickup: 4 .. 20 mA <=> 100 % .. 0%) with the position setpoint of the master controller. The deviation (signal) acts on the subordinated magnetic force controller. The change in magnetic force F results in an adjustment of way valve (control pin). The control edges of way valve release an oil flow to and also from the double-acting cylinder.
The position pickup gives a signal of change in piston travel of double-acting cylinder back to the positioner. A decreasing deviation (w - x) also results in a reduction of magnetic force F and at w = x the way valve is in the hydraulic center position.
The electromagnetic actuator feeds the actual position (4 .. 20 mA <=> 0 .. 100 %) of actuator (scoop tube or guide vanes) back. This signal is not electrically isolated and can be used by the master controller or a local display unit.
To enable the dynamics of positioner to meet the exacting requirements, the electronics of electromagnetic actuator is designed in analog technology.
The electromagnetic actuator does not include fault monitoring. The master controller is required to monitor the position setpoint with the actual position value fed back, when all electrical and hydraulic sources of error are recorded.

3. Integrated Positioner Parameter Settings

The control response of positioner is set via parameter Kp (proportional-action coefficient). All other parameters are already factory-set and do not need to be changed.

FM: Setting of hydraulic control pin center position at w - x = 0
x0: Control pin setting at s = min, w = 4 mA
x1: Control pin setting at s = max, w = 20 mA
Kp: Setting of proportional-action coefficient -> increases in clockwise direction

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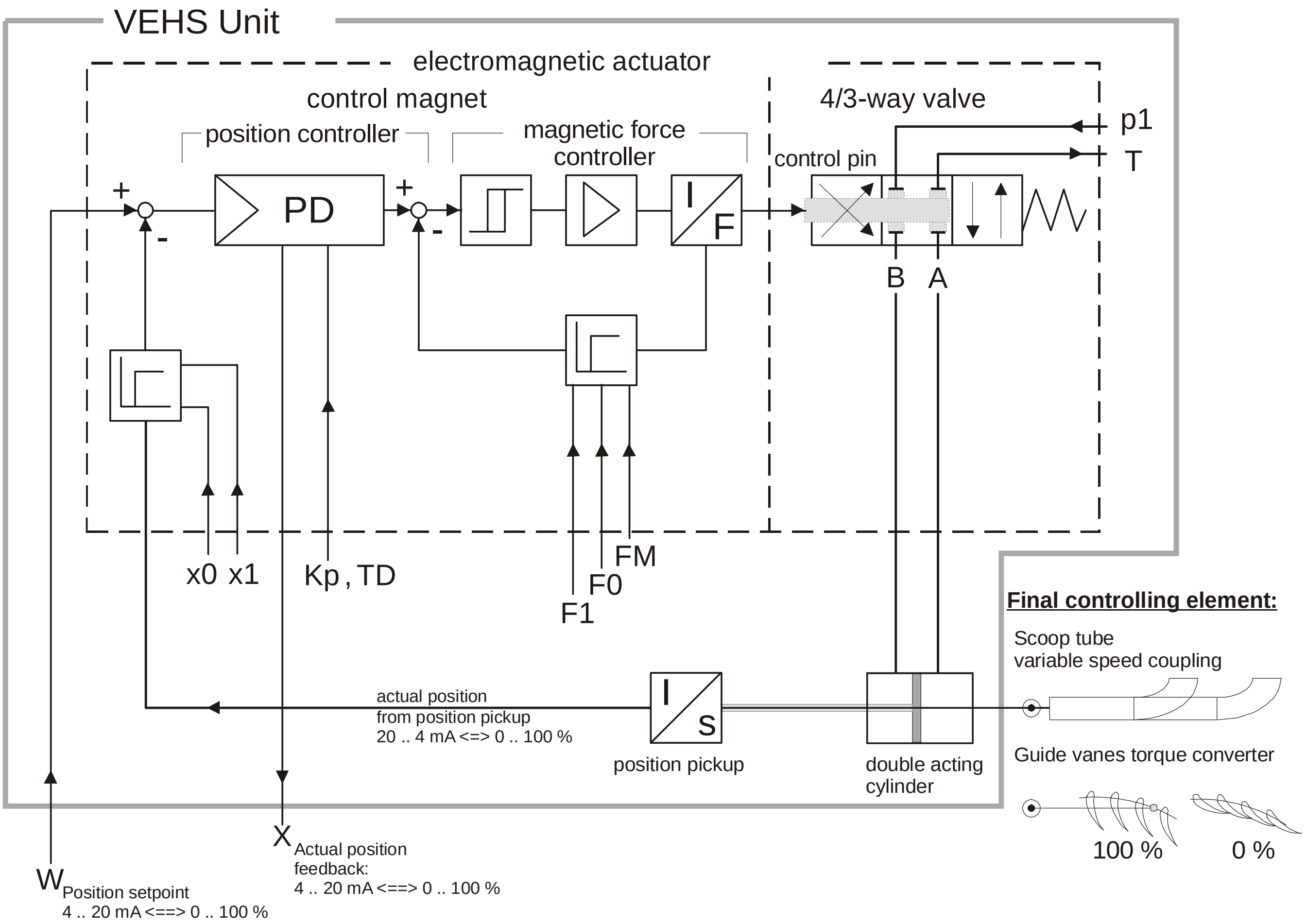
4. Block Diagram of Voith Electro Hydraulic Positioning Control



p1	=	Control oil pressure
T	=	Tank return pipe
A	=	Consumer
B	=	Consumer
W$_{\text{position setpoint}}$	=	Position setpoint of master controller: 4 .. 20 mA <=> 0 .. 100 %
X$_{\textbf{actual position}}$	=	Actual position feedback: 4 .. 20 mA <=> 0 .. 100 %

x0, x1
KP, FM
} Parameter setting through potentiometer

F1 and F0 factory-set and lacquered
TD factory-set and lacquered
} potentiometers are located behind the black cap.

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5. Technical Data

Supply voltage - stabilized: (residual ripple rated load < 1 %)	24 VDC ± 15 %	*1)
Maximum current consumption (temporarily):	3.0 A	
Current consumption during normal closed-loop control:	approx. 1.2 A	
Time constant (electrohydraulic conversion):	approx. 20 msec	
Settling time at 0 <=> 100 % setpoint step change at geared variable speed coupling and torque converter:	typical 5 - 10 sec	*2)
Settling time at 0 <=> 100 % setpoint step change at Vorecon:	typical 30 sec	*2)
Sensitivity of positioning control:	< 0.1 %	
Actual position of position pickup:	20 .. 4 mA = 0 ... 100 % input load 332 Ω	*3)
Analog output actual position feedback - : "**X**$_{\textbf{actual position}}$“ (non-isolated) Must not be supplied with 24 VDC (4-wire system).	4 .. 20 mA = 0 .. 100 % max. load: 400 ohm	
Analog input for position setpoint – "**W**$_{\textbf{position setpoint}}$“: (from the master controller), mA signal has to be provided with voltage as usual at a current source.	4 .. 20 mA = 0 .. 100 % max. 25 mA, input load 100 Ω, with suppressor circuit	
Grade of filtration for control oil:	20 µm	
Ambient temperature:	-20 °C ... 80 °C	
Protection:	IP 65	
Electromagnetic actuator:		
Explosion-proof design to PTB No. Ex-90.C.1065:	EExde IIC T4.	
Certificated to CSA <u>and</u>	Class I, Divisions 1 and 2, Groups B,C and D.	
Factory Mutal (1Z3A7.AE 0003000967)	XP/I/1/BCD/T4.	

<u>Remarks:</u>

*1) Nominal current consumption is approx. 1.2 A. The 24 VDC auxiliary energy supply line is to be dimensioned so that the terminal voltage does not fall below the value of 20.4 V on current consumption. On starting operation or during settling of greater disturbances, current consumption may temporarily (2 sec) rise up to 3.0 A.

*2) This short settling time is required for the rapid start function. To guarantee a sufficient control stability in case of a closed-loop control circuit, the master controller is required to output the position setpoint via a ramp function. In this case it is necessary to set the ramp time as a function of the process.

*3) Regarding circuit logic the positioner is designed to correct the 0 % position on failure of the position pickup signal:
xd = $W_{position\ setpoint}$ – inverted actual position of position pickup. On failure the actual position of position pickup is greater than 100 %.

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6. Electrical Connection

- The technical data regarding voltages, currents, powers, cable lengths (voltage drop) and tolerances are to be observed.
- A power supply protection is to be provided by the customer.
- All signal lines are to be shielded.
- Run motor lines and signal lines separately.
- It is mandatory to ground the reference potential of VEHS unit.
- For order-specific information, please refer to project wiring diagram.

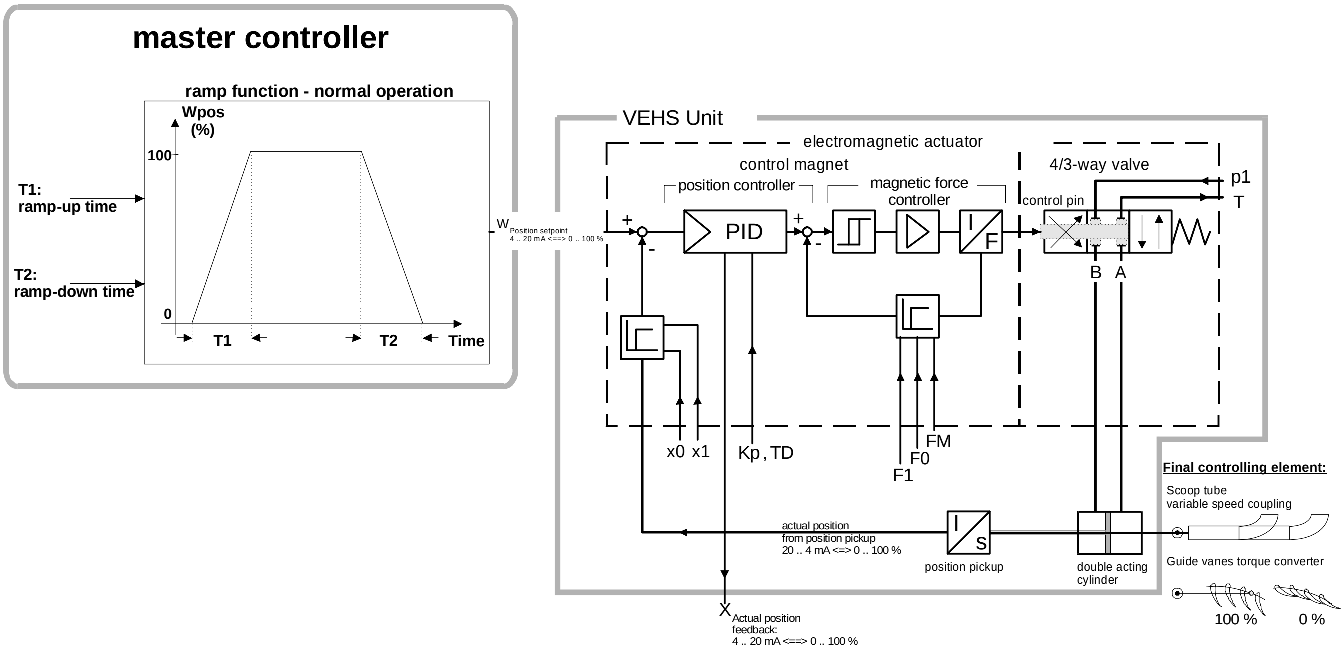
7. Integration of VEHS in a closed-loop process control circuit

The **V**oith **E**lectro **H**ydraulic Po**s**itioning Control shows a very high control dynamics required for the function of "rapid starting device".
A setpoint change from Wpos = 0 % to Wpos = 100 % is corrected within a short time.
A normal closed-loop process control circuit does not need this high control dynamics. On account of excellent control characteristics the VEHS reacts very rapidly, without noteworthy overshooting of actual position (typical 4 % at Δ Wpos = 0 .. 80 %).
The master process controller is provided with an adjustable ramp function, in order to set a <u>process-dependent</u> <u>ramp time</u> for the positioning range ΔWpos = 100 %.

If a "rapid startup function" is required, the master process controller is required to switch off the ramp function for normal closed-loop control during startup.

7.1 Normal closed-loop process control circuit

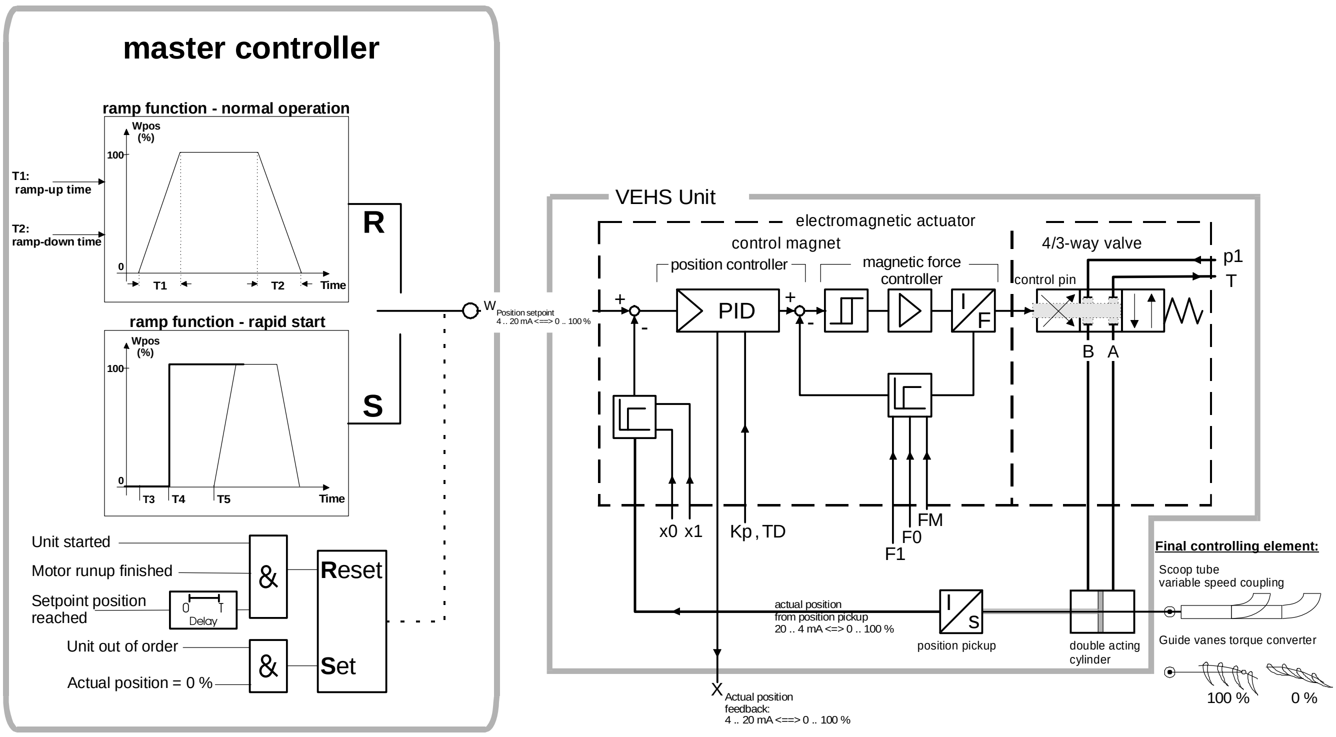
For normal control applications the master controller must be provided with an adjustable ramp function in order to match the VEHS to the controlled system.
The different inputs for ramp-up and ramp-down time are to be done by the master controller.



7.2 Closed-loop process control circuit with rapid start function

"Rapid start function“ enable run-up of drive motor virtually at no load at 0 % position (scoop tube or guide vanes). The master controller is required to output a position setpoint of 0% to the VEHS unit during drive motor run-up.
When the drive motor reached is maximum speed, the master controller outputs the required position setpoint abruptly. After reaching the position setpoint , switch over to ramp function required for closed-loop control. For this purpose the input for ramp-up and ramp-down time may vary.

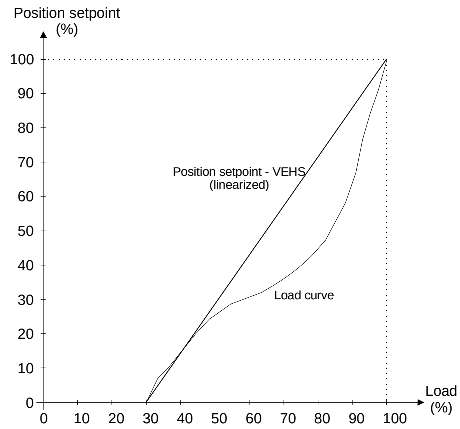
<u>The following logic explains the "rapid startup function“:</u>



T1: Ramp-up time - Ramp function
T2: Ramp-down time - Ramp function
T3: Main motor start
T4: Main motor run-up completed
T5: Changeover from rapid start up ramp function to the ramp function for normal operation

7.3 Linearization of process variable

The VEHS is to be controlled by the process controller using a linearized 4 .. 20 mA position setpoint signal, when a linear connection exists between position setpoint and process variable.
Voith Turbo supplies the linearization of position setpoint as option to the VEHS (please see chapter 9).



The linearization function is to be stored in the master controller or in the supplementary Voith device (option).

8. Commissioning of the VEHS Unit

8.1 Safety information with regard to the VEHS

1. The ***24 VDC power supply*** for the VEHS should basically be protected against voltage drop, to obtain a high availability of the complete unit (***security of supply, <u>u</u>ninterrupted <u>p</u>ower <u>s</u>upply***).

2. In the event of the following ***sources of failure*** it is standard to move to ***0 % position*** (a customer-specific 100 % position is also possible):

   - if the complete 24 VDC power supply fails
   - if the actual position of position pickup (20 .. 4 mA <=> 0 .. 100 %) fails.
   - if the position setpoint (4 .. 20 mA <=> 0 .. 100 %) of the master controller fails.

3. ***Monitoring procedures*** of the master process controller.
   The VEHS does <u>not</u> perform an internal self-test. It is not provided with an output "unit ready for operation". The following monitoring procedures can be performed by the process controller:

   - Absolute value: | $W_{\text{position setpoint}}$ - $X_{\text{actual position}}$ | is greater than 3 .. 5 %
     The VEHS unit does not correct the preset position setpoint within the ramp time.
   - Monitoring of 24 VDC power supply for the VEHS unit.

8.2 Setting the position pickup

For setting the position pickup separate the electromagnetic actuator from the 24 VDC power supply. The control oil pressure must be available on the VEHS so that the final controlling element (scoop tube or guide vanes) can be positioned by the handwheel of electromagnetic actuator (see page 10).

Please observe the following for balancing the position pickup:

Position pickups of different manufacturers are used in order to observe the required specifications for the relevant field of application:

a) Position pickup for the non-hazardous area.
b) Position pickup for the hazardous area.

Balancing differs for the relevant position pickup, dependent on the manufacturer. Please refer, in this case, to the separate instruction manual for the position pickup attached.
Please observe the following balancing sequence of position pickup in case of all different manufacturers.

Balancing procedure:

- A current measuring instrument is to be connected in series in the output of position pickup.

- Move the final controlling element in the *zero position of position pickup* using the handwheel located on the electromagnetic actuator:
  Set to the zero point in the zero position of position pickup according to the instruction manual of position pickup.

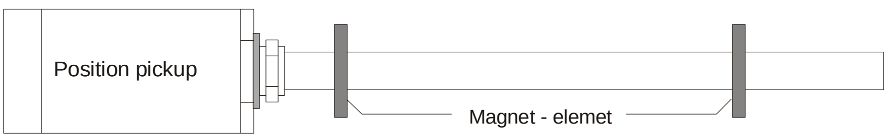
- Move the final controlling element to the *end position of position pickup* using the handwheel located on the electromagnetic actuator:
  Set to the end point in the end position of position pickup according to the instruction manual of position pickup.

- Check the zero and end position of position pickup repeatedly and rebalance, if necessary.

- After balancing secure the handwheel of electromagnetic actuator using the locking bracket.

Zero position	
Rising signal:	
output value	actual position
4 mA	100 %
Falling signal:	
output value	actual position
20 mA	0 %

End position	
output value	actual pos.
20 mA	0 %
output value	actual pos.
4 mA	100 %



8.3 Setting the electromagnetic actuator:

The electromagnetic actuator is factory-set according to the following items 1. to 4., so that normally a further setting is not necessary.
The position pickup should already be set for setting the electromagnetic actuator and the VEHS unit is to be supplied with 24 VDC.

The positioner is set by the four potentiometers on the control magnet:

1. Setting the hydraulic center position of control pin:
   - Run the unit warm with the factory setting.
   - Check the control oil pressure.
   - Preset $W_{\text{position setpoint}}$ = 12 mA,
   - balance the feedback of actual position using the potentiometer $\mathbf{F_M}$ until reaching 12 mA.

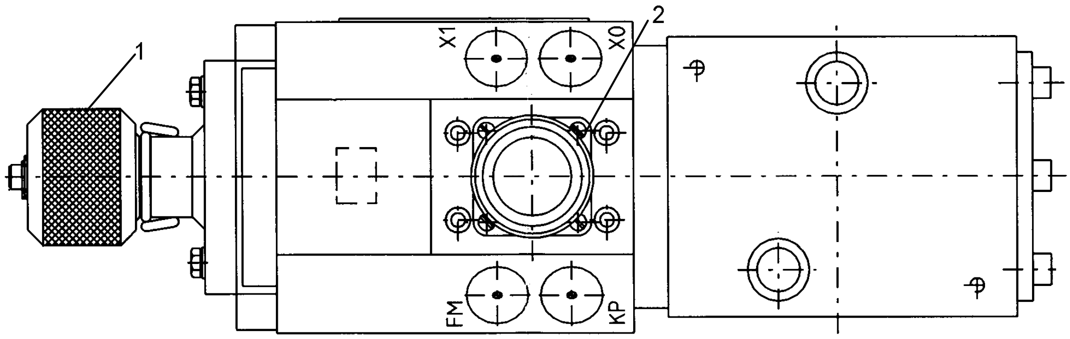
2. Setting 0 % position:
   - Preset $W_{\text{position setpoint}}$ = 4 mA,
   - set the feedback of actual position to the relevant 0 % position using potentiometer **x0**.

3. Setting 100 % position:
   - Preset $W_{\text{position setpoint}}$ = 20 mA,
   - set the feedback of actual position to the relevant 100 % position using potentiometer **x1**.

4. Optimization of positioner:
   - The positioner is optimized using potentiometer **Kp** (and perhaps by TD), when presetting $W_{\text{position setpoint}}$ steps, e.g. $W_{\text{position setpoint 2}}$ = 15 mA < $W_{\text{position setpoint 1}}$ = 10 mA. In the event of a too great system deviation correct the Kp factory setting.
   - If the Kp potentiometer is rotated in clockwise direction this results in an increase of proportional gain of positioner.

Electromagnetic actuator (top view):

1: Handwheel with locking bracket
2: Connector plug
x0, x1, FM, Kp: Potentiometer used for setting



9. Options as to the VEHS

1. It is also possible to supply the VEHS unit in ***explosion-proof design***. The following protection class is observed: EExde IIC T4.

2. A customer-specific ***auxiliary device*** can be supplied, in addition to the VEHS unit with the following options:

   - W_Position setpoint limitation:
     Adjustable ramp function for separate presetting of ramp-up and ramp-down time. The acting time limitation performs an electronic damping of final controlling element.

   - Linearization unit:
     Conversion of a non-linear process variable to a linear position setpoint function.

   - Local control station with selector switch:
     - Local / remote changeover switch
     - Min. / max. pushbutton for local positioning of final controlling element.

   - Check of analog VEHS signal:
     - Monitoring of actual position by the position pickup. In the event of a failure a signal is given to the master controller.
     - Monitoring of $W_{\text{position setpoint}}$ by the master controller. In the event of a failure the last position setpoint ($W_{\text{position setpoint}}$) is retained.

<u>Technical data of auxiliary device:</u>

The auxiliary device is a programmable controller (S7-214), to be attached directly next to the VEHS. All parameters are output via a display unit and programmed.

The controller (Siemens S7-214) has the following hardware configuration:

14 binary (24 VDC) inputs	10 binary (24 VDC) outputs
3 analog inputs (4 - 20 mA, 12 bit)	1 analog output (4 - 20 mA, 11 bit)

Supply voltage:	21 ..... 28 VDC / 8 W
Dimensions B x H x T:	250 mm x 80 mm x 62 mm
Operating temperature:	0 - 50 °C

Technical data of display unit (Siemens OP 73):

Power consumption:	6 W
Dimensions B x H x T:	144 mm x 180 mm x 70 mm

PC

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Appendix: A

Monitoring procedures of the master process controller.

The VEHS does not perform an internal self-test. It is not provided with an output "unit ready for operation". The following monitoring procedures can be performed by the process controller:

1. Absolute value of | $W_{position\ setpoint}$ - $X_{actual\ position}$ | must be smaller than 5 % within a specified time.

   The process controller must monitor whether the preset 4.. 20 mA position setpoint is being reached within e.g. 15 seconds.
   The time period depends on the max. VEHS positioning time for 0 % <=> 100 % position.
   However, it should not be selected too small (< 10 sec.) to avoid false trippings.
   The process controller must form the positive difference of position setpoint and feedback signal (| $W_{position\ setpoint}$ - $X_{actual\ position}$ |).
   - When the difference is <= 5 %, VEHS function is given.
   - When the difference is > 5 %, the timer must be started with 15 s operating time. When the difference is still > 5 % after the timer operation, i.e. after 15 s, there is a malfunction at the VEHS.

   Causes:
   - Auxiliary lube oil pump not in operation, control oil pressure not available.
   - 4/3-way valve is not adjusted properly.
   - Incorrect wiring (e.g. wire breakage).

2. If the feedback signal of the VEHS is > 22 mA, the position pick-up is faulty.

   Causes:
   - Position pick-up is not adjusted properly.
   - Position pick-up is defective.
   - Incorrect wiring (e.g. wire breakage)

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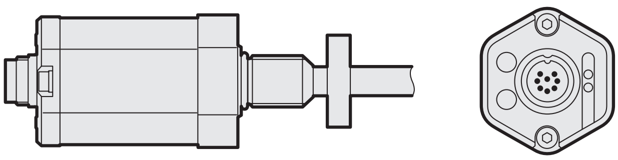
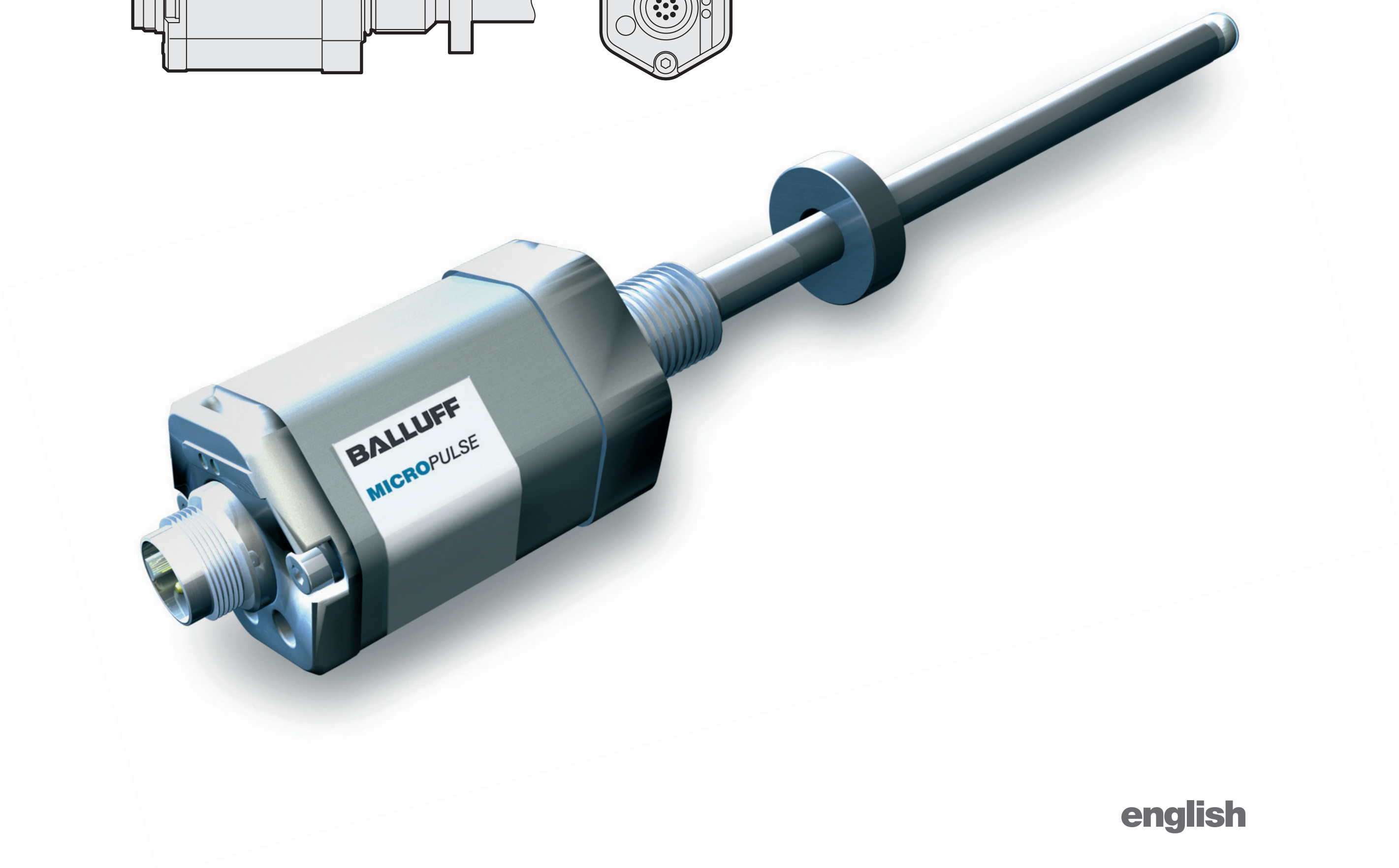
BALLUFF

sensors worldwide

BTL7-A/C/E/G_ _ _-M_ _ _ _-A/B/Y/Z(8)-S32/S115/S135/KA_ _

User's Guide





english

1 Notes to the user

1.1 Validity

This guide describes the construction, function and setup options for the BTL7 Micropulse Transducer with analog interface. It applies to types **BTL7-A/C/E/G_ _ _-M_ _ _ _-A/B/Y/Z(8)-S32/S115/S135/KA_ _** (see Ordering code on page 25).

The guide is intended for qualified technical personnel. Read this guide before installing and operating the transducer.

1.2 Symbols and conventions

Individual **handling instructions** are indicated by a preceding triangle.

▶ Handling instruction 1

Handling sequences are numbered consecutively:

1. Handling instruction 1
2. Handling instruction 2

i	**Note, tip** This symbol indicates general notes.
❶ ②	These symbols indicate the buttons on the calibration device.
LED	Symbols of this type indicate the LED displays.

1.3 Scope of delivery

– BTL7 transducer
– Calibration device
– Condensed guide

> i The magnets are available in various models and must be ordered separately.

1.4 Approvals and markings

c UL us — UL approval File no. E227256

US Patent 5 923 164
The US patent was awarded in connection with this product.

CE — The CE Mark verifies that our products meet the requirements of EU Directive 2004/108/EC (EMC Directive).

The transducer meets the requirements of the following generic standards:

– EN 61000-6-2 (noise immunity)
– EN 61000-6-4 (emission)

Emission tests:

– RF emission EN 55016-2-3	Group 1, classes A and B

Noise immunity tests:

– Static electricity (ESD) EN 61000-4-2	Severity level 3
– Electromagnetic fields (RFI) EN 61000-4-3	Severity level 3
– Electrical fast transients (burst) EN 61000-4-4	Severity level 3
– Surge EN 61000-4-5	Severity level 2
– Conducted interference induced by high-frequency fields EN 61000-4-6	Severity level 3
– Magnetic fields EN 61000-4-8	Severity level 4

> i More detailed information on the guidelines, approvals, and standards is included in the declaration of conformity.

2 Safety

2.1 Intended use

The BTL7 Micropulse Transducer, together with a machine controller (e.g. PLC), comprises a position measuring system. It is intended to be installed into a machine or system. Flawless function in accordance with the specifications in the technical data is ensured only when using original BALLUFF accessories. Use of any other components will void the warranty.

Opening the transducer or non-approved use are not permitted and will result in the loss of warranty and liability claims against the manufacturer.

2.2 General safety notes for the position measuring system

Installation and **startup** may only be performed by trained specialists with basic electrical knowledge. Specialists are those who can recognize possible hazards and institute the appropriate safety measures due to their professional training, knowledge, and experience, as well as their understanding of the relevant regulations pertaining to the work to be done.

The **operator** is responsible for ensuring that local safety regulations are observed.
In particular, the operator must take steps to ensure that a defect in the position measuring system will not result in hazards to persons or equipment.
If defects and unresolvable faults occur in the transducer, it should be taken out of service and secured against unauthorized use.

2.3 Explanation of the warnings

Always observe the warnings in these instructions and the measures described to avoid hazards.

The warnings used here contain various signal words and are structured as follows:

SIGNAL WORD
Hazard type and source
Consequences if not complied with
► Measures to avoid hazards

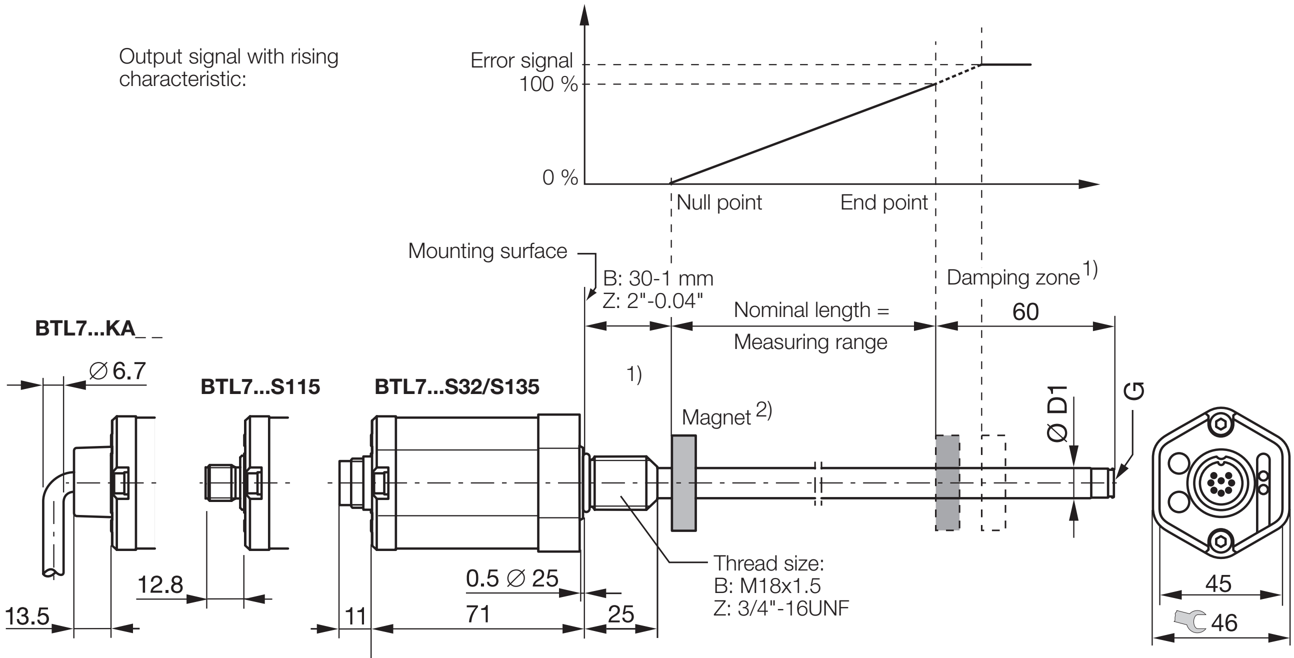
The individual signal words mean:

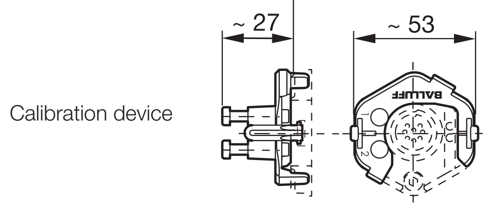
NOTICE!
Identifies a hazard that could **damage** or **destroy the product**.
⚠ DANGER
The general warning symbol in conjunction with the signal word DANGER identifies a hazard which, if not avoided, **will certainly result in death** or **serious injury**.

2.4 Disposal

► Observe the national regulations for disposal.

3 Construction and function





Version	D1	G
...-A/B/Y/Z-...	10.2 mm	Thread M4x4/6 deep
...-A/B/Y/Z8-...	8 mm	No thread

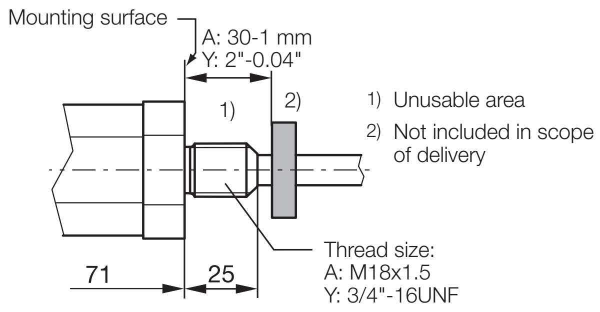


Fig. 3-1: BTL7...A/B/Y/Z(8)... transducer, construction and function

3.1 Construction

Electrical connection: The electrical connection is made via a cable or a connector (see Ordering code on page 25).

BTL housing: Aluminum housing containing the processing electronics.

Mounting thread: The transducers with Ø 10.2 mm have an additional thread at the end of the rod to support larger nominal lengths. We recommend assembling this transducer on the mounting thread:

– BTL7-…-A/B: M18×1.5
– BTL7-…-Y/Z: 3/4"-16UNF

Magnet: Defines the position to be measured on the waveguide. Magnets are available in various models and must be ordered separately (see accessories on page 23).

Nominal length: Defines the available measuring range. Rods with various nominal lengths from 25 mm to 7600 mm are available depending on the version:

– Ø 10.2 mm: Nominal length from 25 mm to 7600 mm
– Ø 8 mm: Nominal length from 25 mm to 1016 mm

Damping zone: Area at the end of the rod that cannot be used for measurements, but which may be passed over.

Calibration device: Additional device for calibrating the transducer.

3 Construction and function (continued)

3.2 Function

The Micropulse Transducer contains the waveguide which is protected by an outer stainless steel tube (rod). A magnet is moved along the waveguide. This magnet is connected to the system part whose position is to be determined.

The magnet defines the position to be measured on the waveguide.

An internally generated INIT pulse interacts with the magnetic field of the magnet to generate a torsional wave in the waveguide which propagates at ultrasonic speed.

The component of the torsional wave which arrives at the end of the waveguide is absorbed in the damping zone to prevent reflection. The component of the torsional wave which arrives at the beginning of the waveguide is converted by a coil into an electrical signal. The travel time of the wave is used to calculate the position. Depending on the version, this information is made available as a voltage or current output with a rising or falling gradient.

3.3 LED display

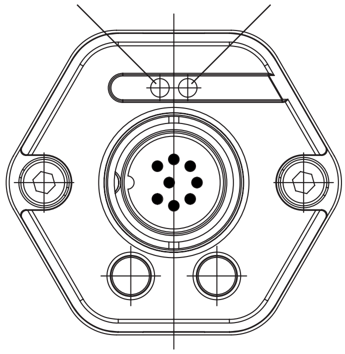


Fig. 3-2: Position of the BTL7 LED displays

In normal operation LED 1 indicates the operating states of the transducer. Both LEDs together are used for displaying additional information in programming mode (see page 16 ff).

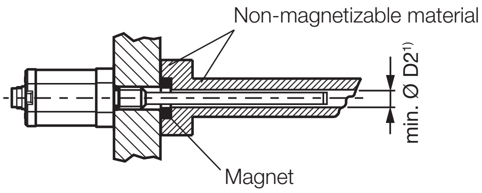
LED 1	LED 2	Operating state
Green	Off	**Normal function** Magnet is within the measuring range.
Flashing red		**Measuring range left** Magnet is outside the measuring range.
Red		**Error** No magnet or magnet outside the limits.

Tab. 3-1: LED displays in normal operation

4 Installation and connection

4.1 Installation guidelines

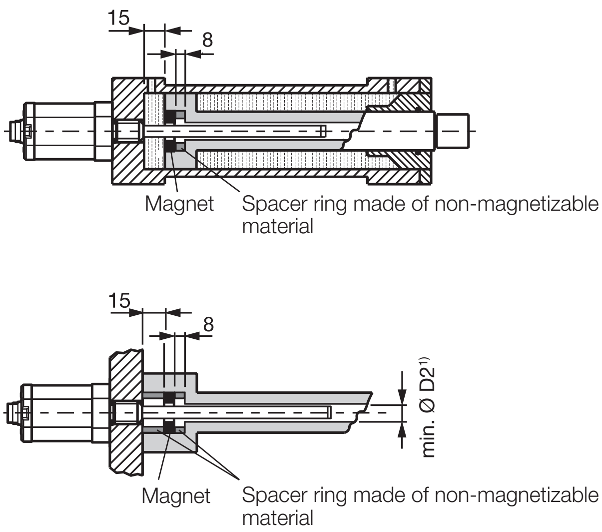
Non-magnetizable material



[1] Min. Ø D2 = Minimum diameter of the bore (see Tab. 4-1)

Fig. 4-1: Installation in non-magnetizable material

Magnetizable material
If using magnetizable material, the transducer must be protected against magnetic interference through suitable measures (e.g. spacer ring made of non-magnetizable material, a suitable distance from strong external magnetic fields).



[1] Min. Ø D2 = Minimum diameter of the bore (see Tab. 4-1)

Fig. 4-2: Installation in magnetizable material

Tube diameter	Bore diameter D2
10.2 mm	At least 13 mm
8 mm	At least 11 mm

Tab. 4-1: Bore diameter if installed in a hydraulic cylinder

4.2 Preparing for installation

Installation note: We recommend using non-magnetizable material to mount the transducer and magnet.

Horizontal assembly: If installing horizontally with nominal lengths > 500 mm, we recommend tightening the outer rod at the end (only possible with Ø 10.2 mm) or supporting it.

Hydraulic cylinder: If installed in a hydraulic cylinder, ensure that the minimum value for the bore diameter of the support piston is complied with (see Tab. 4-1).

Mounting hole: The transducer comes with an M18×1.5 (ISO) or 3/4"-16UNF (SAE) mounting thread. Depending on the version, a mounting hole must be made before assembly.

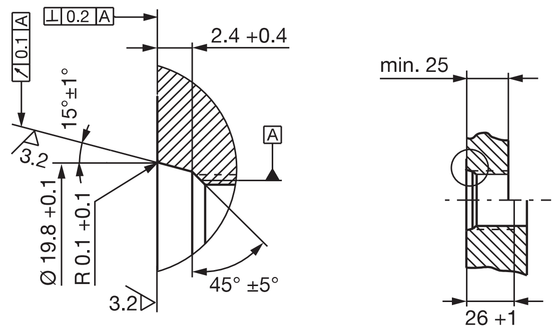


Fig. 4-3: Mounting hole M18x1.5 per ISO 6149 O-ring 15.4x2.1

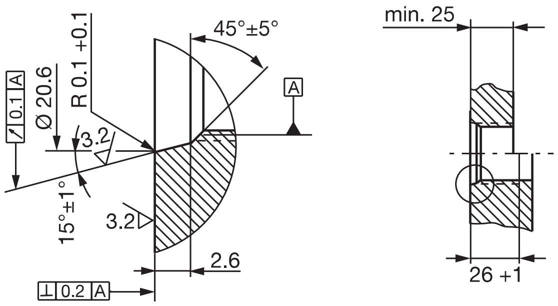


Fig. 4-4: Mounting hole 3/4" 16UNF per SAE J475 O-ring 15.3x2.4

Magnet: Various magnets are available for the BTL7 transducer (see Accessories on page 23).

4 Installation and connection (continued)

4.3 Installing the transducer

NOTICE!

Interference in function

Improper installation can compromise the function of the transducer and result in increased wear.

- ▶ The mounting surface of the transducer must make full contact with the supporting surface.
- ▶ The bore must be perfectly sealed (O-ring/flat seal).

- ▶ Make a mounting hole with thread (possibly with countersink for the O-ring) acc. to Fig. 4-3 or Fig. 4-4.
- ▶ Screw the transducer with mounting thread into the mounting hole (max. torque 100 Nm).
- ▶ Install the magnet (accessories).
- ▶ For nominal lengths > 500 mm: Tighten the outer rod at the end (only possible with Ø 10.2 mm) or support it.

i Suitable nuts for the mounting thread are available as accessories (see page 23).

4.3.1 Installation recommendation for hydraulic cylinders

If you seal the hole with a flat seal, the max. operating pressure will be reduced in accordance with the larger pressurized surface.
If installing horizontally in a hydraulic cylinder (nominal lengths > 500 mm), we recommend affixing a sliding element to protect the rod end from wear.

i Dimensioning of the detailed solutions is the responsibility of the cylinder manufacturer.

The sliding element material must be suitable for the appropriate load case, medium used, and application temperatures. E.g. Torlon, Teflon or bronze are all possible materials.

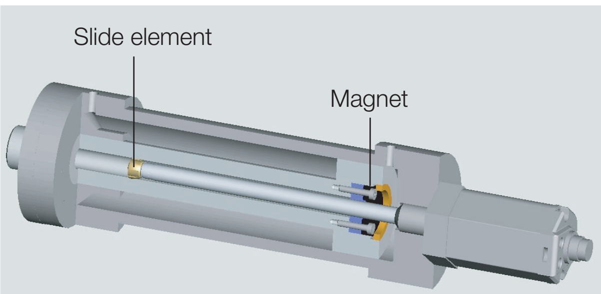


Fig. 4-5: Example 1, transducer installed with sliding element

The sliding element can be screwed on or bonded.

- ▶ Secure the screws so they cannot be loosened or lost.
- ▶ Select a suitable adhesive.

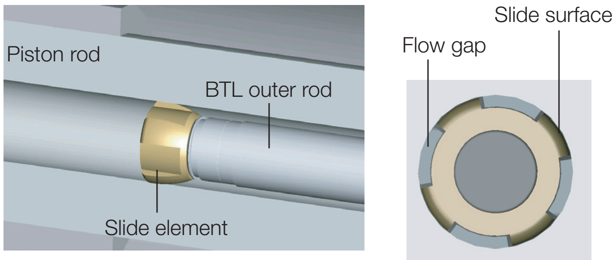


Fig. 4-6: Detailed view and top view of sliding element

There must be a gap between the sliding element and piston bore that is sufficiently large for the hydraulic oil to flow through.

Options for fixing the magnet:

- Screws
- Threaded ring
- Press fitting
- Notches (center punching)

i If installed in a hydraulic cylinder, the magnet should not make contact with the outer rod.

The hole in the spacer ring must ensure optimum guidance of the outer rod by the sliding element.

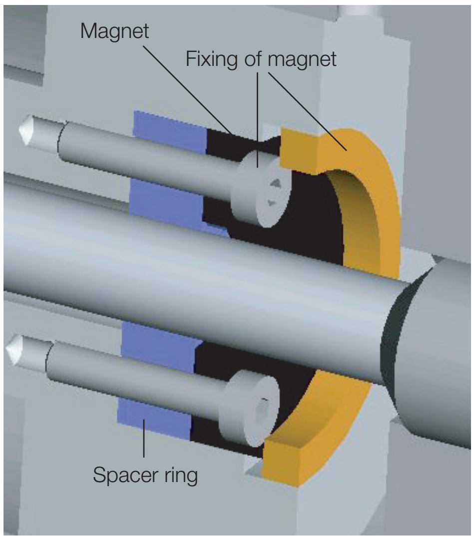


Fig. 4-7: Fixing the magnet

An example of how to install the transducer with a supporting rod is shown in Fig. 4-8 on page 10.

4 Installation and connection (continued)

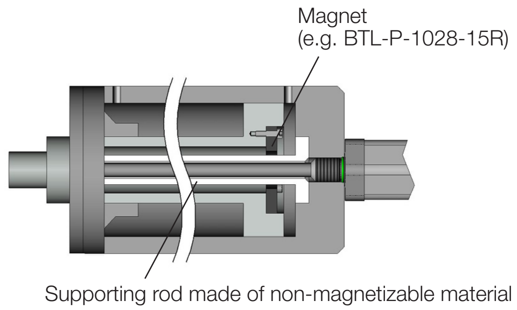


Fig. 4-8: Example 2, transducer installed with supporting rod

4.4 Electrical connection

Depending on the model, the electrical connection is made using a cable (BTL7...-KA) or a connector (BTL7...-S32, BTL7...-S115, BTL7...-S135).
The connection or pin assignments for the respective version can be found in Tables 4-2 to 4-5.

> **i** Note the information on shielding and cable routing on page 11.

4.4.1 Connector type S32

Pin	-A_10	-G_10	-C_00	-C_70	-E_00	-E_70
1	Not used[1)		0 to 20 mA	20 to 0 mA	4 to 20 mA	20 to 4 mA
2	0 V					
3	10 to 0 V	10 to –10 V	Not used[1)			
4	La (programming input)					
5	0 to 10 V	–10 to 10 V	Not used[1)			
8	Lb (programming input)					
	BTL7-_1_ _-...			**BTL7-_5_ _-...**		
6	GND[2)			GND[2)		
7	20 to 28 V			10 to 30 V		

[1) Unassigned leads can be connected to the GND on the controller side but not to the shield.
[2) Reference potential for supply voltage and EMC-GND.

Tab. 4-2: Connection assignment BTL7...-S32

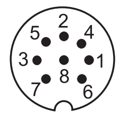


Fig. 4-9: Pin assignment of S32 (view of connector pins of transducer), 8-pin M16 circular plug

4.4.2 Connector type S115

Pin	-A_10	-G_10	-C_00	-C_70	-E_00	-E_70
1	0 V (pin 3)					
2	0 V (pin 5)					
3	10 to 0 V	10 to –10 V	Not used[1)			
4	La (programming input)					
5	0 to 10 V	–10 to 10 V	0 to 20 mA	20 to 0 mA	4 to 20 mA	20 to 4 mA
8	Lb (programming input)					
	BTL7-_1_ _-...			**BTL7-_5_ _-...**		
6	GND[2)			GND[2)		
7	20 to 28 V			10 to 30 V		

[1) Unassigned leads can be connected to the GND on the controller side but not to the shield.
[2) Reference potential for supply voltage and EMC-GND.

Tab. 4-3: Connection assignment BTL7...-S115

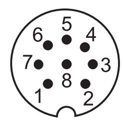


Fig. 4-10: Pin assignment of S115 (view of connector pins of transducer), 8-pin M12 circular plug

4 Installation and connection (continued)

4.4.3 Connector type S135

Pin	-A_10	-G_10	-C_00	-C_70	-E_00	-E_70
1	0 to 10 V	–10 to 10 V	0 to 20 mA	20 to 0 mA	4 to 20 mA	20 to 4 mA
2	0 V (pin 1)					
3	10 to 0 V	10 to –10 V	Not used[1]			
4	0 V (pin 3)		Not used[1]			
	BTL7-_1_ _-...			**BTL7-_5_ _-...**		
5	20 to 28 V			10 to 30 V		
6	GND[2]			GND[2]		

[1] Unassigned leads can be connected to the GND on the controller side but not to the shield.
[2] Reference potential for supply voltage and EMC-GND.

Tab. 4-4: Connection assignment BTL7...-S135

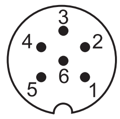


Fig. 4-11: Pin assignment of S135 (view of connector pins of transducer), 6-pin M16 circular plug

4.4.4 Cable connection KA_ _

Cable color	-A_10	-G_10	-C_00	-C_70	-E_00	-E_70
YE yellow	Not used[1]		0 to 20 mA	20 to 0 mA	4 to 20 mA	20 to 4 mA
GY gray	0 V					
PK pink	10 to 0 V	10 to –10 V	Not used[1]			
RD red	La (programming input)					
GN green	0 to 10 V	–10 to 10 V	Not used[1]			
WH white	Lb (programming input)					
	BTL7-_1_ _-...			**BTL7-_5_ _-...**		
BU blue	GND[2]			GND[2]		
BN brown	20 to 28 V			10 to 30 V		

[1] Unassigned leads can be connected to the GND on the controller side but not to the shield.
[2] Reference potential for supply voltage and EMC-GND.

Tab. 4-5: Connection assignment BTL7...-KA_ _

4.5 Shielding and cable routing

Defined ground!
The transducer and the control cabinet must be at the same ground potential.

Shielding
To ensure electromagnetic compatibility (EMC), observe the following:

– Connect the transducer and controller using a shielded cable.
  Shielding: Copper filament braided, at least 85% coverage.
– Connector version: Shield is interally connected to connector housing.
– Cable version: On the transducer side, the cable shielding is connected to the housing.
  Ground the cable shielding on the controller side (connect with the protective earth conductor).

Magnetic fields
The position measuring system is a magnetostrictive system. It is important to maintain adequate distance between the transducer cylinder and strong, external magnetic fields.

Cable routing
Do not route the cable between the transducer, controller, and power supply near high voltage cables (inductive stray noise is possible).
The cable must be routed tension-free.

Bending radius for fixed cable
The bending radius for a fixed cable must be at least five times the cable diameter.

Cable length

BTL7-A/G	Max. 30 m[1]
BTL7-C/E	Max. 100 m[1]

Tab. 4-6: Cable lengths BTL7

[1] Prerequisite: Construction, shielding and routing preclude the effect of any external noise fields.

5 Startup

5.1 Starting up the system

> ⚠ **DANGER**
>
> **Uncontrolled system movement**
>
> When starting up, if the position measuring system is part of a closed loop system whose parameters have not yet been set, the system may perform uncontrolled movements. This could result in personal injury and equipment damage.
>
> ▶ Startup must be performed only by trained technical personnel.
>
> ▶ Observe the safety instructions of the equipment or system manufacturer.

1. Check connections for tightness and correct polarity. Replace damaged connections.
2. Turn on the system.
3. Check measured values and adjustable parameters and readjust the transducer, if necessary.

> ℹ Check for the correct values at the null point and end point, especially after replacing the transducer or after repair by the manufacturer.

5.2 Operating notes

– Check the function of the transducer and all associated components on a regular basis.
– Take the position measuring system out of operation whenever there is a malfunction.
– Secure the system against unauthorized use.

6 Calibration procedure

6.1 Calibration device

The calibration device is an additional device for calibrating the transducer.

- ▶ Before calibrating: Place the calibration device on the connection side of the transducer.
- ▶ When finished with calibration: Remove the calibration device to prevent changes.
- ▶ Keep the calibration device for later use.

Automatic deactivation!
If the buttons on the calibration device are not pressed for approx. 10 min., programming mode is automatically ended.

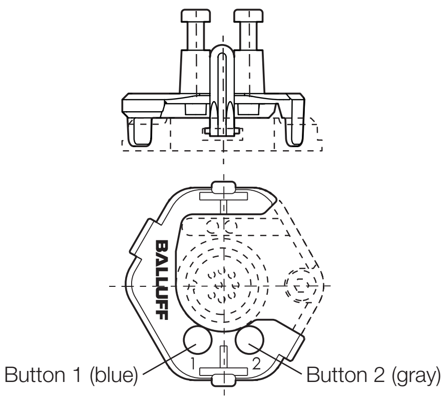


Fig. 6-1: Calibration device in place

6.2 Programming inputs (not for BTL7-…-S135)

Instead of the calibration device, the programming inputs may also be used for setting.

- La corresponds to button 1,
- Lb corresponds to button 2,
- Programming input at 20 to 28 V (BTL7-_1_ _-...) or 10 to 30 V (BTL7-_5_ _-...) corresponds to button depressed (high active).

Automatic deactivation!
If no signals are sent over the programming inputs for approx. 10 min., programming mode is automatically ended.

6.3 Calibration procedure overview

6.3.1 Teach-in

The factory set null point and end point is replaced by a new null point and end point.

The detailed procedure for teach-in is described on page 16.

Steps:

- ▶ Move magnet to the new zero position.
- ▶ Read new null point by pressing the buttons.

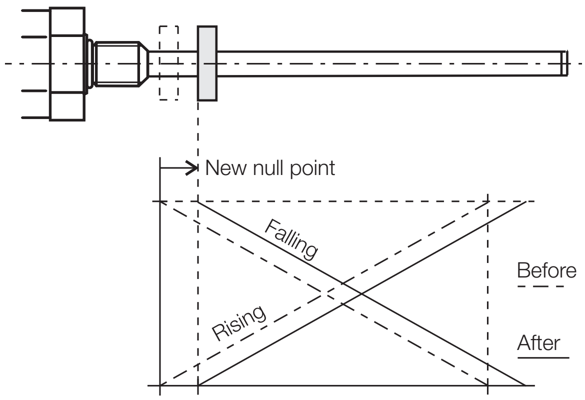


Fig. 6-2: Reading new null point (offset shift)

- ▶ Move magnet to the new end position.
- ▶ Read new end point by pressing the buttons.

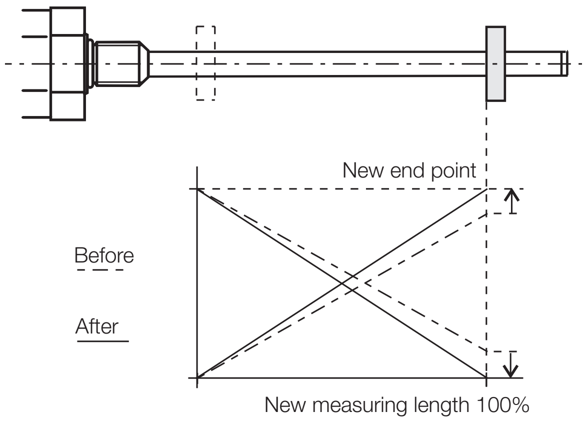


Fig. 6-3: Reading new end point (changing the output gradient)

6 Calibration procedure (continued)

6.3.2 Adjusting

The detailed procedure for adjustment is described on page 17 ff.

A new start and/or end value is adjusted. This is recommended when the magnet cannot be brought to the null point or end point.

Steps

- ▶ Move magnet to the new start position.
- ▶ Set the new start value by pressing the buttons.

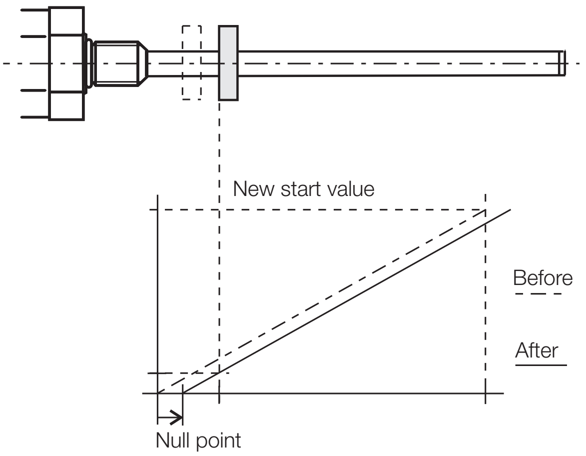


Fig. 6-4: Adjusting new start position (offset shift)

- ▶ Move magnet to the new end position.
- ▶ Set the new end value by pressing the buttons.

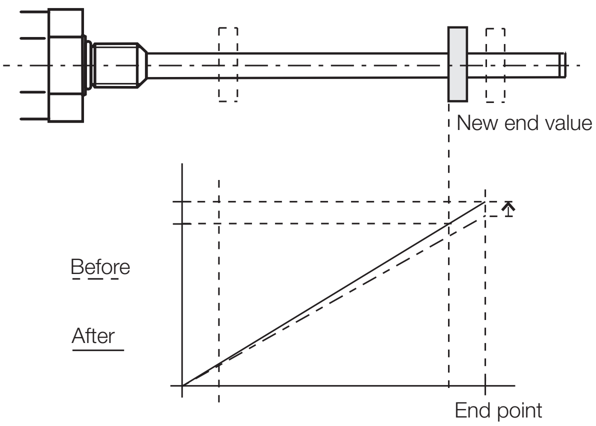


Fig. 6-5: Adjusting new end position (changing the output gradient)

6.3.3 Online setting

The detailed procedure for online setting is described on page 19.

Setting start and end values while the system is running.

6.3.4 Reset

The detailed procedure for the reset is described on page 20.

Restoring the transducer to its factory settings.

6.4 Selecting the calibration procedure

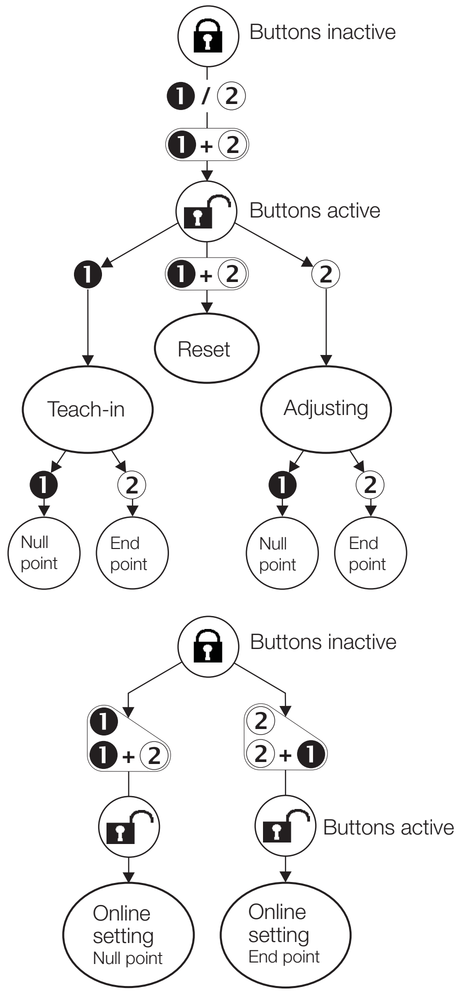


Fig. 6-6: Selecting the calibration procedure

6 Calibration procedure (continued)

6.5 Calibration procedure notes

Prerequisites

– The calibration device is in place or the programming inputs are connected.
– The transducer is connected to the system controller.
– Voltage or current values from the transducer can be read (using a multimeter or the system controller).

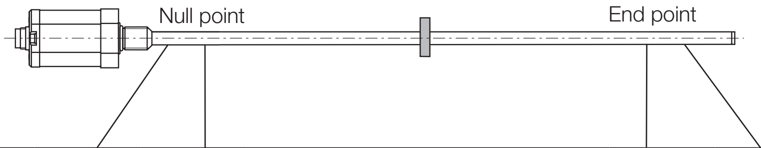
Values for zero and end point

– Any desired position of the magnet can be used as the zero or end point. However, the zero and end points may not be reversed.
– The absolute zero and end points must lie within the minimum or maximum limits of what can be output (see value table).
– The distance between the null point and end point must be at least 4 mm.

i The last set values are always saved, regardless of whether the setting was ended using the buttons, the programming inputs or automatically after 10 min. have expired.

Value table for teach-in and adjustment

i The following examples refer to transducers with 0 to 10 V or 4 to 20 mA output.
For all other versions, use the values in the value table below.



Output gradient	Linear transducer	Unit	Min. value	Null value	Identification for adjustment	Identification for teach-in	End value	Max. value	Error value
Rising	BTL7-A…	V	–0.5	0	2.0	4.0	+10.0	+10.5	+10.5
	BTL7-G…	V	–10.5	–10.0	2.0	4.0	+10.0	+10.5	+10.5
	BTL7-C…	mA	0	0	6.0	12.0	20.0	20.4	20.4
	BTL7-E…	mA	3.6	4.0	6.0	12.0	20.0	20.4	3.6
Falling	BTL7-A…	V	+10.5	+10.0	8.0	6.0	0	–0.5	–0.5
	BTL7-G…	V	+10.5	+10.0	–2.0	–4.0	–10.0	–10.5	–10.5
	BTL7-C…	mA	20.4	20.0	14.0	8.0	0	0	20.4
	BTL7-E…	mA	20.4	20.0	14.0	8.0	4.0	3.6	3.6

Tab. 6-1: Value table for teach-in and adjustment

7 Calibration using teach-in

> **NOTICE!**
>
> **Interference in function**
>
> Teach-in while the system is running may result in malfunctions.
>
> ▶ Stop the system before performing teach-in.

Initial situation:

– Transducer with magnet within measuring range

1. Activate buttons

▶ Hold down any button for at least 3 s.

▶ Release button.

▶ Within 1 s, hold down ➊ and ② simultaneously for at least 3 s.

⇒ Output indicates error value.

⇒ Buttons are activated.

> **i** If an error or an interruption occurs while activating the buttons, allow a wait time of **12 s** before retrying.

2. Select teach-in

▶ Hold down ➊ for at least 2 s.

⇒ Indication for "Teach-in" is displayed.

▶ Release ➊.

⇒ Current position value is displayed.

3. Set null point

▶ Bring magnet to the new null point.

▶ Hold down ➊ for at least 2 s.

⇒ The new null point is set.

4. Set end point

▶ Bring magnet to the new end point.

▶ Hold down ② for at least 2 s.

⇒ The new end point is set.

5. Exit teach-in and deactivate buttons

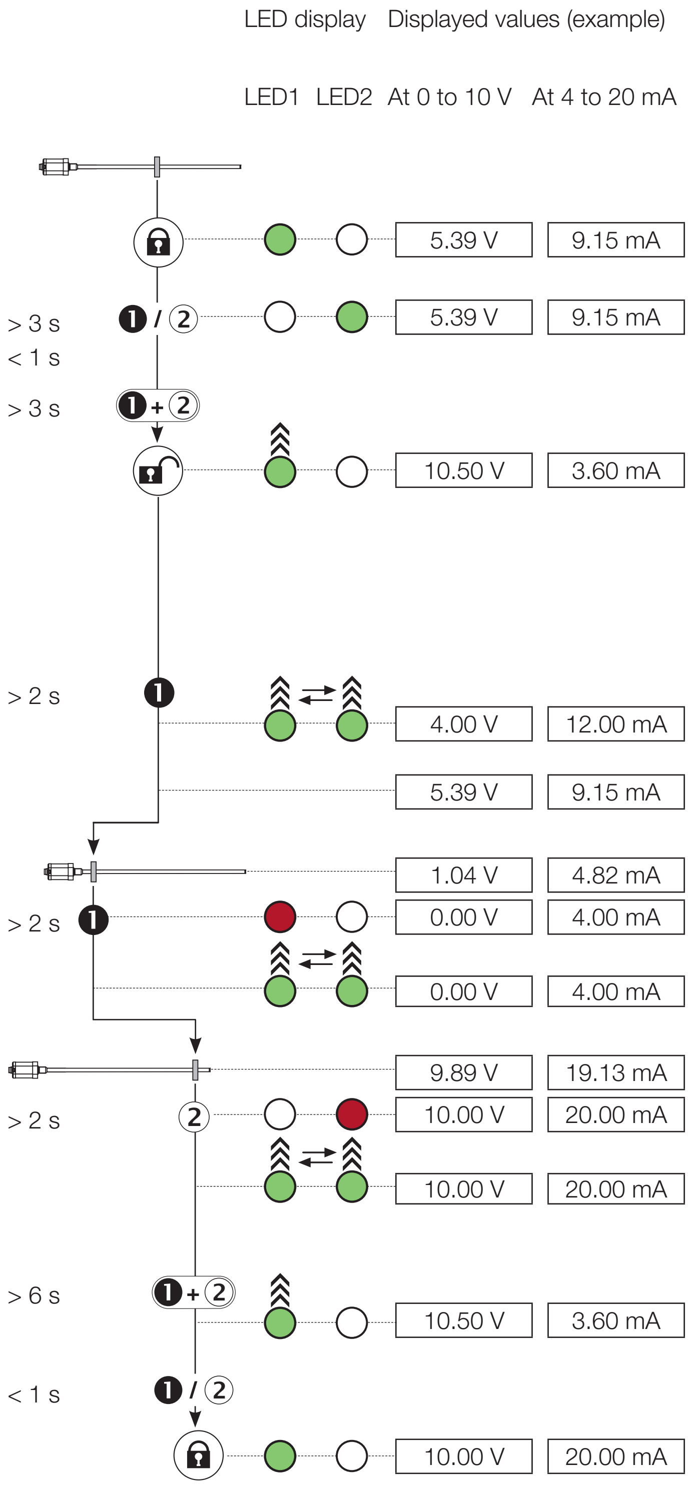
▶ Hold down ➊ and ② simultaneously for at least 6 s.

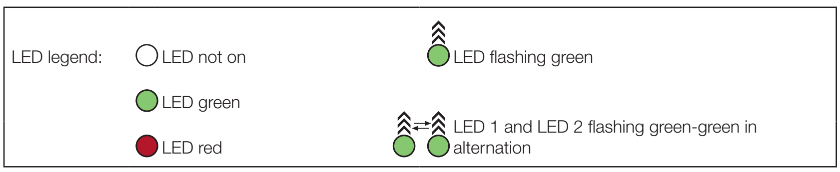
⇒ Output indicates error value.

▶ Briefly press ➊ or ② (< 1 s).

⇒ Buttons are deactivated.

⇒ Current position value is displayed.





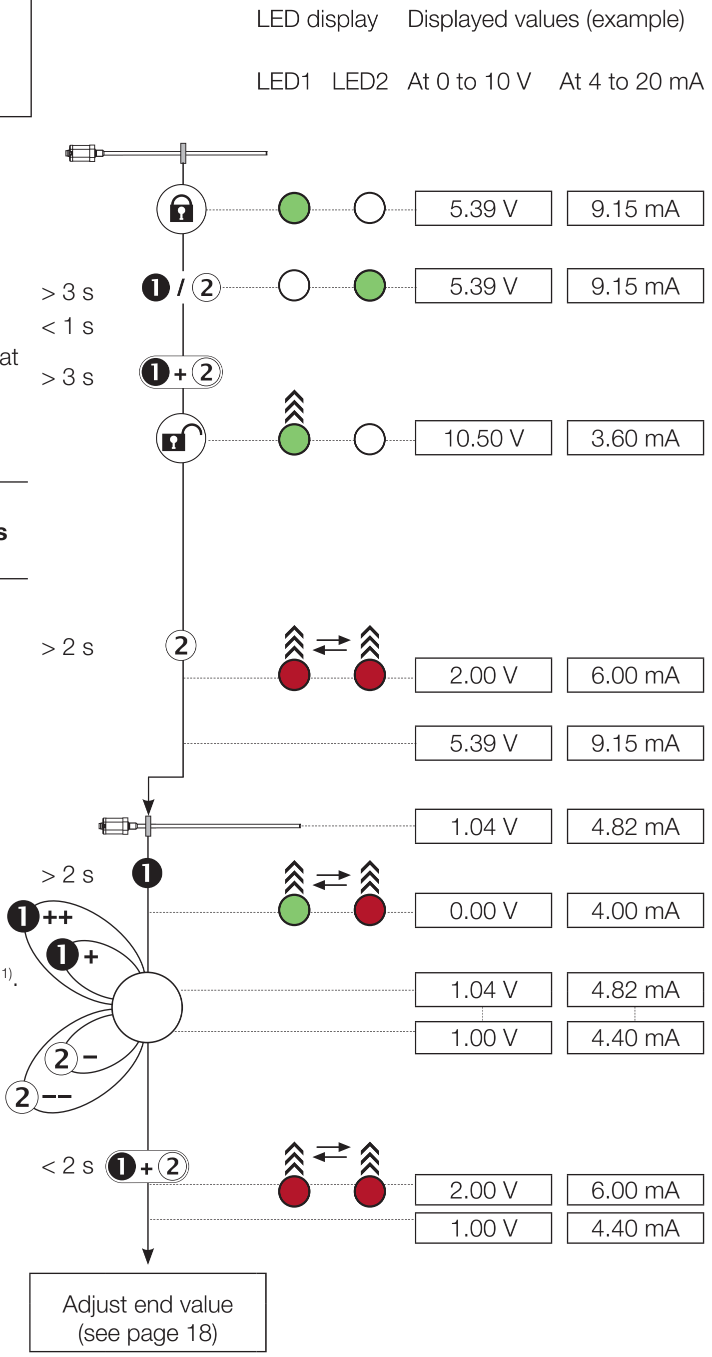
8 Calibration using adjustment

NOTICE!

Interference in function

Adjustment while the system is running may result in malfunctions.

▶ Stop the system before performing adjustment.



Initial situation:

– Transducer with magnet within measuring range

1. Activate buttons

▶ Hold down any button for at least 3 s.

▶ Release button.

▶ Within 1 s, hold down ➊ and ② simultaneously for at least 3 s.

⇒ Output indicates error value.

⇒ Buttons are activated.

ℹ If an error or an interruption occurs while activating the buttons, allow a wait time of **12 s** before retrying.

2. Select adjustment

▶ Hold down ② for at least 2 s.

⇒ Indication for "Adjustment" is displayed.

▶ Release ②.

⇒ Current position value is displayed.

3. Adjust start value

▶ Bring magnet to start position.

▶ Hold down ➊ for at least 2 s.

⇒ Indication for "Adjust start value" is displayed.

▶ Adjust start value.

⇒ The start value can be changed using ➊ and ②[1]. The gradient of the output remains constant (see page 14).

▶ Exit calibration procedure: Press ➊ and ② for no more than 2 s.

⇒ Indication for "Adjustment" is displayed.

⇒ Set position value is saved.

1) Briefly press button: Current value is increased or decreased by approx. 1 mV or 1 µA. If a button is held down longer than 1 s, the step interval is increased.

LED legend:
- LED not on
- LED green
- LED flashing green
- LED 1 and LED 2 flashing green-red in alternation
- LED 1 and LED 2 flashing red-red in alternation

8 Calibration using adjustment (continued)

4. Adjust end value

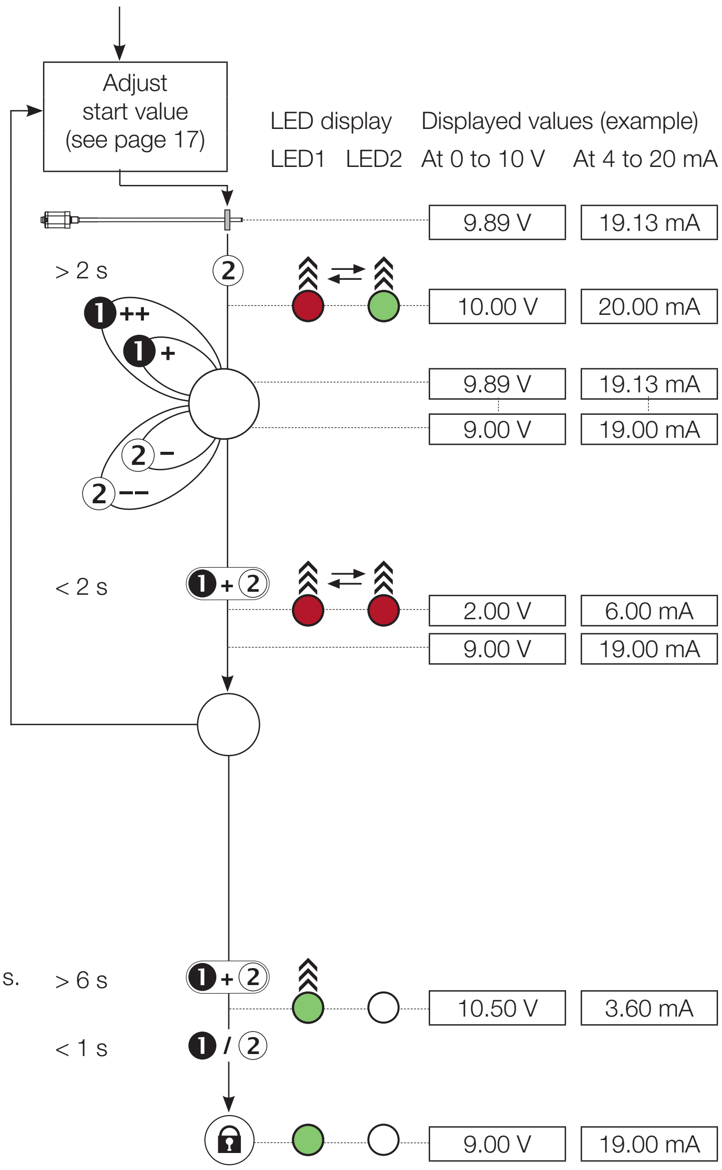
- ▶ Bring magnet to end position.
- ▶ Hold down ② for at least 2 s.
  - ⇒ Indication for "Adjust end value" is displayed.
- ▶ Adjust end value
  - ⇒ The end value can be changed using ❶ and ②[1]. The gradient of the output is changed, but the zero value remains unchanged (see page 14).

- ▶ Exit calibration procedure: Press ❶ and ② for no more than 2 s.
  - ⇒ Indication for "Adjustment" is displayed.
  - ⇒ Set position value is saved.

Check values
The settings for the start value and end value have a mutual effect depending on the measuring position.
Repeat steps 3 and 4 until the desired values are exactly set.

5. Exit adjustment and deactivate buttons

- ▶ Hold down ❶ and ② simultaneously for at least 6 s.
  - ⇒ Output indicates error value.
- ▶ Briefly press ❶ or ② (< 1 s).
  - ⇒ Buttons are deactivated.
  - ⇒ Current position value is displayed.



1) Briefly press button: Current value is increased or decreased by approx. 1 mV or 1 µA.
If a button is held down longer than 1 s, the step interval is increased.

LED legend:
- LED not on
- LED green
- LED flashing green
- LED 1 and LED 2 flashing red-green in alternation
- LED 1 and LED 2 flashing red-red in alternation

9 Calibration using online setting

NOTICE!
Interference in function Changing the transducer output signal may result in personal injury and equipment damage if the system is ready for operation. ▶ Persons must keep away from the system's hazardous zones.

In online setting the system is not shut down. The start and end values are set online.

Maximum setting range for each calibration procedure:

Start value: ±25% of present stroke
End value: ±25% of present output value

If the desired value cannot be attained in the first calibration procedure (max. setting range exceeded), the calibration procedure must be started again.

1. Set start value online:

▶ Move the system so that the magnet is in the start position.

▶ Hold down ➊ for at least 3 s.
▶ Hold down ➊ and additionally press ② for at least 3 s.

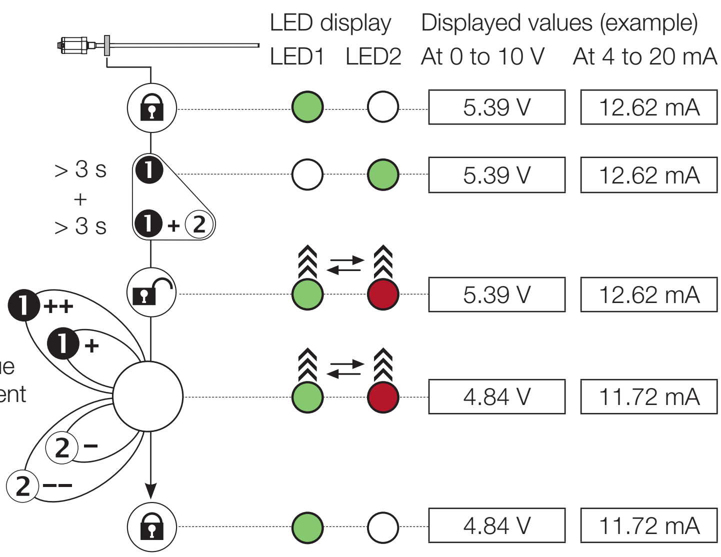
⇒ Buttons are activated.

▶ Set start value.

⇒ Using ➊ and ②, you can change the start value within the permissible setting range[1]. The gradient of the output remains constant (see page 14).

▶ Exit setting (do not press a button for at least 15 s).

⇒ The start value is saved, the buttons are deactivated.



> **i** After each calibration procedure you must wait for the lockout time of **15 s**. This also applies to switching between the start value and end value setting.

2. Set end value online:

▶ Move the system so that the magnet is in the end position.

▶ Hold down ② for at least 3 s.
▶ Hold down ② and additionally press ➊ for at least 3 s.

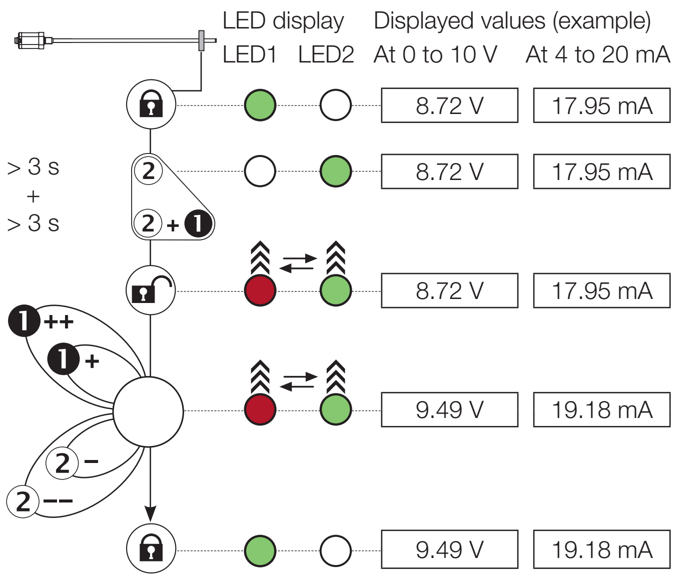
⇒ Buttons are activated.

▶ Set end value.

⇒ Using ➊ and ②, you can change the end value within the permissible setting range[1]. The gradient of the output is changed, but the zero value remains unchanged (see page 14).

▶ Exit setting (do not press a button for at least 15 s).

⇒ The end value is saved, the buttons are deactivated.



1) Briefly press button: Current value is increased or decreased by approx. 1 mV or 1 µA.
If a button is held down longer than 1 s, the step interval is increased.

LED legend:	○ LED not on	LED 1 and LED 2 flashing green-red in alternation
	LED green	LED 1 and LED 2 flashing red-green in alternation

10 Resetting all values (reset)

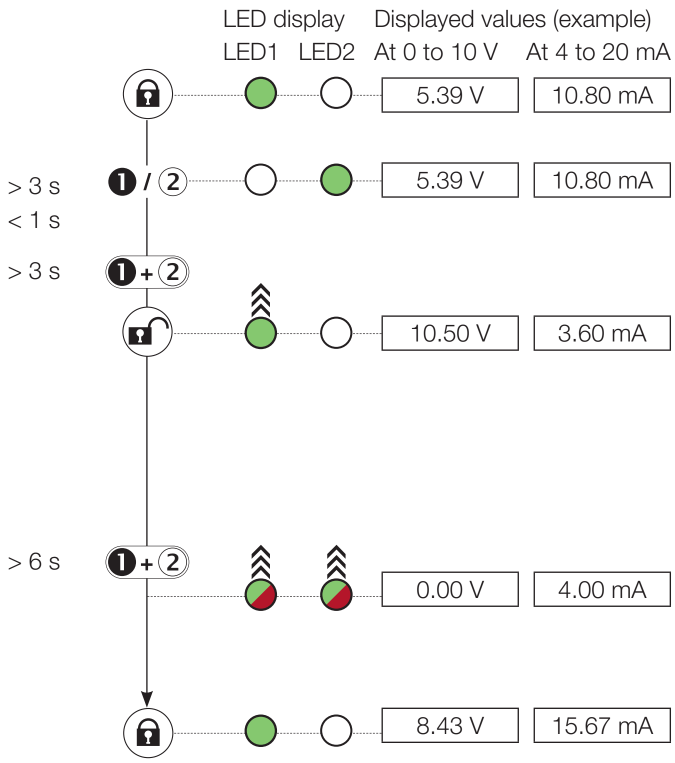
NOTICE!

Interference in function

Resetting the values while the system is running may result in malfunctions.

- Stop the system before performing the reset.

The reset function can be used to restore all the settings to the factory settings. For a reset the magnet may also be located outside the measuring range.



1. Activate buttons

- Hold down any button for at least 3 s.
- Release button.
- Within 1 s, hold down ❶ and ② simultaneously for at least 3 s.
  ⇒ Output indicates error value.
  ⇒ Buttons are activated.

If an error or an interruption occurs while activating the buttons, allow a wait time of **12 s** before retrying.

2. Reset

- Hold down ❶ and ② for at least 6 s.
  ⇒ Output indicates zero value.
  ⇒ All values are reset.
- Release buttons.
  ⇒ Current position value is displayed.
  ⇒ Buttons are locked.

LED legend: LED not on
LED green
LED flashing green
LED 1 and LED 2 flashing green-red simultaneously

11 Technical data

11.1 Accuracy

The specifications are typical values for BTL7-A/C/E/G... at 24 V DC and room temperature, with a nominal length of 500 mm in conjunction with the BTL-P-1013-4R, BTL-P-1013-4S, BTL-P-1012-4R, BTL-P-1014-2R or BTL-P-0814-GR-PAF magnet.
The BTL is fully operational immediately, with full accuracy after warm-up.

> **i** For special versions, other technical data may apply.
> Special versions are indicated by the suffix -SA on the part label.

Repeat accuracy	
Voltage, typical	±10 µm
Current, typical	±5 µm
Sampling rate	
Dependent on nominal length	250 µs to 5.5 ms
At nominal length = 500 mm	500 µs
Non-linearity at	
Nominal length ≤ 500 mm	±50 µm
Nominal length > 500 to ≤ 5500 mm	±0.01% FS
Nominal length > 5500 mm	±0.02% FS
Temperature coefficient (nominal length = 500 mm, magnet in the middle of the measuring range)	≤ 30 ppm/K
Max. detectable speed	10 m/s

11.2 Ambient conditions

Operating temperature	–40°C to +85°C
Storage temperature	–40°C to +100°C
Relative humidity	< 90%, non-condensing
Outer rod pressure rating (when installed in hydraulic cylinders)	
For Ø 8 mm	≤ 250 bar
For Ø 10.2 mm	≤ 600 bar
Shock rating per EN 60068-2-27[1)]	150 g/6 ms
Continuous shock per EN 60068-2-29[1)]	150 g/2 ms
Vibration per EN 60068-2-6[1)]	20 g, 10 to 2000 Hz
Degree of protection per IEC 60529	
Connector S32/S115/S135 (when attached)	IP67
Cable KA_ _	IP68[1)]

[1)] Individual specifications as per Balluff factory standard

11.3 Supply voltage (external)

Voltage, stabilized:	
BTL7-_1_ _-...	20 to 28 V DC
BTL7-_5_ _-...	10 to 30 V DC
Ripple	≤ 0.5 V_{ss}
Current draw (at 24 V DC)	≤ 150 mA
Inrush current	≤ 500 mA/10 ms
Reverse polarity protection	Up to 36 V
Overvoltage protection	Up to 36 V
Dielectric strength (GND to housing)	500 V AC

11.4 Output

BTL7-A… Output voltage	0 to 10 V and 10 to 0 V
Load current	≤ 5 mA
BTL7-C… Output current	0 to 20 mA/20 to 0 mA
Load resistance	≤ 500 ohms
BTL7-E… Output current	4 to 20 mA/20 to 4 mA
Load resistance	≤ 500 ohms
BTL7-G… Output voltage	–10 to 10 V and 10 to –10 V
Load current	≤ 5 mA
Short circuit resistance	Signal cable to 36 V Signal cable to GND

11.5 Input

Programming inputs La, Lb:	High-active
BTL7-_1_ _-...	20 to 28 V DC
BTL7-_5_ _-...	10 to 30 V DC
Overvoltage protection	up to 36 V

11 Technical data (continued)

11.6 Dimensions, weights

Diameter of outer rod	8 mm or 10.2 mm
Nominal length	
For Ø 8 mm	25 to 1016 mm
For Ø 10.2 mm	25 to 7600 mm
Weight (depends on length)	Approx. 2 kg/m
Housing material	Anodized aluminum
Outer rod material	Stainless steel 1.4571
Outer rod wall thickness	
For Ø 8 mm	0.9 mm
For Ø 10.2 mm	2 mm
Young's modulus	Approx. 200 kN/mm^2
Housing mounting via threads	M18×1.5 or 3/4"-16UNF
Tightening torque	Max. 100 Nm
Cable diameter[1)]	6.7 mm
Permissible cable bending radius[1)]	
Fixed routing	≥ 35 mm
Movable	≥ 105 mm

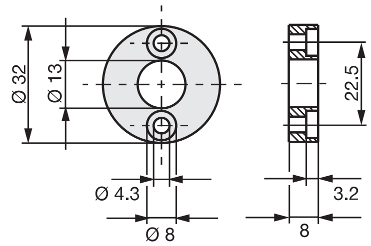
[1)] For BTL7-...-KA_ _

12 Accessories

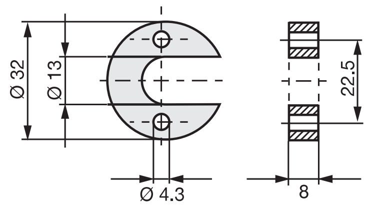
Accessories are not included in the scope of delivery and must be ordered separately.

12.1 Magnets

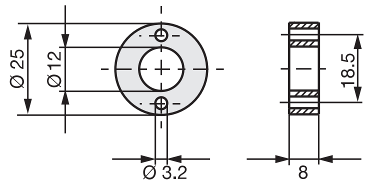
BTL-P-1013-4R



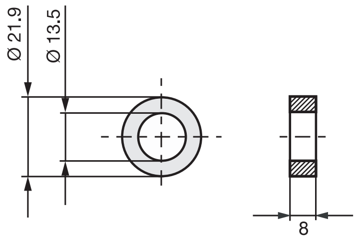
BTL-P-1013-4S



BTL-P-1012-4R



BTL-P-1014-2R



BTL-P-0814-GR-PAF

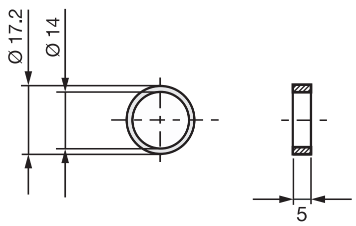


Fig. 12-1: Magnet installation dimensions

BTL-P-1013-4R, BTL-P-1013-4S, BTL-P-1012-4R, BTL-P-1014-2R:

Weight:	Approx. 10 g
Housing:	Anodized aluminum

BTL-P-0814-GR-PAF:

Weight:	Approx. 2 g
Housing:	Ferrite bound in PA

The scope of delivery for BTL-P-1013-4R, BTL-P-1013-4S, BTL-P-1012-4R magnets includes:

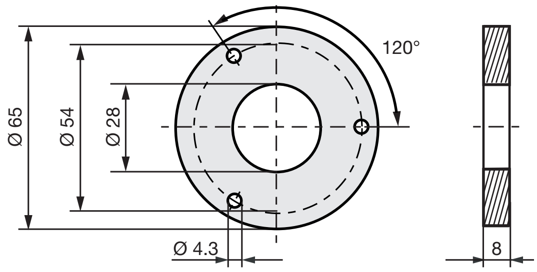
Spacer:	8 mm, material: polyoxymethylene (POM)

BTL5-P-4500-1 magnet (solenoid):

Weight:	Approx. 90 g
Housing:	Plastic
Operating temperature:	–40°C to +60°C

BTL-P-1028-15R (special accessories for applications with a supporting rod):

Weight:	Approx. 68 g
Housing:	Anodized aluminum



12.2 Mounting nut

– M18×1.5 mounting nut:
BTL-A-FK01-E-M18×1.5

– 3/4"-16UNF mounting nut:
BTL-A-FK01-E-3/4"-16UNF

12 Accessories (continued)

12.3 Connectors and cables

BKS-S32M-00
Straight connector, freely configurable
M16 per IEC 130-9, 8-pin

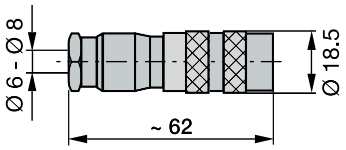


Fig. 12-2: Connector type BKS-S32M-00

BKS-S33M-00
Angled connector, freely configurable
M16 per IEC 130-9, 8-pin

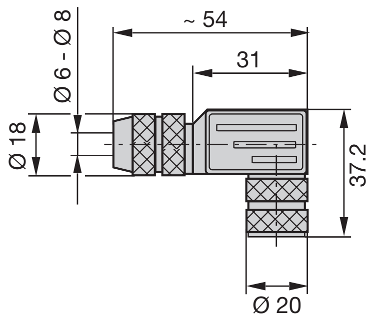


Fig. 12-3: Connector type BKS-S33M-00

BKS-S115-PU-_ _
Straight connector, molded-on cable, preassembled
M12, 8-pin
Various cable lengths can be ordered, e.g.
BKS-S115-PU-05: Cable length 5 m

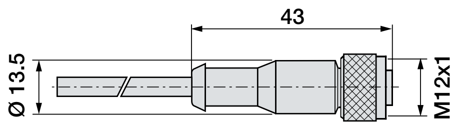


Fig. 12-4: Connector type BKS-S115-PU-_ _

BKS-S116-PU-_ _
Angled connector, molded-on cable, preassembled
M12, 8-pin
Various cable lengths can be ordered, e.g.
BKS-S116-PU-05: Cable length 5 m

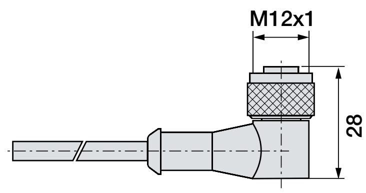


Fig. 12-5: Connector type BKS-S116-PU_ _

BKS-S135M-00
Straight connector, freely configurable
M16 per IEC 130-9, 6-pin

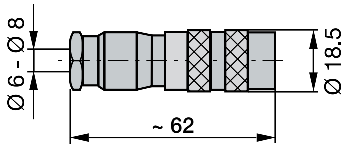


Fig. 12-6: Connector type BKS-S135M-00

BKS-S136M-00
Angled connector, freely configurable
M16 per IEC 130-9, 6-pin

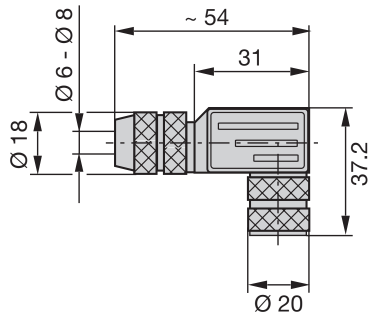


Fig. 12-7: Connector type BKS-S136M-00

13 Ordering code

BTL7 - A 1 1 0 - M0500 - B - S32

Micropulse transducer

Interface:
A = Analog interface, voltage output 0 to 10 V
G = Analog interface, voltage output –10 to 10 V
C = Analog interface, current output 0 to 20 mA
E = Analog interface, current output 4 to 20 mA

Supply voltage:
1 = 20 to 28 V DC
5 = 10 to 30 V DC

Output gradient:
00 = Rising (e.g. C_00 = 0 to 20 mA)
10 = Rising + falling (e.g. A_10 = 10 to 0 V and 0 to 10 V)
70 = Falling (e.g. C_70 = 20 to 0 mA)

Nominal stroke (4-digit):
M0500 = Metric specification in mm, nominal length 500 mm

Rod version, fastening:
A = Metric mounting thread M18x1.5, rod diameter 10.2 mm
B = Metric mounting thread M18x1.5, O-ring, rod diameter 10.2 mm
Y = 3/4"-16UNF thread, rod diameter 10.2 mm
Z = 3/4"-16UNF thread, O-ring, rod diameter 10.2 mm

A8 = Metric mounting thread M18x1.5, rod diameter 8 mm
B8 = Metric mounting thread M18x1.5, O-ring, rod diameter 8 mm
Y8 = 3/4"-16UNF thread, rod diameter 8 mm
Z8 = 3/4"-16UNF thread, O-ring, rod diameter 8 mm

Electrical connection:
S32 = 8-pin, M16 plug per IEC 130-9
S115 = 8-pin, M12 plug
S135 = 6-pin, M16 plug per IEC 130-9
KA05 = Cable, 5 m

14 Appendix

14.1 Converting units of length

1 mm = 0.0393700787 inch

mm	inches
1	0.03937008
2	0.07874016
3	0.11811024
4	0.15748031
5	0.19685039
6	0.23622047
7	0.27559055
8	0.31496063
9	0.35433071
10	0.393700787

Tab. 14-1: Conversion table mm to inches

1 inch = 25.4 mm

inches	mm
1	25.4
2	50.8
3	76.2
4	101.6
5	127
6	152.4
7	177.8
8	203.2
9	228.6
10	254

Tab. 14-2: Conversion table inches to mm

14.2 Part label

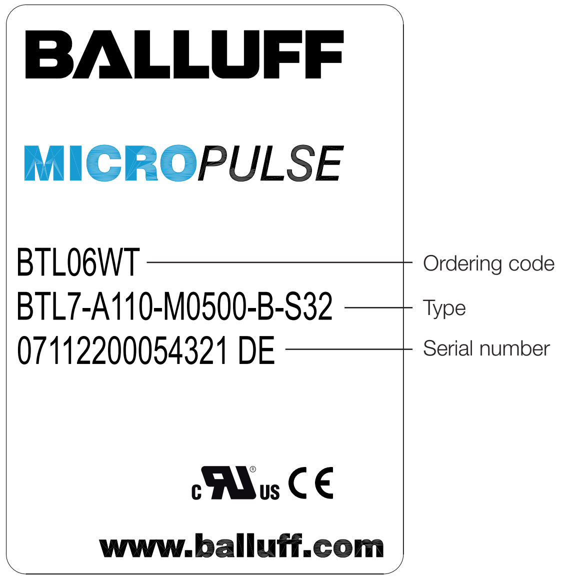


Fig. 14-1: BTL7 part label

www.balluff.com

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73765 Neuhausen a.d.F.
Phone + 49 7158 173-0
Fax +49 7158 5010
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Toll-free 1-800-543-8390
Fax (859) 727-4823
technicalsupport@balluff.com

No. 857628-726 E · 01.110183 · Edition 0907; Subject to modification. Replaces edition 0803.

14.11 Auxiliary lube oil pump with motor

14.11.1 Auxiliary lube oil pump

Voith Article No.: 204.00431210

Type: R 35/40 FL-Z

Operating Instructions. . . . . Rickmeier

14.11.2 Motor

Voith Article No: 204.00536010

Typ: 2 P 100 L WFF2

(3.0 kW; 3000 rpm; 400 V, 50 Hz, IP55)

Description . . . . WEG

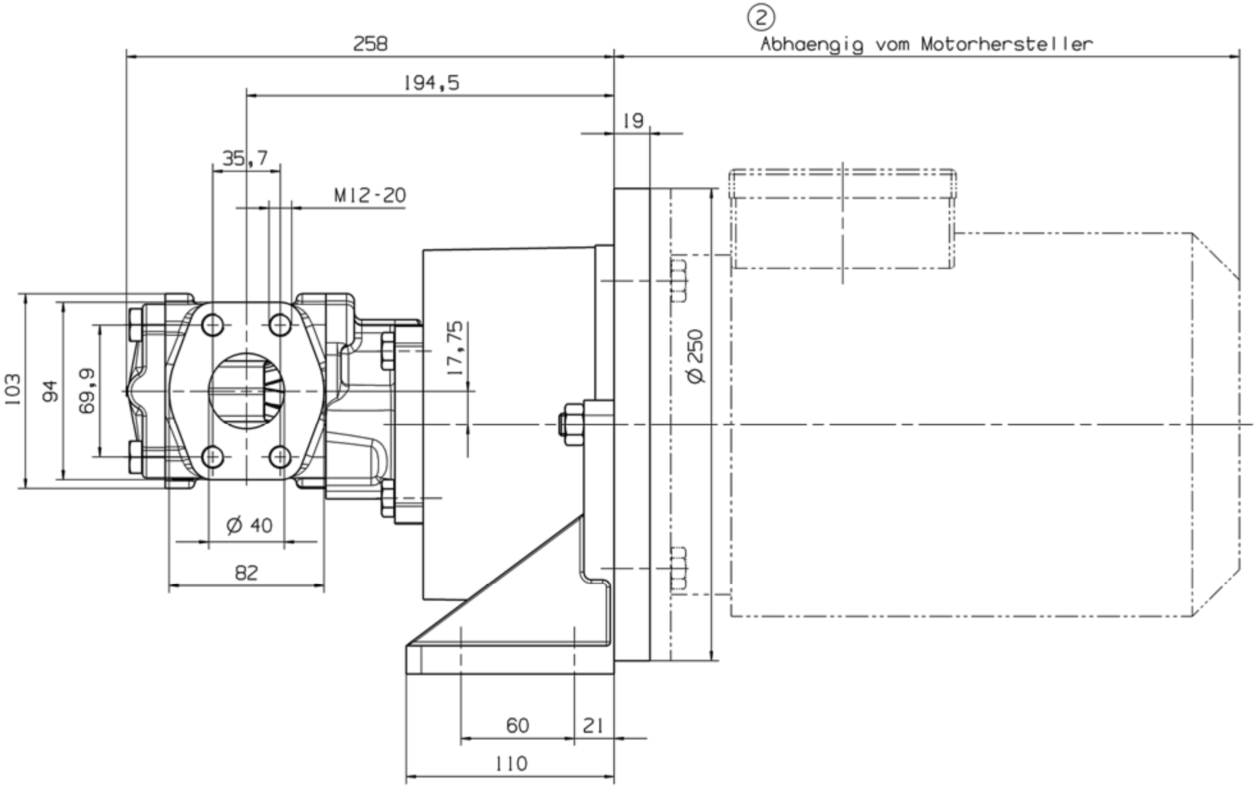
RICKMEIER.
PUMPENTECHNOLOGIE

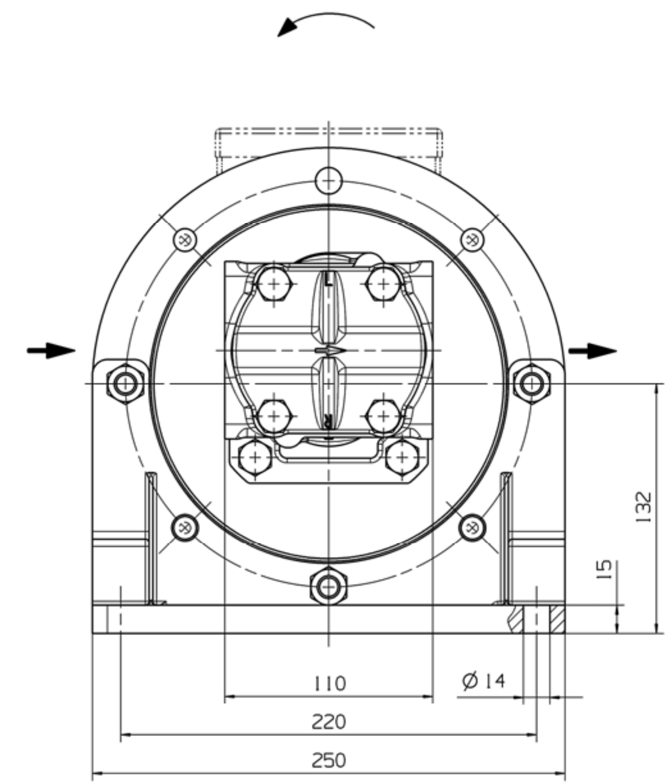
D A T A   S H E E T

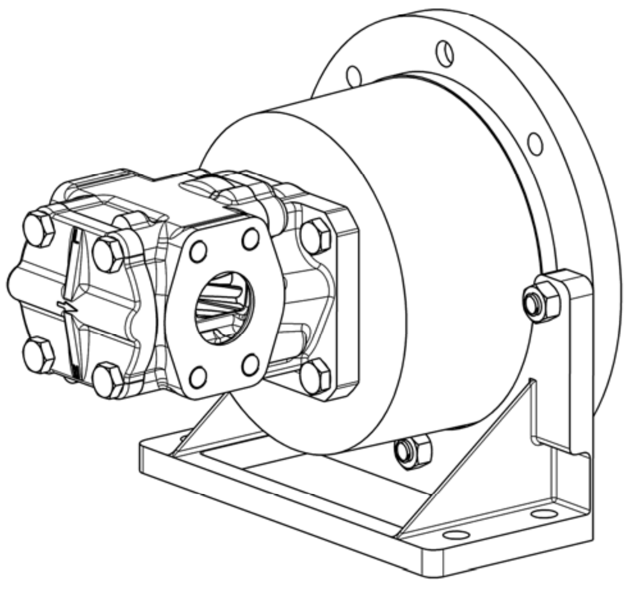
DESCRIPTION	**: Pump unit**		
D.S. NO.	**: 158065**	**REF.**	**: B5047461-POS.10**
ITEM-NO.	**: 441505**	**PROJECT**	**:**
REV.-DATE	**:**	**PRINT DATE**	**: 29.01.15**

gear pump unit		R35/40 FL-Z-SO
acc. to drawing		MZ441505//2
		(Pump 180° turn mounted)
tagging		204.00431210
complete assembled and tested		
consisting of:		
gear pump		R35/40 FL-Z-W-SAE1.1/2-R-SO
claw coupling		KB055A20A28-11
bracket		PT250A080-120
unit foot		PTFL250
suction connection		acc. SAE1.1/2, without flange
pressure connection		acc. SAE1.1/2, without flange
pump data:		
pumping medium		mineral oil ISO VG 32/46
fluid temperature	in deg. C	20...80
kin. viscosity	in mm²/s	32/46 at 40 °C, max. 150
oil flow approx.	in dm³/min	112
inlet pressure	in bar	0 (-0,4...+0,4)
outlet pressure	in bar	5
speed	in rpm	2880
sense of rotation (seen on shaft end)		cw
requested driving power	in kW	2,7 (5 bar, 150 mm²/s)
kind of shaft sealing		rubber radial shaft sealing
pressure relief valve		no
3-ph. squirrel-cage AC motor		will be supplied and mounted by you
motor data:		
type of construction		IM B5 / IM V1
frame size		100L
flange diameter		FF215 (A250)
explosion protection	(motor)	without
power	in kW	3,0
pump materials:		
casing		EN-GJL-250 (GG-25)
gear shafts		16MnCr5
elastomere		FKM
further data		
base coating		2-comp. epoxy varnish
		Seevenax 114 (light green)
		thickness about 40 µm
internal pump preservation	(pump)	by test fluid
approx. net weight pump unit	in kg	12,1

A.m. product is not conform to
the ATEX rules.







Nennmassbereich in mm		0,5 ...3	>3 ...6	>6 ...30	>30 ...120	>120 ...400	>400 ...1000	>1000 ...2000	>2000 ...4000
Allgemeintoleranzen aus DIN ISO 2768-1 fuer Laengen- und Winkelmasse	Mittel	± 0,1	± 0,1	± 0,2	± 0,3	± 0,5	± 0,8	± 1,2	± 2
	Grob	± 0,2	± 0,3	± 0,5	± 0,8	± 1,2	± 2	± 3	± 4
		Form und Lage nach DIN ISO 2768-2						H	K	L

Diese Tabelle ist nur durch Ankreuzen von Feld "Mittel" oder "Grob" bzw. "H", "K" oder "L" gueltig!

Nennmassbereich in mm		≤30	>30 ...120	>120 ...400	>400 ...1000	>1000 ...2000	>2000 ...4000	>4000 ...8000	>8000 ...12000
Freimasstoleranzen aus DIN EN ISO 13920 fuer Schweisskonstruktionen	B	±1	±2	±2	±3	±4	±6	±8	±10
	C	±1	±3	±4	±6	±8	±11	±14	±18
	D	±1	±4	±7	±9	±12	±16	±21	±27

Diese Tabelle ist nur durch Ankreuzen von Feld "B", "C" oder "D" gueltig!

① Pumpenaggregat
Pump unit
Groupe motopompe
Gruppo di pompaggio
Pompaggregaat
Agregat pompowy
Grupo da bomba
Насосный агрегат
Grupo de engranajes

② Abhaengig vom Motorhersteller
Manufacturer-specific
Dépendant du fabricant du moteur
In base al produttore del motore
Afhankelijk van de motorfabrikant
Zależności od produzenta silnika
Depende do fabricante do motor
В зависимости от производителя мотора
Dependiendo del fabricante

R35/25...40

			Tolerierung nach DIN 7167				
			Allgemeintoleranzen fuer Gussrohteile nach DIN 1680-1 und DIN EN ISO 8062				
			Zulaessige Abweichungen fuer thermisches Schneiden nach DIN EN ISO 9013				
			Guete: ☐ I ☐ II Toleranzklasse: ☐ A ☐ B	01	441505/A	25.02.2014	hul/web
			Werkstueckkanten nach DIN ISO 13715	AN-ZU	Aend.-Mittlg.-Nr.	Datum	Gez./Gepr.
				Masstab: Scale: 1:2	Gez.	26.01.2011	hul
			Schutzvermerk nach DIN ISO 16016 beachten! *Reprint with our permission only!*		Gepr.	26.01.2011	sche
Passmass	Oberes Abmass	Unteres Abmass			Normg.		

Bemerkung:

DIN ISO 5456

Benennung: *Denomination:* PUMPENAGGREGAT ①
R35/40 FL-Z-SO

Gewicht: 12.10 kg
Werkstoff:
Ursprungs-Zeichnung:
Ersetzt durch:
Ersatz fuer:

PUMPENTECHNOLOGIE RICKMEIER
☐ Zahnradpumpen ☐ Ventile ☐ Sonderprodukte ☐ Systeme

Sach-Nr.: *Object number:* MZ2-1200-441505//2
Format-Kennz.
Zeichnung besteht aus 1 Blatt | Blatt-Nr. 1

Dok-Id:1131313 Rev:02 Vers:01

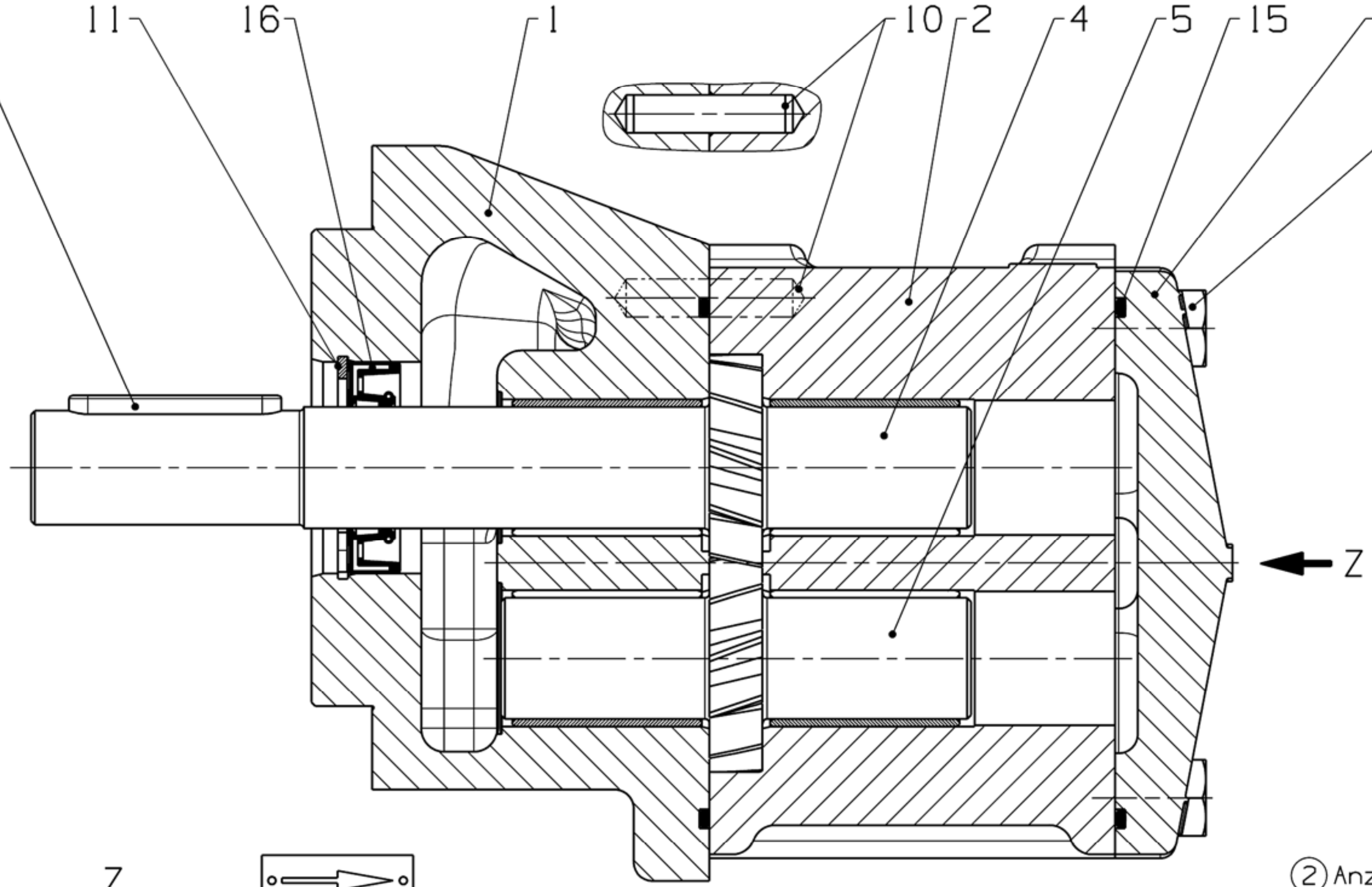
Rickmeier GmbH - Postfach 1340 - D-58797 Balve
Hausadresse: Garbeck - Langenholthauser Strasse 20-22 - D-58802 Balve - Germany

RICKMEIER.
PUMPENTECHNOLOGIE

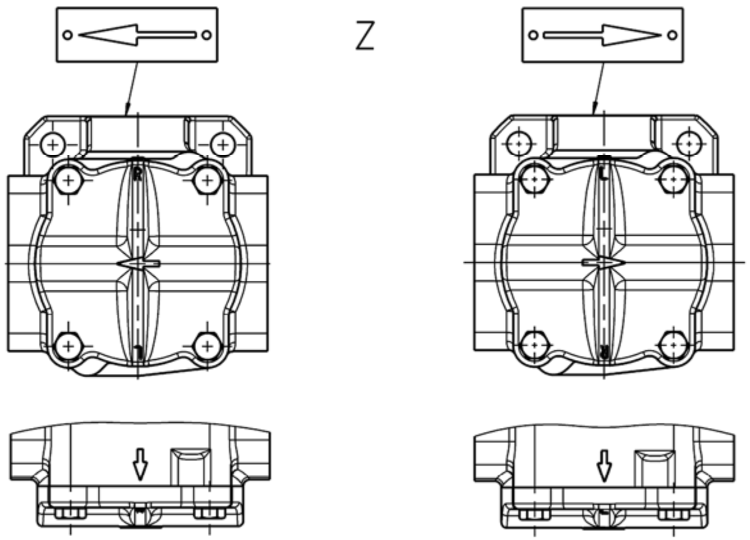
RICKMEIER WP | **Pump unit R35/40 FL-Z-SO** | **Page 1** | **Date 29.01.15** | **Rev.01/25.02.14**

Object-no. : 441505
Flow diagr. :
Documentation : MZ

Pos	Quantity	Description	Object-no.	Rev.
1	1	Gear pump R35/40 FL-Z-W-SAE1.1/2-R-SO	330102-5	
3	1	Claw coupling WP-N 8-2360-KB055A20A28-11 AL/T-PUR92	262795-8	
4	1	Unit foot WP-N 8-2114-PTFL250 AL	407779	
5	1	Bracket WP-N 8-2101-PT250A080-120 ALUMINIUM	259871-2	
8	4	Hexagonal head screw DIN 933-M10X30-8.8 STAHL	250090-8	
10	3	Cheese-head-screw DIN 912-M12X35-8.8 STAHL	250576-6	
11	3	Hexagonal nut DIN 934-M12-8 STAHL	252189-6	



Z



② Anziehdrehmoment
Tightening torque
Pos.9 : R25: 14 Nm
R35: 50 Nm
R45: 86 Nm
R65: 150 Nm

R25/2,5...R65/630

Nennmassbereich in mm	0,5 ...3	>3 ...6	>6 ...30	>30 ...120	>120 ...400	>400 ...1000	>1000 ...2000
Mittel	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2
Grob	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±3

Allgemeintoleranzen aus DIN ISO 2768 T1 ONr. 8-4111/01 fuer Laengen- und Winkelmasse. Form und Lage nach DIN ISO 2768 T2 ONr. 8-4111/02. Diese Tabelle ist nur durch Ankreuzen von Feld "Mittel" oder "Grob" bzw. "H", "K" oder "L" gueltig!

Nennmassbereich in mm	≤30	>30 ...120	>120 ...315	>315 ...1000	>1000 ...2000	>2000 ...4000	>4000 ...8000
B	±1	±2	±2	±3	±4	±6	±8
C	±1	±3	±4	±6	±8	±11	±14

Freimasstoleranzen aus DIN EN ISO 13920 ONr. 8-4117/01 fuer Schweisskonstruktionen. Diese Tabelle ist nur durch Ankreuzen von Feld "B" oder "C" gueltig!

Oberflaechensymbole nach DIN EN ISO 1302 ONr. 8-5227

Passmass	Oberes Abmass	Unteres Abmass

TOLERIERUNG DIN 7167 ONr. 8-4106

Allgemeintoleranzen fuer Gussrohteile nach DIN 1680 T1 ONr. 8-4120/01 und DIN ISO 8062 ONr. 8-412. GT...

Zulaessige Abweichungen fuer thermisches Schneiden nach DIN EN ISO 9013 ONr. 8-4116/03

Guete: ☐ I ☐ II Toleranzklasse: ☐ A ☐ B

Werkstueckkanten nach DIN ISO 13715 ONr. 8-5231

Zeichnungs-Zusatzangaben nach ONr. 8-5291

Schutzvermerk nach DIN ISO16016 beachten!
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AN-ZU	Aend.-Mittlg.-Nr.	Datum	Name
02	12/006	23.08.2012	hul/web
01	06/007	07.09.2006	bs/bs

Masstab: Scale: —		Datum	Name
	Gez.	28.06.2004	hul
	Gepr.	28.06.2004	web
	Normg.		

Bemerkung: XZ3-10-NN-113

Gewicht: 3.90 kg

Werkstoff:

Ursprungs-Zeichnung:

Ersetzt durch:

Ersatz fuer: Zchng.gl.Nr.

DIN ISO 5456

Benennung: *Denomination:*

ZAHNRADPUMPE/GEAR PUMP ①

R25/2,5 FL-Z-W-G3/4-R

PUMPENTECHNOLOGIE RICKMEIER
☐ Zahnradpumpen ☐ Ventile ☐ Sonderprodukte ☐ Systeme

Sach-Nr.: *Object number:* FZ3-1000-330000-1//3

Format-Kennz.

Zeichnung besteht aus 1 Blatt | Blatt-Nr. 1

☒ Zutreffendes bitte ankreuzen

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PUMPENTECHNOLOGIE

Object-no. : 330102-5
Flow diagr. : MZ3-2000-330020-9
Documentation : FZ3-1000-330000-1

Pos	Quantity	Description	Object-no.	Rev.
1	1	Driving cover R35 FL-W EN-GJL-250	185998-2	
2	1	Gear casing R35/40 SAE1.1/2 EN-GJL-250	185385-2	
3	1	End cover R35 EN-GJL-250	169168-2	
4	1	Driving gear shaft R35/40 Z-W 16MNCRS5+FP	167352-4	
5	1	Gear shaft R35/40 16MNCRS5+FP	167223-7	
9	4	Hexagonal head screw DIN 931-M10X110-8.8 STAHL	250290-4	
10	2	Parallel pin DIN 6325-6M6X24 STAHL	253250-5	
11	1	Circlip DIN 472-32X1,2 FEDERSTAHL	251968-4	
12	1	Fitted key DIN 6885-A6X6X32 C45+C	253838-7	
15	2	O-ring WP-N8-1515-01-75,87X2,62-FKM75 (2-151) FKM75	258404-3	
16	1	Rotary shaft seal DIN 3760-AS22X32X7-FKM FKM	440392	
100	1	Closure set Transport covering	438730	

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Translation of the original assembly instructions

Assembly and maintenance instructions for gear pumps and units

Series R25, R35, R45, R65, R95

BA2-0NNN-112	
AN-ZU: 05	
Prep.: Web/15.03.10	
Checked: Lü/31.03.10	
Name / Date	

English

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PUMPENTECHNOLOGIE
RICKMEIER
■ Zahnradpumpen ■ Ventile ■ Sonderprodukte ■ Systeme

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Illustrations

List of tables

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1 General Information

1.1 Important General Information

In addition to the information given in these assembly instructions, the acceptance of order and the technical documentation must also be strictly observed.

The following documents must also be strictly observed:

→ Pump unit without drive motor: clutch operating manual.

→ Pump unit with drive motor: motor operating manual.

→ Other manuals.

→ For operation in a potentially explosive environment the ATEX operating manual BA2-0NNN-113 supplied by Rickmeier GmbH must also be observed. The information in that manual on operation of the gear pump **supersedes** the information in this assembly and maintenance manual.

The documentation must always be available at the operating location of the machine so that dangers or injuries and damage can be prevented to the greatest extent possible. For storage, transport, commissioning, operation, maintenance / service or decommissioning, the applicable national, local and system-specific regulations must be observed.

Special designs and design variants may differ in their technical details! In case of uncertainty, we strongly recommend consulting Rickmeier GmbH with the data on the nameplate.

1.2 Warnings and Symbols

The warnings in this assembly manual must be observed at all times. They are designed for your personal safety and to prevent property damage. If there are multiple hazards, the warning for the highest level is used.

Warning		Hazard level	Consequences of non-observance
	DANGER	Warns of an immediate danger	Causes death or serious injury
	WARNING	Warns of a potential danger	May cause death or serious injury
	CAUTION	Warns of a potential hazardous situation	May cause minor injury
CAUTION		Warns of a potential hazardous situation	May cause property damage

Table 1: Warnings and consequences of non-observance

Symbol	Meaning
	Hazard symbol ➢ Take action to prevent personal injury and property damage.
➢	Instructions
☞ 1., 2., ...	Instructions consisting of multiple steps
→	Cross reference

Table 2: Symbols and their meaning

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1.3 Basic Safety Rules

The safety instructions, the current national rules and regulations for accident prevention and also internal working, operational and safety rules of the operator contained in these assembly instructions must be strictly observed. Failure to observe the safety precautions may lead to the loss of any and all warranty claims and claims to damages.

If the safety instructions are not observed, the following hazards may be encountered:
- Leakage of hazardous flow media (e.g. explosive, toxic, hot) may endanger persons and the environment. Leaks must be managed to eliminate any hazards. Legal requirements must be observed at all times.
- If hot or cold machine parts pose a danger, then these parts must be guarded to prevent contact by the customer.
- Failure of important functions of the machine or system.
- Reduction of the expected service life of the machine or system.
- Failure of specified maintenance and service methods.

Never remove safety equipment or deactivate it by making modifications to the machine!

Assembly, commissioning, operation, maintenance, de-commissioning must be conducted only by persons who are qualified as follows:
- They must have carefully read and understood the assembly and maintenance manual(s).
- They must be technically qualified for the planned work and must be authorised by their employer.
- EC Directive 89/655/EEC **Minimum safety and health requirements for the use of work equipment by workers at work** must be observed.

Information attached directly to the gear pump (such as **name plate**, **direction of rotation arrow**, **direction of flow arrow**, **markings of the fluid connections)** must always be observed. These must always be kept in a completely legible condition.

2 Technical data

2.1 Intended use

Rickmeier gear pumps of the R25, R35, R45, R65, R95 model range must be used exclusively for the supply of lubricating media.

The gear pumps must be used exclusively within the framework of the operational limits agreed by the contract. The data relevant for operation is set out in the acceptance of order and/or in the technical documentation.

Use in a potentially explosive environment is only permissible when the gear pump or pump unit is marked accordingly!

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2.2 Non-designated use

Non-designated use may result in damage to the gear pump. If the pump is subsequently operated under conditions other than those specified, this must be cleared with Rickmeier GmbH, otherwise all warranty claims will be rendered null and void.

Non-designated use	Possible consequences
Limits of operation of gear pump or pump unit not observed → Acceptance of order or technical documentation of gear pump or pump unit • Entry pressure too low or too high • Outlet pressure too low or too high • Operating temperature too low or too high • Viscosity of flow medium too low or too high • Speed too low or too high • Chemically aggressive constituents in the flow medium	• Noise generation and damage to the gear pump by cavitation • Damage to seals (leakage) • Delivery volume does not conform to order specifications • Corrosion in the gear pump • Damage to bearings, possible failure of gear pump • Damage to rotor housing (leakage) • Motor damage
Limit value for flow medium with solid particles exceeded → Acceptance of order or technical documentation of gear pump or pump unit → Assembly and maintenance manual, Chapter 2.3 “Flow medium“	• Damage to bearings • Possible failure of gear pump as a result of axial and radial corrosion in the gear pump • Delivery volume does not conform to order specifications
Limit value for gas constituents (undissolved gas) in flow medium exceeded → Acceptance of order or technical documentation of gear pump or pump unit → Assembly and maintenance manual, Chapter 2.3 “Flow medium“	• Noise generation by cavitation • Delivery volume does not conform to order specifications

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Non-designated use	Possible consequences
Parallel operation of two gear pumps without protection by check valves	• Delivery volume does not conform to order specifications • Damage to bearings • Possible failure of gear pump as a result of axial and radial corrosion in the gear pump
Incorrect direction of rotation	• Damage to seals (leakage) • No pumping • Possible failure of gear pump as a result of axial and radial corrosion in the gear pump

Table 3: Consequences of non-designated use

2.3 Flow medium

The flow medium must have lubricating properties to ensure a long service life and maximum operating safety. The flow medium should always be free of hard solid particles.

Consideration must be given also to the following:

Property	Unit	min.	max.
Kinematic viscosity	mm^2/s	5	15000
Degree of contamination	ISO 4406:1999	-	21/19/17
Gas content (undissolved)	Vol.-%	-	10

Table 4: Flow medium

Undissolved gas in the flow medium leads to increased noise emissions.

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2.4 Sound pressure level

The sound pressure level reference values measured on the test stand by Rickmeier GmbH are applicable for gear pumps only. With pump units the increase in the sound pressure level is minimal and is covered by the tolerance specified in Table 5.

Measurement conditions:

- Operating conditions: viscosity 33 mm^2/s, outlet pressure 25 bar, cavitation-free
- Distance to gear pump: 1 m
- Motor: IEC standard motor, n = 1450 min^{-1}

Gear pump	R25	R35	R45	R65	R95
Max. sound pressure level $L_{pA} \pm 3$ dB(A)	67	73	78	85	93

Table 5: Sound pressure level

3 Description

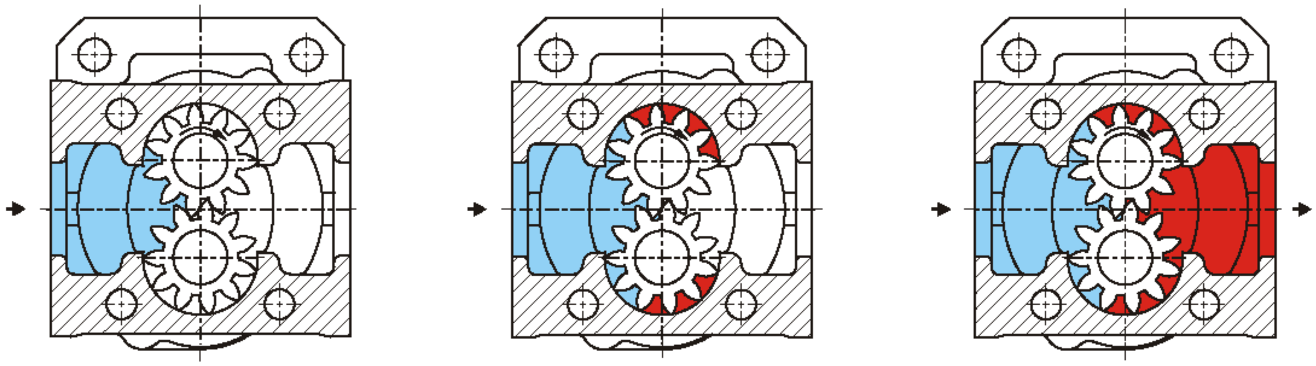

Figure 1: Gear pump delivery principle

Rickmeier gear pumps of the R25, R35, R45, R65, R95 model range are rotary displacement pumps. When the gear wheels turn, the flow medium enclosed in the space between the teeth is transported from the suction to the pressure side. Then the flow medium is displaced toward the pressure side by the intermeshing teeth. The transport of the flow medium results in a pressure drop on the suction side of the gear pump. The flow medium compensates for this pressure drop by flowing in, thereby maintaining the feed process.

This process is the same for both gaseous and liquid flow media. As a result, the gear pump is capable of priming the suction pipe itself until it is completely filled with liquid flow medium.

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3.1 Pressure relief valve

The pressure relief valve integrated in the end cover of the gear pump as an option is designed as a spring-loaded valve. It may only be used as an occasionally, briefly actuated valve for pressure relief. If a larger partial volume of the flow medium must be drained off over an extended period, a separate valve with a return pipe to the suction tank in the pipe (e.g. Rickmeier valves RSn, DBV40, DBV80, DB9) or another form of pressure relief must be provided. This also applies if the pressure pipe may become completely blocked during gear pump operation.

Special designs and design variants may differ in their technical details!

3.2 Using pressure relief valve R25, R35 DB (if installed)

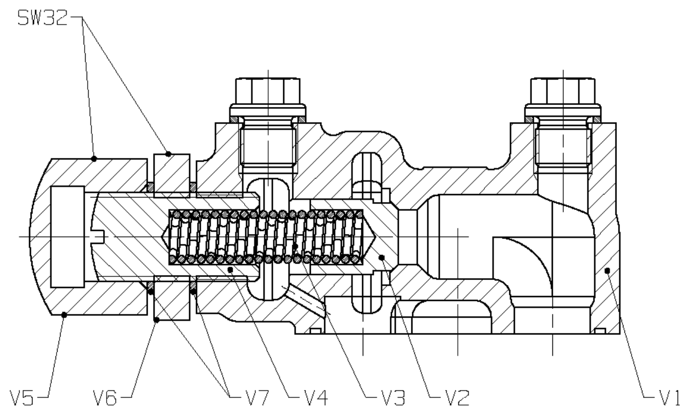

Figure 2: Pressure relief valve R25 DB

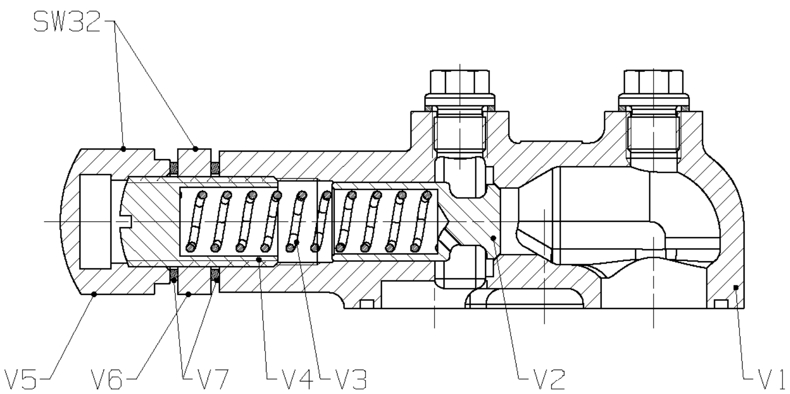

Figure 3: Pressure relief valve R35 DB

V1 End cover with integrated pressure relief valve
V2 Piston
V3 Compression spring
V4 Spindle
V5 Cap nut
V6 Hexagonal nut
V7 Copper sealing ring

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CAUTION

Risk of injury due to leaks of dangerous flow media (e.g. explosive, toxic, hot)

- During the pressure adjustment the spindle (Item V4) may only be screwed in clockwise (pressure increase).

  The spindle is not secured to prevent unscrewing!

☞ In the case of later pressure adjustment, the following must be observed:

1. Unscrew cap nut (Item V5).
2. Unscrew hexagonal nut (Item V6).
3. Adjust pressure by adjustment of the spindle (Item V4).

   Pressure increase = direction of rotation clockwise
4. Replace copper sealing ring (Item V7) (DIN 7603-A21x26-Cu).
5. Tighten sealing hexagon nut (Item V6).
6. Tighten cap nut (Item V5).

	Figure	**Item**	**Tightening torque [Nm]**
Pressure relief valve R25 DB	2	V5	70
		V6	70
Pressure relief valve R35 DB	3	V5	100
		V6	100

Table 6: Tightening torques for pressure relief valves

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4 Transport and storage

Dispose of the packing material after unpacking according to the applicable legal regulations.

Connections of the gear pump must be closed during transport and storage. The closures should not be removed until just before installation to prevent ingress of impurities into the gear pump.

The gear pump or the pump unit must be kept stable during transport. The gear pump or the pump unit must not be tilted more than 10° in any direction (e.g. use braces, not included with the equipment supplied by Rickmeier GmbH).

4.1 Storage and preservation

The gear pump is coated inside with test oil left from the test run and is therefore preserved. Renewed preservation is only permitted in consultation with Rickmeier GmbH.

Always protect the gear pump against damage due to moisture, dust, water and/or other contaminants. Store the gear pump in a clean and dry place (relative humidity ≤ 70%) at temperatures between -25 °C and 40 °C; uncoated components should be stored at a relative humidity ≤ 40%. Gear pumps with a rotary shaft seal or mechanical seal should be commissioned no later than 24 months after delivery. Storage conditions which differ from this are subject to separate consultation.

The coating supplied by Rickmeier GmbH is a base coat designed for protection from corrosion only during transport and storage. Do not damage the coating.

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4.2 Lifting the gear pump or pump unit

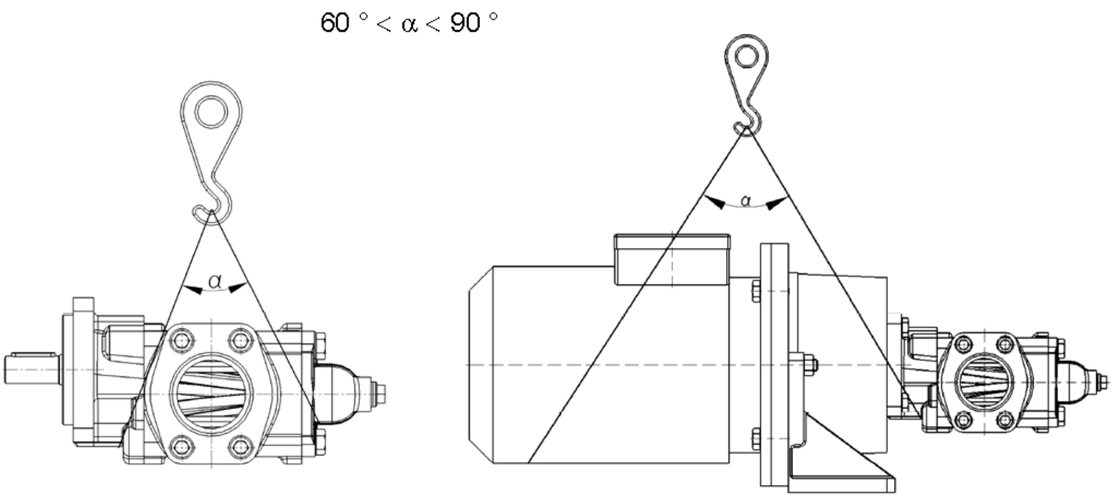

Figure 4: Transport / Lifting

	WARNING
⚠	**Danger of death or serious injury if the gear pump or pump unit falls**

- Use a suitable hoist.
  - → For weight specifications see acceptance of order or technical documentation for the gear pump or the pump unit
- Do not remain under suspended loads.

If the gear pump or the pump unit is lifted with straps, the centre of gravity must be between the straps to prevent the gear pump or the pump unit from tipping (see Figure 4).

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5 Set-up / Mounting and Connection

5.1 Set-up / Mounting

5.1.1 Preparation

CAUTION
Damage to gear pump or pump unit by inadequate fastening
➢ Install the equipment on an even surface securely fastened foot and flange fastening and accurate alignment.

☞ Preparing for set-up:

1. Checking the environmental conditions.

   → Acceptance of order or technical documentation of gear pump or pump unit

2. Ensure that there is sufficient space for set-up, mounting, operation and maintenance.
3. Ensure that the foundation is flat, clean and has sufficient load capacity.
4. Place the gear pump or the pump unit in the specified position.
5. Fasten gear pump or pump unit.

The drive of the gear pump must be adjusted to its power input.

Appropriate contact protection must be installed for pump models without factory-installed clutch guards.

→ E.g. Machinery Directive 2006/42/EC Section 1.3.8

Drive elements (drive pinion) must be fitted with ISO fit H7 on the drive shaft of the gear pump, unless otherwise specified. Drive elements (driving pinion) must not be driven on with hammer blows, as the gear pump can be damaged in the process.

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5.1.2 Clutch alignment

CAUTION

Damage to gear pump by faulty alignment of clutch

- When aligning the driving gear shaft of the gear pump to the drive, the permissible differences of the clutch may not be exceeded.

  → Clutch operating manual

Drive elements (clutches) must be fitted with ISO fit H7 on the drive shaft of the gear pump, unless otherwise specified. Drive elements (clutches) must not be driven on with hammer blows, as the gear pump can be damaged in the process.

5.1.3 Motor mounting

☞ Motor mounting:

1. Insert the motor key.
2. Slide on motor side clutch halves and tighten the setscrew.

   → Clutch operating manual
3. Fastening the motor to the bracket.
   Use the specified threaded holes only to attach the motor. The screws must be locked in position with Loctite medium 242 or 243 or comparable adhesives.

   → For screw tightening torques see Table 7

Tightening torque [Nm]	**Thread (Min. strength class 8.8)**					
	M8	M10	M12	M16	M20	M24
Bracket of aluminium	12	23	40	100	190	-
Bracket of steel and grey cast iron	27	53	92	230	460	590

Table 7: Tightening torques for brackets

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5.2 Planning and connection of pipes

5.2.1 Suction pipe design, NPSHR value

For correct operation the static pressure immediately at the inlet to the gear pump must not be less than **-0.4 bar** under any operating conditions (corresponding to 0.6 bar absolute). Deviations from this specification must be agreed with Rickmeier GmbH when ordering.

→ Acceptance of order or technical documentation of gear pump or pump unit

It is therefore advisable to calculate or measure the lowest possible static pressure at the pump entrance during operation. When doing so, all hydraulic resistance in the planned suction pipe must be taken into account. This is particularly important if a filter that may become partially blocked over time is to be installed in the suction line. In this case, we recommend monitoring the pump inlet pressure with a pressure measuring device as close to the gear pump as possible and that the filter is serviced regularly.

If no measuring connection is available in the suction pipe, the pressure gauge connection facing the suction side can also be used for this purpose for gear pumps with a pressure relief valve. Otherwise, the suction pipe must be absolutely leak-tight so that no air can be aspirated.

The NPSHR value of the pumps frequently used for comparison with the NPSHA value of a system is provided in Figure 5.

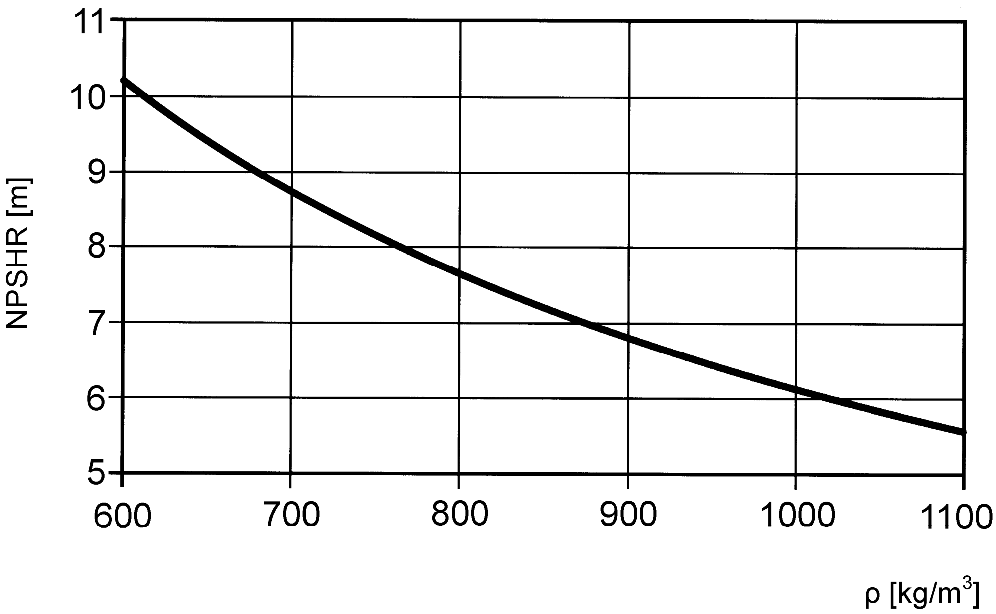

Figure 5: NPSHR
(ρ: density of the flow medium)

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5.2.2 Connection of pipes

CAUTION
Damage by impurities in the pipes
➢ The interior of the gear pump and the pipeline must be free of foreign particles. Residues are certain to lead to failures (pressure drop). ➢ Impurities resulting from welding (e.g. welding beads, grinding dust) must not penetrate the gear pump and the pipes. Connections must be closed during welding.

CAUTION
Damage by distortion during mounting
➢ The pipes must be free from tension. ➢ Do not exceed approved forces and torques at pipe connections.

Remove any cover screws, flange covers, shipping covers where present.

The gear pump connections and the mating surfaces must not be damaged. They must be free from paint residues and impurities. Maintain cleanliness as much as possible.

The connections must be sealed in accordance with the operating conditions (flow medium, pressure, temperature). All connections must match accurately. Centre the seals between the flanges. Use only male components with precisely fitted cylindrical threads for connections for models with internal thread.

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5.3 Electrical connection

DANGER
Danger of death by electrocution

- ➢ The pump unit must be connected by an authorised electrical technician only.
- ➢ Disconnect the electrical power supply.
  - → Motor operating manual

☞ Connecting motor:

→ Motor operating manual

1. Open terminal box on motor.
2. Ensure that the connector cable is not live.
3. Connect motor as shown in the wiring diagram.
4. Close terminal box on motor.
5. Install Emergency Stop switch.

6 Commissioning

6.1 Before commissioning

CAUTION
Danger of injury by leakage of drops of flow medium

- ➢ Catch leaking flow medium safely (e.g. collection trough under the gear pump) and dispose of in accordance with environmental regulations.

CAUTION
Damage from overheating of the gear pump

- ➢ The gear pump must not pump against the closed pressure line.

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☞ Before commissioning:

1. Fill gear pump with flow medium.
2. Fill suction and feed line with flow medium.

When operating two gear pumps in parallel which are protected against each other with non-return valves, both gear pumps must be bled on the pressure side. The same applies to a gear pump working against a closed system (loaded non-return valve etc.).

With difficult suction conditions, the gear pump must be installed so that the driving gear shaft and the gear shaft are located above each other. This installation position provides better priming after extended downtime due to the residual oil remaining in the gear pump.

The gear pump is prevented from running empty if:

- A check valve is installed in the suction line.
- The suction and pressure line at the gear pump are designed to form a siphon.

6.2 Dry running

CAUTION
Damage from running the gear pump dry
➢ The gear pump must be filled with flow medium before starting it for the first time.

Dry running frequently occurs during start-up with unfilled suction pipe or during operation when the supply of flow medium has been interrupted.

Gear pumps wetted with flow medium inside beforehand can be operated for up to 20 minutes under the following conditions:

- The gear pump is driven via a clutch, i.e. without radial force.
- The pressures at the inlet and outlet of the gear pump are virtually identical.

On gear pumps driven via a pinion, chain or belt, dry running is <u>not permissible</u> and must be avoided by the operator (fill gear pump with flow medium prior to start-up).

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6.3 Direction of rotation

6.3.1 Checking the direction of rotation

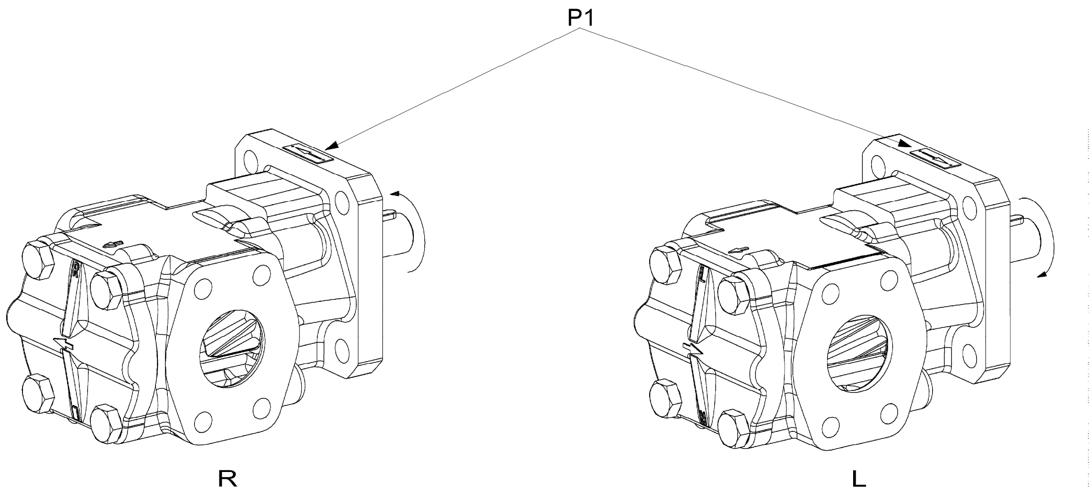

Figure 6: Direction of rotation
(direction of rotation R: clockwise)
(direction of rotation L: anticlockwise)

The direction of rotation is marked by the rotation arrow (Item P1) on the gear pump.

When checking the direction of drive rotation, a pressure build-up in the suction pipe must be prevented (e.g. caused by an integrated non-return valve). Otherwise the shaft seal may be damaged if the direction of rotation is incorrect.

DANGER

Danger of death by rotating parts

➢ Lock or remove the key when checking the direction of rotation to prevent it from flying out.

CAUTION

Damage by incorrect direction of rotation

➢ Disconnect the motor from the gear pump.

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☞ Checking the direction of rotation:

1. Disconnect the clutch so the gear pump cannot be driven.
   If this is not possible, the pipes must be disconnected to prevent damage to the gear pump.
2. Switch motor on and then off immediately.
3. Check that the fan impeller of the motor rotates in the direction of the rotation arrow on the gear pump (see Figure 6).
4. If the direction of rotation is incorrect, reverse the phases.
5. Connect the motor again.

6.3.2 Reversing the direction of rotation

Rickmeier gear pumps of the R25, R35, R45, R65, R95 model range are designed so the direction of rotation can be changed at any time. This also reverses the direction of flow. Rickmeier GmbH must be consulted before conversion to a different direction of rotation and therefore reversing the flow direction.

The direction of rotation of gear pumps with a mechanical seal **cannot** be changed after delivery. Rickmeier GmbH must carry out the conversion to a different direction of rotation and therefore reversing the flow direction.

6.4 Commissioning

Commissioning can be conducted as follows:

- The gear pump or the pump unit is correctly mounted, secured and connected.
- The motor is correctly mounted and connected to the electrical power supply.

  → Motor operating manual

- All connections are attached to the pipes without tension.
- The pipes are free from impurities.
- All safety equipment is installed and the operation has been tested.
- The gear pump has been filled and bled.

CAUTION

Danger of injury by leakage of drops of flow medium

➢ Catch leaking flow medium safely (e.g. collection trough under the gear pump) and dispose of in accordance with environmental regulations.

CAUTION

Damage from running the gear pump dry

➢ The gear pump must be filled with flow medium before starting it for the first time.

☞ Commissioning:

1. Open suction and pressure side fittings completely.
2. Switch on motor.
3. Run gear pump for some minutes to bleed the pipes completely.
4. As soon as the operating point is reached, check that the gear pump does not leak.
5. If leaks are detected, switch off the motor and check connections for leaks.

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6.5 Recommissioning

CAUTION

Danger of injury by leakage of drops of flow medium

- ➢ Catch leaking flow medium safely (e.g. collection trough under the gear pump) and dispose of in accordance with environmental regulations.

CAUTION

Damage from running the gear pump dry

- ➢ The gear pump must be filled with flow medium before starting it for the first time.

→ Chapter 6.1 "Before commissioning"

7 Dismantling

WARNING

Danger of injury by hot components

- ➢ Allow flow medium to cool to ambient temperature.

CAUTION

Danger of injury
by leakage of hot, toxic or corrosive flow medium

- ➢ Observe safety regulations when working with hazardous flow media.
- ➢ Assembly work must be carried out by qualified personnel only.
- ➢ Catch leaking flow medium safely (e.g. collection trough under the gear pump) and dispose of in accordance with environmental regulations.

☞ Dismantling:

1. Before disassembly the gear pump drive must be disconnected from the electrical power supply by an authorised electrical technician.
2. In case of operation at high temperatures the flow medium must be left to cool to ambient temperature before disassembly.
3. Block suction and pressure line.
4. Unscrew the fastening screws of the suction and pressure connections and collect the flow medium with a collection trough.
   Attention: Loosen the pressure side first.
5. Once the flow medium has drained completely, remove the suction and pressure connection flange.
6. Close the connections of the gear pump and the relevant mating surfaces with an oil-tight seal.

8 Maintenance / Service

8.1 Gear pump

Rickmeier gear pumps of the R25, R35, R45, R65, R95 model range usually require little maintenance when operated within the permissible operating limits. If a gear pump becomes unusable as the result of wear, it must be replaced. The installation of replacement parts generally does not restore the original performance.

The service life of the shaft seals is mainly dependent on the manner of operation of the gear pump and the purity and quality of the flow medium. As a result, in many cases no reliable prediction as to the time of failure can be made. For gear pumps with shaft seals it is recommended that they are inspected externally for signs of leakage at regular intervals (recommendation: after **48 h**, then every **4000 operating hours**). If a high danger potential exists due to the flow medium, a check should be made at shorter intervals.

When operated in a potentially explosive environment, the maintenance intervals of the related **ATEX operating instructions BA2-0NNN-113** apply.

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8.2 Pump unit

The maintenance of pump units also requires compliance with the maintenance intervals and service work of the clutch and the motor (see Table 8).

Product	Clutch model	Maintenance information
Unit without drive	Rotex and Bowex clutch	Gear pump: → Chapter 8.1 "Gear pump"
		Clutch: maintenance-free
	Other clutches	Gear pump: → Chapter 8.1 "Gear pump"
		Clutch: → Separate operating manual
Unit with drive	Rotex and Bowex clutch	Gear pump: → Chapter 8.1 "Gear pump"
		Clutch: maintenance-free
		Motor: → Separate operating manual
	Other clutches	Gear pump: → Chapter 8.1 "Gear pump"
		Clutch: → Separate operating manual
		Motor: → Separate operating manual

Table 8: Maintenance of pump units

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9 Conversion / Changes

Conversion or changes are permitted only after prior consultation with Rickmeier GmbH. Original spare parts and accessories approved by Rickmeier GmbH maintain safety. The use of other parts may mean that the manufacturer is no longer liable for any consequences. When ordering spare parts, please always give the data on the rating plate.

10 Decommissioning

CAUTION

Environmental damage from leaking flow medium

- Observe safety regulations when working with hazardous flow media.
- Catch leaking flow medium safely (e.g. collection trough under the gear pump) and dispose of in accordance with environmental regulations.
- Observe local regulations for disposal.

When decommissioning the gear pump, ensure that no pressure greater than atmospheric pressure exists in the gear pump, and that the drive cannot be started accidentally. For environmental protection reasons, disposal is permitted by licensed specialised companies only.

11 Malfunctions / Causes / Remedies

The following table contains directions for remedying any faults and finding their possible causes. If faults that are not listed here occur, we recommend contacting Rickmeier GmbH. If it is necessary to remove the gear pump for troubleshooting, observe the recommendations in Chapter 7 "Dismantling" and 10 "Decommissioning".

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Fault	Possible causes	Remedy
Gear pump has no suction	Gear pump direction of rotation is incorrect	Compare direction of rotation with the mark on the gear pump. Reverse motor poles if necessary. → Chapter 6.3 “Direction of rotation“
	Gear pump not sufficiently filled with flow medium (dry running)	Fill gear pump with flow medium. → Chapter 6.1 "Before commissioning"
	Suction line or seals leak	Inspect suction line for leaks.
		Check gear pump seals, replace if necessary.
		If there is a pressure relief valve installed: check seals, replace if necessary.
	Pressure drop in suction line too high	Enlarge pipe cross-section.
		Shorten suction line.
		Increase suction side fluid level.
		If filter is installed: clean it, if necessary install filter with larger mesh size. Attention: Note approved mesh size (max. 60 µm).
	Pressure relief valve dirty or damaged	Remove pressure relief valve, clean, replace defect parts.
	Air inclusions or gas bubbles in the flow medium	Check pipe for leaks. Bleed pressure line.
		Terminate return lines below the oil level of the tank.

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Fault	Possible causes	Remedy
	Gear pump does not vent	Check pipe for leaks. Bleed pressure line.
		Terminate return lines below the oil level of the tank.
Delivery volume too low or outlet pressure too low	Suction line or seals leak	Inspect suction line for leaks.
		Check gear pump seals, replace if necessary.
		If there is a pressure relief valve installed: check seals, replace if necessary.
	Pressure drop in suction line too high	Enlarge pipe cross-section.
		Shorten suction line.
		Increase suction side fluid level.
		If filter installed: clean it, if necessary install filter with larger mesh size. <ins>Attention:</ins> Note approved mesh size (max. 60 µm).
	Opening pressure of pressure relief valve not correct	Set opening pressure approx. 10% above the value of the operating pressure. → Acceptance of order or technical documentation of gear pump
	Pressure relief valve dirty or damaged	Remove pressure relief valve, clean, replace defect parts.
	Motor operated with incorrect voltage or frequency	Check circuit type, speed and power consumption of drive motor. Compare voltage and frequency with motor type plate.

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Fault	Possible causes	Remedy
	Flow media with high vapour pressure	In the case of flow media with high vapour pressure (petrol, solvents, paints etc.) the flow medium must flow around the gear pump. Motor speed max. 1000 min^{-1}.
	Air inclusions or gas bubbles in the flow medium	Check pipe for leaks. Bleed pressure line.
		Terminate return lines below the oil level of the tank.
	Viscosity of flow medium too high	Increase temperature of flow medium.
		Reduce speed.
	Viscosity of flow medium too low	Reduce temperature of flow medium.
		Increase speed.
	Size of gear pump too small	Install larger gear pump.
Outlet pressure too high	Pressure relief valve dirty or damaged	Remove pressure relief valve, clean, replace defective parts.
	Maximum approved speed exceeded	Reduce speed. → Acceptance of order or technical documentation of gear pump
	Viscosity of flow medium too high	Increase temperature of flow medium.
		Reduce speed.
Gear pump is noisy	Suction line or seals leak	Inspect suction line for leaks.
		Check gear pump seals, replace if necessary.
		If there is a pressure relief valve installed: check seals, replace if necessary.

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Fault	Possible causes	Remedy
	Pressure drop in suction line too high	Enlarge pipe cross-section.
		Shorten suction line.
		Increase suction side fluid level.
		If filter installed: clean it, if necessary install filter with larger mesh size. Attention: Note approved mesh size (max. 60 µm).
	Opening pressure of pressure relief valve not correct	Set opening pressure approx. 10% above the value of the operating pressure. → Acceptance of order or technical documentation of gear pump
	Gear pump has no pressure	With unpressurised pumping of liquid flow media load the gear pump with 1-2 bar.
	Maximum approved speed exceeded	Reduce speed. → Acceptance of order or technical documentation of gear pump
	Flow media with high vapour pressure	In the case of flow media with high vapour pressure (petrol, solvents, paints etc.) the flow medium must flow around the gear pump. Motor speed max. 1000 min^{-1}.
	Air inclusions or gas bubbles in the flow medium	Check pipe for leaks. Bleed pressure line.
		Terminate return lines below the oil level of the tank.
	Viscosity of flow medium too high	Increase temperature of flow medium.
		Reduce speed.

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Fault	Possible causes	Remedy
Gear pump does not start, stops suddenly or has stalled	Gear pump not sufficiently filled with flow medium (dry running)	Fill gear pump with flow medium. → Chapter 6.1 "Before commissioning"
	Foreign bodies in the gear pump	Remove and clean gear pump, replace defective parts, smooth surface damage.
	Power of motor too low	Install larger motor. → Acceptance of order or technical documentation of gear pump
	Viscosity of flow medium too high	Increase temperature of flow medium.
		Reduce speed.
	Viscosity of flow medium too low	Reduce temperature of flow medium.
		Increase speed.
	Bearings overloaded by excessive differential pressure	Check the value of the differential pressure → Acceptance of order or technical documentation of gear pump
	Bearings overloaded by excessively low viscosity	Reduce temperature of flow medium.
		Increase speed.
		Use higher viscosity flow medium.
	Gear pump distorted	Remove gear pump, check pipes.

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Fault	Possible causes	Remedy
Pressure relief valve is noisy	Opening pressure of pressure relief valve not correct	Set opening pressure approx. 10% above the value of the operating pressure. → Acceptance of order or technical documentation of gear pump
	Air inclusions or gas bubbles in the flow medium	Check pipe for leaks. Bleed pressure line.
		Terminate return lines below the oil level of the tank, check oil system.
		Check seals, screw fastenings.

Table 9: Troubleshooting

AN-ZU	Changes	Date	Editor
05	ÄM 10/021	15.03.2010	Web

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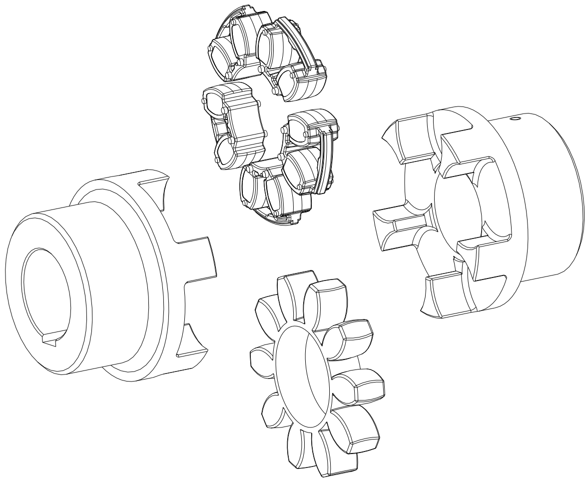
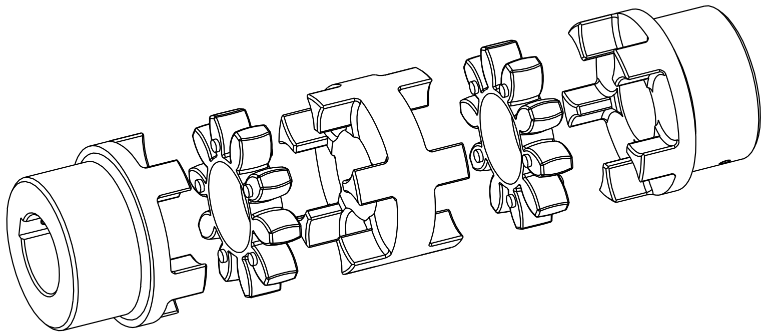
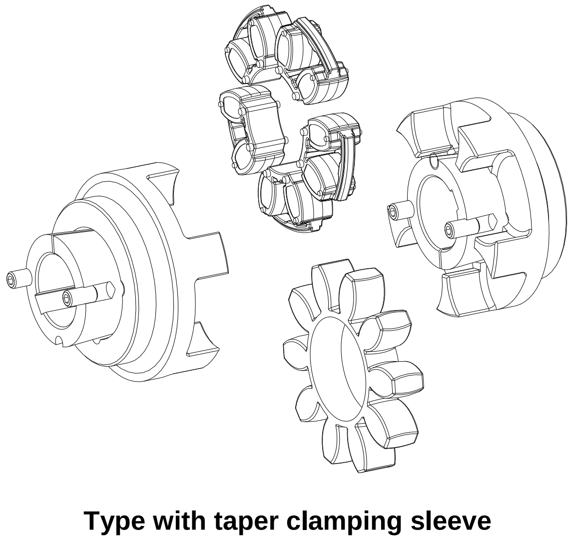
(ATEX 95) for finish bored, pilot bored
and unbored couplings



Type No. 001 – shaft coupling



**Type No. 018 – DKM
double-cardanic coupling**



Type with taper clamping sleeve

ROTEX® is a torsionally flexible jaw coupling. It is able to compensate for shaft misalignment, for example caused by manufacturing inaccuracies, thermal expansion, etc.

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1 Technical data

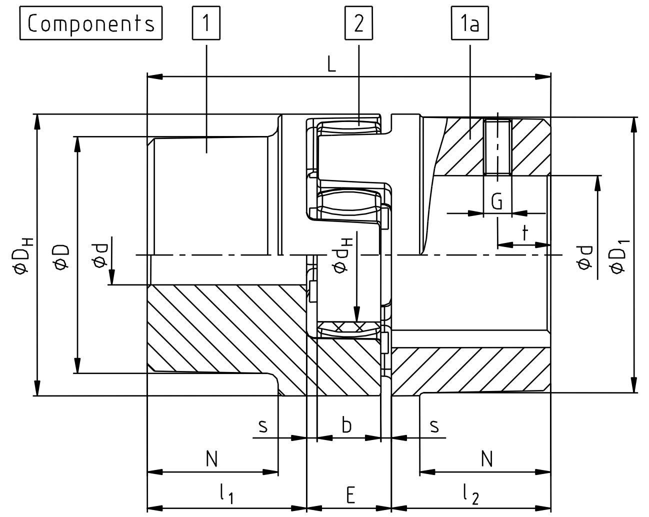


Illustration 1: ROTEX® (material: Al-D)

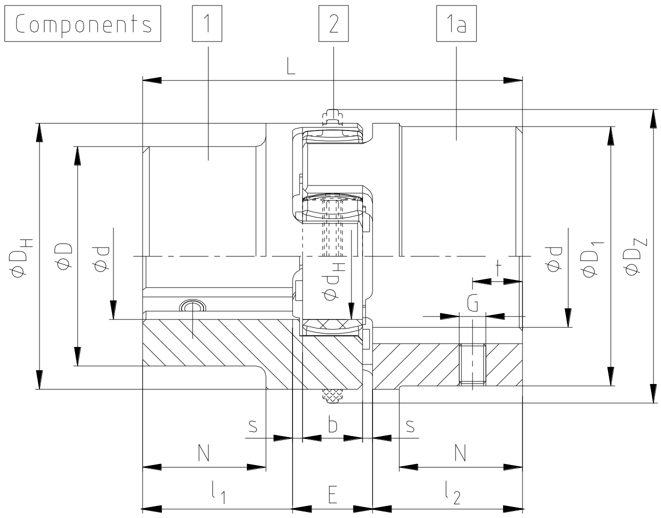


Illustration 2: ROTEX® (material: EN-GJL-250/EN-GJS-400-15)

Table 1: Material Al-D

Size	Com-ponent	Spider [1] (component 2) Rated torque [Nm]			Dimensions [mm] [3]											
					Finish bore [2]	General										
		92 Sh A	98 Sh A	64 Sh D	d (min-max)	L	l_1; l_2	E	b	s	D_H	D_Z	D_{Z1} [4]	d_H	D;D_1	N
14	1a	7.5	12.5	-	6 - 16	35	11	13	10	1.5	30	-	-	10	30	-
19	1	10	17	-	6 - 19	66	25	16	12	2.0	41	-	-	18	32	20
	1a				19 - 24										41	
24	1	35	60	-	9 - 24	78	30	18	14	2.0	56	-	-	27	40	24
	1a				22 - 28										56	
28	1	95	160	-	10 - 28	90	35	20	15	2.5	67	-	-	30	48	28
	1a				28 - 38										67	

Table 2: Material EN-GJL-250 (GG 25)/EN-GJS-400-15 (GGG 40)

Size	Com-ponent	Spider [1] (component 2) Rated torque [Nm]			Dimensions [mm] [3]											
					Finish bore [2]	General										
		92 Sh A	98 Sh A	64 Sh D	d (min-max)	L	l_1; l_2	E	b	s	D_H	D_Z	D_{Z1} [4]	d_H	D;D_1	N
Cast iron EN-GJL-250																
38	1	190	325	405	12 - 40	114	45	24	18	3.0	80	-	-	38	66	37
	1a				38 - 48										78	
	1b				12 - 48	164	70									62
42	1	265	450	560	14 - 45	126	50	26	20	3.0	95	-	-	46	75	40
	1a				42 - 55										94	
	1b				14 - 55	176	75									65
48	1	310	525	655	15 - 52	140	56	28	21	3.5	105	-	-	51	85	45
	1a				48 - 62										104	
	1b				15 - 62	188	80									69
55	1	410	685	825	20 - 60	160	65	30	22	4.0	120	-	-	60	98	52
	1a				55 - 74										118	
65	1	625	940	1175	22 - 70	185	75	35	26	4.5	135	-	-	68	115	61
75	1	1280	1920	2400	30 - 80	210	85	40	30	5.0	160	-	-	80	135	69
90	1	2400	3600	4500	40 - 97	245	100	45	34	5.5	200	218	230	100	160	81
Nodular iron EN-GJS-400-15																
100	1	3300	4950	6185	50 - 115	270	110	50	38	6.0	225	246	260	113	180	89
110	1	4800	7200	9000	60 - 125	295	120	55	42	6.5	255	276	290	127	200	96
125	1	6650	10000	12500	60 - 145	340	140	60	46	7.0	290	315	330	147	230	112
140	1	8550	12800	16000	60 - 160	375	155	65	50	7.5	320	345	360	165	255	124
160	1	12800	19200	24000	80 - 185	425	175	75	57	9.0	370	400	415	190	290	140
180	1	18650	28000	35000	85 - 200	475	185	85	64	10.5	420	450	465	220	325	156

1) Maximum torque of the coupling $T_{Kmax.}$ = rated torque of the coupling $T_{K\ rated}$ x 2
2) Bores H7 with keyway to DIN 6885 sheet 1 [JS9] and thread for setscrew
3) For dimensions G and t see table 6; threads for setscrews are located opposite the keyway with material Al-D and on the keyway with material EN-GJL-250/EN-GJS-400-15
4) D_{Z1} = internal diameter of housing

1 Technical data

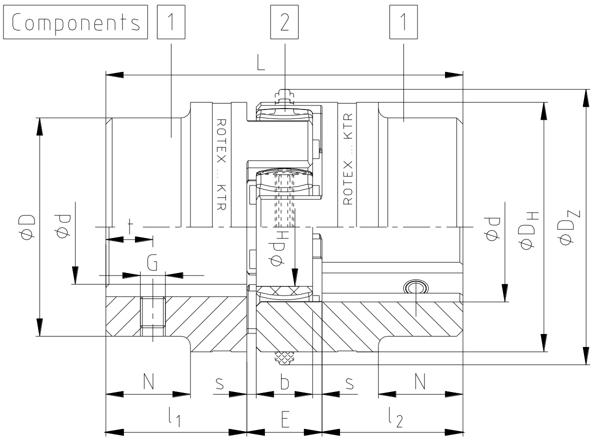


Illustration 3: ROTEX® (material: steel)

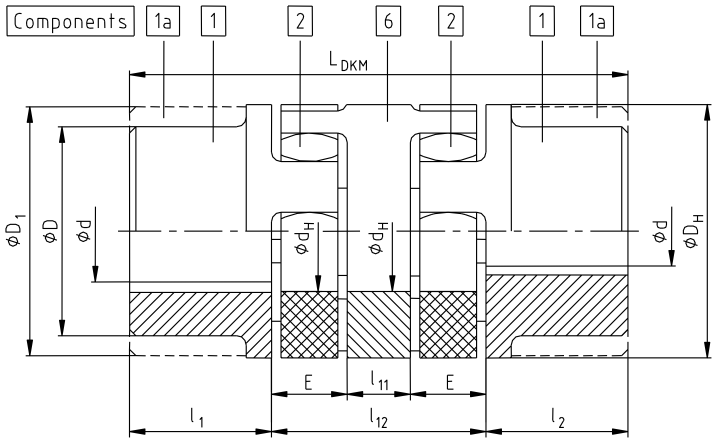


Illustration 4: ROTEX®, type DKM [5)]

Table 3: Material steel

Size	Com-ponent	Spider [1)] (component 2) Rated torque [Nm]			Dimensions [mm] [3)]											
					Finish bore [2)]	General										
		92 Sh A	98 Sh A	64 Sh D	d (min-max)	L	l_1; l_2	E	b	s	D_H	D_Z	D_{Z1} [4)]	d_H	D	N
14	1a	7.5	12.5	16	0 - 16	35	11	13	10	1.5	30	-	-	10	30	-
	1b					50	18.5									
19	1a	10	17	21	0 - 25	66	25	16	12	2.0	40	-	-	18	40	-
	1b					90	37									
24	1a	35	60	75	0 - 35	78	30	18	14	2.0	55	-	-	27	55	-
	1b					118	50									
28	1a	95	160	200	0 - 40	90	35	20	15	2.5	65	-	-	30	65	-
	1b					140	60									
38	1	190	325	405	0 - 48	114	45	24	18	3.0	80	-	-	38	70	27
	1b					164	70								80	-
42	1	265	450	560	0 - 55	126	50	26	20	3.0	95	-	-	46	85	28
	1b					176	75								95	-
48	1	310	525	655	0 - 62	140	56	28	21	3.5	105	-	-	51	95	32
	1b					188	80								105	-
55	1	410	685	825	0 - 74	160	65	30	22	4.0	120	-	-	60	110	37
	1b					210	90								120	-
65	1	625	940	1175	0 - 80	185	75	35	26	4.5	135	-	-	68	115	47
	1b					235	100								135	-
75	1	1280	1920	2400	0 - 95	210	85	40	30	5.0	160	-	-	80	135	53
	1b					260	110								160	-
90	1	2400	3600	4500	0 - 110	245	100	45	34	5.5	200	218	230	100	160	62
	1b					295	125								200	-

Table 4: Type DKM [5)]

Size	Spider [1)] (component 2) Rated torque [Nm]		Dimensions [mm] [3)]									
			Dimensions	General								
	92 Sh A	98 Sh A	d, D, D_1	L_{DKM}	l_1; l_2	E	b	s	D_H	d_H	l_{11}	l_{12}
19	10	17	see table 1 to 3	92	25	16	12	2.0	40	18	10	42
24	35	60		112	30	18	14	2.0	55	27	16	52
28	95	160		128	35	20	15	2.5	65	30	18	58
38	190	325		158	45	24	18	3.0	80	38	20	68
42	265	450		174	50	26	20	3.0	95	46	22	74
48	310	525		192	56	28	21	3.5	105	51	24	80
55	410	685		218	65	30	22	4.0	120	60	28	88
65	625	940		252	75	35	26	4.5	135	68	32	102
75	1280	1920		286	85	40	30	5.0	160	80	36	116
90	2400	3600		330	100	45	34	5.5	200	100	40	130

1) Maximum torque of the coupling $T_{Kmax.}$ = rated torque of the coupling $T_{K\ rated}$ x 2
2) Bores H7 with keyway to DIN 6885 sheet 1 [JS9] and thread for setscrew
3) For dimensions G and t see table 6; threads for setscrews are located opposite the keyway with material Al-D and on the keyway with material EN-GJL-250/EN-GJS-400-15
4) D_{Z1} = internal diameter of housing
5) Type DKM not available with DZ elements.

1 Technical data

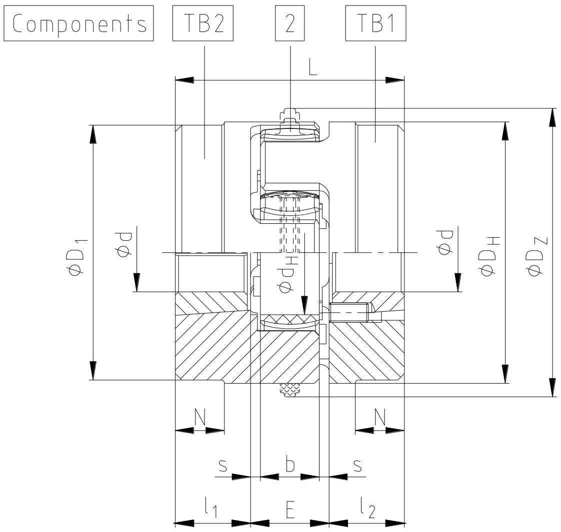


Illustration 5: ROTEX®, type with taper clamping sleeve

Coupling design:

TB1 Screwing on cam side
TB2 Screwing on collar side

Different combinations of types TB1 and TB2 are possible.

Table 5: Type with taper clamping sleeve

Size	Com-ponent	Spider [1] (component 2) Rated torque [Nm]		Dimensions [mm]												Taper clam-ping sleeve
				Finish bore d (min-max)	General											
		92 Sh A	98 Sh A		L	l_1; l_2	E	b	s	D_H	D_Z	D_{Z1} [2]	d_H	D_1	N	
24	1a	35	60	10 - 25	64	23	18	14	2.0	55	-	-	27	-	-	1008
28	1a	95	160	10 - 25	66	23	20	15	2.5	65	-	-	30	-	-	1108
38	1a	190	325	10 - 25	70	23	24	18	3.0	80	-	-	38	78	15	1108
42	1a	265	450	14 - 25	78	26	26	20	3.0	95	-	-	46	94	16	1610
48	1a	310	525	14 - 40	106	39	28	21	3.5	105	-	-	51	104	28	1615
55	1a	410	685	14 - 50	96	33	30	22	4.0	120	-	-	60	118	20	2012
65	1	625	940	14 - 50	101	33	35	26	4.5	135	-	-	68	115	5	2012
75	1	1280	1920	16 - 60	144	52	40	30	5.0	160	-	-	80	158	36	2517
				25 - 75												3020 [3]
90	1	2400	3600	25 - 75	149	52	45	34	5.5	200	218	230	100	160	14	3020
100	1	3300	4950	35 - 90	230	90	50	38	6.0	225	246	260	113	180	69	3535
125	1	6650	10000	55 - 110	288	114	60	46	7.0	290	315	330	147	230	86	4545

1) Maximum torque of the coupling $T_{Kmax.}$ = rated torque of the coupling $T_{K\ rated}$ x 2
2) D_{Z1} = internal diameter of housing
3) Available for type TB2 only

ROTEX® couplings with attachments that can generate heat, sparks and static charging (e. g. combinations with brake drums, brake disks, overload systems like torque limiters, fans etc.) are <u>not</u> permitted for the use in hazardous areas.
A separate analysis must be performed.

2 Advice

2.1 General advice

Please read through these assembly instructions carefully before you start up the coupling.
Please pay special attention to the safety instructions!

The **ROTEX®** coupling is suitable and approved for the use in hazardous locations. When using the coupling in hazardous locations please observe the special advice and instructions regarding safety in enclosure A.

The assembly instructions are part of your product. Please store them carefully and close to the coupling.

2 Advice

2.2 Safety and advice symbols

Warning of potentially explosive atmospheres	This symbol indicates notes which may contribute to preventing bodily injuries or serious bodily injuries that may result in death caused by explosion.
STOP	**Warning of personal injury**	This symbol indicates notes which may contribute to preventing bodily injuries or serious bodily injuries that may result in death.
!	**Warning of product damages**	This symbol indicates notes which may contribute to preventing damage on material or machines.
☞	**General advice**	This symbol indicates notes which may contribute to preventing undesirable results or conditions.
	Warning of hot surfaces	This symbol indicates notes which may contribute to preventing burns with hot surfaces resulting in light to serious bodily injuries.

2.3 General hazard warnings

STOP **With assembly, operation and maintenance of the coupling it has to be made sure that the entire drive train is secured against accidental switch-on. You may be seriously hurt by rotating parts. Please make absolutely sure to read through and observe the following safety indications.**

- All operations on and with the coupling have to be performed taking into account "safety first".
- Please make sure to switch off the power pack before you perform your work on the coupling.
- Secure the power pack against accidental switch-on, e. g. by providing warning signs at the place of switch-on or removing the fuse for current supply.
- Do not reach into the operation area of the coupling as long as it is in operation.
- Please secure the coupling against accidental contact. Please provide for the necessary protection devices and covers.

2.4 Intended use

You may only assemble, operate and maintain the coupling if you

- have carefully read through the assembly instructions and understood them
- had technical training
- are authorized by your company

The coupling may only be used in accordance with the technical data (see chapter 1). Unauthorized modifications on the coupling design are not admissible. We will not assume liability for any damage that may arise. In the interest of further development we reserve the right for technical modifications.
The **ROTEX®** described in here corresponds to the technical status at the time of printing of these assembly instructions.

2 Advice

2.5 Coupling selection

C A U T I O N !
For a long-lasting and failure-free operation of the coupling it must be selected according to the selection instructions (according to DIN 740 part 2) for the particular application (see ROTEX® catalogue).
If the operating conditions (performance, speed, modifications on engine and machine) change, the coupling selection must be reviewed again.
Please make sure that the technical data regarding torque refer to the spider only. The transmittable torque of the shaft-hub-connection must be reviewed by the customer and is subject to his responsibility.

For drives subject to torsional vibrations (drives with cyclic stress due to torsional vibrations) it is necessary to perform a torsional vibration calculation to ensure a reliable selection. Typical drives subject to torsional vibrations are e. g. drives with diesel engines, piston pumps, piston compressors etc. If requested, KTR will perform the coupling selection and the torsional vibration calculation.

If the coupling is used in hazardous locations, the size must be selected such that there is a minimum safety of s = 2.0 between the torque of the machine and the rated torque of the coupling or shaft-hub-connection.

3 Storage, transport and packaging

3.1 Storage

The coupling hubs are supplied in preserved condition and can be stored at a dry and covered place for 6 - 9 months.
The features of the coupling spiders (elastomers) remain unchanged for up to 5 years with favourable stock conditions.

The storage rooms must not include any ozone-generating devices like e. g. fluorescent light sources, mercury-vapour lamps or electrical high-voltage appliances.
Humid storage rooms are not suitable.
Please make sure that condensation is not generated. The best relative air humidity is less than 65 %.

3.2 Transport and packaging

In order to avoid any injuries and any kind of damage please always make use of proper lifting equipment.

The couplings are packed differently each depending on size, number and kind of transport. Unless otherwise contractually agreed, packaging will follow the in-house packaging regulations of KTR Kupplungstechnik GmbH.

4 Assembly

The coupling is generally supplied in individual parts. Before assembly the coupling has to be inspected for completeness.

4 Assembly

4.1 Components of the coupling

Components of ROTEX®, shaft coupling type No. 001

Compo-nent	Quantity	Description
1	2	Hub
2	1	Spider 1)
3	5 2)	DZ elements 1)
4	2	Setscrews DIN EN ISO 4029

1) Optionally spider or DZ elements
2) With size 180 the quantity is 6.

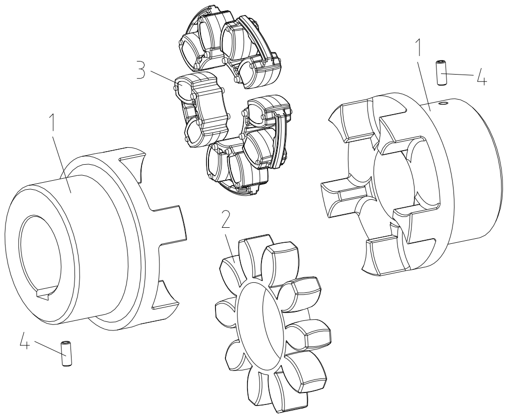


Illustration 6: ROTEX®

Components of ROTEX®, type DKM 1)

Compo-nent	Quantity	Description
1	2	Hub
2	2	Spider
3	1	DKM spacer
4	2	Setscrews DIN EN ISO 4029

1) Type DKM not available with DZ elements.

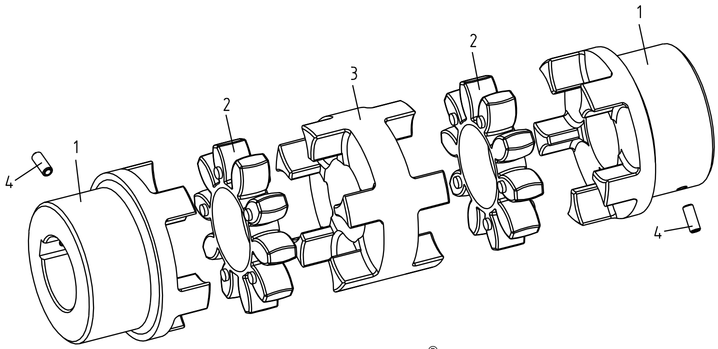


Illustration 7: ROTEX® DKM

Components of ROTEX®, type with taper clamping sleeve

Compo-nent	Quantity	Description
TB1/TB2	2	Hub for taper clamp-ing sleeve
1	2	Taper clamping slee-ve
2	1	Spider 1)
3	5 2)	DZ elements 1)
4	4	Setscrews DIN EN ISO 4029

1) Optionally spider or DZ elements
2) With size 180 the quantity is 6.

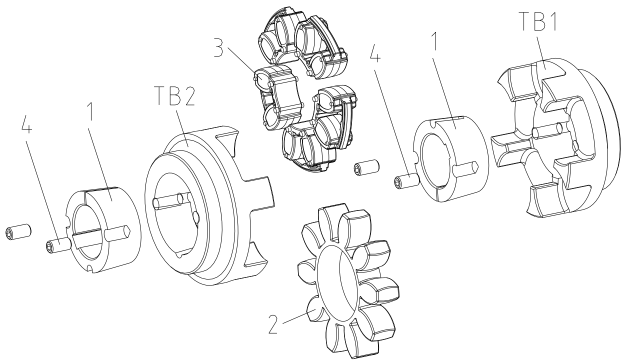


Illustration 8: ROTEX® type with taper clamping sleeve

Features of standard spiders

Spider hardness (Shore)	92 Shore-A		95/98 Shore-A		64 Shore-D	
	T-PUR® (orange)	PUR (yellow)	T-PUR® (purple)	PUR (red)	T-PUR® (light green)	PUR (natural white 1))
Marking (colour)						

1) Natural white with green marking of teeth

4 Assembly

4.2 Advice for finish bore

STOP

The maximum permissible bore diameters d (see table 1 to 5 in chapter 1 - technical data) must not be exceeded. If these figures are disregarded, the coupling may tear. Rotating particles may cause danger to life.

- Hub bores machined by the customer have to observe concentricity or axial runout, respectively (see illustration 9).
- Please make absolutely sure to observe the figures for Ø d_{max}.
- Carefully align the hubs when the finish bores are drilled.
- Please provide for a setscrew according to DIN EN ISO 4029 with a cup point or an end plate to fasten the hubs axially.

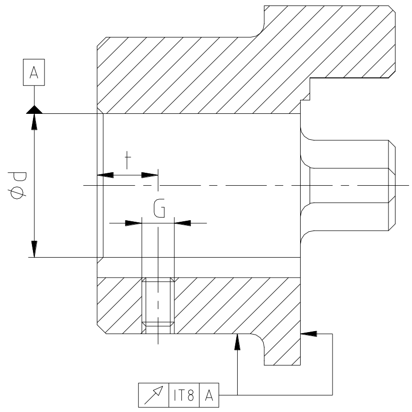


Illustration 9: Concentricity and axial runout

The customer bears the sole responsibility for all machining processes performed subsequently on unbored or pilot bored as well as finish machined coupling components and spare parts. KTR does not assume any warranty claims resulting from insufficient remachining.

KTR supplies unbored or pilot bored coupling components and spare parts only upon explicit request of the customer. These parts are additionally labelled with the symbol Ⓤ.

Table 6: Setscrews DIN EN ISO 4029

Size	14	19	24	28	38	42	48	55	65	75	90	100	110	125	140	160	180
Dimension G	M4	M5	M5	M8	M8	M8	M8	M10	M10	M10	M12	M12	M16	M16	M20	M20	M20
Dimension t	5	10	10	15	15	20	20	20	20	25	30	30	35	40	45	50	50
Tightening torque T_A [Nm]	1.5	2	2	10	10	10	10	17	17	17	40	40	80	80	140	140	140

Table 7: Recommended fit pairs acc. to DIN 748/1

Bore [mm]		Shaft tolerance	Bore tolerance
above	up to		
	50	k6	H7 (KTR standard)
50		m6	

If a feather key is intended to be used in the hub, it should correspond to the tolerance ISO JS9 (KTR standard) with normal operating conditions or ISO P9 with difficult operating conditions (frequently alternating torsional direction, shock loads, etc.). The keyway should preferably be located between the cams. With axial fastening by setscrews the tapping should be located on the keyway with the exception of Al-D which should be located opposite to the keyway.

The transmittable torque of the shaft-hub-connection must be reviewed by the customer and is subject to his responsibility.

4 Assembly

4.3 Assembly of the hubs

We recommend to inspect bores, shaft, keyway and feather key for dimensional accuracy before assembly.

Heating the hubs lightly (approx. 80 °C) allows for an easier mounting on the shaft.

Please pay attention to the ignition risk in hazardous locations!

Touching the heated hubs causes burns.
Please wear safety gloves.

With the assembly please make sure that the distance dimension E (see table 1 to 5) is observed to allow for axial clearance of the spider when in operation.
Disregarding this advice may cause damage to the coupling.

- Mount the hubs on the shaft of driving and driven side (see illustration 10).
- Insert the spider or DZ elements into the cam section of the hub on the driving or driven side.
- Shift the power packs in axial direction until the distance dimension E is achieved (see illustration 11).
- If the power packs are already firmly assembled, shifting the hubs axially on the shafts allows for adjusting the distance dimension E.
- Fasten the hubs by tightening the setscrews DIN EN ISO 4029 with a cup point (tightening torque see table 6).

If the shaft diameters with inserted feather key are smaller than dimension d_H (see table 1 to 5) of the spider, one or two shaft ends may protude into the spider.

If used in hazardous locations the setscrews to fasten the hubs as well as all screw connections must be secured against working loose additionally, e. g. conglutinating with Loctite (average strength).

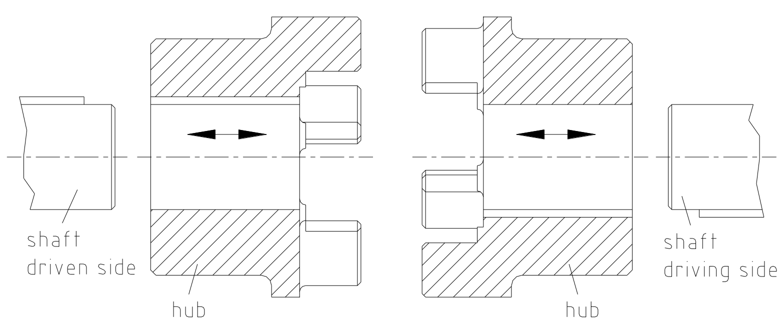


Illustration 10: Assembly of the hubs

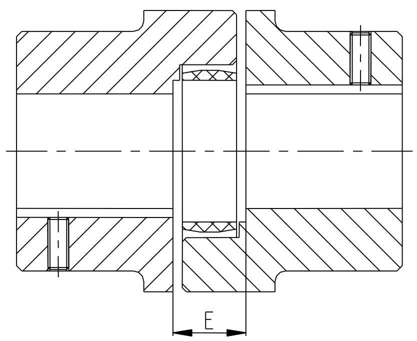


Illustration 11: Assembly of coupling

4 Assembly

4.4 Assembly of taper clamping sleeve

Assembly of taper clamping sleeve:

Clean the contact surfaces of the taper clamping sleeves and of shaft and hub and afterwards apply thin fluid oil lightly (e. g. Ballistol Universal oil or Klüber Quietsch-Ex).
The taper clamping sleeves have got axially parallel, cylindrical and smooth blind holes. Only half of these holes are located in the material of the sleeve. The other half located in the hub has got threads.
Fit the coupling element and the taper clamping sleeve into each other, make sure that the bores cover each other and tighten the setscrews lightly. Fit the coupling element along with the taper clamping sleeve on the shaft and tighten the setscrews at the tightening torque specified in table 8.
During the process of screwing the hub is mounted onto the taper sleeve and thus the sleeve is pressed onto the shaft. By light blows of the hammer the taper clamping sleeve must be pushed further into the taper bore by means of a suitable sleeve. Afterwards please re-tighten the setscrews at the tightening torque indicated in table 8. This process must be performed at least once.
After the drive has operated under load for a short while please inspect if the setscrews have unscrewed.
An axial fixing of the Taper Lock hub (coupling hub with taper clamping sleeve) is obtained by proper assembly only.

If used in hazardous locations the setscrews to fix the taper clamping sleeves have to be secured against working loose additionally, e. g. conglutinating with Loctite (average strength).
The use of taper clamping sleeves without a feather key is not permitted in hazardous locations.

Oils and greases with molybdenum disulphide or high-pressure additives, additives of Teflon and silicone as well as internal lubricants reducing the coefficient of friction significantly must not be used.

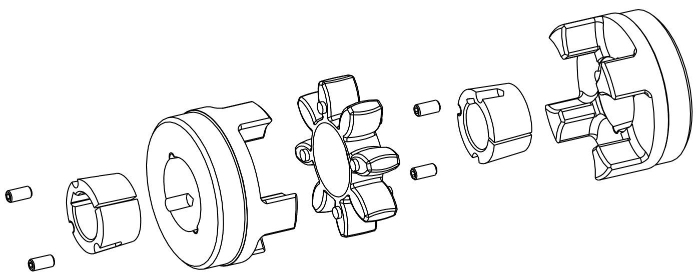


Illustration 12: ROTEX®, type with taper clamping sleeve

Disassembly of taper clamping sleeve:

The taper clamping sleeve is released by removing the setscrews. Afterwards one of the setscrews used as forcing screw is screwed in the thread of the sleeve and tightened.
The coupling hub detached in this way can be manually removed from the shaft with the taper clamping sleeve.

Table 8:

Taper clamping sleeve	Screw dimensions G [inch]	L [inch]	SW [mm]	T_A [Nm]	Quantity
1008	1/4	1/2	3	5.7	2
1108	1/4	1/2	3	5.7	2
1610	3/8	5/8	5	20	2
1615	3/8	5/8	5	20	2
2012	7/16	7/8	6	31	2
2517	1/2	7/8	6	49	2
3020	5/8	1 1/4	8	92	2
3535	1/2	1 1/2	10	115	3
4545	3/4	1 3/4	12	170	3

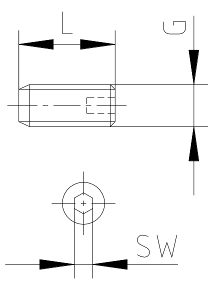


Illustration 13: Withworth setscrew (BSW)

4 Assembly

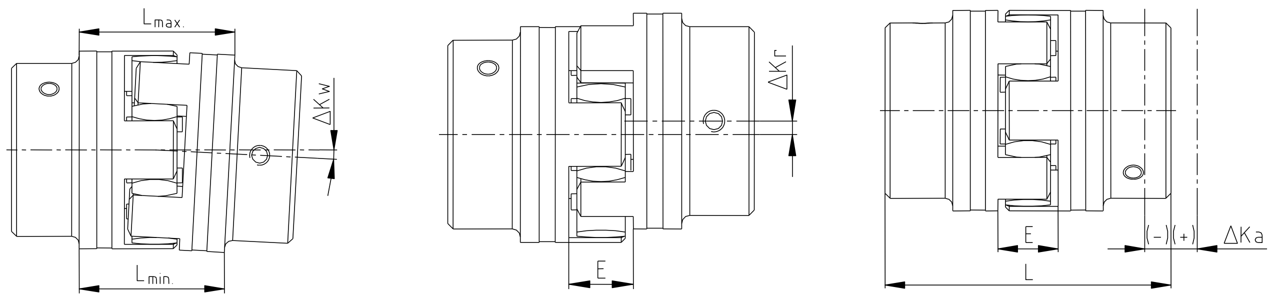
4.5 Displacements - alignment of the couplings

The displacement figures shown in tables 9 to 11 provide for sufficient safety to compensate for external influences like, for example, heat expansion or foundation settling.

In order to ensure a long service life of the coupling and avoid dangers with the use in hazardous locations, the shaft ends must be accurately aligned.
Please absolutely observe the displacement figures indicated (see tables 9 to 11). If the figures are exceeded, the coupling will be damaged.
The more accurate the alignment of the coupling, the longer is its service life.
If used in hazardous locations for the explosion group IIC (marking II 2GD c IIC T X), only half of the displacement figures (see tables 9 to 11) are permissible.

Please note:

- The displacement figures mentioned in tables 9 to 11 are maximum figures which must not arise in parallel. If radial and angular displacements arise at the same time, the permissible displacement values may only be used proportionally (see illustration 15).
- Please inspect with a dial gauge, ruler or feeler whether the permissible displacement figures of tables 9 to 11 can be observed.



Angular displacements

Radial displacements

Axial displacements

$\Delta K_w = L_{1max.} - L_{1min.}$ [mm]

$L_{max} = L + \Delta K_a$ [mm]

Illustration 14: Displacements

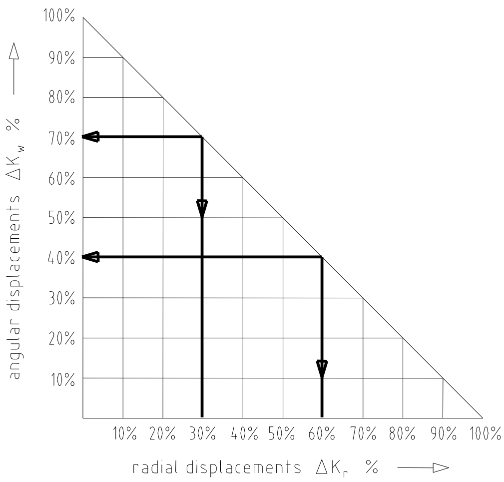
Examples of the displacement combinations specified in illustration 15:

Example 1:
$\Delta K_r = 30\ \%$
$\Delta K_w = 70\ \%$

Example 2:
$\Delta K_r = 60\ \%$
$\Delta K_w = 40\ \%$

$\Delta K_{total} = \Delta K_r + \Delta K_w \leq 100\ \%$

Illustration 15: Combinations of displacement



4 Assembly

4.5 Displacements - alignment of the couplings

Table 9: Displacement figures for 92 and 95/98 Shore-A

ROTEX® size		14	19	24	28	38	42	48	55	65	75	90	100	110	125	140	160	180
Max. axial displacement ΔKa [mm]		-0.5	-0.5	-0.5	-0.7	-0.7	-1.0	-1.0	-1.0	-1.0	-1.5	-1.5	-1.5	-2.0	-2.0	-2.0	-2.5	-3.0
		+1.0	+1.2	+1.4	+1.5	+1.8	+2.0	+2.1	+2.2	+2.6	+3.0	+3.4	+3.8	+4.2	+4.6	+5.0	+5.7	+6.4
Max. radial displacement ΔKr [mm] with	1500 rpm	0.17	0.20	0.22	0.25	0.28	0.32	0.36	0.38	0.42	0.48	0.50	0.52	0.55	0.60	0.62	0.64	0.68
	3000 rpm	0.11	0.13	0.15	0.17	0.19	0.21	0.25	0.26	0.28	0.32	0.34	0.36	0.38	-	-	-	-
ΔKw [degree] max. angular displacement with n=1500 rpm ΔKw [mm]		1.2	1.2	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.2	1.2	1.2	1.3	1.3	1.2	1.2	1.2
		0.67	0.82	0.85	1.05	1.35	1.70	2.00	2.30	2.70	3.30	4.30	4.80	5.60	6.50	6.60	7.60	9.00
ΔKw [degree] max. angular displacement with n=3000 rpm ΔKw [mm]		1.1	1.1	0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.1	1.1	1.2	-	-	-	-
		0.60	0.70	0.75	0.85	1.10	1.40	1.60	2.00	2.30	2.90	3.80	4.20	5.00	-	-	-	-

Table 10: Displacement figures for 64 Shore-D

ROTEX® size		14	19	24	28	38	42	48	55	65	75	90	100	110	125	140	160	180
Max. axial displacement ΔKa [mm]		-0.5	-0.5	-0.5	-0.7	-0.7	-1.0	-1.0	-1.0	-1.0	-1.5	-1.5	-1.5	-2.0	-2.0	-2.0	-2.5	-3.0
		+1.0	+1.2	+1.4	+1.5	+1.8	+2.0	+2.1	+2.2	+2.6	+3.0	+3.4	+3.8	+4.2	+4.6	+5.0	+5.7	+6.4
Max. radial displacement ΔKr [mm] with	1500 rpm	0.11	0.13	0.15	0.18	0.21	0.23	0.25	0.27	0.30	0.34	0.36	0.37	0.40	0.43	0.45	0.46	0.49
	3000 rpm	0.08	0.09	0.10	0.13	0.15	0.16	0.18	0.19	0.21	0.24	0.25	0.26	0.28	-	-	-	-
ΔKw [degree] max. angular displacement with n=1500 rpm ΔKw [mm]		1.1	1.1	0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.1	1.1	1.2	1.2	1.1	1.1	1.1
		0.57	0.77	0.77	0.90	1.25	1.40	1.80	2.00	2.50	3.00	3.80	4.30	5.30	6.00	6.10	7.10	8.00
ΔKw [degree] max. angular displacement with n=3000 rpm ΔKw [mm]		1.0	1.0	0.7	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0	1.0	1.1	-	-	-	-
		0.52	0.70	0.67	0.80	1.00	1.30	1.60	1.80	2.20	2.70	3.50	4.00	4.90	-	-	-	-

Table 11: Displacement figures for type DKM only

ROTEX® size		19	24	28	38	42	48	55	65	75	90
Max. axial displacement ΔKa [mm]		+1.2	+1.4	+1.5	+1.8	+2.0	+2.1	+2.2	+2.6	+3.0	+3.4
		-1.0	-1.0	-1.4	-1.4	-2.0	-2.0	-2.0	-2.0	-3.0	-3.0
Max. radial displacement ΔKr [mm] with n =	1500 rpm	0.45	0.59	0.66	0.77	0.84	0.91	1.01	1.17	1.33	1.48
	3000 rpm	0.40	0.53	0.60	0.70	0.75	0.82	0.81	1.05	1.19	1.33
ΔKw [degree] max. angular displacement with n =	1500 rpm	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	3000 rpm	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

5 Start-up

Before start-up of the coupling, please inspect the tightening of the setscrews in the hubs, the alignment and the distance dimension E and adjust, if necessary, and also inspect all screw connections for the tightening torques specified, dependent on the type of coupling.

If used in hazardous locations the setscrews to fasten the hubs as well as all screw connections must be secured against working loose additionally, e. g. conglutinating with Loctite (average strength).

Finally the coupling protection against accidental contact must be fitted.

The cover must be electrically conductive and included in the equipotential bonding. Bellhousings (magnesium share below 7.5 %) made of aluminium and damping rings (NBR) can be used as connecting element between pump and electric motor. The cover may only be taken off with standstill of the unit.

During operation of the coupling, please pay attention to

- different operating noise
- vibrations occurring.

If the couplings are used in locations subject to dust explosion and in mining the user must make sure that there is no accumulation of dust in a dangerous volume between the cover and the coupling. The coupling must not operate in an accumulation of dust.

For covers with unlocked openings on the top face no light metals must be used if the couplings are used as equipment of equipment group II (*if possible, from stainless steel*).
If the couplings are used in mining (equipment group I M2), the cover must not be made of light metal. In addition, it must be resistant to higher mechanical loads than if it is used as equipment of equipment group II.

The minimum distance „Sr" between the protective device and the rotating parts must at least correspond to the figures specified below.

If the protective device is used as cover, regular openings complying with the explosion protection demands can be made that must not exceed the following dimensions:

Openings	Cover [mm]		
	Top side	Lateral components	Distance „Sr"
Circular - max. diameter	4	8	≥ 10
Rectangular - max. lateral length	4	8	≥ 10
Straight or curved slot - max. lateral length/height	not permissible	8	≥ 20

If you note any irregularities with the coupling during operation, the drive unit must be switched off immediately. The cause of the breakdown must be specified by means of the table „Breakdowns" and if possible, be eliminated according to the proposals. The potential breakdowns mentioned can be hints only. To find out the cause all operating factors and machine components must be considered.

Coupling coating:

If coated (priming, painting etc.) couplings are used in hazardous locations, the requirements on conductibility and coating thickness must be considered. In case of paintings up to 200 µm electrostatic load does not have to be anticipated. Multiple coatings exceeding 200 µm are prohibited for explosion group IIC.

6 Breakdowns, causes and elimination

The below-mentioned failures can lead to a use of the **ROTEX®** coupling other than intended. In addition to the specifications given in these operating and assembly instructions please make sure to avoid these failures.
The errors listed can only be clues to search for the failures. When searching for the failure the adjacent components must generally be included.

If used other than intended the coupling can become a source of ignition.
EC directive 94/9/EC requires special care by the manufacturer and the user.

General failures with use other than intended:

- Important data for the coupling selection were not forwarded.
- The calculation of the shaft-hub-connection was not considered.
- Coupling components with damage occurred during transport are assembled.
- If the heated hubs are assembled, the permissible temperature is exceeded.
- The clearance of the components to be assembled is not coordinated with one another.
- Tightening torques have been fallen below/exceeded.
- Components are mixed up by mistake/assembled incorrectly.
- A wrong or no spider/DZ elements are inserted in the coupling.
- No original **KTR** parts (purchased parts) are used.
- Old/already worn out spiders/DZ elements or spiders/DZ elements stored for too long are used.
- Ex: The coupling used/the coupling protection used is not suitable for the operation in hazardous locations and does not correspond to EC directive 94/9/EC, respectively.
- Maintenance intervals are not observed.

Breakdowns	Causes	Hazard notes for hazardous locations	Elimination
Different operating noise and/or vibrations occurring	Misalignment	Increased temperature on the spider surface; ignition risk by hot surfaces	1) Set the unit out of operation 2) Eliminate the reason for the misalignment (e. g. loose foundation bolts, breaking of the engine mount, heat expansion of unit components, modification of the mounting dimension E of the coupling) 3) Inspection of wear see item inspection
	Wear of spider, short-term torque transmission due to metal contact	Ignition risk due to sparking	1) Set the unit out of operation 2) Disassemble the coupling and remove remainders of the spider 3) Inspect coupling components and replace coupling components that are damaged 4) Insert spider, assemble coupling components 5) Inspect alignment, adjust if necessary
	Screws for axial fastening of hubs working loose	Ignition risk due to hot surfaces and sparking	1) Set the unit out of operation 2) Inspect alignment of coupling 3) Tighten the screws to secure the hubs and secure against working loose 4) Inspection of wear see item inspection
Breaking of cam	Wear of spider, torque transmission due to metal contact	Ignition risk due to sparking	1) Set the unit out of operation 2) Replace complete coupling 3) Inspect alignment
	Breaking of the cams due to high impact energy/overload		1) Set the unit out of operation 2) Replace complete coupling 3) Inspect alignment 4) Find out the reason for overload

6 Breakdowns, causes and elimination

Breakdowns	Causes	Hazard notes for hazardous locations	Elimination
Breaking of cam	Operating parameters do not correspond to the performance of the coupling	Ignition risk due to sparking	1) Set the unit out of operation 2) Review the operating parameters and select a bigger coupling (consider mounting space) 3) Assemble new coupling size 4) Inspect alignment
	Operating error of the unit		1) Set the unit out of operation 2) Replace complete coupling 3) Inspect alignment 4) Instruct and train the service staff
Early wear of spider	Misalignment	Increased temperature on the spider surface; ignition risk by hot surfaces	1) Set the unit out of operation 2) Eliminate the reason for the misalignment (e. g. loose foundation bolts, breaking of the engine mount, heat expansion of unit components, modification of the mounting dimension E of the coupling) 3) Inspection of wear see item inspection
	e. g. contact with aggressive liquids/oils, ozone influence, too high/low ambient temperatures etc. causing a physical change of the spider	Ignition risk due to sparking with metallic contact of the cams	1) Set the unit out of operation 2) Disassemble the coupling and remove remainders of the spider 3) Inspect coupling components and replace coupling components that are damaged 4) Insert spider, assemble coupling components 5) Inspect alignment, adjust if necessary 6) Make sure that further physical modifications of the spider are excluded
	Ambient/contact temperatures which are too high for the spider, max. permissible e. g. with T-PUR® T4 = - 50 °C/ + 120 °C		1) Set the unit out of operation 2) Disassemble the coupling and remove remainders of the spider 3) Inspect coupling components and replace coupling components that are damaged 4) Insert spider, assemble coupling components 5) Inspect alignment, adjust if necessary 6) Inspect and adjust ambient/contact temperature (possibly remedy by using different spider materials)
Early wear of spider (liquefaction of material inside the spider cam)	Vibrations of drive		1) Set the unit out of operation 2) Disassemble the coupling and remove remainders of the spider 3) Inspect coupling components and replace coupling components that are damaged 4) Insert spider, assemble coupling components 5) Inspect alignment, adjust if necessary 6) Find out the reason for the vibrations (possibly remedy by spider with lower or higher shore hardness)

If you operate with a worn spider/DZ elements (see item 10.3) and with the subsequent contact of metal parts a proper operation meeting the explosion protection requirements and acc. to directive 94/9/EC is not ensured.

7 Disposal

In respect of environmental protection we would ask you to dispose of the packaging or products on termination of their service life in accordance with the legal regulations and standards that apply, respectively.

- **Metal**
  Any metal components have to be cleaned and disposed of by scrap metal.
- **Nylon materials**
  Nylon materials have to be collected and disposed of by a waste disposal company.

8 Maintenance and service

ROTEX® is a low-maintenance coupling. We recommend to perform a visual inspection on the coupling at least once a year. Please pay special attention to the condition of the spider of the coupling.

- Since the flexible machine bearings of the driving and driven side settle during the course of load, please inspect the alignment of the coupling and re-align the coupling, if necessary.
- The coupling parts have to be inspected for damages.
- The screw connections have to be inspected visually.

Having started up the coupling the tightening torques of the screws have to be inspected during the usual inspection intervals.

With the use in hazardous locations please observe chapter 10.2 *Inspection intervals for couplings in Ex- hazardous locations*.

9 Spares inventory, customer service addresses

A basic requirement to ensure the operational readiness of the coupling is a stock of the most important spare parts on site.

Contact addresses of the KTR partners for spare parts and orders can be obtained from the KTR homepage at www.ktr.com.

☞ **KTR does not assume any liability or warranty for the use of spare parts and accessories which are not provided by KTR and for the damages which may incur as a result.**

10 Enclosure A

Advice and instructions regarding the use in Ex hazardous locations

Type		Hub design	Sizes	Material
001	Standard	1.0, 1.1, 1.3 1a (large hub) clamping set 4.1, 4.2, 4.3	38 - 90	Cast iron (GJL)
			100 - 180	Nodular iron (GJS)
			14 - 180	Steel
	Clamping sleeve	Taper clamping sleeve	24 - 125	
019	Clamping ring hub	6.0, 6.5	19 - 90	
	Clamping hub	2.0, 2.1, 2.3	19 - 180	
018	DKM	1.0, 1.1 spacers for drop-out center lengths 10 to 40 mm	19 - 90	

ROTEX® DKM and ROTEX® ZS-DKM only with spacer made of steel or aluminium semi-finished products with a yield point of $R_{p0.2} \geq 250$ N/mm^2.

Hubs, clamping hubs or similar types without feather keys may be used on category 3 only.

If the coupling is used in hazardous locations, the size must be selected such that there is a minimum safety of s = 2.0 between the torque of the machine and the rated torque of the coupling or shaft-hub-connection.

10.1 Intended use in Ex hazardous locations

Conditions of operation in Ex hazardous locations

ROTEX® couplings are suitable for the use according to EC directive 94/9/EC.

1. Industry (with the exception of mining)

- Equipment group II of category 2 and 3 (*coupling is not approved for equipment group 1*)
- Media class G (*gases, fogs, steams*), zone 1 and 2 (*coupling is not approved for zone 0*)
- Media class D (*dusts*), zone 21 and 22 (*coupling is not approved for zone 20*)
- Explosion group IIC (*explosion class IIA and IIB are included in IIC*)

Temperature class:

T-PUR®			PUR		
Temperature class	Ambient or operating temperature T_a	Max. surface temperature	Temperature class	Ambient or operating temperature T_a	Max. surface temperature
T3, T2, T1	- 50 °C to + 120 °C 1)	+ 140 °C 2)	T4, T3, T2, T1	- 30 °C to + 90 °C 1)	+ 110 °C 2)
T4	- 50 °C to + 115 °C	+ 135 °C	T5	- 30 °C to + 80 °C	+ 100 °C
T5	- 50 °C to + 80 °C	+ 100 °C	T6	- 30 °C to + 65 °C	+ 85 °C
T6	- 50 °C to + 65 °C	+ 85 °C			

Explanation:
The maximum surface temperatures each result from the maximum permissible ambient or operating temperature T_a plus the maximum temperature increase ΔT of 20 K which has to be taken into account.

1) The ambient or operating temperature T_a is limited to + 90 °C (valid for T-PUR® only: + 120 °C) due to the permissible permanent operating temperature of the elastomers used.
2) The maximum surface temperature of + 110 °C (valid for T-PUR® only: + 140 °C) applies for the use in locations which are potentially subject to dust explosion, too.

10 Enclosure A

Advice and instructions regarding the use in Ex hazardous locations

10.1 Intended use in Ex hazardous locations

2. Mining

Equipment group I of category M2 (coupling is <u>not</u> approved for equipment group M1).
Permissible ambient temperature - 30 °C to + 90 °C (valid for T-PUR® only: - 50 °C to + 120 °C).

10.2 Inspection intervals for couplings in Ex hazardous locations

Explosion group	Inspection intervals
3G 3D	For couplings which are classified in category 3G or 3D the operating and assembly instructions that are usual for standard operation apply. During the standard operation which has to be subject to the ignition risk analysis the couplings are free from any ignition source. Merely the temperature increase produced by self-heating and depending on the coupling type has to be considered: for ROTEX®: $\Delta T = 20$ K
II 2GD c IIB T4, T5, T6	An inspection of the torsional backlash and a visual inspection of the flexible spider/DZ elements must be performed after 3,000 operating hours for the first time, at the latest after 6 months after start-up of the coupling. If you note insignificant or no wear on the spider/DZ elements upon this initial inspection, further inspections can each be performed after 6,000 operating hours or at the latest after 18 months, provided that the operating parameters remain the same. If you note significant wear during the initial inspection so that it would be recommendable to replace the spider/DZ elements, please find out the cause according to the table „Breakdowns“, if possible. The maintenance intervals must be adjusted to the modified operating parameters without fail.
II 2GD c IIC T4, T5, T6	An inspection of the torsional backlash and a visual inspection of the flexible spider/DZ elements must be performed after 2,000 operating hours for the first time, at the latest after 3 months after start-up of the coupling. If you note insignificant or no wear on the spider/DZ elements upon this initial inspection, further inspections can each be performed after 4,000 operating hours or at the latest after 12 months, provided that the operating parameters remain the same. If you note significant wear during the initial inspection so that it would be recommendable to replace the spider/DZ elements, please find out the cause according to the table „Breakdowns“, if possible. The maintenance intervals must be adjusted to the modified operating parameters without fail.

Hubs, clamping hubs or similar types without feather keys may be used on category 3 only.

10 Enclosure A

Advice and instructions regarding the use in Ex hazardous locations

10.2 Inspection intervals for couplings in Ex hazardous locations

ROTEX® coupling

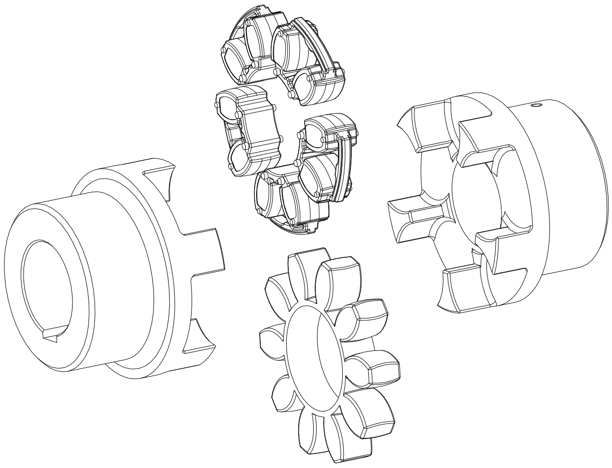


Illustration 16: ROTEX® coupling

Illustration 17.1: ROTEX® DZ elements

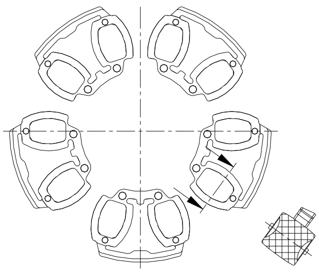
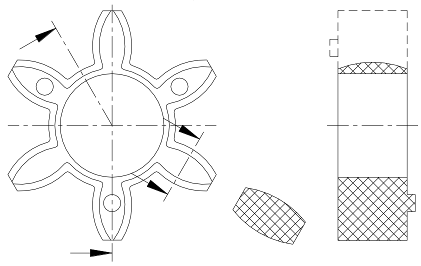


Illustration 17.2: ROTEX® spider



Here the backlash between the cams of the coupling and the flexible spider/DZ element must be inspected by means of a feeler gauge.
When reaching the wear limit ***maximum friction***, the spider/DZ element must be replaced immediately, irrespective of the inspection intervals.

10.3 Standard values of wear

In case of backlash > X mm, the flexible spider/DZ elements must be replaced.

Reaching the limits for replacing depends on the operating conditions and the existing operating parameters.

C A U T I O N !
In order to ensure a long service life of the coupling and avoid dangers with the use in hazardous locations, the shaft ends must be accurately aligned.
Please absolutely observe the displacement figures indicated (see tables 9 to 11). If the figures are exceeded, the coupling will be damaged.

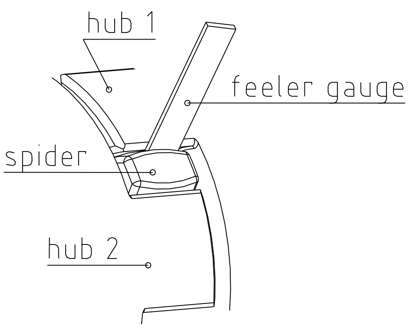


Illustration 18: Inspection of the limit of wear

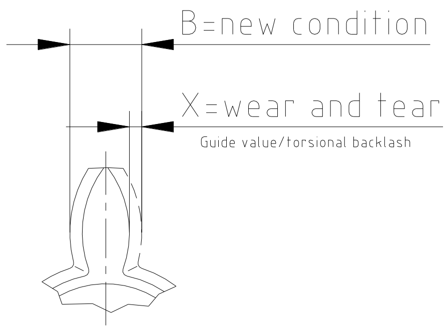


Illustration 19: Wear of spider

10 Enclosure A

Advice and instructions regarding the use in Ex hazardous locations

10.3 Standard values of wear

Table 12:

ROTEX® size	Limits of wear (friction) $X_{max.}$ [mm]	ROTEX® size	Limits of wear (friction) $X_{max.}$ [mm]
9	2	65	5
14	2	75	6
19	3	90	8
24	3	100	9
28	3	110	9
38	3	125	10
42	4	140	12
48	4	160	14
55	5	180	14

10.4 Permissible coupling materials in Ex hazardous locations

In the explosion groups **IIA**, **IIB** and **IIC** the following materials may be combined:

EN-GJL-250 (GG 25)
EN-GJS-400-15 (GGG 40)
Steel
Stainless steel

Semi-finished products made of aluminium with a magnesium share of up to 7.5°% and a yield point of $R_{p0.2} \geq 250$ N/mm² are permitted for the use in hazardous locations.
Aluminium diecast is generally excluded for hazardous locations.

10.5 Ex marking of coupling for hazardous locations

Couplings for the use in hazardous locations are marked on at least one component completely and on the remaining components by an Ex label on the outside diameter of the hub or on the front side each for the operating conditions permitted. The flexible spider or DZ element is excluded. For reason of limited space only the symbol Ex is stamped up to size 19.

Short labelling: (standard)	Ex	II 2GD c IIC T X/I M2 c X
Complete labelling: (valid for T-PUR® only)	Ex	II 2G c IIC T6, T5, T4 resp. T3 - 50 °C ≤ T_a ≤ + 65 °C, + 80 °C, + 115 °C resp. + 120 °C II 2D c T 140 °C/I M2 c - 50 °C ≤ T_a ≤ + 120 °C
Complete labelling: (valid for PUR only)	Ex	II 2G c IIC T6, T5 resp. T4 - 30 °C ≤ T_a ≤ + 65 °C, + 80 °C resp. + 90 °C II 2D c T 110 °C/I M2 c - 30 °C ≤ T_a ≤ + 90 °C

The labelling with explosion group IIC includes the explosion groups IIA and IIB.

If the symbol Ex was stamped in addition to Ⓤ, the coupling component was supplied unbored or pilot bored by KTR.

10 Enclosure A

Advice and instructions regarding the use in Ex hazardous locations

10.6 EC Certificate of conformity

EC Certificate of conformity

corresponding to EC directive 94/9/EC dated 23 March 1994
and to the legal regulations

The manufacturer - KTR Kupplungstechnik GmbH, D-48432 Rheine - states that the

flexible ROTEX® couplings

in an explosion-proof design described in these assembly instructions are devices corresponding to article 1 (3) b) of directive 94/9/EC and comply with the general safety and health requirements according to enclosure II of directive 94/9/EC.

According to article 8 (1) of directive 94/9/EC the technical documentation is deposited with the institution:

IBExU
Institut für Sicherheitstechnik GmbH
Fuchsmühlenweg 7

09599 Freiberg

Rheine, Place	2014-10-08 Date	i. V. Reinhard Wibbeling Engineering/R&D	i. V. Michael Brüning Product Manager

Translation of the original declaration of incorporation

Declaration of Incorporation

In conformity with the Machinery Directive 2006/42/EC, Annex II, No. 1 B

HE3-NNNN-111
AN-ZU: 09
04.11.2014

English

Product type: **Gear pump**

Model range: **HH**
R2/..., R3/... (HDa, HDFa, HDFb, FMa,)
R4,0; R4,5; R6,0
R25/..., R35/..., R45/..., R65/..., R95/...
R31/..., R41/..., R61/..., R91/...
R29/..., R49/..., R59/..., R69/..., R79/..., R89/..., R99/..., R109/..., R119/..., R129/...
R93C/...

We hereby declare that the above-mentioned partly completed machinery in the version supplied is designed for incorporation into a machine. It must not be commissioned until it has been ascertained that the machine into which this partly completed machinery is to be incorporated meets the requirements of EC Machinery Directive 2006/42/EC.

The following fundamental safety and health protection requirements according to Annex I are applied and fulfilled:
Section 1.1.1, 1.1.2, 1.1.3, 1.1.5, 1.3.1, 1.3.2, 1.3.4, 1.3.7, 1.3.8.1, 1.4.1, 1.5.4, 1.5.5, 1.5.8, 1.7.1.1, 1.7.2, 1.7.3, 1.7.4.1, 1.7.4.2.

Applied harmonised standard:

DIN EN 809

The specific technical documentation as prescribed in Annex VII B has been created and can be submitted to the respective national authority in file format on request.

Dr. Lünzmann is authorised to compile the specific technical documentation in accordance with Annex VII B.

Balve, 2014-11-10

Lünzmann

Dr. Lünzmann (Head of Development)

The safety instructions contained in the product documentation must be observed.

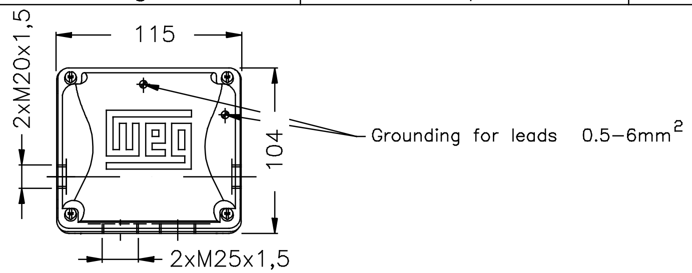
AN-ZU	Changes	Date	Editor
09	ÄM 14/010	04.11.2014	Web

Rickmeier GmbH
Langenholthauser Str. 20-22 · D-58802 Balve
Postfach 13 40 · D-58797 Balve
Telefon: +49 (0) 23 75 / 9 27-0
Telefax: +49 (0) 23 75 / 9 27-26
E-mail: kontakt@rickmeier.de · www.rickmeier.de

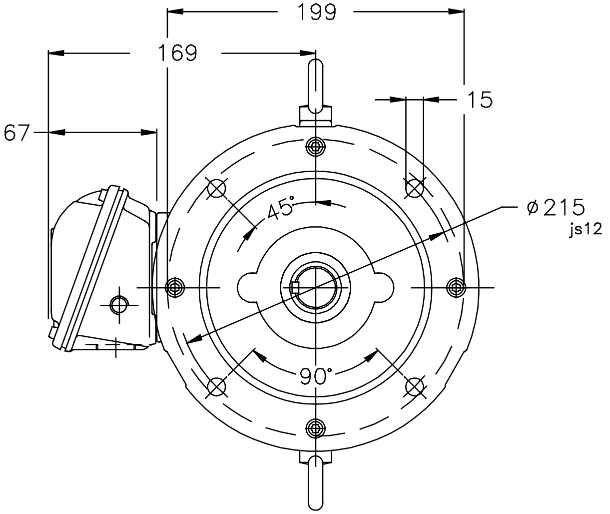
EIXO/SHAFT	
PADRÃO/STANDARD	X
OPCIONAL/OPTIONAL	
ESPECIAL/SPECIAL	

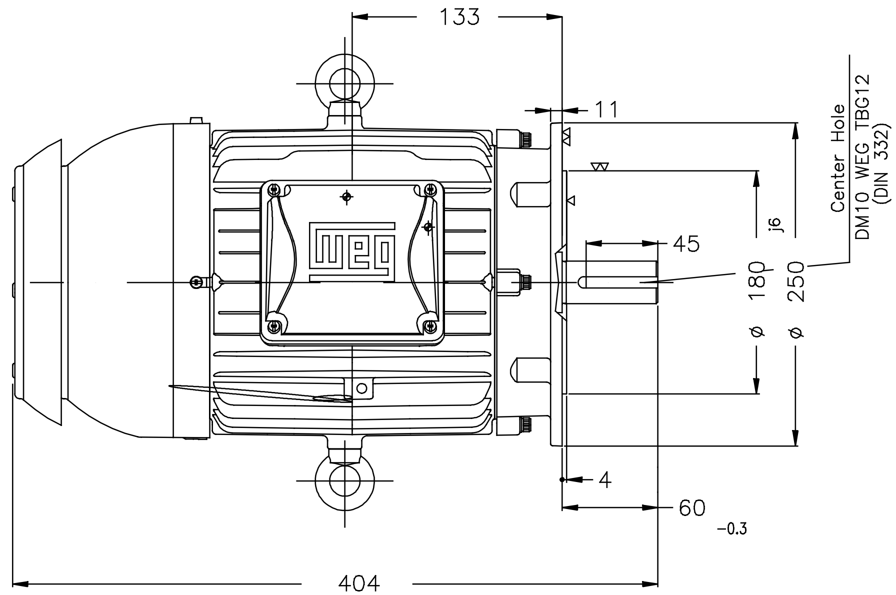
Dimensões em mm
Dimensions in mm

THIS IS AN UPDATED REVISION, THE PREVIOUS ONE MUST BE DISREGARDED.



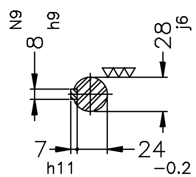
Main terminal box





Placa Informações Motor 01 / Motor Information plate

VOITH–MAT–NR. 204.00536010



DE Shaft End

Resistência de aquecimento 110–127 V / 200–240 V / Space heaters 110–127 V / 200–240 V
Proteção térmica desligamento – Termistor 155°C / Thermistors 155°C To trip
Plano de pintura 202P / Painting plan 202P
Forma construtiva V1 / Mounting V1

VOITH TURBO GMBH & CO.KG

OV: 3038440
PC: 1000/4501155616/210

ECM	LOC	SUMMARY OF MODIFICATIONS	EXECUTED	CHECKED	RELEASED	DATE	VER
500000854416		DOCUMENTO NOVO	AKUSAK		PIRWBUSER	10.02.2014	00

EXECUTED	AKUSAK	THREE PHASE W22 MOTOR - HIGH EFF
CHECKED		FRAME 100L IP55
RELEASED	PIRWBUSER	
REL DT	10.02.2014	WMO JARAGUA DO SUL ENGENHARIA DE PRODUTO

10002699714
000 | 00
SHEET 1 / 1

A3 ZME

3 kW 02 Poles 50 Hz

A

DATA SHEET

Nr.: 097217/2013-A

Date: 18-JUN-2013

Three-phase Induction Motor - Squirrel Cage

Customer	: VOITH TURBO GMBH & CO.KG
Product code	:
Product line	: IP55 - W22 - IE2 High Efficiency Multivoltage

Frame	: 100L
Output	: 3 kW
Frequency	: 50 Hz
Poles	: 2
Rated speed	: 2830-2840-2860 rpm
Slip	: 5.67-5.33-4.67 %
Rated voltage	: 220-230-240/380-400-415V
Rated current	: 11.0-10.9-10.8/6.34-6.24-6.24 A
L. R. Amperes	: 77.8-77.1-76.6/45.0-44.3-44.3 A
Il/In	: 7.1
No load current	: 5.87-6.55-7.09/3.40-3.77-4.10 A
Rated torque	: 10.1-10.1-10.0 Nm
Locked rotor torque	: 320-340-360 %
Breakdown torque	: 320-340-360 %
Design	: N
Insulation class	: F
Locked rotor time	: 8-9-9 s (hot)
Service factor	: 1.00
Duty cycle	: S1
Ambient temperature	: -20°C to +40°C
Altitude	: 1000 m.a.s.l

Enclosure	: IP55 (TEFC)
Mounting	: B3T
Rotation	: Both
Aprox. weight*	: 25.0 kg
Moment of inertia	: 0.0030 kgm²
Sound Pressure Level	: 62.0 dB(A) (global)
Foundation loads	
- Max. traction	: 908 N
- Max. compression	: 1154 N

Load	Power factor	Efficiency (%)**
100%	0.85-0.82-0.79	84.6-84.6-84.7
75%	0.79-0.75-0.71	84.5-84.6-84.7
50%	0.67-0.61-0.57	84.5-84.0-84.0

	Bearing	Quantity (lubricant)
Front	6205-ZZ	-----
Rear	6204-ZZ	-----

Lubrication interval: -----

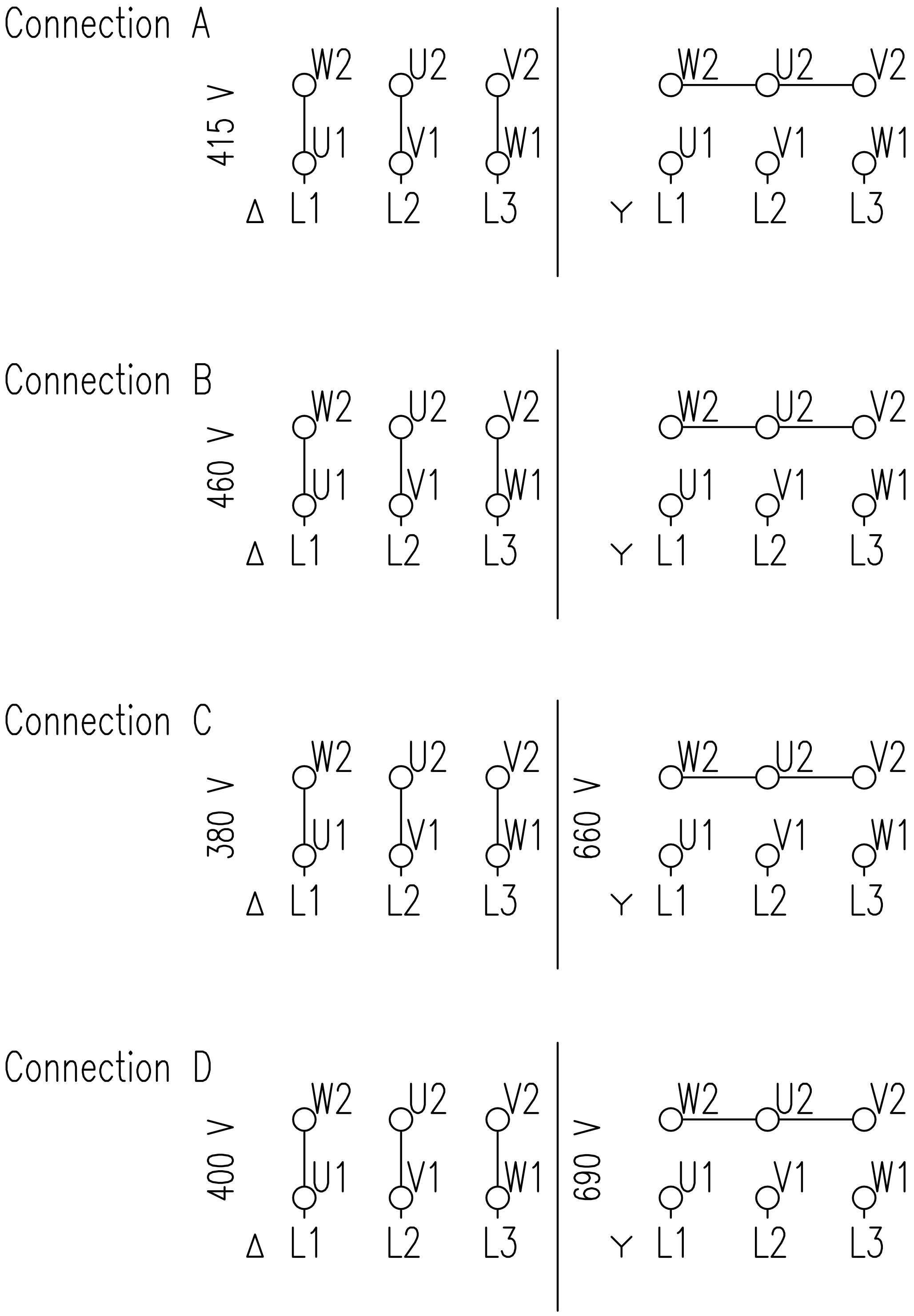
Grease - MOBIL POLYREX EM

Notes:

The figures given herewith are regarded as guaranteed values and applied to sinusoidal power supplied motors, within permissible tolerances under IEC 60034-1. Noise level with tolerance of +3 dB(A). (*) Weight value can be changed without previous notification. (**) Efficiencies according to the indirect method of IEC 60034-2-1:2007 with stray load losses determined from measurement.

Performed	Checked	Revision	Approved
akusak	AUTOMATICO	Nr.: 0 Date: 18-JUN-2013	

THIS IS AN UPDATED REVISION, THE PREVIOUS ONE MUST BE DISREGARDED.



		ORIGINAL ISSUE	ARTHUR	DIEGO	CASTELLA	01.03.2013	00
ECM *ECM*	LOC *LOC*	RESUMO MODIFICAÇÃO *SUMMARY OF MODIFICATIONS*	EXECUTADO *EXECUTED*	VERIFICADO *CHECKED*	LIBERADO *RELEASED*	DATA *DATE*	VER *VER*

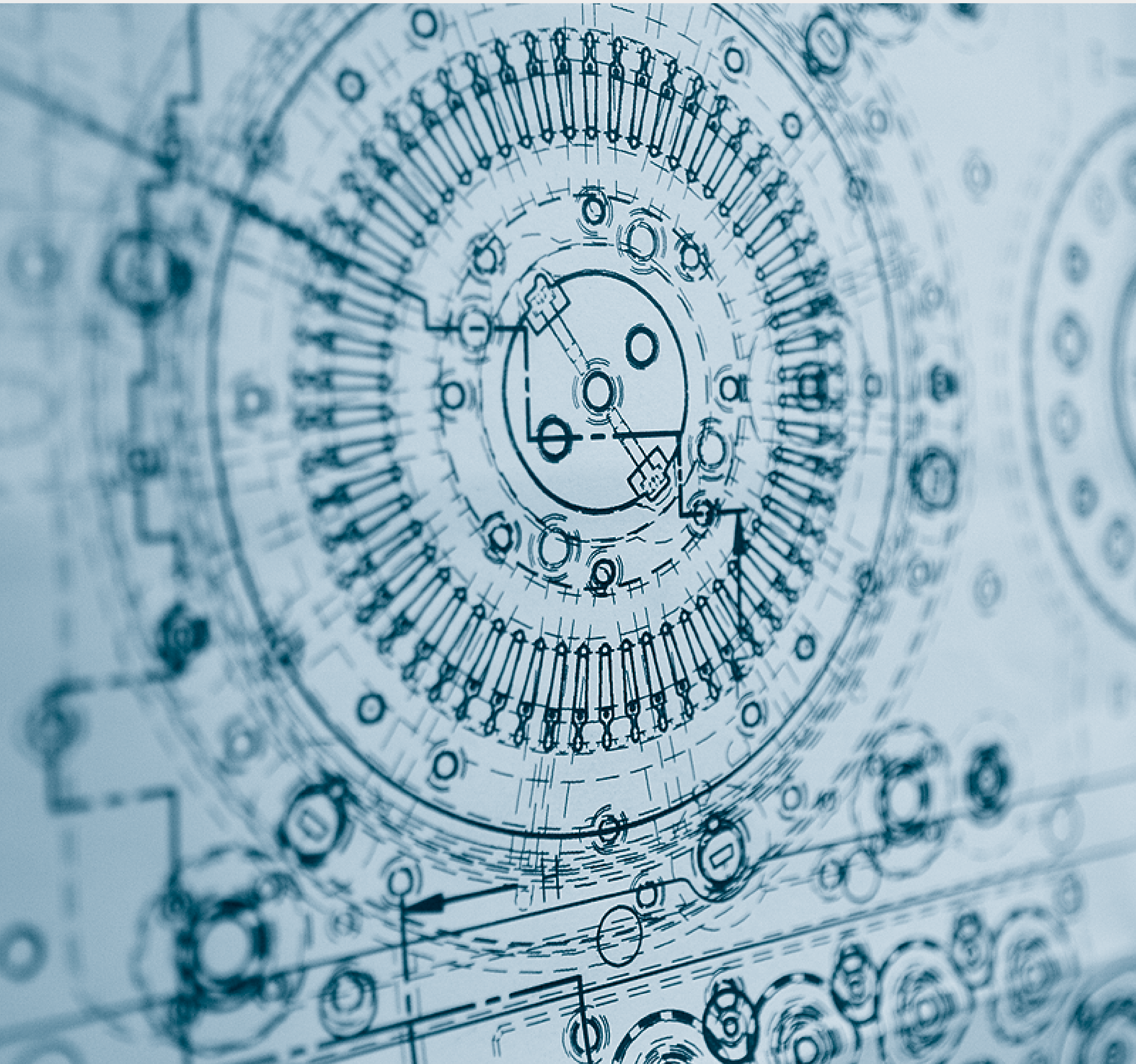
EXEC. / *EXECUTED*	ARTHUR	LOW VOLTAGE - CONNECTION DIAGRAM	MULTI/6
VERIF. / *CHECKED*	DIEGO	380-415/660//440-460 V	
LIBER. / *RELEASED*	CASTELLA	MOTOR WITH 06 CABLES	IEC 00
DATA LB / *REL DT*	01.03.2013	WMO JARAGUÁ DO SUL VENDAS TÉCNICAS	FOLHA / *SHEET* 1 / 1

A4

Manual Geral de Instalação, Operação e Manutenção de Motores Elétricos

Installation, Operation and Maintenance Manual of Electric Motors

Manual General de Instalación, Operación y Mantenimiento de Motores Eléctricos



Manual Geral de Instalação, Operação e Manutenção de Motores Elétricos

Este manual apresenta informações referentes aos motores elétricos WEG de indução com rotor de gaiola, com rotor de ímãs permanentes ou híbridos, de baixa e alta tensão, nas carcaças IEC 56 a 630 e NEMA 42 a 9606/10.
As linhas listadas abaixo possuem informações adicionais, encontradas em manuais específicos:

- Motores para extração de fumaça (Smoke Extraction Motor);
- Motores com freio eletromagnético;
- Motores para Áreas Classificadas.

Estes produtos estão de acordo com as seguintes normas, quando aplicáveis:

- NBR 17094-1: Máquinas Elétricas Girantes - Motores de Indução - Parte 1:
  - Trifásicos
- NBR 17094-2: Máquinas Elétricas Girantes - Motores de Indução - Parte 1:
  - Monofásicos
- IEC 60034-1: Rotating Electrical Machines - Part 1:
  - Rating and Performance
- NEMA MG 1: Motors and Generators
- CSA C 22.2 N°100: Motors and Generators
- UL 1004-1: Rotating Electrical Machines – General Requirements

Em caso de dúvidas sobre a aplicabilidade desse material, contate a WEG.

ÍNDICE

PORTUGUÊS

1. DEFINIÇÕES

Balanceamento: procedimento pelo qual a distribuição de massa de um corpo é verificada e, se necessário, ajustada para garantir que o desbalanceamento residual ou as vibrações e forças nos mancais na frequência de rotação mecânica estejam dentro de limites especificados nas normas internacionais.

Grau de balanceamento: indica a amplitude de pico da velocidade de vibração, expressa em mm/s, de um rotor girando livre no espaço e é produto de um desbalanceamento específico e a velocidade angular do rotor na velocidade máxima de operação.

Parte aterrada: partes metálicas eletricamente conectadas ao sistema de aterramento.

Parte viva: partes metálicas eletricamente conectadas ao sistema de aterramento.

Pessoal autorizado: trabalhador que tem anuência formal da empresa.

Pessoal capacitado: trabalhador que atenda as seguintes condições, simultaneamente:
- Receba capacitação sob orientação e responsabilidade de profissional habilitado e autorizado;
- Trabalhe sob responsabilidade de profissional habilitado e autorizado.

Nota: *A capacitação só é válida para a empresa que o capacitou e nas condições estabelecidas pelo profissional habilitado e autorizado responsável pela capacitação.*

Pessoal habilitado: trabalhador previamente qualificado e com registro no conselho de classe competente.

Pessoal qualificado: trabalhador que comprovar conclusão de curso específico na área elétrica pelo sistema oficial de ensino.

2. RECOMENDAÇÕES INICIAIS

Motores elétricos possuem circuitos energizados, componentes girantes e superfícies quentes durante sua operação normal que podem causar danos às pessoas. Dessa forma, todas as atividades relacionadas ao seu transporte, armazenagem, instalação, operação e manutenção devem ser realizadas por pessoal capacitado.
Devem ser observadas as normas e procedimentos vigentes no país de instalação.
A não observação das instruções indicadas neste manual e demais referenciadas no site pode resultar em sérios danos pessoais e materiais e anular a garantia do produto.

Neste manual não são apresentadas todas as informações detalhadas sobre possíveis variantes construtivas e nem considerados todos os casos de montagem, operação ou manutenção. Este documento contém informações necessárias para que pessoas capacitadas possam executar o serviço. As imagens apresentadas são meramente ilustrativas.

Para motores utilizados para extração de fumaça (*Smoke Extraction Motors*), consultar adicionalmente as instruções do manual 50026367 (inglês) disponível no website www.weg.net.

Para operação de motores com freio, consultar as informações do manual do motofreio WEG 50000701 (português) / 50006742 (inglês) ou motofreio Intorq 50021505 (português) / 50021973 (inglês) disponíveis no website www.weg.net.

A correta definição das características do ambiente e da aplicação é de responsabilidade do usuário.

Durante o período de garantia do motor, os serviços de reparo, revisão e recuperação devem ser realizados por Assistentes Técnicos autorizados WEG para continuidade do termo de garantia.

2.1. SINAIS DE ADVERTÊNCIA

Advertência sobre segurança e garantia.

2.2. VERIFICAÇÃO NO RECEBIMENTO

Todos os motores são testados durante o processo de fabricação.
No recebimento do motor, verificar se ocorreram danos durante o transporte. Na ocorrência de qualquer dano, registrar por escrito junto ao agente transportador, e comunicar imediatamente a companhia seguradora e a WEG. A não comunicação pode resultar no cancelamento da garantia.
Deve-se realizar uma inspeção completa no produto:

- Verificar se os dados contidos na placa de identificação estão de acordo com o pedido de compra;
- Remover os dispositivos de travamento de eixo (caso existam) e girar manualmente o eixo para verificar se o mesmo gira livremente.
- Assegurar que o motor não tenha sido exposto à poeira e umidade excessiva durante o transporte.

Não remover graxa de proteção da ponta do eixo, nem os tampões que fecham os furos da caixa de ligação, caso existam. Estes itens de proteção devem ser mantidos até que a instalação completa seja concluída.

2.3. PLACAS DE IDENTIFICAÇÃO

A placa de identificação contém as informações que descrevem as características construtivas e o desempenho do motor. Nas Figura 2.1 e Figura 2.2 são apresentados exemplos dos leiautes das placas de identificação.

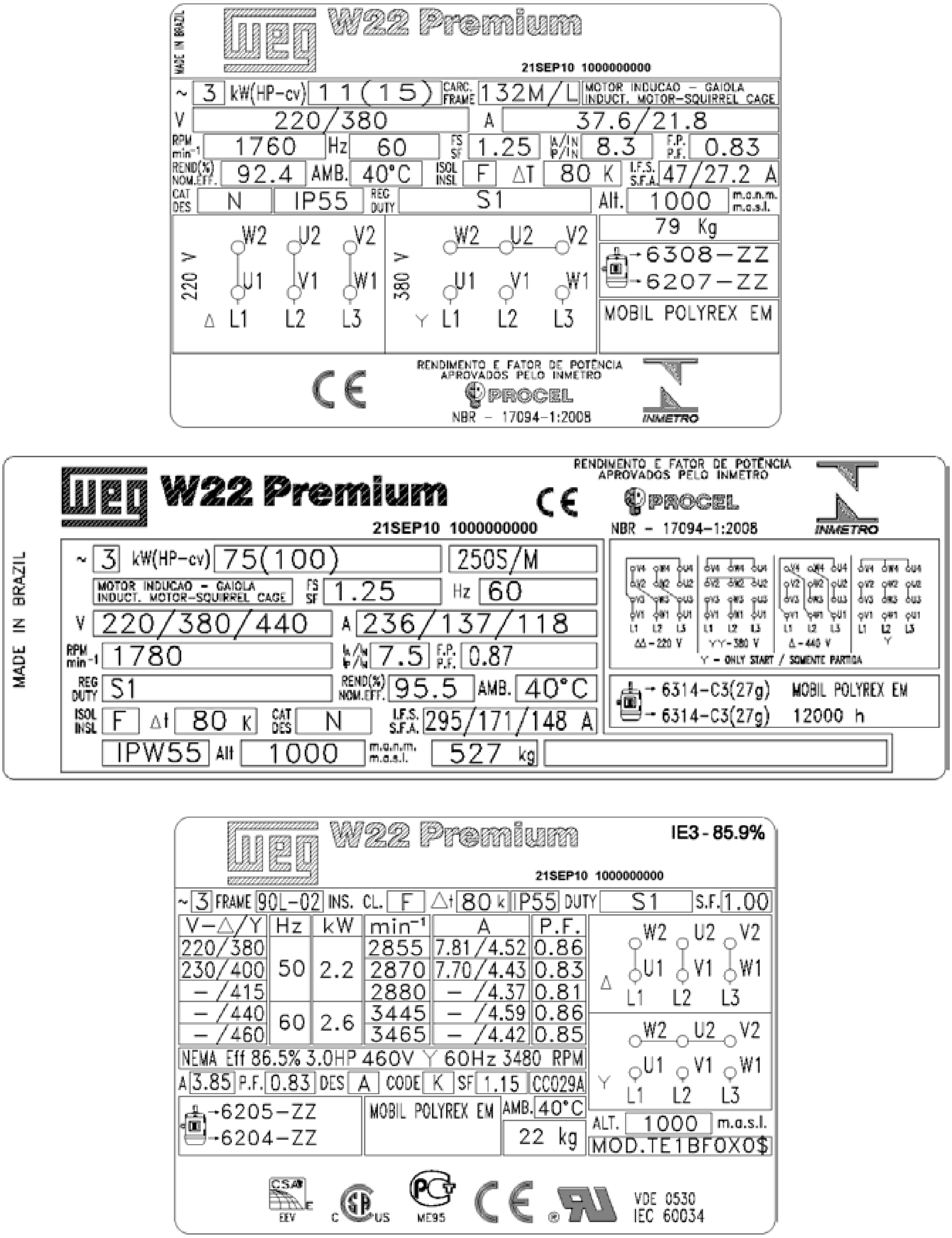
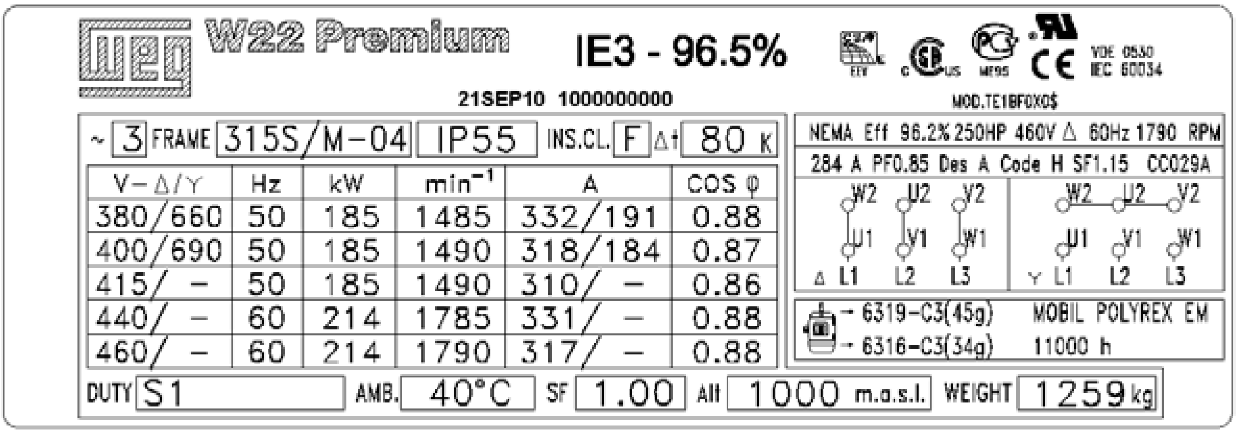
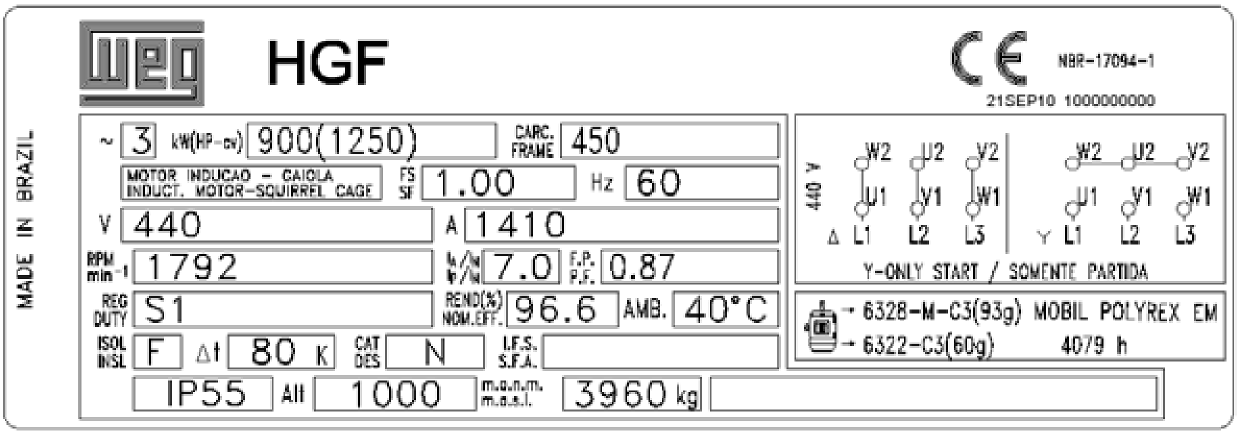


Figura 2.1 - Placa de identificação de motores IEC.

PORTUGUÊS





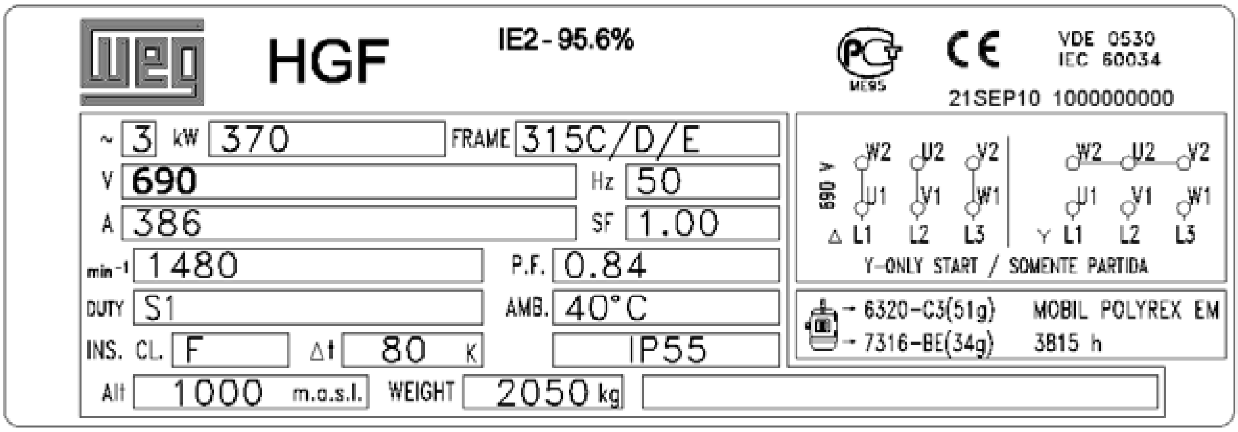


Figura 2.1 - *Placa de identificação de motores IEC.*

PORTUGUÊS

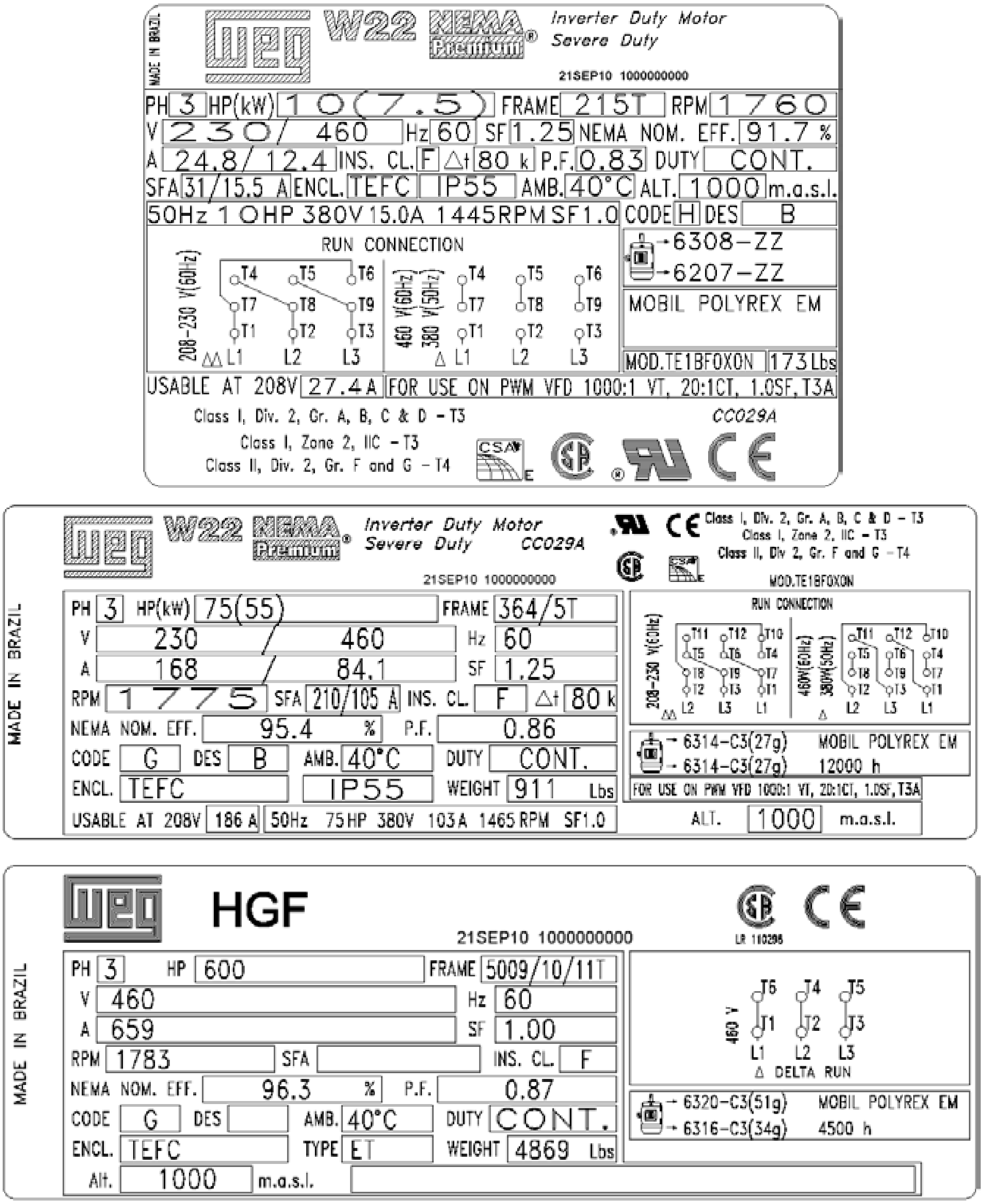


Figura 2.2 - *Placa de identificação de motores NEMA.*

3. SEGURANÇA

Durante a instalação e manutenção, os motores devem estar desconectados da rede, estar completamente parados e cuidados adicionais devem ser tomados para evitar partidas acidentais.

Os profissionais que trabalham em instalações elétricas, seja na montagem, na operação ou na manutenção, devem utilizar ferramentas apropriadas e serem instruídos sobre a aplicação das normas e prescrições de segurança, inclusive sobre o uso de Equipamentos de Proteção Individual (EPI), que devem ser cuidadosamente observados.

Motores elétricos possuem circuitos energizados, componentes girantes e superfícies quentes durante sua operação normal que podem causar danos às pessoas. Dessa forma, todas as atividades relacionadas ao seu transporte, armazenagem, instalação, operação e manutenção devem ser realizadas apenas por pessoal capacitado.

4. MANUSEIO E TRANSPORTE

Motores embalados individualmente não devem ser içados pelo eixo ou embalagem, mas sim pelo(s) olhal(is) de içamento (quando existentes) e com dispositivos adequados. Os olhais de içamento são dimensionados para suportar apenas a massa do motor indicada na placa de identificação. Motores fornecidos em pallets devem ser içados pela base do *pallet*.
Em nenhuma circunstância, a embalagem deve ser tombada.

Não utilizar os olhais de içamento para suspender o motor em conjunto com outros equipamentos, como por exemplo: bases, polias, ventiladores, bombas, redutores, etc.

Olhais danificados, por exemplo, com trincas, deformações, etc, não devem ser utilizados. Verificar suas condições antes de utilizá-los.

Os olhais de içamento em componentes como tampas, kit de ventilação forçada, entre outros, devem ser utilizados somente para o içamento destes componentes de maneira isolada e nunca do motor completo.

Toda a movimentação deve ser realizada de forma suave, sem impactos, caso contrário os rolamentos podem ser danificados bem como os olhais serem expostos a esforços excessivos, podendo provocar o rompimento dos olhais.

Os dispositivos de travamento do eixo (utilizados para proteção durante o transporte), em motores com rolamentos de rolos ou contato angular, devem ser utilizados para todo e qualquer transporte do motor, mesmo que isso requeira o desacoplamento da máquina acionada.
Todos os motores HGF, independentemente do tipo de mancal, devem ter seu rotor travado para transporte.

4.1. IÇAMENTO

Antes de iniciar qualquer processo de içamento, certificar-se que os olhais estejam adequadamente fixos, totalmente parafusados e com sua base em contato com a superfície a ser içada, conforme Figura 4.1. A Figura 4.2 exemplifica o uso incorreto.
Certificar-se de que o equipamento utilizado no içamento e suas dimensões sejam adequados ao tamanho do olhal e da massa do motor.

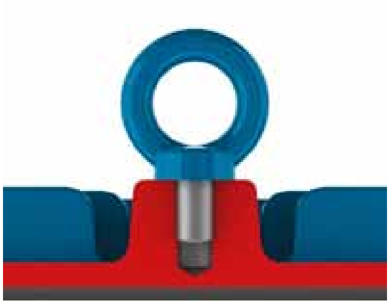


Figura 4.1 – *Maneira correta de fixação do olhal de içamento.*

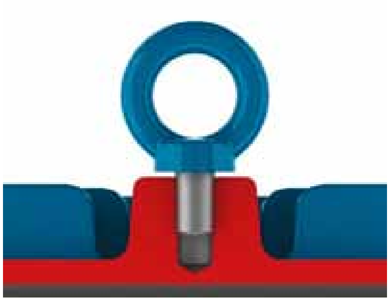


Figura 4.2 – *Maneira incorreta de fixação do olhal de içamento*

PORTUGUÊS

4.1.1. Motores horizontais com um olhal de içamento

Para motores com um olhal de içamento, o ângulo máximo resultante durante o processo de içamento não poderá exceder 30° em relação ao eixo vertical, conforme Figura 4.3.

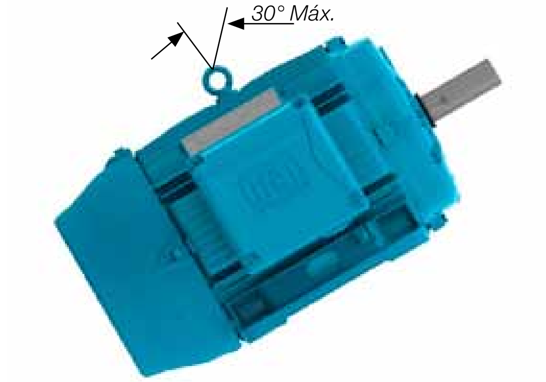


Figura 4.3 *– Ângulo máximo resultante para motores com um olhal de içamento.*

4.1.2. Motores horizontais com dois ou mais olhais de içamento

Para motores que possuem dois ou mais olhais para o içamento, todos os ollhais fornecidos devem ser utilizados simultaneamente para o içamento.

Existem duas disposições de olhais possíveis (verticais e inclinados), conforme apresentadas a seguir:

- Motores com olhais verticais, conforme Figura 4.4, o ângulo máximo resultante deve ser de 45° em relação ao eixo vertical. Recomenda-se a utilização de uma barra separadora (spreader bar), para manter o elemento de içamento (corrente ou cabo) no eixo vertical e evitando danos à superfície do motor.

Figura 4.4 *– Ângulo máximo resultante para motores com dois ou mais olhais de içamento.*

Para motores HGF, conforme Figura 4.5, o ângulo máximo resultante deve ser de 30° em relação ao eixo vertical.

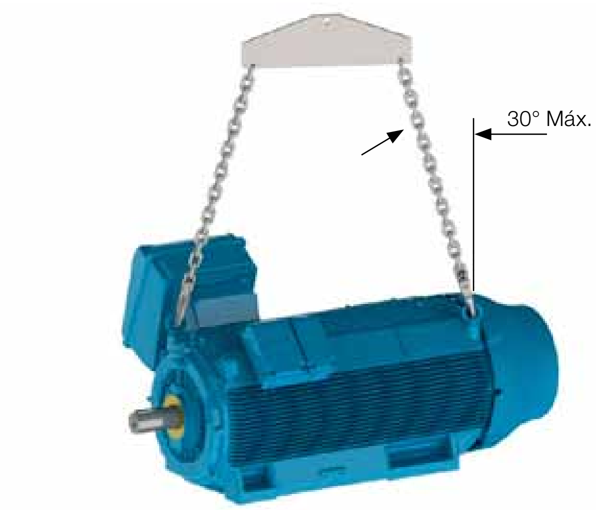


Figura 4.5 *– Ângulo máximo resultante para motores HGF horizontais.*

PORTUGUÊS

- Motores com olhais inclinados, conforme Figura 4.6, é necessária a utilização de uma barra separadora (spreader bar), para manter o elemento de içamento (corrente, cabo, etc.) no eixo vertical e assim também evitar danos à superfície do motor.

Figura 4.6 – *Uso de barra separadora no içamento.*

4.1.3. Motores verticais

Para motores verticais, conforme Figura 4.7, é necessária a utilização de uma barra separadora (spreader bar), para manter o elemento de içamento (corrente, cabo) no eixo vertical e assim também evitar danos à superfície do motor.

Figura 4.7 *– Içamento de motores verticais.*

Utilizar sempre os olhais que estão dispostos na parte superior do motor em relação à posição de montagem e diametralmente opostos. Ver Figura 4.8.

Figura 4.8 *– Içamento de motores HGF.*

4.1.3.1. Procedimento para colocação de motores W22 na posição vertical

De forma geral, por questões de segurança durante o transporte, os motores verticais são embalados e fornecidos na posição horizontal.

Para a colocação de motores W22 com olhais inclinados (ver Figura 4.6) na vertical, devem ser seguidos os passos abaixo:

1. Certificar-se que os olhais estão adequadamente fixos, conforme Figura 4.1;
2. Remover o motor da embalagem, utilizando os olhais superiores, conforme Figura 4.9;

Figura 4.9 *– Remoção do motor da embalagem.*

3. Instalar o segundo par de olhais, conforme Figura 4.10;

Figura 4.10 *– Instalação do segundo par de olhais.*

4. Reduzir a carga sobre o primeiro par de olhais para iniciar a rotação do motor, conforme Figura 4.11. Esse procedimento deve ser realizado de forma lenta e cautelosa.

Figura 4.11 *– Resultado final: motor posicionado na vertical.*

PORTUGUÊS

4.1.3.2. Procedimento para colocação de motores HGF na posição vertical

Os motores verticais HGF são fornecidos com oito pontos de içamento, sendo quatro na parte dianteira e quatro na parte traseira e geralmente são transportados na posição horizontal, mas para a instalação precisam ser colocados na posição vertical.

Para a colocação de motores HGF na posição vertical, devem ser seguidos os passos abaixo:

1. Levantar o motor através dos quatro olhais laterais, utilizando duas talhas, ver Figura 4.12;

Figura 4.12 *– Içamento do motor HGF utilizando duas talhas.*

2. Baixar a talha que está presa à parte dianteira do motor e ao mesmo tempo levantar a talha que está presa no lado traseiro do motor até que o motor atinja o equilíbrio, ver Figura 4.13.

Figura 4.13 *- Colocação de motor HGF na vertical.*

3. Soltar a talha presa na parte dianteira do motor e girar o motor 180° para possibilitar a fixação da talha solta nos outros dois olhais da parte traseira do motor, ver Figura 4.14.

Figura 4.14 *– Suspensão de motor HGF pelos olhais traseiros.*

4. Fixar a talha solta nos outros dois olhais da parte traseira do motor e levantá-la até que o motor fique na posição vertical, ver Figura 4.15.

Figura 4.15 *- Motor HGF na posição vertical.*

Estes procedimentos servem para movimentação de motores construídos para a montagem na posição vertical. Estes mesmos procedimentos podem ser utilizados para a colocação do motor da posição horizontal para a posição vertical e vice-versa.

4.2. PROCEDIMENTO PARA TOMBAMENTO DE MOTORES W22 VERTICAIS

Para realizar o tombamento de motores W22 originalmente na vertical, siga os passos mostrados abaixo:

1. Certificar-se que os olhais estão adequadamente fixos, conforme item 4.1;

2. Instalar o primeiro par de olhais e suspender o motor, ver Figura 4.16;

Figura 4.16 *– Instalação do primeiro par de olhais*

3. Instalar o segundo par de olhais, ver Figura 4.17

Figura 4.17 *– Instalação do segundo par de olhais.*

PORTUGUÊS

4. Reduzir a carga sobre o primeiro par de olhais para iniciar a rotação do motor, conforme Figura 4.18. Esse procedimento deve ser realizado de forma lenta e cautelosa.

Figura 4.18 – *Motor posicionado na vertical.*

5. Remover o primeiro par de olhais, ver Figura 4.19.

Figura 4.19 – *Resultado final: motor posicionado na posição horizontal.*

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5. ARMAZENAMENTO

Se os motores não forem instalados imediatamente, recomenda-se armazená-los em local seco com umidade relativa do ar de até 60%, com temperatura ambiente acima de 5°C e abaixo de 40°C, isento de poeira, vibrações, gases, agentes corrosivos, com temperatura uniforme, em posição normal e sem apoiar sobre eles outros objetos. Remova polias, caso existam, da ponta de eixo, que deve ser mantida livre e com graxa protetiva para evitar corrosão. Os motores devem ser armazenados de tal modo que a drenagem de água condensada seja facilitada.

Caso o motor possua resistência de aquecimento, esta deverá ser energizada sempre que o motor não estiver em operação. Isto se aplica também para os casos em que o motor estiver instalado, porém fora de uso por um longo período. Nestas situações, dependendo das condições do ambiente, poderá ocorrer condensação de água no interior do motor, provocando queda na resistência de isolamento.

As resistências de aquecimento nunca devem estar energizadas enquanto o motor estiver operando.

5.1. SUPERFÍCIES USINADAS EXPOSTAS

Todas as superfícies usinadas expostas (por exemplo, ponta de eixo e flange) são protegidas na fábrica por um inibidor de oxidação temporário. Esta película protetora deve ser reaplicada periodicamente durante o período de armazenagem (pelo menos a cada seis meses) ou quando for removida ou estiver deteriorada.

5.2. EMPILHAMENTO

O empilhamento de embalagens durante o armazenamento não deve ultrapassar a 5 metros de altura, obedecendo-se aos critérios da Tabela 5.1:

Tabela 5.1 *- Empilhamento máximo recomendado*

Tipo de Embalagem	Carcaças	Quantidade máxima de empilhamento
Caixa de Papelão	IEC 63 a 132 NEMA 143 a 215	indicada na aba superior da caixa de papelão
Engradado de madeira	IEC 63 a 315 NEMA 48 a 504/5	06
	IEC 355 NEMA 586/7 e 588/9	03
	HGF IEC 315 a 630 HGF NEMA 5000 a 9600	Indicado na própria embalagem

Notas:
1) Não empilhar embalagens maiores sobre menores.
2) Posicionar corretamente uma embalagem sobre a outra (ver Figura 5.1 e Figura 5.2).

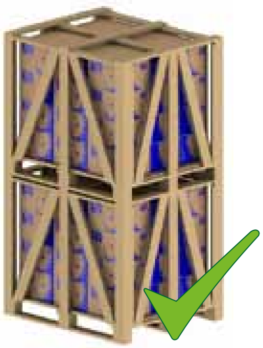

Figura 5.1 *- Montagem adequada.*

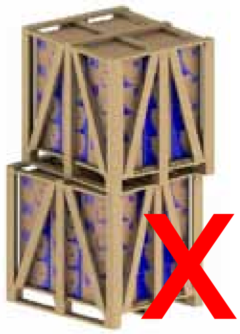

Figura 5.2 *- Montagem inadequada.*

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3) Os pés das embalagens superiores devem estar apoiados sobre calços de madeiras (Figura 5.3) e não sobre as fitas de aço e nem tampouco ficar sem apoio (Figura 5.4).

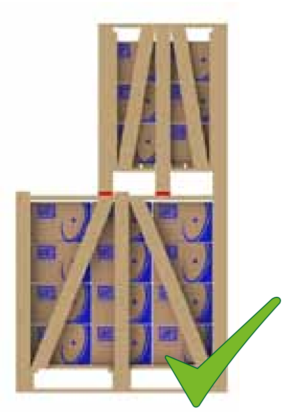

Figura 5.3 *- Empilhamento adequado.*

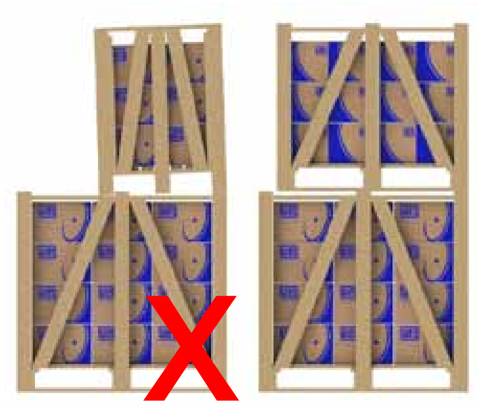

Figura 5.4 *- Empilhamento inadequado.*

4) Para o empilhamento de um volume menor sobre um volume maior, acrescentar sarrafos transversais entre os mesmos quando o maior não oferecer resistência ao peso do menor (ver Figura 5 5). Esta situação normalmente ocorre com os volumes dos motores de carcaça acima da IEC 225S/M (NEMA 364/5T).

Figura 5.5 *- Utilização de sarrafos adicionais para empilhamento.*

5.3 MANCAIS

5.3.1 Mancais de rolamento lubrificados a graxa

Recomenda-se girar o eixo do motor pelo menos uma vez ao mês (manualmente, no mínimo cinco voltas, deixando o eixo em posição diferente da original). Obs.: caso o motor possua dispositivo de travamento do eixo, este deve ser retirado antes de girar o eixo e ser recolocado novamente antes de transportar o motor.
Motores verticais podem ser armazenados na posição vertical ou na posição horizontal.
Para motores com rolamento aberto armazenados por mais de seis meses, os rolamentos devem ser relubrificados, conforme item 8.2, antes da entrada em operação.
Caso o motor permaneça armazenado por um período superior a dois anos, recomenda-se substituir os rolamentos ou então estes devem ser removidos, lavados, inspecionados e relubrificados conforme item 8.2.

5.3.2 Mancais de rolamento com lubrificação a óleo

O motor deve ser armazenado na sua posição original de funcionamento, e com óleo nos mancais. O nível do óleo deve ser respeitado, permanecendo na metade do visor de nível.
Durante o período de armazenagem, deve-se, retirar o dispositivo de travamento do eixo e, mensalmente, rotacionar o eixo manualmente cinco voltas, para recircular o óleo e conservar o mancal em boas condições.
Sendo necessário movimentar o motor, o dispositivo de travamento do eixo deve ser reinstalado.
Para motores armazenados por mais de seis meses, os rolamentos devem ser relubrificados, conforme item 8.2, antes da entrada em operação.
Caso o motor permaneça armazenado por um período maior do que dois anos, recomenda-se substituir os rolamentos ou então estes devem ser removidos, lavados, inspecionados e relubrificados conforme item 8.2.
O óleo dos mancais dos motores verticais, que são transportados na posição horizontal, é retirado para evitar vazamento durante o transporte. Após o recebimento, esses motores devem ser colocados na posição vertical e seus mancais devem ser lubrificados.

5.3.3 Mancais de rolamento com lubrificação do tipo Oil Mist

O motor deve ser armazenado na sua posição horizontal. Preencher os mancais com óleo mineral ISO VG 68 com a quantidade de óleo indicada na Tabela 5.2 (também válida para rolamentos com dimensões equivalentes). Após a colocação de óleo nos mancais, gire o eixo (mínimo de cinco voltas).
Durante o período de armazenagem, deve-se retirar o dispositivo de travamento do eixo (quando fornecido) e, semanalmente, rotacionar o eixo manualmente 5 voltas, deixando o eixo em posição diferente da original. Sendo necessário movimentar o motor, o dispositivo de travamento do eixo deve ser reinstalado.
Caso o motor permaneça armazenado por um período maior do que dois anos, recomenda-se substituir os rolamentos ou então estes devem ser removidos, lavados, inspecionados e relubrificados conforme item 8.2.

Tabela 5.2 - *Quantidade de óleo por rolamento*

Tamanho de Rolamento	Quantidade de Óleo (ml)	Tamanho de Rolamento	Quantidade de Óleo (ml)
6201	15	6309	65
6202	15	6311	90
6203	15	6312	105
6204	25	6314	150
6205	25	6315	200
6206	35	6316	250
6207	35	6317	300
6208	40	6319	350
6209	40	6320	400
6211	45	6322	550
6212	50	6324	600
6307	45	6326	650
6308	55	6328	700

Durante qualquer manuseio do motor, os mancais devem estar sem óleo. Dessa forma, antes da entrada em operação, todo o óleo dos mancais deve ser drenado. Após a instalação, caso o sistema de névoa não esteja em operação, o óleo deve ser recolocado para garantir a conservação do mancal. Neste caso, deve-se também proceder com o giro semanal do eixo.

5.3.4 Mancais de deslizamento

O motor deve ser armazenado na sua posição original de funcionamento, e com óleo nos mancais. O nível do óleo deve ser respeitado, permanecendo na metade do visor de nível.
Durante o período de armazenagem, deve-se retirar o dispositivo de travamento do eixo e, mensalmente, rotacionar o eixo manualmente 5 voltas, para recircular o óleo e conservar o mancal em boas condições de operação. Caso seja necessário movimentar o motor, o dispositivo de travamento do eixo deve ser reinstalado.
Para motores armazenados por mais de seis meses, os rolamentos devem ser relubrificados, conforme item 8.2, antes da entrada em operação.
Caso o motor fique armazenado por período maior que o intervalo de troca de óleo, ou não seja possível rotacionar o eixo do motor, o óleo deve ser drenado e aplicada uma proteção anticorrosiva e desumidificadores.

5.4. RESISTÊNCIA DE ISOLAMENTO

Recomenda-se medir periodicamente a resistência de isolamento dos motores, para assim avaliar as condições de armazenamento sob o ponto de vista elétrico. Se forem observadas quedas nos valores de Resistência de Isolamento, as condições do armazenamento devem ser analisadas, avaliadas e corrigidas, quando necessário.

5.4.1. Procedimento para medição da resistência de isolamento

A medição da resistência de isolamento deve ser realizada em área segura.

A resistência de isolamento deve ser medida com um megômetro e com o motor parado, frio e completamente desconectado da rede elétrica.

Para evitar o risco de choque elétrico, descarregue os terminais imediatamente antes e depois de cada medição. Caso o motor possua capacitores, estes devem ser descarregados.

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É recomendável que cada fase seja isolada e testada separadamente, permitindo que seja feita uma comparação entre a resistência de isolamento entre cada fase. Para testar uma das fases, as demais fases devem estar aterradas.
O teste de todas as fases simultaneamente avalia apenas a resistência de isolamento contra o terra. Neste caso não é avaliada a resistência de isolamento entre as fases.
Os cabos de alimentação, chaves, capacitores, e outros equipamentos externos ligados ao motor podem influenciar consideravelmente a medição da resistência de isolamento. Ao realizar estas medições, todos os equipamentos externos devem estar desconectados e aterrados.
A leitura da resistência de isolamento deve ser realizada após a tensão ser aplicada pelo período de um minuto (1 min). A tensão a ser aplicada deve obedecer à Tabela 5.3

Tabela 5.3 *– Tensão para medição da resistência de isolamento*

Tensão nominal do motor (V)	Tensão aplicada para a medição da resistência de isolamento (V)
< 1000V	500
1000 - 2500	500 - 1000
2501 - 5000	1000 - 2500
5001 - 12000	2500 - 5000
> 12000	5000 - 10000

A medição da resistência de isolamento deve ser corrigida para a temperatura de 40°C conforme Tabela 5.4

Tabela 5.4 *- Fator de Correção da Resistência de Isolamento para 40°C*

Temperatura de Medição da Resistência de Isolamento (°C)	Fator de correção da Resistência de Isolamento para 40°C	Temperatura de Medição da Resistência de Isolamento (°C)	Fator de correção da Resistência de Isolamento para 40°C
10	0,125	30	0,500
11	0,134	31	0,536
12	0,144	32	0,574
13	0,154	33	0,616
14	0,165	34	0,660
15	0,177	35	0,707
16	0,189	36	0,758
17	0,203	37	0,812
18	0,218	38	0,871
19	0,233	39	0,933
20	0,250	40	1,000
21	0,268	41	1,072
22	0,287	42	1,149
23	0,308	43	1,231
24	0,330	44	1,320
25	0,354	45	1,414
26	0,379	46	1,516
27	0,406	47	1,625
28	0,435	48	1,741
29	0,467	49	1,866
30	0,500	50	2,000

A condição do isolamento do motor deverá ser avaliada comparando-se o valor medido com os valores da Tabela 5.5 (referenciados a 40°C):

Tabela 5.5 *– Avaliação do sistema de isolamento*

Valor Limite para tensão nominal até 1,1 kV (MΩ)	Valor Limite para tensão nominal acima de 1,1 kV (MΩ)	Situação
Até 5	Até 100	Perigoso, o motor não deve operar nessa condição.
Entre 5 e 100	Entre 100 e 500	Regular
Entre 100 e 500	Acima de 500	Bom
Acima de 500	Acima de 1000	Excelente

Os dados indicados na tabela servem apenas como valores de referências. Sugere-se manter o histórico da resistência de isolamento do motor durante toda a sua vida.
Se a resistência de isolamento estiver baixa, o estator do motor pode estar úmido. Nesse caso, recomenda-se levá-lo até um Assistente Técnico Autorizado WEG para que sejam realizados a avaliação e o reparo adequado. Este serviço não é coberto pelo Termo de Garantia.
Para procedimento de adequação da resistência de isolamento, ver item 8.4.

6. INSTALAÇÃO

A instalação de motores deve ser feita por profissionais capacitados com conhecimentos sobre as normas e as prescrições de segurança

Antes de continuar com o procedimento de instalação alguns pontos devem ser avaliados:

1. Resistência de isolamento: deve estar dentro dos valores aceitáveis. Ver item 5.4.
2. Mancais:
   a. Rolamentos: se apresentarem sinais de oxidação, devem ser substituídos. Caso não apresentem oxidação, realize o procedimento de relubrificação conforme descrito no item 8.2. Motores armazenados por um período superior a dois anos devem ter seus rolamentos substituídos antes de colocados em operação.
   b. Mancais de deslizamento: para motores armazenados por período igual ou maior que o intervalo de troca de óleo, devem ter seu óleo substituído. Caso o óleo tenha sido retirado, é necessário retirar o desumificador e recolocar o óleo no mancal. Maiores informação estão descritas no item 8.2.
3. Condição dos capacitores de partida: para motores monofásicos armazenados por um período maior que dois anos, é recomendado que seus capacitores de partida sejam substituídos.
4. Caixa de ligação:
   a. Devem estar limpas e secas no seu interior.
   b. Os elementos de contato devem estar isentos de oxidação e corretamente conectados. Ver itens 6.9 e 6.10.
   c. As entradas de cabos não utilizadas devem estar corretamente seladas, a tampa da caixa de ligação deve ser fechada e as vedações devem estar em condições apropriadas para atender o grau de proteção do motor.
5. Ventilação: as aletas, a entrada e a saída de ar devem estar limpas e desobstruídas. A distância de instalação recomendada entre as entradas de ar do motor e a parede não deve ser inferior a ¼ (um quarto) do diâmetro da entrada de ar. Deve-se assegurar espaço suficiente para realização de serviços de limpeza. Ver item 7.
6. Acoplamento: remover o dispositivo de travamento do eixo (caso exista) e a graxa de proteção contra corrosão da ponta do eixo e do flange somente pouco antes de instalar o motor. Ver item 6.4.
7. Dreno: devem sempre estar posicionados de forma que a drenagem seja facilitada (no ponto mais baixo. Caso exista uma seta indicativa, o dreno deve ser montado para que a seta aponte para baixo).
   Para motores com grau de proteção IP55, os drenos de borracha (caso disponíveis) podem permanecer na posição aberta (ver Figura 6.1).
   Para graus de proteção mais elevados (por exemplo, IP56, IP65 e IP66), os drenos (independente do tipo) devem permanecer na posição fechada (ver Figura 6.2), sendo abertos apenas durante a manutenção do motor para permitir a drenagem da água condensada (ver item 8.1).
   Motores com lubrificação do tipo Oil Mist devem ter seus drenos conectados a um sistema de coleta específico (ver Figura 6.12 na página 29).

Figura 6.1 - Detalhe do dreno de borracha montado na posição aberto.

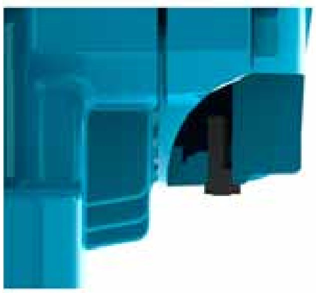

Figura 6.2 *- Detalhe do dreno de borracha montado na posição fechado.*

8. Recomendações adicionais:
   a. Confira o sentido de rotação do motor, ligando-o a vazio antes de acoplá-lo à carga.
   b. Para motores montados na vertical com a ponta de eixo para baixo, recomenda-se o uso de chapéu para evitar a penetração de corpos estranhos no interior do motor.
   c. Para motores montados na vertical com a ponta de eixo para cima, recomenda-se o uso de um defletor de água (water slinger ring) para evitar a penetração de água pelo eixo.

Remova ou fixe completamente a chaveta antes de ligar o motor.

6.1. FUNDAÇÕES PARA O MOTOR

Fundação é o elemento estrutural, base natural ou preparada, destinada a suportar os esforços produzidos pelos equipamentos instalados, permitindo a operação destes com estabilidade, desempenho e segurança. O projeto das fundações deve considerar as estruturas adjacentes para evitar influência de um equipamento sobre o outro, a fim de que não ocorra a propagação de vibrações.

A fundação deve ser plana e a sua escolha, detalhamento e execução exige as características:

a) Da construção do próprio equipamento, envolvendo não somente os valores e forma de atuação das cargas, como ainda sua finalidade e limites máximos das deformações e vibrações compatíveis em cada caso (exemplo, motores com valores reduzidos de: nível de vibração, planicidade dos pés, concentricidade do flange, batimento do flange, etc); .

b) Das construções vizinhas, compreendendo o estado de conservação, estimativa das cargas máximas aplicadas, tipo da fundação e fixação empregadas e níveis de vibração transmitidos por estas construções.

Quando o motor for fornecido com parafuso de alinhamento/nivelamento, deverá ser previsto na base uma superfície que permita o alinhamento/nivelamento.

Esforços gerados durante a operação pela carga acionada devem ser considerados como parte do dimensionamento das fundações.
O usuário é totalmente responsável pelo projeto, preparação e execução da fundação.

Os motores podem ser montados sobre:
- Bases de concreto: mais recomendadas e usuais para os motores de grande porte (ver Figura 6.3);
- Bases metálicas: mais comuns para motores de pequeno porte (ver Figura 6.4).

***Figura 6.3** – Motor instalado sobre base de concreto.*

***Figura 6.4** – Motor instalado sobre base metálica.*

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Nas bases metálicas e de concreto pode existir um sistema de deslizamento. Normalmente são utilizados em aplicações em que o acionamento ocorre por polias e correias. São mais flexíveis permitindo montagens e desmontagens mais rápidas, além de permitir ajustes na tensão da correia. Outro aspecto importante é a posição dos parafusos de travamento da base, que devem ser opostos e na diagonal. O trilho mais próximo da polia motora é colocado de forma que o parafuso de posicionamento fique entre o motor e a máquina acionada. O outro trilho deve ser colocado com o parafuso na posição oposta (diagonal), como apresentado na Figura 6.5.

Para facilitar a montagem, as bases podem possuir características como:
- Ressaltos e/ou reentrâncias;
- Parafusos de ancoragem com placas soltas;
- Parafusos fundidos no concreto;
- Parafusos de nivelamento;
- Parafusos de posicionamento;
- Blocos de ferro ou de aço, placas com superfícies planas.

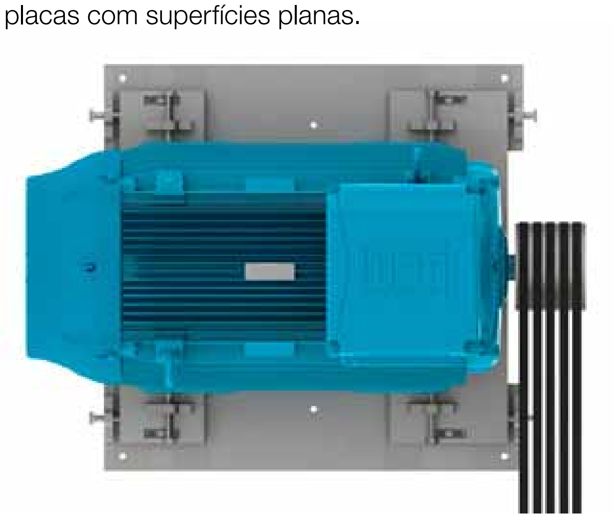

Figura 6.5 *– Motor instalado sobre base deslizante.*

Também se recomenda que após a instalação do motor, as partes metálicas expostas sejam protegidas contra oxidação.

6.2. FIXAÇÃO DO MOTOR

6.2.1. Fixação pelos pés

O dimensional da furação dos pés, baseado nas normas IEC ou NEMA, é informado no catálogo técnico do produto.
O motor deve ser apoiado sobre a base, alinhado e nivelado a fim de que não provoque vibrações e esforços excessivos no eixo e nos mancais. Para mais detalhes, consultar item 6.3 e 6.6.
Recomenda-se que o parafuso de fixação tenha comprimento roscado livre de 1,5 vezes o diâmetro do parafuso. Em aplicações severas, pode ser necessária a utilização de um comprimento roscado livre maior. A Figura 6.4 representa a fixação do motor com pés indicando o comprimento livre mínimo do parafuso.

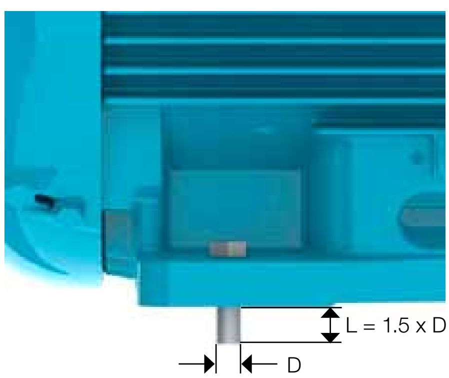

Figura 6.6 *– Representação da fixação do motor por pés*

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6.2.2. Fixação por flange

O dimensional do flange, baseado nas normas IEC ou NEMA, é informado no catálogo eletrônico ou no catálogo técnico do produto.
O flange do motor deve ser apoiado na base, que deve possuir dimensional de encaixe adequado para o tamanho do flange do motor a assim assegurar a concentricidade do conjunto.
Dependendo do tipo do flange, a fixação pode ser realizada do motor para a base (flange FF(IEC) ou D (NEMA)) ou da base para o motor (flange C (DIN ou NEMA)).
Para fixação da base para o motor, a determinação do comprimento do parafuso deve levar em consideração a espessura da base do usuário e a profundidade da rosca do flange do motor.

Nos casos que a furação do flange é passante, o comprimento do parafuso de fixação do motor não deve exceder o comprimento roscado do flange e assim evitar contato com a bobina do motor.

Para fixação do motor à base, recomenda-se que o parafuso de fixação tenha comprimento roscado livre de 1,5 vezes o diâmetro do parafuso. Em aplicações severas, pode ser necessária a utilização de um comprimento roscado livre maior.
Para fixação de motores de grande porte e/ou em aplicações severas, recomenda-se que, além da fixação por flange, o motor seja apoiado (por pés ou pad). O motor nunca pode ser apoiado sobre suas aletas.
Ver Figura 6.7.

Figura 6.7 *– Representação da fixação do motor com flange e apoio na base da carcaça.*

Para aplicação de motores com a presença de líquidos no interior do flange (ex.: óleo), a vedação do motor deve ser adequada para impedir a penetração de líquidos para o interior do motor.

6.2.3. Fixação por pad

Esse tipo de fixação é normalmente utilizado em dutos de ventilação. A fixação do motor é feita através de furos roscados na estrutura do motor, cujo dimensional é informado no catálogo eletrônico ou no catálogo técnico do produto.
O dimensionamento da haste de fixação/parafuso do motor deve levar em consideração o dimensional do duto de ventilação ou base de instalação e a profundidade da rosca no motor. As hastes de fixação e a parede do duto devem ter rigidez suficiente para evitar a vibração excessiva do conjunto (motor e ventilador). A Figura 6.8 representa a fixação por pad's.

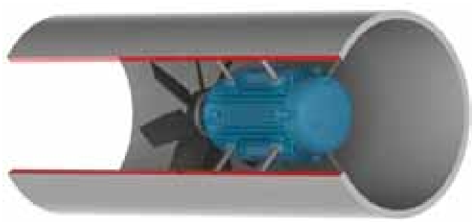

Figura 6.8 *– Representação da fixação do motor no interior de um duto de ventilação.*

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6.3. BALANCEAMENTO

Equipamentos desbalanceados geram vibrações que podem causar danos ao motor. Os motores WEG são balanceados dinamicamente com “meia chaveta” em vazio (desacoplados). Balanceamentos especiais devem ser solicitados no ato da compra.

Os elementos de transmissão tais como polias, acoplamentos, etc., devem ser balanceados antes de serem instalados nos eixos dos motores.

O grau de qualidade de balanceamento do motor segue as normas vigentes para cada linha de produto.

Recomenda-se que os desvios máximos de balanceamento sejam registrados no relatório de instalação.

6.4. ACOPLAMENTOS

Os acoplamentos são utilizados para a transmissão do torque do motor para a máquina acionada. Ao utilizar um acoplamento, devem ser observados os tópicos abaixo:
- Utilizar ferramentas apropriadas para a montagem e desmontagem dos acoplamentos e assim evitar danos ao motor.
- Recomenda-se a utilização de acoplamentos flexíveis, capazes de absorver pequenos desalinhamentos durante a operação do equipamento.
- As cargas máximas e limites de velocidade informados nos catálogos dos fabricantes dos acoplamentos e do motor não devem ser excedidos.
- Realizar o nivelamento e alinhamento do motor conforme itens 6.5 e 6.6, respectivamente.

Motores acionados sem elementos de transmissão acoplados devem ter sua chaveta firmemente fixa ou removida, para prevenir acidentes.

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6.4.1. Acoplamento direto

O acoplamento direto é caracterizado quando o eixo do motor está acoplado diretamente ao eixo da carga acionada, sem o uso de elementos de transmissão. O acoplamento direto apresenta menor custo, maior segurança contra acidentes e ocupa menos espaço.

Em aplicações com acoplamento direto, recomenda-se o uso de rolamentos de esferas.

6.4.2. Acoplamento por engrenagem

O acoplamento por engrenagens é utilizado quando há a necessidade de uma redução de velocidade.
É imprescindível que os eixos estejam perfeitamente alinhados, rigorosamente paralelos (no caso de engrenagens retas) e no ângulo de engrenamento (no caso de engrenagens cônicas ou helicoidais).

6.4.3. Acoplamento por polias e correias

É um tipo de transmissão utilizado quando há a necessidade de uma relação de velocidades entre o motor e a carga acionada.

Uma tensão excessiva nas correias danifica os rolamentos e pode provocar a ruptura do eixo do motor

6.4.4. Acoplamento de motores equipados com mancais de deslizamento

Motores equipados com mancais de deslizamento devem estar acoplados diretamente à máquina acionada ou por meio de um redutor. Mancais de deslizamento não permitem o acoplamento através de polias e correias

Os motores equipados com mancais de deslizamento possuem 3 (três) marcas na ponta do eixo, sendo que a marca central é a indicação do centro magnético e as outras 2 (duas) marcas externas indicam os limites de movimento axial permitidos para o rotor, conforme Figura 6.9.
O motor deve ser acoplado de maneira que a seta fixada na carcaça do mancal fique posicionada sobre a

marca central, quando o motor está em operação. Durante a partida, ou mesmo em operação, o rotor pode mover-se livremente entre as duas ranhuras externas, caso a máquina acionada exerça algum esforço axial sobre o eixo do motor. No entanto, em hipótese alguma o motor pode operar de maneira constante com esforço axial sobre o mancal.

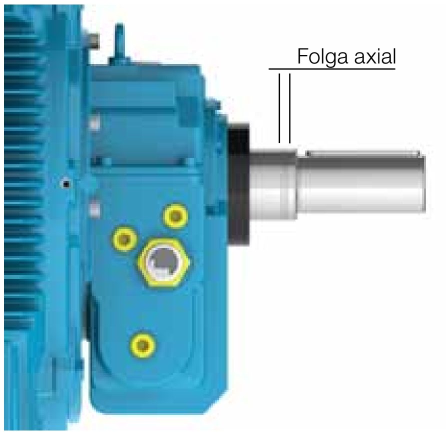

Figura 6.9 *- Folga axial em motor equipado com mancal de deslizamento.*

Ao avaliar o acoplamento, deve-se considerar a folga axial máxima do mancal conforme Tabela 6.1. As folgas axiais da máquina acionada e do acoplamento influenciam na folga máxima do mancal.

Tabela 6.1 *Folgas utilizadas em mancais de deslizamento*

Tamanho do mancal	Folga axial total (mm)
9*	3 + 3 = 6
11*	4 + 4 = 8
14*	5 + 5 =10
18	7,5 + 7,5 = 15

** para motores conforme a norma API 541, a folga axial total é 12,7 mm*

Os mancais de deslizamento utilizados pela WEG não foram projetados para suportar esforço axial contínuo. Não é recomendada a operação contínua da máquina nos seus limites da folga axial.

6.5. NIVELAMENTO

O nivelamento do motor deve ser realizado para corrigir eventuais desvios de planicidade, que possam existir provenientes de outros processos e acomodações dos materiais. O nivelamento pode ser feito por meio de um parafuso de nivelamento fixo no pé ou flange do motor ou por meio de finas chapas de compensação. Após o nivelamento, a diferença de altura entre a base de fixação do motor e o motor não deve exceder 0,1 mm. Caso uma base metálica seja utilizada para ajustar a altura da ponta de eixo do motor com a ponta de eixo da máquina acionada, esta deve ser nivelada na base de concreto.

Recomenda-se que os desvios máximos de nivelamento sejam registrados e armazenados no relatório de instalação.

6.6. ALINHAMENTO

O alinhamento entre a máquina motora e a acionada é uma das variáveis que mais contribuem para prolongar a vida do motor. O desalinhamento entre os acoplamentos geram elevadas cargas que reduzem a vida útil dos mancais, provocam vibrações e, em casos extremos, podem causar a ruptura do eixo. A Figura 6.10 ilustra o desalinhamento entre o motor e o equipamento acionado.

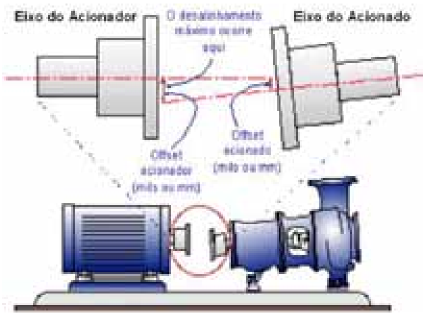

Figura 6.10 *– Condição típica de desalinhamento.*

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Para se efetuar um bom alinhamento do motor, devem-se utilizar ferramentas e dispositivos adequados, como relógio comparador, instrumento de alinhamento a laser, entre outros. O eixo deve ser alinhado axialmente e radialmente com o eixo da máquina acionada

O valor lido em relógios comparadores para o alinhamento, de acordo com a Figura 6.11, não deve exceder 0,03 mm, considerando um giro completo do eixo. Deve existir uma folga entre os acoplamentos, para compensar a dilatação térmica dos eixos, conforme especificação do fabricante do acoplamento.

Alinhamento paralelo   Alinhamento angular

***Figura 6.11** – Alinhamento com relógio comparador.*

Caso o alinhamento seja realizado através de um instrumento a laser, devem ser seguidas as instruções e recomendações fornecidas pelo fabricante do instrumento.

A verificação do alinhamento deve ser realizada na temperatura ambiente e na temperatura de trabalho dos equipamentos.

É recomendado que o alinhamento dos acoplamentos seja verificado periodicamente.

Para acoplamento por polias e correias, o alinhamento deve ser realizado de tal modo que o centro da polia motora esteja no mesmo plano do centro da polia movida e os eixos do motor e da máquina estejam perfeitamente paralelos.

Após a realização dos procedimentos descritos anteriormente, deve-se certificar de que os dispositivos de montagem do motor não permitam alterações no alinhamento e no nivelamento e não causem danos ao equipamento.

Recomenda-se que os desvios máximos de alinhamento sejam registrados e armazenados no relatório de instalação.

6.7. CONEXÃO DE MOTORES LUBRIFICADOS A ÓLEO OU DO TIPO OIL MIST

Nos motores com lubrificação a óleo ou do tipo oil mist, deve-se conectar os tubos de lubrificação existentes (entrada, saída do mancal e dreno do motor), conforme indicado na Figura 6.12.
O sistema de lubrificação deve garantir lubrificação contínua do mancal de acordo com as especificações do fabricante deste sistema.

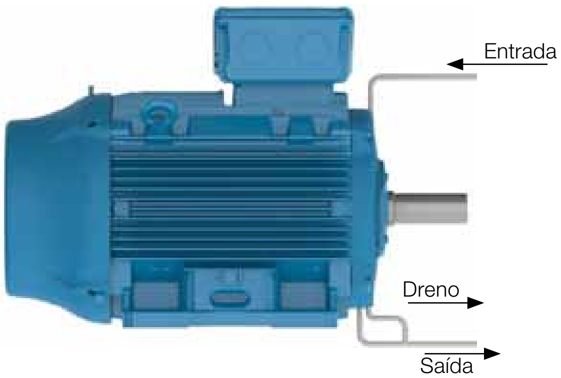

***Figura 6.12** – Sistema de alimentação e drenagem para motores lubrificados por óleo ou do tipo Oil Mist.*

6.8. CONEXÃO DO SISTEMA DE REFRIGERAÇÃO À ÁGUA

Nos motores com refrigeração à água, deve ser prevista a instalação de dutos na entrada e saída de água do motor para garantir a sua refrigeração. Deve-se observar, conforme item 7.2, a vazão mínima e temperatura da água na instalação

6.9. CONEXÃO ELÉTRICA

Para o dimensionamento dos cabos de alimentação e dispositivos de manobra e proteção devem ser considerados: corrente nominal do motor, fator de serviço, corrente de partida, condições do ambiente e da instalação, a máxima queda de tensão, etc. conforme as normas vigentes.

Todos os motores devem ser instalados com sistemas de proteção contra sobrecarga. Para motores trifásicos recomenda-se também a instalação de sistemas de proteção contra falta de fase.

Antes de conectar o motor, verificar se a tensão e a frequencia da rede são as mesmas marcadas na placa de identificação do motor. Seguir o diagrama de ligação indicado na placa de identificação do motor.
Para evitar acidentes, verificar se o aterramento foi realizado conforme as normas vigentes.

Assegurar que o motor esteja conectado corretamente à rede de alimentação elétrica através de contatos seguros e permanentes.

Para motores sem placa de bornes, isolar os cabos terminais do motor, utilizando materiais isolantes compatíveis com a tensão de alimentação e classe de isolamento informadas na placa de identificação.

Para a conexão do cabo de alimentação e do sistema de aterramento devem ser respeitados os torques de aperto indicados na Tabela 8.7.

A distância de isolação (ver Figura 6.13) entre partes vivas não isoladas entre si e entre partes vivas e partes aterradas deve respeitar a os valores indicados na Tabela 6.2.

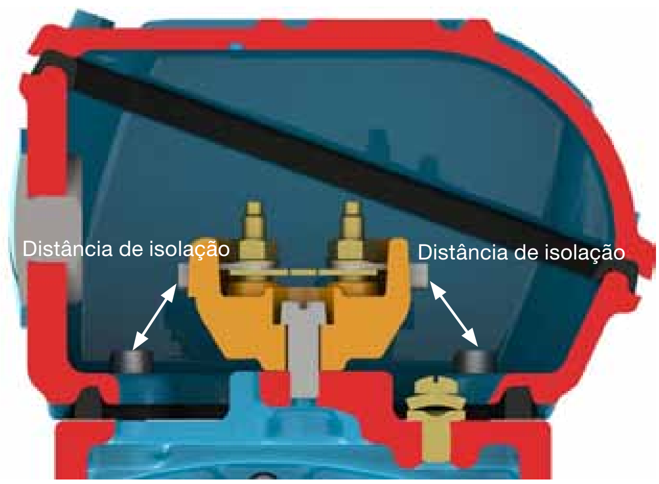

***Figura 6.13** - Representação da distância de isolação.*

***Tabela 6.2** - Distância mínima de isolação (mm) x tensão de alimentação.*

Tensão	Distância mínima de isolação (mm)
U ≤ 440 V	4
440 < U ≤ 690V	5.5
690 < U ≤ 1000V	8
1000 < U ≤ 6900V	45
6900 < U ≤ 11000V	70
11000<U ≤ 16500V	105

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Mesmo com o motor desligado, pode existir energia elétrica no interior da caixa de ligação utilizada para a alimentação das resistências de aquecimento ou inclusive para energizar o enrolamento, quando este estiver sendo utilizado como elemento de aquecimento.
Os capacitores de motores podem reter energia elétrica, mesmo com o motor desligado. Não toque os capacitores e/ou os terminais do motor sem antes verificar a existência de tensão nos mesmos.

Após fazer a conexão do motor, certifique-se que nenhum corpo estranho permaneceu no interior da caixa de ligação.

As entradas da(s) caixa(s) de ligação devem ser fechadas/protegidas para assim garantir o grau de proteção do invólucro indicado na placa de identificação do motor.
As entradas de cabos utilizadas para alimentação e controle devem empregar componentes (como, por exemplo, prensa-cabos e eletrodutos) que atendem as normas e regulamentações vigentes em cada país.

Antes de conectar o motor, verificar se a tensão e a frequência da rede são as mesmas marcadas na placa de identificação do motor. Seguir o diagrama de ligação indicado na placa de identificação do motor.

Todas as proteções, inclusive as contra sobrecorrente, devem ser ajustadas com base nas condições nominais da máquina. Esta proteção também terá que proteger o motor em caso de curto-circuito, falta de fase, ou rotor bloqueado.
Os ajustes dos dispositivos de segurança dos motores devem ser feitos segundo as normas vigentes.

Verificar o sentido de rotação do motor. Caso não haja nenhuma limitação devido à utilização de ventiladores unidirecionais, é possível mudar o sentido de giro de motores trifásicos, invertendo duas fases de alimentação. Para motores monofásicos, verificar o esquema de ligação na placa de identificação.

6.10. CONEXÃO DOS DISPOSITIVOS DE PROTEÇÃO TÉRMICA

Quando fornecido com dispositivos de proteção ou de monitoramento de temperatura, como: protetor térmico bimetálico (termostatos), termistores, protetores térmicos do tipo Automático, PT-100 (RTD), etc., seus terminais devem ser conectados aos dispositivos de controle correspondentes, de acordo com as placas de identificação dos acessórios. A não observação desse procedimento pode resultar em cancelamento da garantia e risco para a instalação.

Não aplicar tensão de teste superior a 2,5 V para termistores e corrente maior do que 5 mA para RTDs (PT-100).

O esquema de ligação dos protetores térmicos bimetálicos (termostatos) e termistores é mostrado nas Figura 6.14 e Figura 6.15, respectivamente.

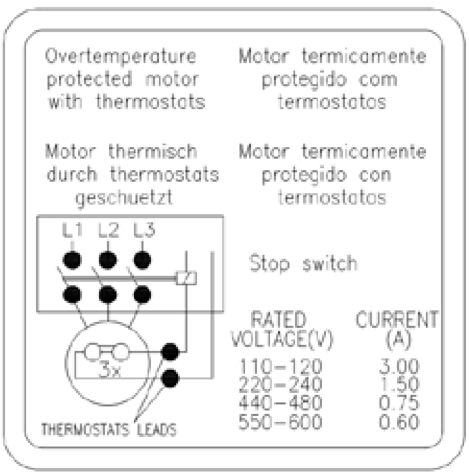

***Figura 6.14** - Conexão dos protetores térmicos bimetálicos (termostatos).*

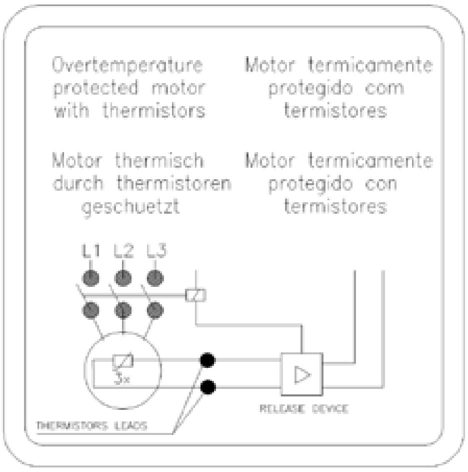

Figura 6.15 *- Conexão dos termistores.*

Os limites de temperatura de alarme e desligamento das proteções térmicas podem ser definidos de acordo com a aplicação, porém não devem ultrapassar os valores indicados na Tabela 6.3.

Tabela 6.3 *- Temperatura máxima de atuação das proteções térmicas.*

Componente	Classe de Isolamento	Temperatura máxima de operação (°C)	
		Alarme	Desligamento
Enrolamento	B	-	130
	F	130	155
	H	155	180
Mancal	Todas	110	120

Notas:
1) A quantidade e o tipo de proteção térmica instalados no motor são informados nas placas de identificação dos acessórios do mesmo.
2) No caso de proteção térmica com resistência calibrada (por exemplo, PT-100), o sistema de proteção deve ser ajustado nas temperatura de operação indicada na Tabela 6.3.

6.11. TERMORRESISTORES (PT-100)

São elementos, cuja operação está baseada na característica de variação da resistência com a temperatura, intrínseca em alguns materiais (geralmente platina, níquel ou cobre).
Possuem resistência calibrada, que varia linearmente com a temperatura, possibilitando um acompanhamento contínuo do processo de aquecimento do motor pelo display do controlador, com alto grau de precisão e sensibilidade de resposta. Sua aplicação é ampla nos diversos setores de técnicas de medição e automatização de temperatura das indústrias. Geralmente, aplica-se em instalações de grande responsabilidade como, por exemplo, em regime intermitente muito irregular. O mesmo detector pode servir tanto para alarme como para desligamento.
A equivalência entre a resistência do PT-100 e temperatura é apresentada na Tabela 6.4 e Figura 6.16.

Tabela 6.4 *- Equivalência entre a resistência do PT-100 e temperatura.*

°C	Ω	°C	Ω	°C	Ω	°C	Ω	°C	Ω
-29	88.617	17	106.627	63	124.390	109	141.908	155	159.180
-28	89.011	18	107.016	64	124.774	110	142.286	156	159.553
-27	89.405	19	107.404	65	125.157	111	142.664	157	159.926
-26	89.799	20	107.793	66	125.540	112	143.042	158	160.298
-25	90.193	21	108.181	67	125.923	113	143.420	159	160.671
-24	90.587	22	108.570	68	126.306	114	143.797	160	161.043
-23	90.980	23	108.958	69	126.689	115	144.175	161	161.415
-22	91.374	24	109.346	70	127.072	116	144.552	162	161.787
-21	91.767	25	109.734	71	127.454	117	144.930	163	162.159
-20	92.160	26	110.122	72	127.837	118	145.307	164	162.531
-19	92.553	27	110.509	73	128.219	119	145.684	165	162.903
-18	92.946	28	110.897	74	128.602	120	146.061	166	163.274
-17	93.339	29	111.284	75	128.984	121	146.438	167	163.646
-16	93.732	30	111.672	76	129.366	122	146.814	168	164.017
-15	94.125	31	112.059	77	129.748	123	147.191	169	164.388
-14	94.517	32	112.446	78	130.130	124	147.567	170	164.760
-13	94.910	33	112.833	79	130.511	125	147.944	171	165.131
-12	95.302	34	113.220	80	130.893	126	148.320	172	165.501
-11	95.694	35	113.607	81	131.274	127	148.696	173	165.872
-10	96.086	36	113.994	82	131.656	128	149.072	174	166.243
-9	96.478	37	114.380	83	132.037	129	149.448	175	166.613
-8	96.870	38	114.767	84	132.418	130	149.824	176	166.984
-7	97.262	39	115.153	85	132.799	131	150.199	177	167.354
-6	97.653	40	115.539	86	133.180	132	150.575	178	167.724
-5	98.045	41	115.925	87	133.561	133	150.950	179	168.095
-4	98.436	42	116.311	88	133.941	134	151.326	180	168.465
-3	98.827	43	116.697	89	134.322	135	151.701	181	168.834
-2	99.218	44	117.083	90	134.702	136	152.076	182	169.204
-1	99.609	45	117.469	91	135.083	137	152.451	183	169.574
0	100.000	46	117.854	92	135.463	138	152.826	184	169.943
1	100.391	47	118.240	93	135.843	139	153.200	185	170.313
2	100.781	48	118.625	94	136.223	140	153.575	186	170.682
3	101.172	49	119.010	95	136.603	141	153.950	187	171.051
4	101.562	50	119.395	96	136.982	142	154.324	188	171.420
5	101.953	51	119.780	97	137.362	143	154.698	189	171.789
6	102.343	52	120.165	98	137.741	144	155.072	190	172.158
7	102.733	53	120.550	99	138.121	145	155.446	191	172.527
8	103.123	54	120.934	100	138.500	146	155.820	192	172.895
9	103.513	55	121.319	101	138.879	147	156.194	193	173.264
10	103.902	56	121.703	102	139.258	148	156.568	194	173.632
11	104.292	57	122.087	103	139.637	149	156.941	195	174.000
12	104.681	58	122.471	104	140.016	150	157.315	196	174.368
13	105.071	59	122.855	105	140.395	151	157.688	197	174.736
14	105.460	60	123.239	106	140.773	152	158.061	198	175.104
15	105.849	61	123.623	107	141.152	153	158.435	199	175.472
16	106.238	62	124.007	108	141.530	154	158.808	200	175.840

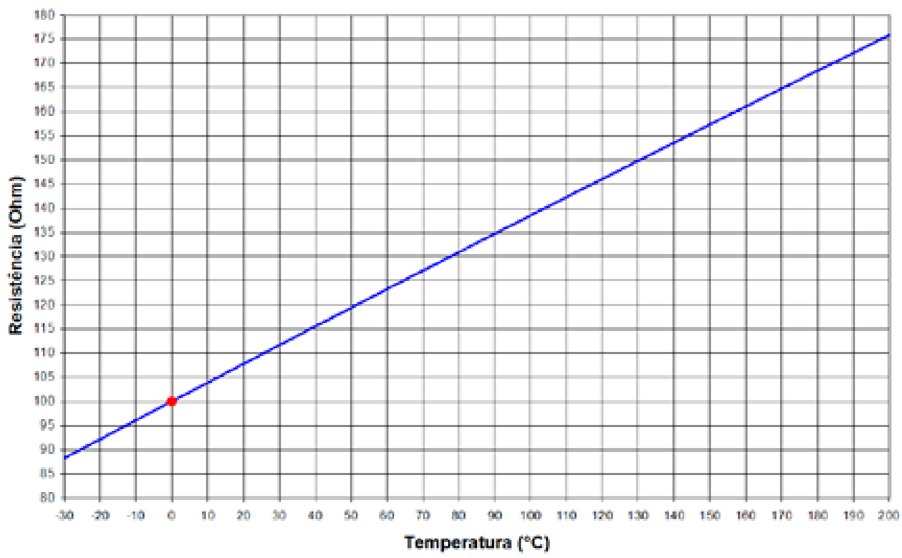

Figura 6.16 *– Resistência ôhmica do PT-100 x temperatura.*

6.12. MÉTODOS DE PARTIDA

Sempre que possível, a partida do motor deve ser direta (em plena tensão). É o método mais simples, no entanto, somente é viável quando a corrente de partida não afeta a rede de alimentação. É importante seguir as regras vigentes da concessionária de energia elétrica.
Nos casos em que a corrente de partida do motor é alta, podem ocorrer as seguintes consequências:

a) Elevada queda de tensão no sistema de alimentação da rede, provocando interferência nos equipamentos instalados neste sistema;
b) O superdimensionamento do sistema de proteção (cabos, contatores), o que eleva os custos da instalação.

Caso a partida direta não seja possível devido aos problemas citados acima, pode-se usar método de partida indireta compatível com a carga e a tensão do motor, para reduzir a corrente de partida.
Quando é utilizado um método de partida com tensão reduzida, o torque de partida do motor também será reduzido.

A Tabela 6.5 indica os métodos de partida indireta possíveis de serem utilizados, de acordo com a quantidade de cabos do motor.

***Tabela 6.5** - Métodos de partida x quantidade de cabos.*

Quantidade de cabos	Métodos de partidas possíveis
3 cabos	Chave Compensadora Soft - Starter
6 cabos	Chave Estrela - Triângulo Chave Compensadora Soft - Starter
9 cabos	Chave Série - Paralela Chave Compensadora Soft - Starter
12 cabos	Chave Estrela - Triângulo Chave Série - Paralela Chave Compensadora Soft - Starter

A Tabela 6.6 indica exemplos de métodos de partida indireta possíveis de serem utilizados, de acordo com a tensão indicada na placa de identificação do motor e a tensão da rede elétrica.

***Tabela 6.6** - Métodos de partida x tensão.*

Tensão da placa de identificação	Tensão de Serviço	Partida com chave Estrela - Triângulo	Partida com chave Compensadora	Partida com chave Série - Paralela	Partida com Soft-Starter
220/380 V	220 V	SIM	SIM	NÃO	SIM
	380 V	NÃO	SIM	NÃO	SIM
220/440 V	220 V	NÃO	SIM	SIM	SIM
	440 V	NÃO	SIM	NÃO	SIM
230/460 V	230 V	NÃO	SIM	SIM	SIM
	460 V	NÃO	SIM	NÃO	SIM
380/660 V	380 V	SIM	SIM	NÃO	SIM
220/380/440 V	220 V	SIM	SIM	SIM	SIM
	380 V	NÃO	SIM	SIM	SIM
	440 V	SIM	SIM	NÃO	SIM

Os motores WQuattro devem ser acionados diretamente a partir da rede ou ser acionados por inversor de frequência em modo escalar.

Outro método de partida possível que não sobrecarregue a rede de alimentação é a utilização de um inversor de frequência. Para mais informações sobre motores alimentados com inversor de frequência ver item 6.13

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6.13. MOTORES ALIMENTADOS POR INVERSOR DE FREQUÊNCIA

A operação com inversor de frequência deve ser informada no momento da compra devido a possíveis diferenças construtivas necessárias para esse tipo de acionamento.

Motores Wmagnet devem ser acionados somente por inversor de frequência WEG.

O conversor utilizado para acionar motores com tensão de alimentação até 690V deve possuir modulação PWM com controle vetorial.

Quando um motor opera com inversor de frequência abaixo da frequência nominal, é necessário reduzir o torque fornecido pelo motor a fim de evitar sobreaquecimento. Os valores de redução de torque (derating torque) podem ser encontrados no item 6.4 do "Guia Técnico Motores de Indução Alimentados por Inversores de Frequência PWM" disponível em www.weg.net.

Para operação acima da frequência nominal deve ser observado:
- Operação com potência constante;
- O motor pode fornecer no máximo 95% da potência nominal;
- Respeitar a rotação máxima, considerando os seguintes critérios:
- Máxima frequência de operação informada na placa adicional;
- Limite de rotação mecânica do motor.
- Torque máximo do motor, conforme a equação:

$$\text{Rotação máxima} = \frac{\text{Rotação nominal x Cmáx/Cn}}{1.5}$$

Recomendações para os cabos de conexão entre motor e inversor são indicadas no item 6.8 do "Guia Técnico Motores de Indução alimentados por Inversores de Frequência PWM" disponível em www.weg.net

6.13.1. Uso de filtros (dV/dt)

6.13.1.1. Motor com fio circular esmaltado

Motores com tensão nominal de até 690 V, quando alimentados por inversores de frequência, não requerem filtros, quando observados os critérios abaixo.

Critérios para utilização de motores de fio circular esmaltado alimentados por inversor de frequência [1]				
Tensão de operação do motor[2]	Tensão de pico no motor (max)	dV/dt na saída do conversor (max)	Rise Time[3] do conversor (mín)	MTBP3 Tempo entre pulsos (min)
Vnon ≤ 460 V	≤ 1600 V	≤ 5200 V/µs	≥ 0,1 µs	≥ 6 µs
460 < Vnon ≤ 575 V	≤ 1800 V	≤ 6500 V/µs		
575 < Vnon ≤ 690 V4	≤ 1600 V	≤ 5200 V/µs		
575 < Vnon ≤ 690 V5	≤ 2200 V	≤ 7800 V/µs		

1. Para motores com fio circular esmaltado com tensão 690 < Vnon ≤ 1100 V, consultar a WEG.
2. Para motores com dupla tensão, exemplo 380/660V, devem ser observados os critérios da tensão menor (380V).
3. Informações fornecidas pelo fabricante pelo inversor.
4. Quando não informado no momento da compra de que o motor irá operar com inversor de frequência.
5. Quando informado no momento da compra que o motor irá operar com inversor de frequência.

6.13.1.2. Motor com bobina pré-formada

Motores com bobina pré-formada (média tensão, independente do tamanho da carcaça e baixa tensão a partir da carcaça IEC 500 / NEMA 80) especificados para utilização com inversor de frequência não requerem filtros, se observados os critérios da Tabela 6.7.

Tabela 6.7 - Critérios para utilização de motores com bobina pré-formada alimentados com inversor de frequência.

Tensão de operação do motor	Tipo de modulação	Isolação da espira (fase-fase)		Isolação principal (fase-terra)	
		Tensão de pico nos terminais do motor	dV/dt nos terminais do motor	Tensão de pico nos terminais do motor	dV/dt nos terminais do motor
690 < Vnon ≤ 4160 V	Senoidal	≤ 5900 V	≤ 500 V/µs	≤ 3400 V	≤ 500 V/µs
	PWM	≤ 9300 V	≤ 2700 V/µs	≤ 5400 V	≤ 2700 V/µs
4160 < Vnon ≤ 6600 V	Senoidal	≤ 9300 V	≤ 500 V/µs	≤ 5400 V	≤ 500 V/µs
	PWM	≤ 12700 V	≤ 1500 V/µs	≤ 7400 V	≤ 1500 V/µs

6.13.2. Isolamento dos Mancais

Como padrão, apenas motores na carcaça IEC 400 (NEMA 68) e acima são fornecidos com mancal isolado. Recomenda-se isolar os mancais para operação com inversor de frequência de acordo com a Tabela 6.8.

Tabela 6.8 - Recomendação sobre o isolamento dos mancais para motores acionados por inversor de frequência.

Carcaça	Recomendação
IEC 315 e 355 NEMA 445/7, 447/9, L447/9, 504/5, 5006/7/8, 5009/10/11, 586/7, 5807/8/9, 5810/11/12 e 588/9	Um mancal isolado Aterramento entre eixo e carcaça por meio de escova
IEC 400 e acima NEMA 6800 e acima	Mancal traseiro isolado Aterramento entre eixo e carcaça por meio de escova

Para motores fornecidos com sistema de aterramento do eixo, deve ser observado constantemente o estado de conservação da escova e, ao chegar ao fim de sua vida útil, a mesma deve ser substituída por outra de mesma qualidade.

6.13.3. Frequência de Chaveamento

A frequência mínima de chaveamento do inversor deverá ser de 2,5 kHz.
Recomenda-se que a frequência máxima de chaveamento do conversor seja de 5 kHz.

A não observação dos critérios e recomendações expostos neste manual pode resultar na anulação da garantia do produto.

6.13.4. Limite da rotação mecânica

A Tabela 6.9 mostra as rotações máximas permitidas para motores acionados por inversor de frequência.

Tabela 6.9 - Rotação máxima do motor (em RPM).

Carcaça	2 polos	4 polos	6 polos	8 polos
90 – 100	7000	7000	7000	7000
112	7000	6000	6000	6000
132	6000	5500	5500	5500
160	5000	5000	5000	5000
180	4500	4000	4000	4000
200	4000	3800	3800	3800
225	3600	3600	3600	3600
250	3600	3600	3600	3600
280	3600	3000	3000	3000
315	3600	2500	2500	2500
355	3600	1800	1800	1800

Nota: *para selecionar a rotação máxima permitida para o motor, considere a curva de redução de torque do motor.*

Para mais informações sobre o uso de inversor de frequência, ou como dimensioná-lo corretamente para a sua aplicação, favor contatar a WEG ou o "Guia Técnico Motores de Indução Alimentados por Inversores de Frequência PWM" disponível em www.weg.net.

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7. OPERAÇÃO

7.1. PARTIDA DO MOTOR

Após executar os procedimentos de instalação, alguns aspectos devem ser verificados antes da partida inicial do motor, principalmente se o motor não foi colocado imediatamente em operação após sua instalação. Aqui devem ser verificados os seguintes itens:

- Se os dados que constam na placa de identificação (tensão, corrente, esquema de ligação, grau de proteção, refrigeração, fator de serviço, entre outras) estão de acordo com a aplicação.
- A correta montagem e alinhamento do conjunto (motor + máquina acionada).
- O sistema de acionamento do motor, considerando que a rotação do motor não ultrapasse a velocidade máxima estabelecida na Tabela 6.9.
- A resistência de isolamento do motor, conforme item 5.4.
- O sentido de rotação do motor.
- A integridade da caixa de ligação, que deve estar limpa e seca, seus elementos de contato isentos de xidação, suas vedações em condições apropriadas de uso e suas entradas de cabos corretamente fechadas/protegidas de acordo com o grau de proteção.
- As conexões do motor, verificando se foram corretamente realizadas, inclusive aterramento e cabos auxiliares, conforme recomendações do item 6.9.
- O correto funcionamento dos acessórios (freio, encoder, proteção térmica, ventilação forçada, etc.) instalados no motor.
- A condição dos rolamentos. Se apresentarem sinais de oxidação, devem ser substituídos. Caso não apresentem oxidação, realize o procedimento de relubrificação conforme descrito no item 8.2. Motores instalados há mais de dois anos, mas que não entraram em operação devem ter seus rolamentos substituídos antes de serem colocados em operação.
- Nos motores com mancais de deslizamento deve ser assegurado :
  - O nível correto de óleo do mancal. O mesmo deve estar na metade do visor (ver Figura 6.9).
  - Que o motor não parte e nem opere com cargas radiais ou axiais.
  - Que quando o motor for armazenado por período igual ou maior ao intervalo de troca de óleo, o óleo deverá ser trocado antes da colocação em funcionamento.
- A análise da condição dos capacitores, se existirem. Para motores instalados por um período superior a dois anos, mas que não entraram em operação, recomenda-se a substituição de seus capacitores de partida de motores monofásicos.
- Que entradas e saídas de ar estejam completamente desobstruídas. O mínimo espaço livre até a parede mais próxima (L) deve ser ¼ do diâmetro da entrada de ar da defletora (D), ver Figura 7.1. O ar na entrada do motor deve estar à temperatura ambiente.

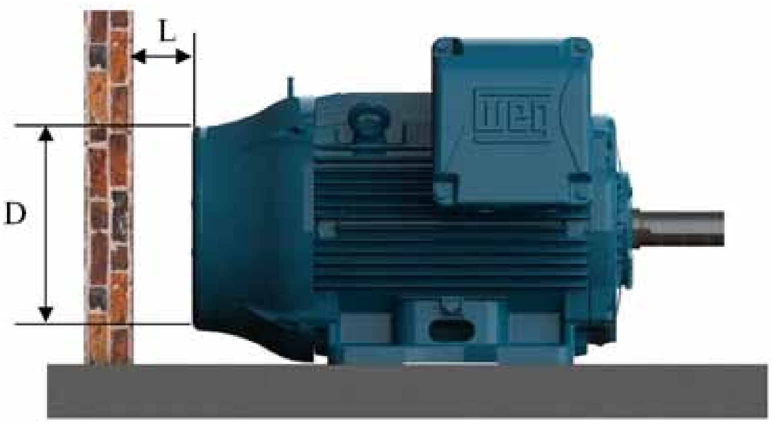

Figura 7.1 *- Distancia mínima do motor até a parede*

Como referência, podem ser seguidas as distâncias mínimas apresentadas na Tabela 7.1

Tabela 7.1 - Distância mínima entre a tampa defletora e a pareda

Carcaça		Distância entre a tampa defletora e a parede (L)	
IEC	NEMA	mm	inches
63	-	25	0,96
71	-	26	1,02
80	-	30	1,18
90	143/5	33	1,30
100	-	36	1,43
112	182/4	41	1,61
132	213/5	50	1,98
160	254/6	65	2,56
180	284/6	68	2,66
200	324/6	78	3,08
225 250	364/5 404/5	85	3,35
280	444/5 445/7 447/9	108	4,23
315	L447/9 504/5	122	4,80
355	586/7 588/9	136	5,35

- Que as vazões e temperaturas da água estejam corretas, quando utilizada na refrigeração do motor. Ver item 7.2.
- Que todas as partes girantes, como polias, acoplamentos, ventiladores externos, eixo, etc., estejam protegidas contra toques acidentais.

Outros testes e verificações que não constam nesta relação podem se fazer necessários, em função das características específicas da instalação, aplicação e/ou do motor.

Após todas as verificações terem sido realizadas, seguir o procedimento abaixo para efetuar a partida do motor:
- Ligar a máquina sem nenhuma carga (quando possível), acionando a chave de partida como se fosse um pulso, verificando o sentido de rotação, a presença de ruído, vibração ou outra condição anormal de operação.
- Religar o motor, que deve partir e funcionar de maneira suave. Caso isso não ocorra, desligue o motor, verifique novamente o sistema de montagem e conexões antes de uma nova partida.
- No caso de vibrações excessivas, verificar se os parafusos de fixação estão adequadamente apertados ou se a vibração é proveniente de máquinas adjacentes. Verificar periodicamente a vibração, respeitando os limites apresentados no item 7.2.1.
- Operar o motor sob carga nominal por um pequeno período de tempo e comparar a corrente de operação com a corrente indicada na placa de identificação.
- Recomenda-se ainda que algumas variáveis do motor sejam acompanhadas até seu equilíbrio térmico: corrente, tensão, temperatura nos mancais e na superfície externa da carcaça, vibração e ruído.
- Recomenda-se que os valores de corrente e tensão sejam registrados no relatório de instalação.

Devido ao valor elevado da corrente de partida dos motores de indução, o tempo gasto na aceleração nas cargas de inércia apreciável resulta na elevação rápida da temperatura do motor. Se o intervalo entre partidas sucessivas for muito reduzido, isso resultará no aumento da temperatura nos enrolamentos, danificando-os ou reduzindo a sua vida útil. Caso não seja especificado regime de serviço diferente de S1 na placa de identificação do motor, os motores estão aptos para:
- Duas partidas sucessivas, sendo a primeira feita com o motor frio, isto é, com seus enrolamentos na temperatura ambiente e uma segunda partida logo a seguir, porém após o motor ter desacelerado até atingir seu repouso.
- Uma partida com o motor a quente, ou seja, com os enrolamentos na temperatura de regime.

O item 10 lista alguns problemas de mau funcionamento do motor, com suas possíveis causas.

7.2. CONDIÇÕES DE OPERAÇÃO

Caso nenhuma outra condição seja informada no momento da compra, os motores elétricos são projetados para operar a uma altitude limitada a 1000m acima do nível do mar e em temperatura ambiente entre -20°C e +40°C. Qualquer variação das condições do ambiente, onde o motor irá operar, deve estar indicada na placa de identificação do motor.
Alguns componentes precisam ser trocados, quando a temperatura ambiente é diferente da indicada acima. Favor contatar a WEG para verificar as características especiais.

O ambiente no local de instalação deverá ter condições de renovação de ar da ordem de 1m³ por segundo para cada 100 kW ou fração de potência do motor. Para motores ventilados, que não possuem ventilador próprio, a ventilação adequada do motor é de responsabilidade do fabricante do equipamento. Caso não haja especificação da velocidade de ar mínima entre as aletas do motor em uma placa de identificação, devem ser seguidos os valores indicados na Tabela 7.2. Os valores apresentados na Tabela 7.2 são válidos para motores aletados alimentados na frequência de 60 Hz. Para obtenção das velocidades mínimas de ar em 50 Hz deve-se multiplicar os valores da tabela por 0,83.

Tabela 7.2 *- Velocidade mínima de ar entre as aletas do motor (m/s)*

Carcaça		Polos			
IEC	**NEMA**	**2**	**4**	**6**	**8**
63 a 90	**143/5**	14	7	5	4
100 a 132	**182/4 and 213/5**	18	10	8	6
160 a 200	**364/5 to 444/5**	20	20	12	7
225 a 280	**364/5 to 444/5**	22	22	18	12
315 a 355	**445/7 to 588/9**	25	25	20	15

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As variações da tensão e frequência de alimentação podem afetar as características de desempenho e a compatibilidade eletromagnética do motor. Estas variações de alimentação devem seguir os valores estabelecidos nas normas vigentes. Exemplos:
- ABNT NBR-17094 - Partes 1 e 2. O motor está apto a fornecer torque nominal, sob as seguintes zonas de variação de tensão e frequência:
- Zona A: ±5% de tensão e ±2% de frequência
- Zona B: ±10% de tensão e +3% -5% de frequência.

Quando operado na Zona A ou B, o motor pode apresentar variações de desempenho e atingir temperaturas mais elevadas. Estas variações são maiores para a operação na zona B. Não é recomendada uma operação prolongada do motor na zona B.
- IEC 60034-1. O motor está apto a fornecer torque nominal, sob as seguintes zonas de variação de tensão e frequência:
- Zona A: ±5% de tensão e ±2% de frequência
- Zona B: ±10% de tensão e +3% -5% de frequência.

Quando operado na Zona A ou B, o motor pode apresentar variações de desempenho e atingir temperaturas mais elevadas. Estas variações são maiores para a operação na zona B. Não é recomendada a operação prolongada do motor na zona B. Para motores multitensão (exemplo 380-415/660 V) é permitida uma variação de tensão de ±5%.
- NEMA MG-1 Parte 12. O motor está apto a operar em uma das seguintes variações:
- ±10% de tensão, com frequência nominal;
- ±5 de frequência, com tensão nominal;
- Uma combinação de variação de tensão e frequência de ±10%, desde que a variação de frequência não seja superior a ±5%.

Para motores que são resfriados através do ar ambiente, as entradas e saídas de ar devem ser limpas em intervalos regulares para garantir uma livre circulação do ar. O ar quente não deve retornar para o motor. O ar utilizado para refrigeração do motor deve estar na temperatura ambiente, limitada a faixa de temperatura indicada na placa de identificação do motor (quando não indicado, considerar uma faixa de temperatura entre -20°C e +40°C).

Para motores refrigerados à água, os valores da vazão da água para cada tamanho de carcaça, bem como a máxima elevação de temperatura da água após circular pelo motor são mostrados na Tabela 7.3. A temperatura da água na entrada não deve exceder a 40°C.

Tabela 7.3 - *Vazão e máxima elevação de temperatura de água.*

Carcaça		Vazão (litros/minuto)	Máxima Elevação de temperatura de água (°C)
IEC	NEMA		
180	284/6	12	5
200	324/6	12	5
225	364/5	12	5
250	404/5	12	5
280	444/5 445/7 447/9	15	6
315	504/5	16	6
355	586/7 588/9	25	6

Para motores com lubrificação do tipo *Oil Mist*, em caso de falha do sistema de bombeamento de óleo, é permitida uma operação em regime contínuo com o tempo máximo de uma hora de operação.

Considerando-se que o calor do sol causa aumento da temperatura de operação, motores instalados externamente devem sempre estar protegidos contra a incidência direta dos raios solares.

Possíveis desvios em relação à operação normal (atuação de proteções térmicas, aumento do nível de ruído, vibração, temperatura e corrente) devem ser examinados e eliminados por pessoal capacitado. Em caso de dúvidas, desligar o motor imediatamente e contatar um Assistente Técnico Autorizado WEG.

A não observação dos critérios e recomendações expostos neste manual pode resultar na anulação da garantia do produto.

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7.2.1. Limites da severidade de vibração

A severidade de vibração é o máximo valor de vibração encontrada, dentre todos os pontos e direções recomendados .
A Tabela 7.4 indica os valores admissíveis da severidade de vibração recomendados na norma IEC 60034-14 para as carcaças IEC 56 a 400, para os graus de vibração A e B.
Os limites de severidade da Tabela 7.4 são apresentados em termos do valor médio quadrático (= valor RMS ou valor eficaz) da velocidade de vibração em mm/s medidos em condição de suspensão livre (base elástica).

Tabela 7.4 - *Limites recomendados para a severidade de vibração de acordo com a norma IEC 60034-14.*

Altura do eixo [mm]	56 ≤ H ≤ 132	132 < H ≤ 280	H > 280
Grau de vibração	**Severidade de vibração em base elástica [mm/s RMS]**		
A	1,6	2,2	2,8
B	0,7	1,1	1,8

Notas:
1 - Os valores da Tabela 7.4 são válidos para medições realizadas com a máquina desacoplada e sem carga, operando na frequência e tensão nominais.
2 - Os valores da Tabela 7.4 são válidos independentemente do sentido de rotação da máquina.
3 - A Tabela 7.4 não se aplica para motores trifásicos com comutador, motores monofásicos, motores trifásicos com alimentação monofásica ou para máquinas fixadas no local de instalação, acopladas em suas cargas de acionamento ou cargas acionadas.

Para motor padrão, de acordo com a norma NEMA MG-1, o limite de vibração é de 0.15 in/s (polegadas/ segundo pico), na mesma condição de suspensão livre e desacoplado.

Nota:
Para condição de operação em carga recomenda-se o uso da norma ISO 10816-3 para avaliação dos limites de vibração do motor. Na condição em carga, a vibração do motor será influenciada por vários fatores, entre eles, tipo de carga acoplada, condição de fixação do motor, condição de alinhamento com a carga, vibração da estrutura ou base devido a outros equipamentos, etc.

8. MANUTENÇÃO

A finalidade da manutenção é prolongar ao máximo possível a vida útil do equipamento. A não observância de um dos itens relacionados a seguir pode levar a paradas não desejadas do equipamento.

Caso, durante a manutenção, houver necessidade de transporte dos motores com rolamentos de rolos ou contato angular, devem ser utilizados os dispositivos de travamento do eixo fornecidos com o motor. Todos os motores HGF, independente do tipo de mancal, devem ter seu eixo travado durante o transporte.

Qualquer serviço em máquinas elétricas deve ser realizado apenas por pessoal capacitado, utilizando somente ferramentas e métodos adequados. Antes de iniciar qualquer serviço, as máquinas devem estar completamente paradas e desconectadas da rede de alimentação, inclusive os acessórios (resistência de aquecimento, freio, etc.).
Assistentes técnicos ou pessoal não capacitado e sem autorização para fazer manutenção e/ou reparar motores são totalmente responsáveis pelo trabalho executado e pelos eventuais danos que possam ocorrer durante o seu funcionamento.

8.1. INSPEÇÃO GERAL

A frequência com que devem ser realizadas as inspeções depende do tipo do motor, da aplicação e das condições do local da instalação. Durante a inspeção, recomenda-se:

- Fazer uma inspeção visual do motor e do acoplamento, observando os níveis de ruído, da vibração, alinhamento, sinais de desgastes, oxidação e peças danificadas. Substituir as peças, quando for necessário.
- Medir a resistência de isolamento conforme descrito no item 5.4.
- Manter a carcaça limpa, eliminando todo acúmulo de óleo ou de pó na parte externa do motor para assim facilitar a troca de calor com o meio ambiente.
- Verificar a condição do ventilador e das entradas e saídas de ar, assegurando um livre fluxo do ar;
- Verificar o estado das vedações e efetuar a troca, se necessário.
- Drenar o motor. Após a drenagem, recolocar os drenos para novamente garantir o grau de proteção do motor. Os drenos devem estar sempre posicionados de tal forma que a drenagem seja facilitada (ver item 6).
- Verificar a conexão dos cabos de alimentação, respeitando as distâncias de isolação entre partes vivas não isoladas entre si e entre partes vivas e partes aterradas de acordo com a Tabela 6.2.
- Verificar se o aperto dos parafusos de conexão, sustentação e fixação está de acordo com o indicado na Tabela 8.7.
- Verificar o estado da passagem dos cabos na caixa de ligação, as vedações dos prensa-cabos e as vedações nas caixas de ligação e efetuar a troca, se necessário.
- Verificar o estado dos mancais, observando o aparecimento de ruídos e níveis de vibração não habituais,verificando a temperatura dos mancais, o nível do óleo, a condição do lubrificante e o monitoramento das horas de operação versus a vida útil informada.
- Registrar e arquivar todas as modificações realizadas no motor.

Não reutilizar peças danificadas ou desgastadas. Substitua-as por novas, originais de fábrica.

8.2. LUBRIFICAÇÃO

A correta lubrificação é de vital importância para o bom funcionamento do motor.
Utilizar o tipo e quantidade de graxa ou óleo especificados e seguir os intervalos de relubrificação recomendados para os mancais. Estas informações podem ser encontradas na placa de identificação e este procedimento deve ser realizado conforme o tipo de lubrificante (óleo ou graxa).
Quando o motor utilizar proteção térmica no mancal, devem ser respeitados os limites de temperatura de operação indicados na Tabela 6.3.
Motores para aplicações especiais podem apresentar temperaturas máximas de operação diferentes das indicadas na tabela.
O descarte da graxa e/ou óleo deve seguir as recomendações vigentes de cada país.

A utilização de motor em ambientes e/ou aplicações especiais sempre requer uma consulta prévia à WEG.

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8.2.1. Mancais de rolamento lubrificados a graxa

Graxa em excesso provoca aquecimento do mancal e sua consequente falha.

Os intervalos de lubrificação especificados nas Tabela 8.1, Tabela 8.2, Tabela 8.3 e Tabela 8.4 consideram uma temperatura ambiente de 40°C, rotação nominal do motor, instalação horizontal, graxa Mobil Polyrex EM, e são determinados seguindo o critério da norma ISO 281, ou seja, estima-se que 90% dos rolamentos atendem os valores calculados. Qualquer variação dos parâmetros indicados acima devem ser avaliados pontualmente.

***Tabela 8.1**- Intervalo de lubrificação para rolamentos de esferas.*

Carcaça		Polos	Rolamento	Quantidade de graxa (g)	INTERVALOS DE RELUBRIFICAÇÃO (horas)					
IEC	NEMA				ODP (Invólucro aberto)		W21 (Invólucro Fechado)		W22 (Invólucro Fechado)	
					50Hz	60Hz	50Hz	60Hz	50Hz	60Hz
160	254/6	2	6309	13	20000	20000	18100	15700	22000	20000
		4					20000	20000	25000	25000
		6								
		8								
180	284/6	2	6311	18	20000	20000	13700	11500	17000	14000
		4					20000	20000	25000	25000
		6								
		8								
200	324/6	2	6312	21	20000	20000	11900	9800	15000	12000
		4					20000	20000	25000	25000
		6								
		8								
225 250 280 315 355	364/5 404/5 444/5 445/7 447/9 L447/9 504/5 5008 5010/11 586/7 588/9	2	6314	27	18000	14400	4500	3600	5000	4000
		4			20000	20000	11600	9700	14000	12000
		6					16400	14200	20000	17000
		8					19700	17300	24000	20000
		2	6316	34	14000	*Mediante consulta	3500	*Mediante consulta	4000	*Mediante consulta
		4			20000	20000	10400	8500	13000	10000
		6					14900	12800	18000	16000
		8					18700	15900	20000	20000
		2	6319	45	9600	*Mediante consulta	2400	*Mediante consulta	3000	*Mediante consulta
		4			20000	20000	9000	7000	11000	8000
		6					13000	11000	16000	13000
		8					17400	14000	20000	17000
		4	6322	60	20000	20000	7200	5100	9000	6000
		6					10800	9200	13000	11000
		8					15100	11800	19000	14000

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Tabela 8.2- Intervalo de lubrificação para rolamentos de rolos

Carcaça		Polos	Rolamento	Quantidade de graxa (g)	Intervalos de relubrificação (horas)					
					ODP (Invólucro aberto)		W21 (Invólucro Fechado)		W22 (Invólucro Fechado)	
IEC	NEMA				50Hz	60Hz	50Hz	60Hz	50Hz	60Hz
160	254/6	2	NU309	13	20000	19600	13300	9800	16000	12000
		4				20000	20000	20000	25000	25000
		6								
		8								
180	284/6	2	NU311	18	18400	12800	9200	6400	11000	8000
		4			20000	20000	20000	19100	25000	25000
		6						20000		
		8								
200	324/6	2	NU312	21	15200	10200	7600	5100	9000	6000
		4			20000	20000	20000	17200	25000	21000
		6						20000		25000
		8								
"225 250 280 315 355"	364/5 404/5 444/5 445/7 447/9 L447/9 504/5 5008 5010/11 586/7 588/9	4	NU314	27	17800	14200	8900	7100	11000	9000
		6			20000	20000	13100	11000	16000	13000
		8					16900	15100	20000	19000
		4	NU316	34	15200	12000	7600	6000	9000	7000
		6			20000	19000	11600	9500	14000	12000
		8				20000	15500	13800	19000	17000
		4	NU319	45	12000	9400	6000	4700	7000	5000
		6			19600	15200	9800	7600	12000	9000
		8			20000	20000	13700	12200	17000	15000
		4	NU322	60	8800	6600	4400	3300	5000	4000
		6			15600	11800	7800	5900	9000	7000
		8			20000	20000	11500	10700	14000	13000

Tabela 8.3 - *Intervalo de lubrificação para rolamento de esferas - linha HGF.*

Carcaça		Polos	Rolamento	Quantidade de graxa (g)	Intervalos de Lubrificação (horas)	
IEC	NEMA				50Hz	60Hz
315L/A/B e 315C/D/E	5006/7/8T e 5009/10/11T	2	6314	27	3100	2100
		4 – 8	6320	50	4500	4500
			6316	34	4500	4500
355L/A/B e 355C/D/E	5807/8/9T e 5810/11/12T	2	6314	27	3100	2100
		4 – 8	6322	60	4500	4500
			6319	45	4500	4500
400L/A/B e 400 C/D/E	6806/7/8T e 6809/10/11T	2	6315	30	2700	1800
		4 – 8	6324	72	4500	4500
			6319	45	4500	4500
450	7006/10	2	6220	31	2500	1400
		4	6328	93	4500	3300
			6322	60	4500	4500
		6 – 8	6328	93	4500	4500
			6322	60	4500	4500
500	8006/10	4	6330	104	4200	2800
			6324	72	4500	4500
		6 – 8	6330	104	4500	4500
			6324	72	4500	4500
500	8006/10	4	6330	104	4200	2800
			6324	72	4500	4500
		6 – 8	6330	104	4500	4500
			6324	72	4500	4500
560	8806/10	4 - 8	*Mediante consulta			
630	9606/10	4 - 8				

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Tabela 8.4 - *Intervalo de lubrificação para rolamento de rolos - linha HGF*

Carcaça		Polos	Rolamento	Quantidade de graxa (g)	Intervalos de Lubrificação (horas)	
IEC	NEMA				50Hz	60Hz
315L/A/B e 315C/D/E	5006/7/8 e 5009/10/11	4	NU320	50	4300	2900
		6 - 8			4500	4500
355L/A/B e 355C/D/E	5807/8/9 e 5810/11/12	4	NU322	60	3500	2200
		6 - 8			4500	4500
400L/A/B e 400C/D/E	6806/7/8 e 6809/10/11	4	NU324	72	2900	1800
		6 - 8			4500	4500
450	7006/10	4	NU328	93	2000	1400
		6			4500	3200
		8			4500	4500
500	8006/10	4	NU330	104	1700	1000
		6			4100	2900
		8			4500	4500
560	8806/10	4	NU228 + 6228	75	2600	1600
		6 - 8		106	4500	4500
630	9606/10	4	NU232 + 6232	92	1800	1000
		6		120	4300	3100
		8		140	4500	4500

Para cada incremento de 15°C na temperatura ambiente, o intervalo de relubrificação deverá ser reduzido pela metade.
Motores originais de fábrica para posição horizontal, porém instalados na posição vertical (com autorização da WEG) devem ter seu intervalo de relubrificação reduzido pela metade.

Para aplicações especiais, tais como: altas e baixas temperaturas, ambientes agressivos, variação de velocidade (acionamento por inversor de frequência), etc., entre em contato com a WEG para obter informações referentes ao tipo de graxa e intervalos de lubrificação a serem utilizados.

8.2.1.1. Motores sem graxeira

Nos motores sem graxeira, a lubrificação deve ser efetuada conforme plano de manutenção preventiva existente. A desmontagem e montagem do motor deve ser feita conforme item 8.3.
Motores com rolamentos blindados (por exemplo, ZZ, DDU, 2RS, VV), os rolamentos devem ser substituídos ao final da vida útil da graxa.

8.2.1.2. Motores com graxeira

Nos motores com graxeira, é recomendado lubrificar os rolamentos com o motor parado, procedendo da seguinte maneira:
- Limpar as proximidades do orifício de entrada de graxa;
- Retirar a proteção de saída de graxa;
- Colocar aproximadamente metade da graxa total recomendada e girar o motor durante aproximadamente 1 (um) minuto na rotação nominal;
- Desligar o motor e colocar o restante da graxa;
- Recolocar as proteções de entrada e saída de graxa.

Para lubrificação, é indicado o uso de lubrificador manual.

Nos motores fornecidos com dispositivo de mola, o excesso de graxa deve ser removido, puxando a vareta da mola e limpando a mola, até que a mesma não contenha mais graxa.

8.2.1.3. Compatibilidade da graxa Mobil Polyrex EM com outras graxas

A graxa Mobil Polyrex EM possui espessante de poliuréia e óleo mineral, e é compatível com outras graxas que contenham:
- Espessante de lítio ou complexo de lítio ou poliuréia e óleo mineral altamente refinado;
- A graxa aplicada deve possuir em sua formulação aditivos inibidores de corrosão e oxidação.

Apesar da graxa Mobil Polyrex EM ser compatível com os tipos de graxa indicados acima, não é recomendada a mistura de graxas.
Caso necessite de outro tipo de graxa, contate a WEG.

8.2.2. Mancais de rolamento lubrificados a óleo

Nos motores com rolamento lubrificados a óleo, a troca de óleo deve ser feita com o motor parado, seguindo os procedimento abaixo:
- Abrir o respiro da entrada de óleo;
- Retirar o tampão de saída de óleo;
- Abrir a válvula e drenar todo o óleo;
- Fechar a válvula;
- Recolocar o tampão;
- Preencher com a quantidade e especificação do óleo indicados na placa de identificação;
- Verificar se o nível do óleo está na metade do visor;
- Fechar o respiro da entrada de óleo;
- Certificar-se que não há vazamento e que todos os furos roscados não utilizados estejam fechados.

A troca de óleo dos mancais deve ser realizada no intervalo indicado na placa de identificação ou sempre que o lubrificante apresentar alterações em suas características (viscosidade, pH, etc.).
O nível de óleo deve ser mantido na metade do visor de óleo e acompanhado diariamente.
O uso de lubrificantes com outras viscosidades requer contato prévio com a WEG.

Obs: motores HGF verticais para alto empuxo são fornecidos com mancais dianteiros lubrificados a graxa e com mancais traseiros, a óleo. Os mancais dianteiros devem seguir as recomendações do item 8.2.1. A Tabela 8 5 apresenta a quantidade e especificação de óleo para essa configuração.

	Carcaça		Polos	Rolamento	Óleo (L)	Intervalo (h)	Lubrificante	Especificação Lubrificante
	IEC	NEMA						
Montagem Alto Empuxo	315L/A/B e 315C/D/E	5006/7/8T e 5009/10/11T	4 - 8	29320	20	8000	Renolin DTA 40 / SHC 629	Óleo mineral ISO VG150 com aditivos anti-espuma e antioxidantes
	355L/A/B e 355C/D/E	5807/8/9T e 5810/11/12T	4 - 8	29320	26			
	400L/A/B e 400C/D/E	6806/7/8T e 6809/10/11T	4 - 8	29320	37			
	450	7006/10	4 - 8	29320	45			

8.2.3. Mancais de rolamento com lubrificação do tipo Oil Mist

Verificar o estado das vedações e, sempre que for necessária alguma troca, usar apenas peças originais.
Realizar a limpeza dos componentes antes da montagem (anéis de fixação, tampas, etc.).
Aplicar veda juntas resistente ao óleo lubrificante utilizado, entre os anéis de fixação e as tampas.
A conexão dos sistemas de entrada, saída e dreno de óleo devem ser realizados conforme Figura 6.12.

8.2.4. Mancais de deslizamento

Para os mancais de deslizamento, a troca de óleo deve ser feita nos intervalos indicados na Tabela 8.6 e deve ser realizada, adotando os seguintes procedimentos:
- Para o mancal traseiro, retirar a tampa de inspeção da defletora.
- Drenar o óleo através do dreno localizado na parte inferior da carcaça do mancal (ver Figura 8.1).
- Fechar a saída de óleo.
- Retirar o bujão da entrada de óleo.
- Preencher com o óleo especificado e com a quantidade indicada na Tabela 8.6 e deve ser realizada, adotando os seguintes procedimentos:
- Para o mancal traseiro, retirar a tampa de inspeção da defletora.
- Drenar o óleo através do dreno localizado na parte inferior da carcaça do mancal (ver Figura 8.1).
- Fechar a saída de óleo.
- Retirar o bujão da entrada de óleo.
- Preencher com o óleo especificado e com a quantidade indicada na Tabela 8.6.
- Verificar se o nível do óleo está na metade do visor.
- Fechar a entrada de óleo.
- Certificar-se que não há vazamento.

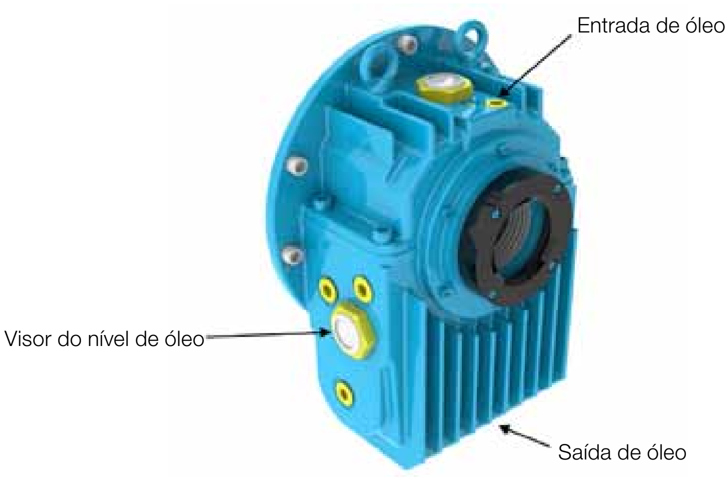

***Figura 8.1** - Mancal de deslizamento.*

***Tabela 8.6** – Características de lubrificação para mancais de deslizamento*

<table>
<tr><th colspan="2">Carcaça</th><th rowspan="2">Polos</th><th rowspan="2">Mancal</th><th rowspan="2">Óleo (L)</th><th rowspan="2">Intervalo (h)</th><th rowspan="2">Lubrificante</th><th rowspan="2">Especificação Lubrificante</th></tr>
<tr><th>IEC</th><th>NEMA</th></tr>
<tr><td>315L/A/B e 315C/D/E</td><td>5006/7/8T e 5009/10/11T</td><td rowspan="4">2</td><td rowspan="4">9-80</td><td rowspan="4">2.8</td><td rowspan="4">8000</td><td rowspan="4">Renolin DTA 10</td><td rowspan="4">Óleo mineral ISO VG32 com aditivos anti-espuma e antioxidantes</td></tr>
<tr><td>355L/A/B e 355C/D/E</td><td>5807/8/9T e 5810/11/12T</td></tr>
<tr><td>400L/A/B e 400C/D/E</td><td>6806/7/8 e 6809/10/11T</td></tr>
<tr><td>450</td><td>7006/10</td></tr>
<tr><td>315L/A/B e 315C/D/E</td><td>5006/7/8T e 5009/10/11T</td><td rowspan="5">4 - 8</td><td>9-90</td><td rowspan="2">2.8</td><td rowspan="5">8000</td><td rowspan="5">Renolin DTA 15</td><td rowspan="5">Óleo mineral ISO VG46 com aditivos anti-espuma e antioxidantes</td></tr>
<tr><td>355L/A/B e 355C/D/E</td><td>5807/8/9T e 5810/11/12T</td><td>9-100</td></tr>
<tr><td>400L/A/B e 400C/D/E</td><td>6806/7/8 e 6809/10/11T</td><td>11-110</td><td rowspan="3">4.7</td></tr>
<tr><td>450</td><td>7006/10</td><td rowspan="2">11-125</td></tr>
<tr><td>500</td><td>8006/10</td></tr>
</table>

A troca de óleo dos mancais deve ser realizada no intervalo indicado na placa de identificação ou sempre que o lubrificante apresentar alterações em suas características (viscosidade, pH, etc).
O nível de óleo deve ser mantido na metade do visor e acompanhado diariamente.
Não poderão ser usados lubrificantes com outras viscosidades sem antes consultar a WEG.

8.3. DESMONTAGEM E MONTAGEM

Serviços de reparo em motores devem ser efetuados apenas por pessoal capacitado seguindo as normas vigentes no país. Devem ser utilizados somente ferramentas e métodos adequados.

Qualquer serviço de desmontagem e montagem deve ser realizado com o motor totalmente desenergizado e completamente parado.

Mesmo o motor desligado pode apresentar energia elétrica no interior da caixa de ligação:,nas resistências de aquecimento, no enrolamento e nos capacitores.

Motores acionados por inversor de frequência podem estar energizados mesmo com o motor parado.

Antes de iniciar o procedimento de desmontagem, registrar as condições atuais da instalação, tais como conexões dos terminais de alimentação do motor e alinhamento / nivelamento que devem ser considerados durante a posterior montagem.

Realizar a desmontagem de maneira cuidadosa, sem causar impactos contra as superfícies usinadas e / ou nas roscas.

Montar o motor em uma superfície plana para garantir uma boa base de apoio. Motores sem pés devem ser calçados/travados para evitar acidentes.

Cuidados adicionais devem ser tomados para não danificar as partes isoladas que operam sob tensão elétrica, como por exemplo, enrolamentos, mancais isolados, cabos de alimentação, etc.

Elementos de vedação, por exemplo, juntas e vedações dos mancais devem ser trocados sempre que apresentarem desgaste ou estiverem danificados.

Motores com grau de proteção superior ao IP55 são fornecidos com produto vedante Loctite 5923 (Henkel) nas juntas e parafusos. Antes de montar os componentes, limpar as superfícies e aplicar uma nova camada deste produto.

8.3.1. Caixa de ligação

Ao retirar a tampa da caixa de ligação para a conexão/desconexão dos cabos de alimentação e acessórios, devem ser adotados os seguintes cuidados:

- Assegurar que durante a remoção dos parafusos, a tampa da caixa não danifique os componentes instalados em seu interior.
- Caso a caixa de ligação seja fornecida com olhal de suspensão, este deve ser utilizado para movimentar a tampa da caixa de ligação.
- Para motores fornecidos com placa de bornes, devem ser assegurados os torques de aperto especificados na Tabela 8.7.
- Assegurar que os cabos não entrem em contato com superfícies com cantos vivos.
- Adotar os devidos cuidados para garantir que o grau de proteção inicial, indicado na placa de identificação do motor não seja alterado. As entradas de cabos para a alimentação e controle devem utilizar sempre componentes (como, por exemplo, prensa-cabos e eletrodutos) que atendam as normas e regulamentações vigentes de cada país.
- Assegurar que a janela de alívio de pressão, quando houver, não esteja danificada. As juntas de vedação da caixa de ligação devem estar em perfeito estado para reutilização e devem ser posicionadas corretamente para garantir o grau de proteção.
- Assegurar os torques de aperto dos parafusos de fixação da tampa da caixa conforme Tabela 8.7.

***Tabela 8.7** – Torques de aperto para elementos de fixação [Nm]*

Tipo de parafuso e Junta	M4	M5	M6	M8	M10	M12	M16	M20
Parafuso sextavado externo/interno (s/ junta)	-	4 a 7	7 a 12	16 a 30	30 a 50	55 a 85	120 a 180	230 a 360
Parafuso fenda combinada (s/ junta)	-	3 a 5	5 a 10	10 a 18	-	-	-	-
Parafuso sextavado externo/interno (c/ junta com batente metálico/cordão)	-	-	-	13 a 20	25 a 37	40 a 55	50 a 65	-
Parafuso fenda combinada (c/ junta plana e/ou batente metálico/cordão)	-	3 a 5	4 a 8	8 a 15	-	-	-	-
Parafuso sextavado externo/interno (c/ junta plana)	-	-	-	8 a 15	18 a 30	25 a 40	35 a 50	-
Placa de bornes	1 a 1,5	1,5 a 4	4 a 6,5	6,5 a 9	10 a 18	18 a 30	35 a 50	-
Aterramento	-	3 a 5	5 a 10	10 a 18	30 a 50	55 a 85	120 a 180	-

8.4. PROCEDIMENTO PARA ADEQUAÇÃO DA RESISTÊNCIA DE ISOLAMENTO

O motor deve ser desmontado e suas tampas, rotor completo (com eixo), ventilador, defletora e caixa de ligação devem ser separados, de modo que apenas a carcaça com o estator passe por um processo de secagem em uma estufa apropriada, por um período de duas horas, a uma temperatura não superior a 120ºC. Para motores maiores, pode ser necessário aumentar o tempo de secagem. Após esse período de secagem, deixar o estator resfriar até a temperatura ambiente e repetir a medição da resistência de isolamento, conforme item 5.4. Caso necessário, deve-se repetir o processo de secagem do estator.
Se, mesmo após repetidos processos de secagem do estator, a resistência de isolamento não voltar aos níveis aceitáveis, recomenda-se fazer uma análise criteriosa das causas que levaram à queda do isolamento do enrolamento e, eventualmente poderá culminar com o rebobinamento do motor.

Para evitar o risco de choque elétrico, descarregue os terminais imediatamente antes e depois de cada medição. Caso o motor possua capacitores, estes devem ser descarregados.

8.5. PARTES E PEÇAS

Ao solicitar peças para reposição, informar a designação completa do motor, bem como seu código e número de série, que podem ser encontrados na placa de identificação do motor.

Partes e peças devem ser adquiridas da rede de Assistência Técnica Autorizada WEG. O uso de peças não originais pode resultar na queda do desempenho e causar a falha no motor.

As peças sobressalentes devem ser armazenadas em local seco com uma umidade relativa do ar de até 60%, com temperatura ambiente maior que 5°C e menor que 40°C, isento de poeira, vibrações, gases, agentes corrosivos, sem variações bruscas da temperatura, em sua posição normal e sem apoiar sobre as mesmas outros objetos.

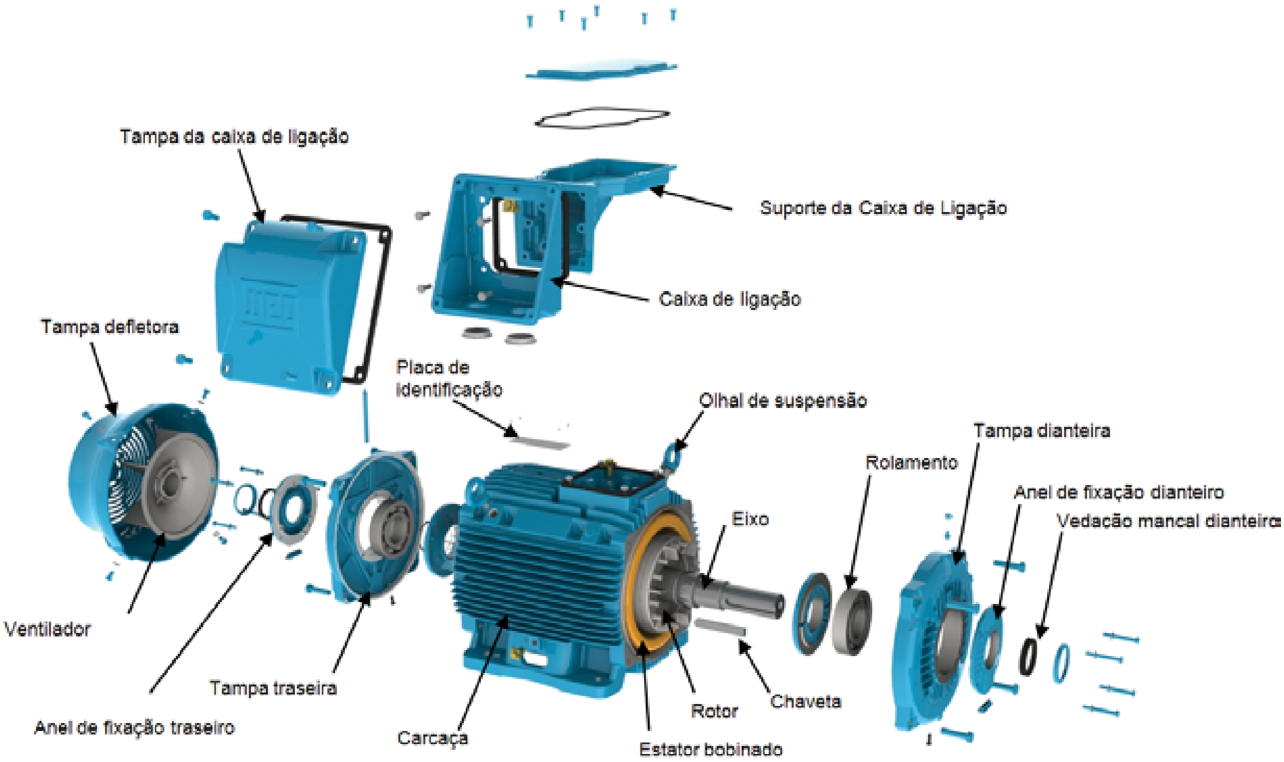

Figura 8.2 - Vista explodida dos componentes de um motor W22.

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9. INFORMAÇÕES AMBIENTAIS

9.1. EMBALAGEM

Os motores elétricos são fornecidos em embalagens de papelão, plástico ou de madeira. Estes materiais são recicláveis ou reutilizáveis e devem receber o destino certo conforme as normas vigentes de cada país. Toda a madeira utilizada nas embalagens dos motores WEG provém de reflorestamento e não é submetida a nenhum tratamento químico para a sua conservação.

9.2. PRODUTO

Os motores elétricos, sob o aspecto construtivo, são fabricados essencialmente com metais ferrosos (aço, ferro fundido), metais não ferrosos (cobre, alumínio) e plástico.

O motor elétrico, de maneira geral, é um produto que possui vida útil longa, porém quando do seu descarte, a WEG recomenda que os materiais da embalagem e do produto sejam devidamente separados e encaminhados para reciclagem.
Os materiais não recicláveis devem, como determina a legislação ambiental, ser dispostos de forma adequada, ou seja, em aterros industriais, co-processados em fornos de cimento ou incinerados. Os prestadores de serviços de reciclagem, disposição em aterro industrial, co-processamento ou incineração de resíduos devem estar devidamente licenciados pelo órgão ambiental de cada estado para realizar estas atividades.

10. PROBLEMAS x SOLUÇÕES

As instruções a seguir apresentam uma relação de problemas comuns com possíveis soluções. Em caso de dúvida, contatar o Assistente Técnico Autorizado ou a WEG.

Problema	Possíveis Causas	Solução
Motor não parte, nem acoplado e nem desacoplado	Interrupção na alimentação do motor	Verificar o circuito de comando e os cabos de alimentação do motor
	Fusíveis queimados	Substituir os fusíveis
	Erro na conexão do motor	Corrigir as conexões do motor conforme diagrama de conexão
	Mancal travado	Verificar se o mancal gira livremente.
Quando acoplado com carga, o motor não parte ou parte muito lentamente e não atinge rotação nominal	Carga com torque muito elevado durante a partida.	Não aplicar carga na máquina acionada durante a partida.
	Queda de tensão muito alta nos cabos de alimentação.	Verificar o dimensionamento da instalação (transformador, seção dos cabos, relés, disjuntores, etc.)
Ruído elevado / anormal	Defeito nos componentes de transmissão ou na máquina acionada.	Verificar a transmissão de força, o acoplamento e o alinhamento.
	Base desalinhada/desnivelada.	Realinhar/nivelar o motor e a máquina acionada
	Desbalanceamento dos componentes ou da máquina acionada	Refazer balanceamento
	Tipos diferentes de balanceamento entre motor e acoplamento (meia chaveta, chaveta inteira)	Refazer balanceamento
	Sentido de rotação do motor errado	Inverter o sentido de rotação do motor
	Parafusos de fixação soltos	Reapertar os parafusos
	Ressonância da fundação	Verificar o projeto da fundação
	Rolamentos danificados	Substituir o rolamento
Aquecimento excessivo no motor	Refrigeração insuficiente	Limpar as entradas e saídas de ar da defletora, e da carcaça
		Verificar as distâncias mínimas entre a entrada da defletora de ar e paredes próximas. Ver item 7
		Verificar temperatura do ar na entrada
	Sobrecarga	Medir a corrente do motor, analisando sua aplicação e, se necessário, diminuir a carga.
	Excessivo número de partidas ou momento de inércia da carga muito elevado	Reduzir o número de partidas
	Tensão muito alta	Verificar a tensão de alimentação do motor. Não ultrapassar a tolerância conforme item 7.2
	Tensão muito baixa	Verificar a tensão de alimentação e a queda de tensão no motor. Não ultrapassar a tolerância conforme item 7.2
	Interrupção de um cabo de alimentação	Verificar a conexão de todos os cabos de alimentação
	Desequilíbrio de tensão nos terminais de alimentação do motor	Verificar se há fusíveis queimados, comandos errados, desequilíbrio nas tensões da rede de alimentação, falta de fase ou nos cabos de ligação
	Sentido de rotação não compatível com o ventilador unidirecional	Verificar sentido de rotação conforme marcação do motor
Aquecimento do mancal	Graxa / óleo em demasia	Fazer limpeza do mancal e lubrificar segundo as recomendações
	Envelhecimento da graxa / óleo	
	Utilização de graxa / óleo não especificados	
	Falta de graxa / óleo	Lubrificar segundo as recomendações
	Excessivo esforço axial ou radial	Reduzir tensão nas correias
		Redimensionar a carga aplicada ao motor

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11. TERMO DE GARANTIA

A WEG Equipamentos Elétricos S/A, Unidade Motores, oferece garantia contra defeitos de fabricação e de materiais para seus produtos por um período de 18 meses, contados a partir da data de emissão da nota fiscal da fábrica ou do distribuidor/revendedor, limitado a 24 meses da data de fabricação. Para motores da linha HGF a garantia oferecida é por um período de 12 meses, contados a partir da data de emissão da nota fiscal da fábrica ou do distribuidor/revendedor, limitado a 18 meses da data de fabricação.
No parágrafo acima estão contidos os prazos de garantia legal. Caso um prazo de garantia diferenciado estiver definido na proposta técnica comercial para um determinado fornecimento, este se sobreporá aos prazos acima definidos.
Os prazos estabelecidos acima independem da data de instalação e desde que satisfeitos os seguintes requisitos: transporte, manuseio, e armazenamento adequado; instalação correta e em condições ambientais especificadas e sem presença de agentes agressivos; operação dentro dos limites de suas capacidades; realização periódica das devidas manutenções preventivas; realização de reparos e/ou modificações somente por pessoas autorizadas por escrito pela WEG; que o produto, na ocorrência de uma anomalia, esteja disponível para o fornecedor por um período mínimo necessário a identificação da causa da anomalia e seus devidos reparos; aviso imediato por parte do comprador dos defeitos ocorridos e que os mesmos sejam posteriormente comprovados pela WEG como defeitos de fabricação. A garantia não inclui serviços de desmontagem nas instalações do comprador, custos de transporte do produto e despesas de locomoção, hospedagem e alimentação do pessoal de Assistência Técnica quando solicitado pelo cliente. Os serviços em garantia serão prestados exclusivamente em oficinas de Assistência Técnica autorizados pela WEG ou na própria fábrica.
Também ficam excluídos das garantias os equipamentos, componentes, partes e materiais, cuja vida útil seja usualmente inferior a 12 (doze) meses.
Em nenhuma hipótese o atendimento em garantia prorrogará os prazos de garantia do equipamento, contudo, novo prazo de garantia equivalente ao original será devido somente para os componentes substituídos ou reparados pela WEG.
A presente garantia se limita ao produto fornecido, não se responsabilizando a WEG por danos a pessoas, a terceiros, a outros equipamentos ou instalações, lucros cessantes ou quaisquer outros danos emergentes ou consequentes.

12. DECLARAÇÃO DE CONFORMIDADE CE

WEG Equipamentos Elétricos S/A
Av. Prefeito Waldemar Grubba, 3000
89256-900 - Jaraguá do Sul – SC – Brasil,

e seu representante autorizado estabelecido na Comunidade Européia,
WEGeuro – Industria Electrica SA
Rua Eng Frederico Ulrich, Apartado 6074
4476-908 – Maia – Porto – Portugal

declaram por meio desta, que os produtos:

Motores de indução WEG e componentes para uso nestes motores:

Trifásicos
Carcaças IEC 63 a 630
Carcaças Nema 42, 48, 56 e 143 a 9610
....

Monofásicos
Carcaças IEC 63 a 132
Carcaças Nema 42, 48, 56 e 143 a 215
....

quando instalados, mantidos e utilizados em aplicações para os quais foram projetados e quando consideradas as normas de instalação e instruções do fabricante pertinentes, eles atendem os requisitos das seguintes Diretivas Européias e normas onde aplicáveis:

Diretivas:
Diretiva de Baixa Tensão 2006/95/CE
Regulamento (CE) No 640/2009
Diretiva 2009/125/CE
Diretiva de Compatibilidade Eletromagnética 2004/108/CE (motores de indução são considerados intrinsecamente benignos em termos de compatibilidade eletromagnética)

Normas:
EN 60034-1/2-1/5/6/7/8/9/11/12/14/30 e EN 60204-1

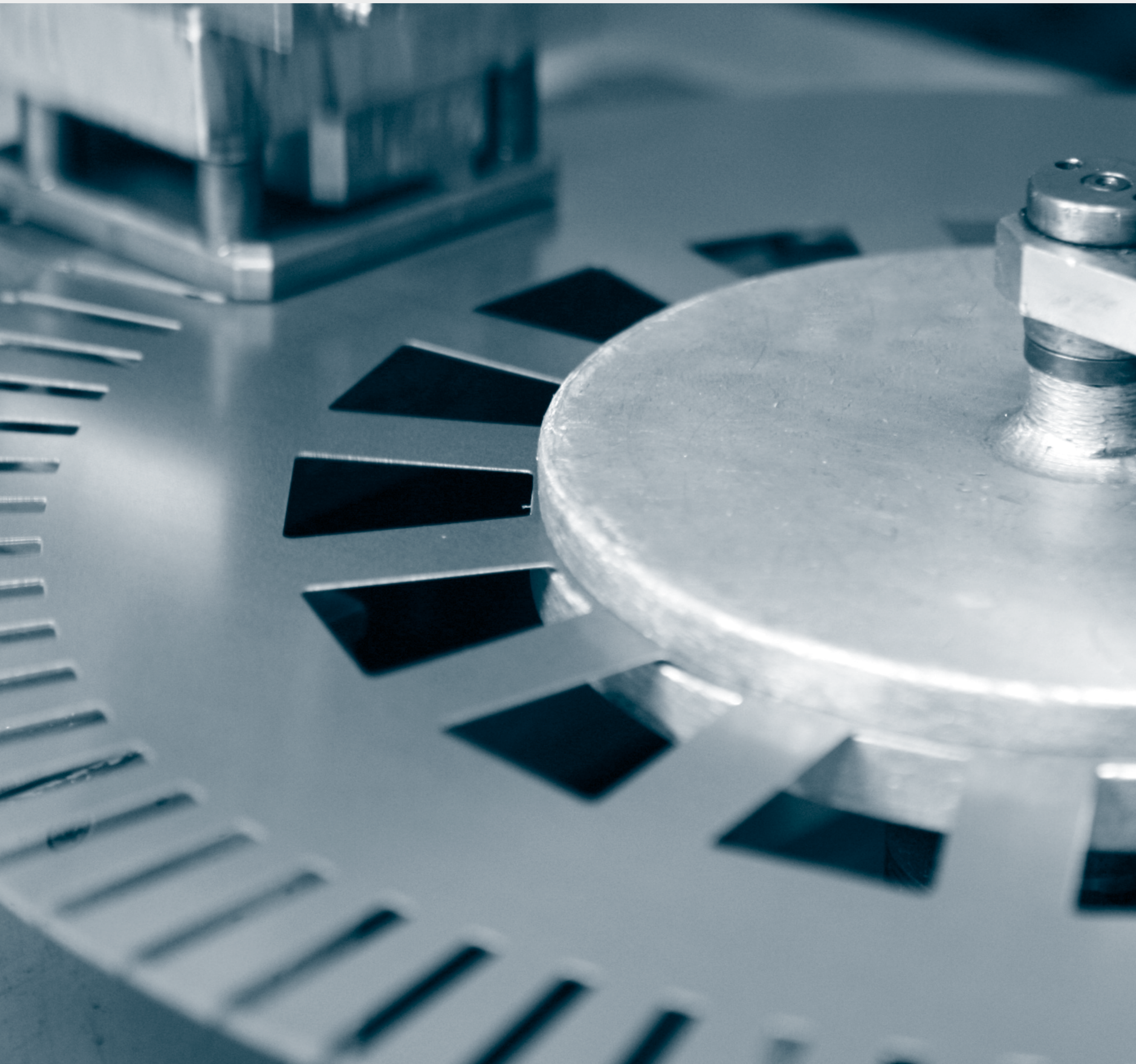
A partir de 29/12/2009, motores elétricos de baixa tensão não são mais considerados sob o escopo da atual Diretiva de Máquinas 2006/42/CE.

Marca CE em: 1996

Milton Oscar Castella
Diretor de Engenharia

Jaraguá do Sul, 31 de Maio de 2011

PORTUGUÊS



Installation, Operation and Maintenance Manual of Electric Motors

This manual provides information about WEG induction motors fitted with squirrel cage, permanent magnet or hybrid rotors, low and high voltage, in frame size IEC 56 to 630 and NEMA 42 to 9606/10.
The motor lines indicated below have additional information that can be checked in their respective manuals:

- Smoke Extraction Motors;
- Electromagnetic Brake Motors;
- Hazardous Area Motors.

These motors meet the following standards, if applicable:

- NBR 17094-1: Máquinas Elétricas Girantes - Motores de Indução - Parte 1:
  - Trifásicos
- NBR 17094-2: Máquinas Elétricas Girantes - Motores de Indução - Parte 1:
  - Monofásicos
- IEC 60034-1: Rotating Electrical Machines - Part 1:
  - Rating and Performance
- NEMA MG 1: Motors and Generators
- CSA C 22.2 N°100: Motors and Generators
- UL 1004-1: Rotating Electrical Machines – General Requirements

If you have any questions regarding this material please contact your local WEG branch, contact details can be found at www.weg.net.

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1. TERMINOLOGY

Balancing: the procedure by which the mass distribution of a rotor is checked and, if necessary, adjusted to ensure that the residual unbalance or the vibration of the journals and/or forces on the bearings at a frequency corresponding to service speed are within specified limits in International Standards.
[ISO 1925:2011, definition 4.1]

Balance quality grade: indicates the peak velocity amplitude of vibration, given in mm/s, of a rotor running free-in-space and it is the product of a specific unbalance and the angular velocity of the rotor at maximum operating speed.

Grounded Part: metallic part connected to the grounding system.

Live Part: Conductor or conductive part intended to be energized in normal operation, including a neutral conductor.

Authorized personnel: employee who has formal approval of the company.

Qualified personnel: employee who meets the following conditions simultaneously:
- Receives training under the guidance and responsibility of a qualified and authorized professional;
- Works under the responsibility of a qualified and approved professional.

Note*: The qualification is only valid for the company that trained the employee in the conditions set out by the authorized and qualified professional responsible for training.*

2. INITIAL RECOMMENDATIONS

Electric motors have energized circuits, exposed rotating parts and hot surfaces that may cause serious injury to people during normal operation. Therefore, it is recommended that transportation, storage, installation, operation and maintenance services are always performed by qualified personnel.
Also the applicable procedures and relevant standards of the country where the machine will be installed must be considered.
Noncompliance with the recommended procedures in this manual and other references on the WEG website may cause severe personal injuries and/or substantial property damage and may void the product warranty.

For practical reasons, it is not possible to include in this Manual detailed information that covers all construction variables nor covering all possible assembly, operation or maintenance alternatives.
This Manual contains only the required information that allows qualified and trained personnel to carry out their services. The product images are shown for illustrative purpose only.

For *Smoke Extraction Motors*, please refer to the additional instruction manual 50026367 available on the website www.weg.net.

For brake motors, please refer to the information contained in WEG 50006742 / 50021973 brake motor manual available on the website www.weg.net.

The user is responsible for the correct definition of the installation environment and application characteristics.

During the warranty period, all repair, overhaul and reclamation services must be carried out by WEG authorized Service Centers to maintain validity of the warranty.

2.1. WARNING SYMBOL

During the warranty period, all repair, overhaul and reclamation services must be carried out by WEG authorized Service Centers to maintain validity of the warranty.

2.2. RECEIVING INSPECTION

All motors are tested during the manufacturing process.
The motor must be checked when received for any damage that may have occurred during the transportation.
All damages must be reported in writing to the transportation company, to the insurance company and to WEG. Failure to comply with such procedures will void the product warranty.
You must inspect the product:
- Check if nameplate data complies with the purchase order;
- Remove the shaft locking device (if any) and rotate the shaft by hand to ensure that it rotates freely.
- Check that the motor has not been exposed to excessive dust and moisture during the transportation.

Do not remove the protective grease from the shaft, or the plugs from the cable entries. These protections must remain in place until the installation has been completed.

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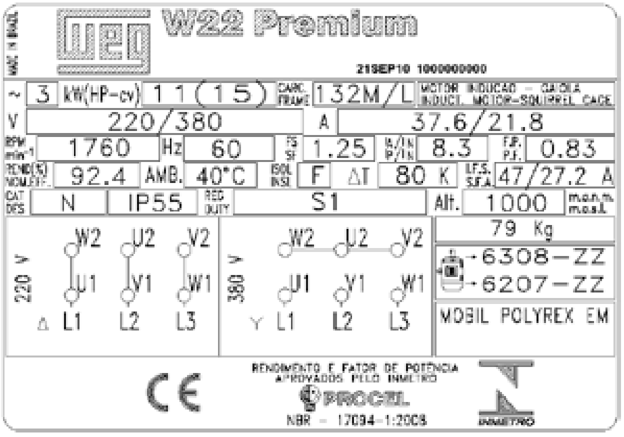
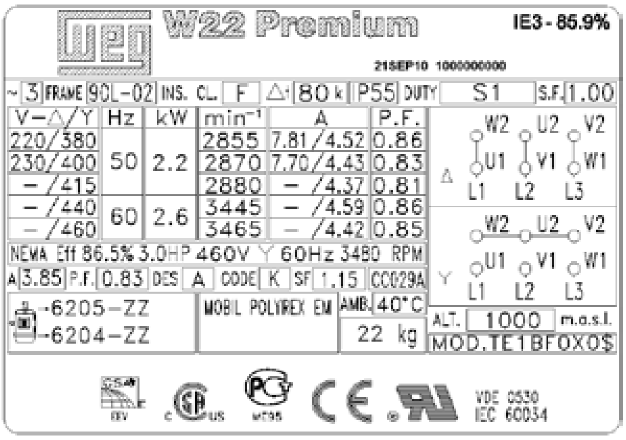
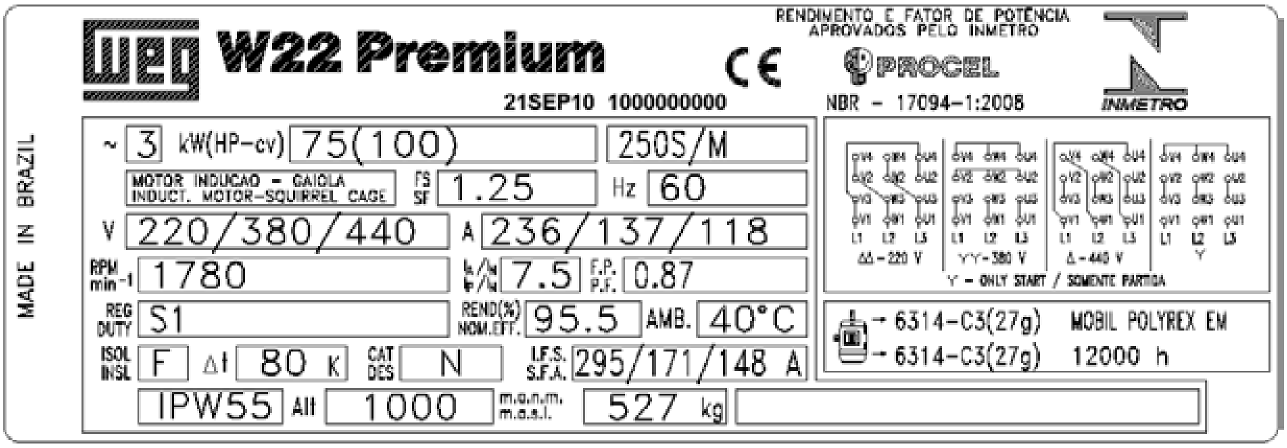
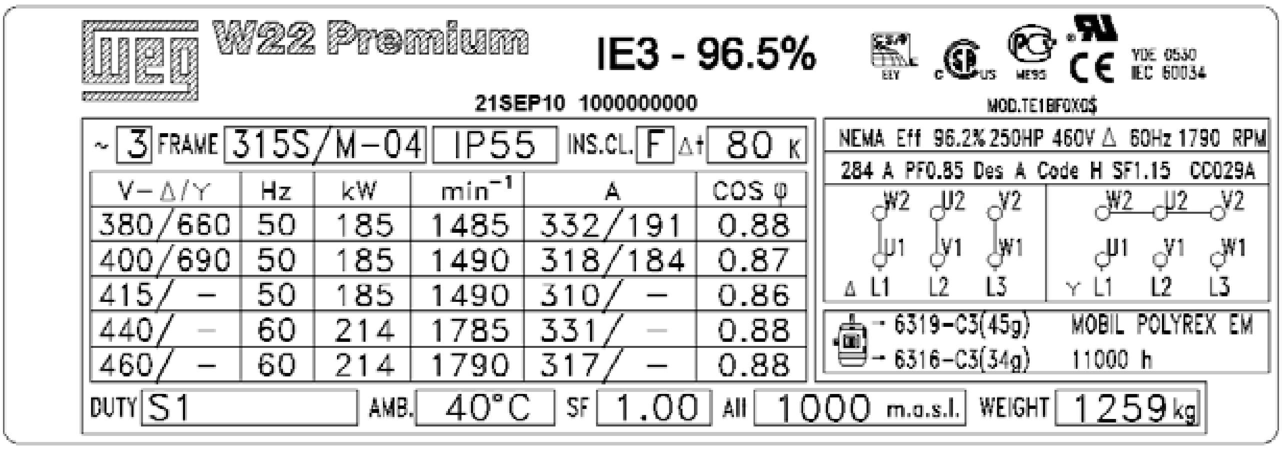
2.3. NAMEPLATES

The nameplate contains information that describes the construction characteristics and the performance of the motor. Figure 2-1 and Figure 2-2 show nameplate layout examples.









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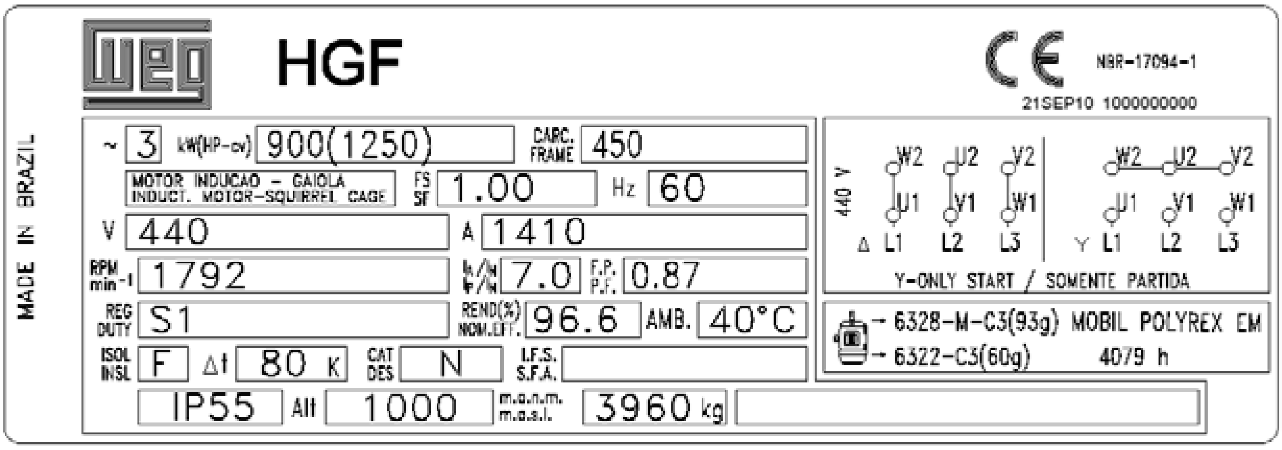


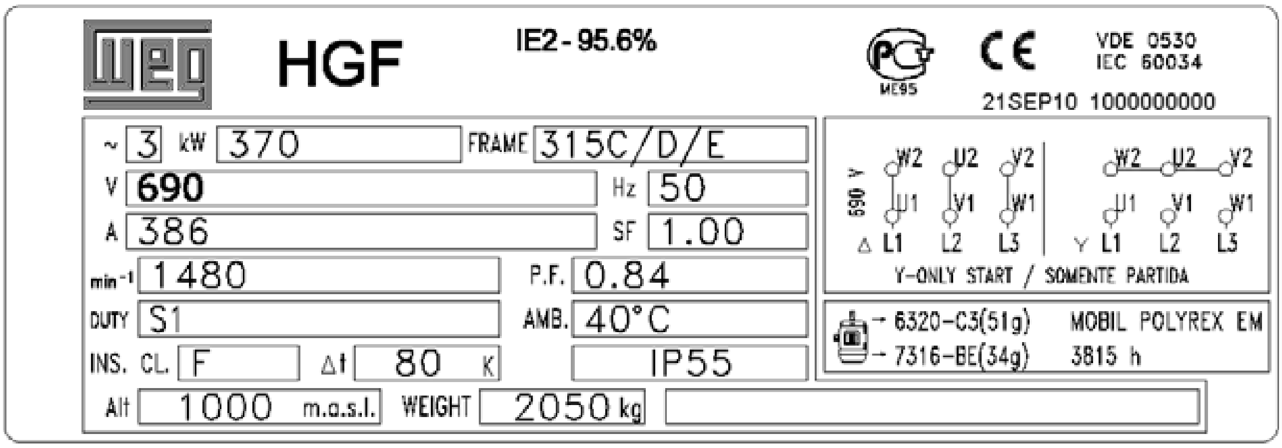
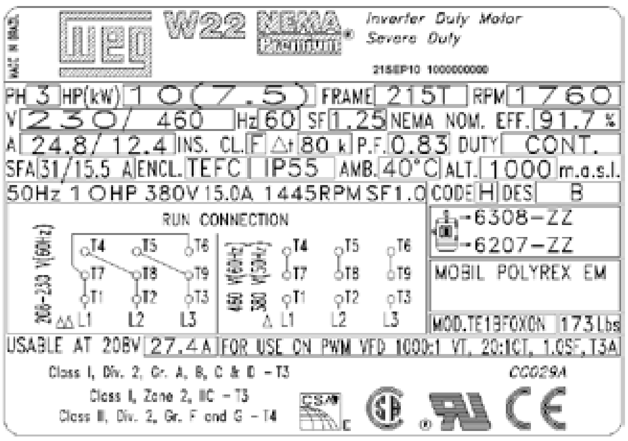


Figure 2-1 – IEC motor nameplate



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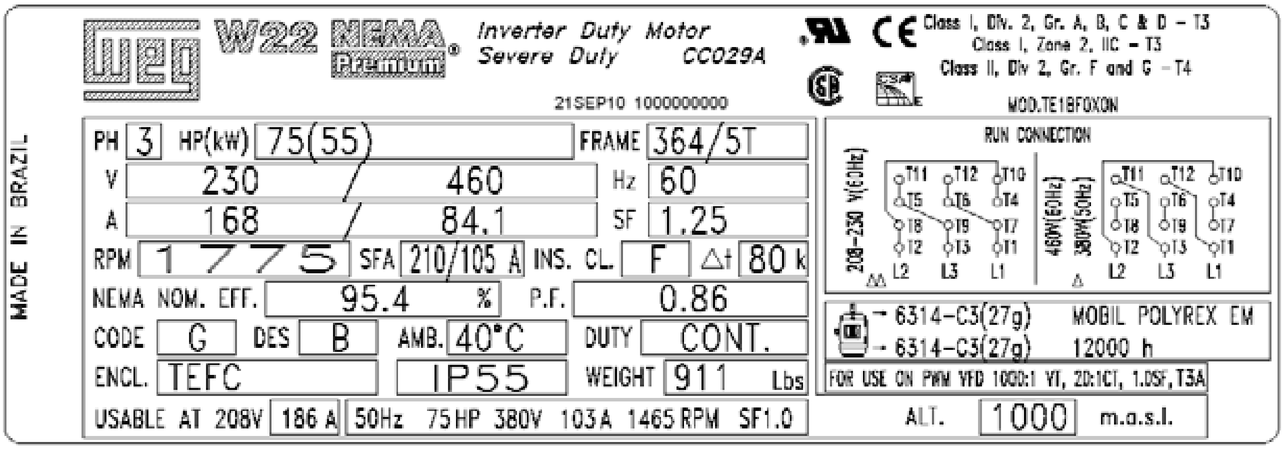

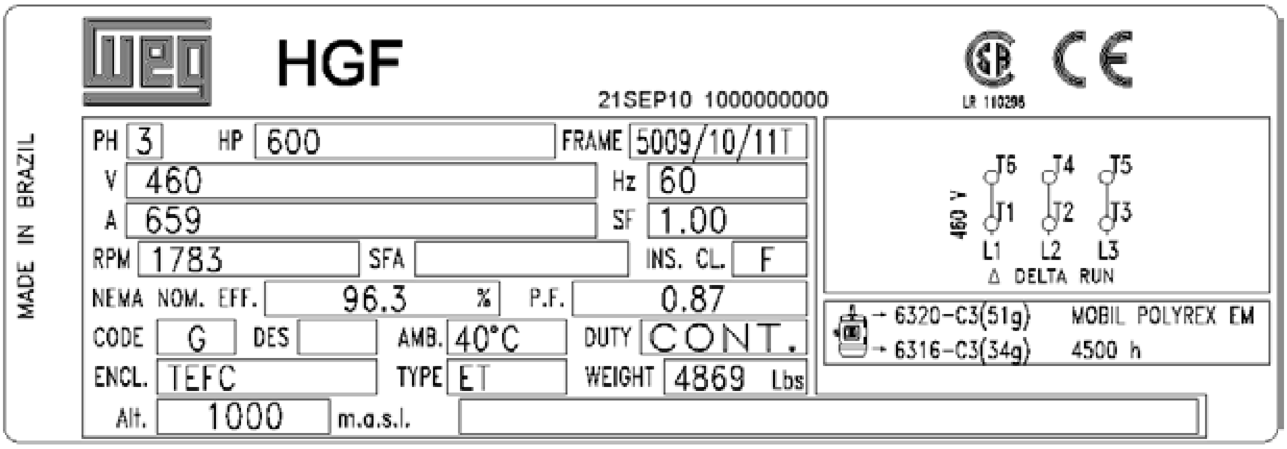

Figure 2-2 – IEC motor nameplate

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3. SAFETY INSTRUCTIONS

The motor must be disconnected from the power supply and be completely stopped before conducting any installation or maintenance procedures. Additional measures should be taken to avoid accidental motor starting.

Professionals working with electrical installations, either in the assembly, operation or maintenance, should use proper tools and be instructed on the application of standards and safety requirements, including the use of Personal Protective Equipment (PPE) that must be carefully observed in order to reduce risk of personal injury during these services.

Electric motors have energized circuits, exposed rotating parts and hot surfaces that may cause serious injury to people during normal operation. It is recommended that transportation, storage, installation, operation and maintenance services are always performed by qualified personnel.

Always follow the safety, installation, maintenance and inspection instructions in accordance with the applicable standards in each country.

4. HANDLING AND TRANSPORT

Individually packaged motors should never be lifted by the shaft or by the packaging. They must be lifted only by means of the eyebolts, when supplied. Use always suitable lifting devices to lift the motor. Eyebolts on the frame are designed for lifting the machine weight only as indicated on the motor nameplate. Motors supplied on pallets must be lifted by the pallet base.

The package should never be dropped. Handle it carefully to avoid bearing damage.

Eyebolts provided on the frame are designed for lifting the machine only. Do not use these eyebolts for lifting the motor with coupled equipment such as bases, pulleys, pumps, reducers, etc.

Never use damaged, bent or cracked eyebolts. Always check the eyebolt condition before lifting the motor.

Eyebolts mounted on components, such as on end shields, forced ventilation kits, etc. must be used for lifting these components only. Do not use them for lifting the complete machine set.

Handle the motor carefully without sudden impacts to avoid bearing damage and prevent excessive mechanical stresses on the eyebolts resulting in its rupture.

To move or transport motors with cylindrical roller bearings or angular contact ball bearings, use always the shaft locking device provided with the motor.
All HGF motors, regardless of bearing type, must be transported with shaft locking device fitted.

4.1. LIFTING

Before lifting the motor ensure that all eyebolts are tightened properly and the eyebolt shoulders are in contact with the base to be lifted, as shown in Figure 4-1. Figure 4-2 shows an incorrect tightening of the eyebolt.
Ensure that lifting machine has the required lifting capacity for the weight indicated on the motor nameplate.

Figure 4-1 *– Correct tightening of the eyebolt*

Figure 4-2 *– Incorrect tightening of the eyebolt*

The center-of-gravity may change depending on motor design and accessories. During the lifting procedures the maximum allowed angle of inclination should never be exceeded as specified below.

4.1.1. Horizontal motors with one eyebolt

For horizontal motors fitted with only one eyebolt, the maximum allowed angle-of-inclination during the lifting process should not exceed 30° in relation to the vertical axis, as shown in Figure 4-3.

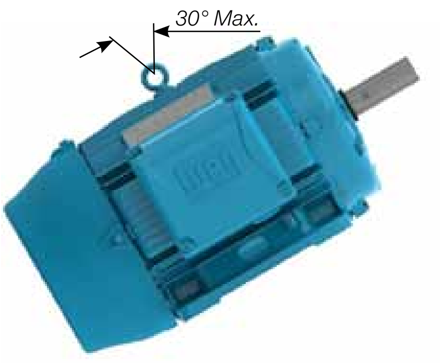

Figure 4-3 *– Maximum allowed angle-of-inclination for motor with one eyebolt*

4.1.2. Horizontal motor with two eyebolts

When motors are fitted with two or more eyebolts, all supplied eyebolts must be used simultaneously for the lifting procedure.

There are two possible eyebolt arrangements (vertical and inclined), as shown below:

- For motors with vertical lifting eyebolts, as shown in Figure 4-4, the maximum allowed lifting angle should not exceed 45° in relation to the vertical axis. We recommend to use a spreader bar for maintaining the lifting elements (chain or rope) in vertical position and thus preventing damage to the motor surface.

Figure 4-4 *– Maximum resulting angle for motors with two or more lifting eyebolts*

- For HGF motors, as shown in Figure 4-5, the maximum resulting angle should not exceed 30° in relation to the vertical axis.

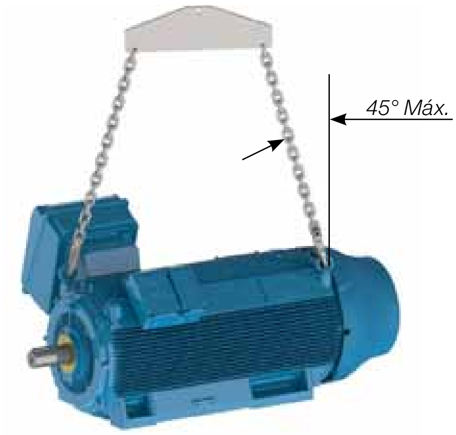

Figure 4-5 *– Maximum resulting angle for horizontal HGF motors*

- For motors fitted with inclined eyebolts, as shown in Figure 4-6, the use of a spreader bar is required for maintaining the lifting elements (chain or rope) in vertical position and thus preventing damage to the motor surface.

Figure 4-6 *– Use of a spreader bar for lifting*

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4.1.3. Vertical Motors

For vertical mounted motors, as shown in Figure 4-7, the use of a spreader bar is required for maintaining the lifting element (chain or rope) in vertical position and thus preventing damage to the motor surface.

Figure 4-7 *– Lifting of vertical mounted motors*

Use always the eyebolts mounted on the top side of the motor, diametrically opposite, considering the mounting position. See Figure 4-8.

Figure 4-8 *– Lifting of HGF motors*

4.1.3.1. Procedures to place W22 motors in the vertical position

For safety reasons during the transport, vertical mounted Motors are usually packed and supplied in horizontal position.
To place W22 motors fitted with eyebolts (see Figure 4-6), to the vertical position, proceed as follows:

1. Ensure that the eyebolts are tightened properly, as shown in Figure 4-1;
2. Remove the motor from the packaging, using the top mounted eyebolts, as shown in Figure 4-9;

Figure 4-9 *– Removing the motor from the packaging*

3. Install a second pair of eyebolts, as shown in Figure 4-10;

Figure 4-10 *– Installation of the second pair of eyebolts*

4. Reduce the load on the first pair of eyebolts to start the motor rotation, as shown in Figure 4-11. This procedure must be carried out slowly and carefully.

Figure 4-11 *– End result: motor placed in vertical position*

These procedures will help you to move motors designed for vertical mounting. These procedures are also used to place the motor from the horizontal position into the vertical position and vertical to horizontal.

4.1.3.2. Procedures to place HGF motors in the vertical position

HGF motors are fitted with eight lifting points: four at drive end and four at non-drive end. The HGF motors are usually transported in horizontal position, however for the installation they must be placed in the vertical position.
To place an HGF motor in the vertical position, proceed as follows:

1. Lift the motor by using the four lateral eyebolts and two hoists, see Figure 4-12;

Figure 4-12 *– Lifting HGF motor with two hoists*

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2. Lower the hoist fixed to motor drive end while lifting the hoist fixed to motor non-drive end until the motor reaches its equilibrium, see Figure 4-13.

Figure 4-13 *– Placing HGF motor in vertical position*

3. Remove the hoist hooks from the drive end eyebolts and rotate the motor 180° to fix the removed hooks into the two eyebolts at the motor non-drive end, see Figure 4-14.

Figure 4-14 *– Lifting HGF motors by the eyebolts at the non-drive end*

4. Fix the removed hoist hooks in the other two eyebolts at the non-drive end and lift the motor until the vertical position is reached, see Figure 4-15.

Figure 4-15 *– HGF motor in the vertical position*

These procedures will help you to move motors designed for vertical mounting. These procedures are also used to place the motor from the horizontal position into the vertical position and vertical to horizontal.

5. STORAGE

If the motor is not installed immediately, it must be stored in a dry and clean environment, with relative humidity not exceeding 60%, with an ambient temperature between 5 ºC and 40 ºC, without sudden temperature changes, free of dust, vibrations, gases or corrosive agents. The motor must be stored in horizontal position, unless specifically designed for vertical operation, without placing objects on it. Do not remove the protection grease from shaft end to prevent rust. Store the motor in such position that the condensed water can be easily drained. If fitted, remove pulleys or couplings from the shaft end.

If the motor are fitted with space heaters, they must always be turned on during the storage period or when the installed motor is out of operation. Space heaters will prevent water condensation inside the motor and keep the winding insulation resistance within acceptable levels.

The space heaters should never be energized when the motor is in operation.

5.1. EXPOSED MACHINED SURFACES

All exposed machined surfaces (like shaft end and flange) are factory-protected with temporary rust inhibitor. A protective film must be reapplied periodically (at least every six months), or when it has been removed and/or damaged.

5.2. STORAGE

The stacking height of the motor packaging during the storage period should not exceed 5 m, always considering the criteria indicated in Table 5-1:

Table 5-1 *– Max. recommended stacking height*

Packaging Type	Frame sizes	Maximum stacking quantity
Cardboard box	IEC 63 to 132 NEMA 143 to 215	Indicated on the top side of the cardboard box
Wood crate	IEC 63 to 315 NEMA 48 to 504/5	06
	IEC 355 NEMA 586/7 and 588/9	03
	HGF IEC 315 to 630 HGF NEMA 5000 to 9600	Indicated on the packaging

Notes:
1) Never stack larger packaging onto smaller packaging.
2) Align the packaging correctly (see Figure 5-1 and Figure 5-2).

Figure 5-1 *– Correct stacking*

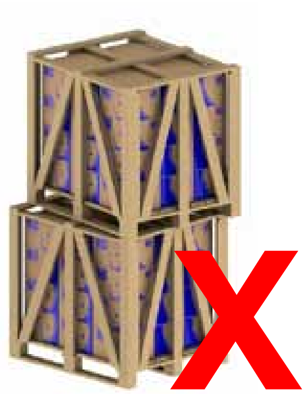

Figure 5-2 *– Incorrect stacking*

3) The feet of the crates above should always be supported by suitable wood battens (Figure 5-3) and never stand on the steel tape or without support (Figure 5-4).

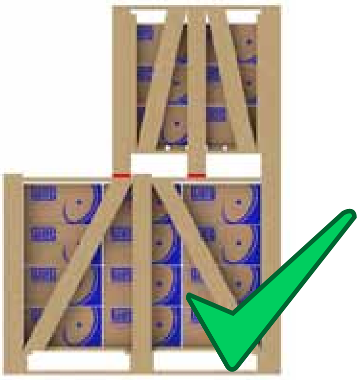

Figure 5-3 – Correct stacking

Figure 5-4 – Incorrect stacking

4) When stacking smaller crates onto longer crates, always ensure that suitable wooden supports are provided to withstand the weight (see Figure 5-5). This condition usually occurs with motor packaging above IEC 225S/M (NEMA 364/5T) frame sizes.

Figure 5-5 *– Use of additional battens for stacking*

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5.3 BEARINGS

5.3.1 Grease lubricated bearings

We recommend rotating the motor shaft at least once a month (by hand, at least five revolutions, stopping the shaft at a different position from the original one). If the motor is fitted with shaft locking device, remove it before rotating the shaft and install it again before performing any handling procedure. Vertical motors may be stored in the vertical or in horizontal position. If motors with open bearings are stored longer than six months, the bearings must be relubricated according to Item 8.2 before commissioning of the motor.
If the motor is stored for longer than 2 years, the bearings must be replaced or removed, washed, inspected and relubricated according to Item 8.2.

5.3.2 Oil Lubricated bearings

The motor must be stored in its original operating position and with oil in the bearings. Correct oil level must be ensured. It should be in the center of the sight glass.
During the storage period, remove the shaft locking device and rotate the shaft by hand every month, at least five revolutions, thus achieving an even oil distribution inside the bearing and maintaining the bearing in good operating conditions. Reinstall the shaft locking device every time the motor has to be moved.
If the motor is stored for a period of over six months, the bearings must be relubricated according to Item 8.2 before starting the operation. If the motor is stored for a period of over two years, the bearings must be replaced or removed, washed according to manufacturer instructions, checked and relubricated according to Item 8.2. The oil of vertical mounted motors that are transported in horizontal position is removed to prevent oils leaks during the transport. These motors must be stored in vertical position after receiving and the bearing must be lubricated.

5.3.3 Oil Mist lubricated bearings

The motor must be stored in its horizontal position. Lubricate the bearings with ISO VG 68 mineral oil in the amount indicated in the Table 5.2 (this is also valid for bearings with equivalent dimensions). After filling with oil, rotate the shaft by hand, at least five revolutions)
During the storage period, remove the shaft locking device (if any) and rotate the shaft by hand every week, at least five revolutions, stopping it at a different position from the original one. Reinstall the shaft locking device every time the motor has to be moved. If the motor is stored for a period of over two years, the bearings must be replaced or removed, washed according to manufacturer instructions, checked and relubricated according to Item 8.2.

Table 5-2 – *Amount of oil per bearing*

Bearing Size	Amount of Oil (ml)	Bearing Size	Amount of Oil (ml)
6201	15	6309	65
6202	15	6311	90
6203	15	6312	105
6204	25	6314	150
6205	25	6315	200
6206	35	6316	250
6207	35	6317	300
6208	40	6319	350
6209	40	6320	400
6211	45	6322	550
6212	50	6324	600
6307	45	6326	650
6308	55	6328	700

The oil must always be removed when the motor has to be handled. If the oil mist system is not operating after installation, fill the bearings with oil to prevent bearing rusting. During the storage period, rotate the shaft by hand, at least five revolutions, stopping it at a different position from the original one. Before starting the motor, all bearing protection oil must be drained from the bearing and the oil mist system must be switched ON.

5.3.4 Sleeve Bearing

The motor must be stored in its original operating position and with oil in the bearings. Correct oil level must be ensured. It should be in the middle of the sight glass. During the storage period, remove the shaft locking device and rotate the shaft by hand every month, at least five revolutions, thus achieving an even oil distribution inside the bearing and maintaining the bearing in good operating conditions. Reinstall the shaft locking device every time the motor has to be moved.
If the motor is stored for a period of over six months, the bearings must be relubricated according to the Item 8.2 before starting the operation.

If the motor is stored for a period longer than the oil change interval, or if it is not possible to rotate the motor shaft by hand, the oil must be drained and a corrosion protection and dehumidifiers must be applied.

5.4. SPACE HEATER

We recommend measuring the winding insulation resistance at regular intervals to follow-up and evaluate its electrical operating conditions. If any reduction in the insulation resistance values are recorded, the storage conditions should be evaluated and corrected, where necessary.

5.4.1. Insulation resistance measurement

We recommend measuring the winding insulation resistance at regular intervals to follow-up and evaluate its electrical operating conditions. If any reduction in the insulation resistance values are recorded, the storage conditions should be evaluated and corrected, where necessary.

The insulation resistance must be measured in a safe environment.

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The insulation resistance must be measured with a megohmmeter. The machine must be in cold state and disconnected from the power supply.

To prevent the risk of an electrical shock, ground the terminals before and after each measurement. Ground the capacitor (if any) to ensure that it is fully discharged before the measurement is taken.

It is recommended to insulate and test each phase separately. This procedure allows the comparison of the insulation resistance between each phase. During the test of one phase, the other phases must be grounded. The test of all phases simultaneously evaluates the insulation resistance to ground only but does not evaluate the insulation resistance between the phases.
The power supply cables, switches, capacitors and other external devices connected to the motor may considerably influence the insulation resistance measurement. Thus all external devices must be disconnected and grounded during the insulation resistance measurement.
Measure the insulation resistance one minute after the voltage has been applied to the winding. The applied voltage should be as shown in Table 5-3.

Table 5-3 *– Voltage for the insulation resistance*

Winding rated voltage (V)	Testing voltage for measuring the insulation resistance (V)
< 1000V	500
1000 - 2500	500 - 1000
2501 - 5000	1000 - 2500
5001 - 12000	2500 - 5000
> 12000	5000 - 10000

The reading of the insulation resistance must be corrected to 40°C as shown in the Table 5-4.

Table 5-4 *– Correction Factor for the Insulation Resistance corrected to 40°C*

Measuring temperature of the insulation resistance (°C)	Correction factor of the insulation resistance corrected to 40°C	Measuring temperature of the insulation resistance (°C)	Correction factor of the insulation resistance corrected to 40°C
10	0,125	30	0,500
11	0,134	31	0,536
12	0,144	32	0,574
13	0,154	33	0,616
14	0,165	34	0,660
15	0,177	35	0,707
16	0,189	36	0,758
17	0,203	37	0,812
18	0,218	38	0,871
19	0,233	39	0,933
20	0,250	40	1,000
21	0,268	41	1,072
22	0,287	42	1,149
23	0,308	43	1,231
24	0,330	44	1,320
25	0,354	45	1,414
26	0,379	46	1,516
27	0,406	47	1,625
28	0,435	48	1,741
29	0,467	49	1,866
30	0,500	50	2,000

The motor insulation condition must be evaluated by comparing the measured value with the values indicated in Table 5-5 (corrected to 40 °C):

***Table 5-5** – Evaluation of the insulation system*

Limit value for rated voltage up to 1.1 kV (MΩ)	Limit value for rated voltage above 1.1 kV (MΩ)	Situation
Up to 5	Up to 100	Dangerous. The motor can not be operated in this condition
5 to 100	100 to 500	Regular
100 to 500	Higher than 500	Good
Higher than 500	Higher than 1000	Excellent

The values indicated in the table should be considered only as reference values. It is advisable to log all measured values to provide a quick and easy overview on the machine insulation resistance.
If the insulation resistance is low, moisture may be present in the stator windings. In this case the motor should be removed and transported to a WEG authorized Service Center for proper evaluation and repair (This service is not covered by the warranty). To improve the insulation resistance through the drying process, see section 8.4.

6. INSTALLATION

The insulation resistance must be measured in a safe environment.

Check some aspects before proceeding with the installation:

1. Insulation resistance: must be within the acceptable limits. See item 5.4.
2. Bearings:
   a. Rolling bearings: oxidized bearings must be replaced. If no oxidation is detected, lubricate the bearings as described in Item 8.2. If the motor is stored for a period of over two years, the bearings must be replaced before starting the motor.
   b. Sleeve bearing: if sleeve bearing motors are stored longer than the recommended oil change interval, the oil must be changed before machine starting. Don't forget to remove the dehumidifiers when you drain the oil from the motor and to fill it again with new oil before starting the machine. For more details, see item 8.2.
3. Operating conditions of the start capacitors: If single-phase motors are stored for a period of over two years, it is recommended to change the start capacitors before motor starting since they lose their operating characteristics.
4. Terminal box:
   a. the inside of the terminal box must be clean and dry.
   b. the contacts must be correctly connected and corrosion free. See 6.9 and 6.10.
   c. the cable entries must be correctly sealed and the terminal box cover properly mounted in order to ensure the degree of protection indicated on the motor nameplate.
5. Cooling: the cooling fins, air inlet and outlet openings must be clean and unobstructed. The distance between the air inlet openings and the wall should not be shorter than ¼ (one quarter) of the diameter of the air inlet. Ensure sufficient space to perform the cleaning services. See item 7.
6. Coupling: remove the shaft locking device (where fitted) and the corrosion protection grease from the shaft end and flange just before installing the motor. See item 6.4.
7. Drain hole: the motor must always be positioned so the drain hole is at the lowest position. (If there is any indication arrow, the drain must be so installed that the arrow points downwards).
   On Motors with IP 55 degree of protection, the rubber drain plugs (where fitted) may be always in open position (see Figure 6-1).
   For higher degrees of protections (for instance, IP56, IP65 and IP66), the drain plugs (regardless of type) should remain in closed position (see Figure 6-2). These drain plugs are opened only during motor repair services to drain the condensed water from inside the motor. (See Section 8.1)
   The drain system of motors with Oil Mist lubrication system must be connected to a specific collection system (see Figure 6-12 on page 27).

Figure 6-1 *– Detail of the rubber drain plug mounted in open position*

Figure 6-2 *– Detail of the rubber drain plug mounted in closed position*

8.Additional recommendations:
   a. Check the direction of motor rotation, starting the motor at no-load before coupling it to the load.
   b. Vertical mounted motors with shaft end down must be fitted with drip cover to protect them from liquids or solids that may drop onto the motors.
   c. Vertical mounted motors with shaft end up must be fitted with water slinger ring to prevent water penetration inside the motor.

Remove or fix the shaft key before starting the motor.

6.1. FOUNDATIONS

The foundation is the structure, structural element, natural or prepared base, designed to withstand the stresses produced by the installed equipment, ensuring safe and stable performance during operation. The foundation design should consider the adjacent structures to avoid the influences of other installed equipment and no vibration is transferred through the structure

The foundation must be flat and its selection and design must consider the following characteristics:

a) The features of the machine to be installed on the foundation, the driven loads, application, maximum allowed deformations and vibration levels (for instance, motors with reduced vibration levels, foot flatness, flange concentricity, axial and radial loads, etc. lower than the values specified for standard motors).

b) Adjacent buildings, conservation status, maximum applied load estimation, type of foundation and fixation and vibrations transmitted by theses constructions.

If the motor is supplied with leveling/alignment bolts, this must be considered in the base design.

Please consider for the foundation dimensioning all stresses that are generated during the operation of the driven load.
The user is responsible for the foundation designing and construction.

The motors may be mounted on:
- Concrete bases: are most used for large-size motors (see Figure 6-3);
- Metallic bases: are generally used for small-size motors (see Figure 6-4).

Figure 6-3 *– Motor installed on concrete base*

Figure 6-4 *– Motor installed on metallic base*

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The metallic and concrete bases may be fitted with sliding system. These types of foundations are generally used where the power transmission is achieved by belts and pulleys. This power transmission system is easier to assemble/disassemble and allows the belt tension adjustment. Other important aspect of this foundation type is the location of the base locking screws that must be diagonally opposite. The rail nearest the drive pulley is placed in such a way that the positioning bolt is between the motor and the driven machine. The other rail must be placed with the bolt on the opposite side (diagonally opposite), as shown in Figure 6-5.

To facilitate assembly, the bases may have the following features:
- shoulders and/or recesses;
- anchor bolts with loose plates;
- bolts cast in the concrete;
- leveling screws;
- positioning screws;
- steel & cast iron blocks, plates with flat surfaces.

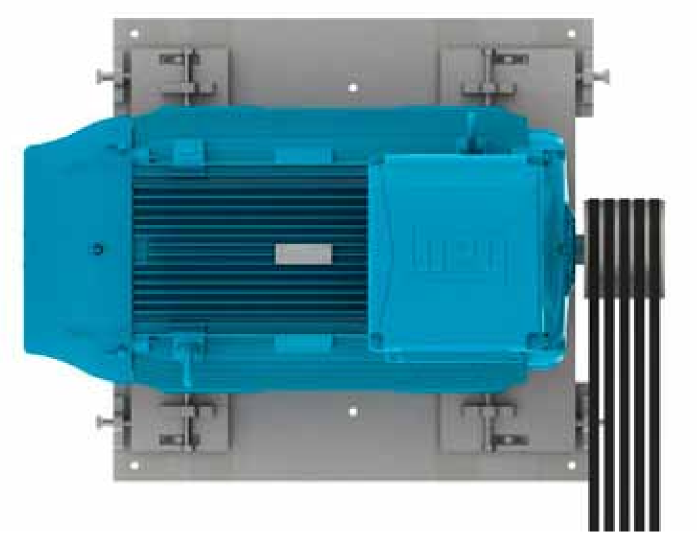

Figure 6-5 *– Motor installed on sliding base*

After completing the installation, it is recommended that all exposed machined surfaces are coated with suitable rust inhibitor.

6.2. MOTOR FIXATION

6.2.1. Foot mounted motors

The drawings of the mounting hole dimensions for NEMA or IEC motors can be checked in the respective technical catalogue.
The motor must be correctly aligned and leveled with the driven machine. Incorrect alignment and leveling may result in bearing damage, generate excessive vibration and even shaft distortion/breakage.
For more details, see section 6.3 and 6.6. The thread engagement length of the fixing bolt should be at least 1.5 times the bolt diameter. This thread engagement length should be evaluated in more severe applications and increased accordingly.
Figure 6-6 shows the fixation system of a foot mounted motor indicating the minimum required thread engagement length.

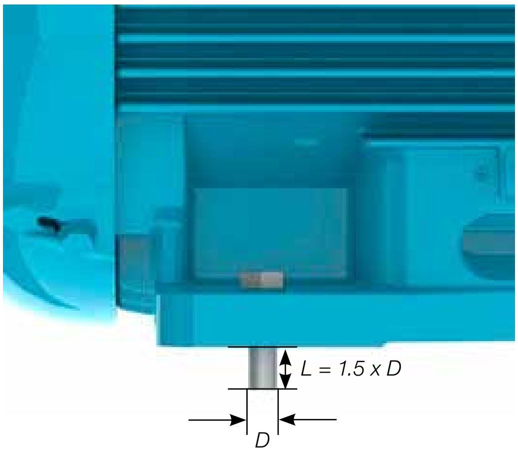

***Figure 6-6** – Fixation system of a foot mounted motor*

6.2.2. Flange mounted motors

The drawings of the flange mounting dimensions, IEC and NEMA flanges, can be checked in the technical catalogue.
The coupling of the driven equipment to the motor flange must be properly dimensioned to ensure the required concentricity of the assembly.
Depending on the flange type, the fixation can be performed from the motor to the driven equipment flange (flange FF (IEC) or D (NEMA)) or from the driven equipment flange to the motor (flange C (DIN or NEMA)).
For the fixing process from the driven equipment flange to the motor, you must consider the bolt length, flange thickness and the thread depth of the motor flange.

If the motor flange has tapped through-holes, the length of the fixing bolts must not exceed the tapped through-hole length of the motor flange, thus preventing damage to the winding head.

For flange fixation the thread engagement length of the fixing bolt should be at least 1.5 times the bolt diameter. In severe applications, longer thread engagement length may be required.
In severe applications or if large motors are flange mounted, a foot or pad fixation may be required in addition to the flange fixation (Figure 6-7). The motor must never be supported on its cooling fins.

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Figure 6-7 *– Fixing method of flange mounted motors with frame base support*

Note*:*
When liquid (for example oil) is likely to come into contact with the shaft seal, please contact your local WEG representative.

6.2.3. Pad mounted motors

Typically, this method of fixation is used in axial fans. The motor is fixed by tapped holes in the frame. The dimensions of these tapped holes can be checked in the respective product catalogue. The selection of the motor fixing rods/bolts must consider the dimensions of the fan case, the installation base and the thread depth in the motor frame.
The fixing rods and the fan case wall must be sufficiently stiff to prevent the transmission of excessive vibration to the machine set (motor & fan). Figure 6-8 shows the pad mounting system.

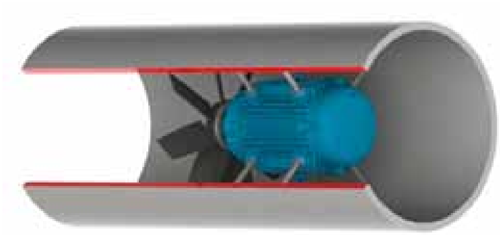

Figure 6-8 *– Fixation of the motor inside the cooling duct*

6.3. BALANCING

Unbalanced machines generate vibration which can result in damage to the motor. WEG motors are dynamically balanced with “half key” and without load (uncoupled). Special balancing quality level must be stated in the Purchase Order.

The transmission elements, such as pulleys, couplings, etc., must balanced with “half key” before they are mounted on the motor shaft.

The balance quality grade meets the applicable standards for each product line.

The maximum balancing deviation must be recorded in the installation report

6.4. COUPLINGS

Couplings are used to transmit the torque from the motor shaft to the shaft of the driven machine. The following aspects must be considered when couplings are installed:
- Use proper tools for coupling assembly & disassembly to avoid damages to the motor and bearings.
- Whenever possible, use flexible couplings, since they can absorb eventual residual misalignments during the machine operation.
- The maximum loads and speed limits informed in the coupling and motor manufacturer catalogues cannot be exceeded.
- Level and align the motor as specified in sections 6.5 and 6.6, respectively.

Remove or fix the shaft key firmly when the motor is operated without coupling in order to prevent accidents.

6.4.1. Direct coupling

Direct coupling is characterized when the Motor shaft is directly coupled to the shaft of the driven machine without transmission elements. Whenever possible, use direct coupling due to lower cost, less space required for installation and more safety against accidents.

Do not use roller bearings for direct coupling.

6.4.2. Gearbox coupling

Gearbox coupling is typically used where speed reduction is required.
Make sure that shafts are perfectly aligned and strictly parallel (in case of straight spur gears) and in the right meshing angle (in case of bevel and helical gears).

6.4.3. Pulley and belt coupling

Pulleys and belts are used when speed increase or reduction between motor shaft and driven load is required.

Excessive belt tension will damage the bearings and cause unexpected accidents such as breakage of the motor shaft.

6.4.4. Coupling of sleeve bearing motors

Motors designed with sleeve bearings must be operated with direct coupling to the driven machine or a gearbox. Pulley and belts can not be applied for sleeve bearing motors.

Motors designed with sleeve bearings have 3 (three) marks on the shaft end. The center mark is the indication of the magnetic center and the 2 (two) outside marks indicate the allowed limits of the rotor axial movement, as shown in Figure 6-9.
The motor must be so coupled that during operation the arrow on the frame is placed over the central mark indicating the rotor magnetic center. During start-up, or even during operation, the rotor may freely move between the two outside marks when the driven machine exerts an axial load on the motor shaft. However, under no circumstance, the motor can operate continuously with axial forces on the bearing.

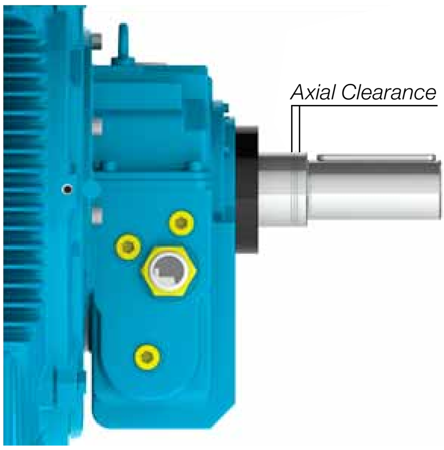

Figure 6-9 *– Axial clearance of motor designed with sleeve bearing*

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For coupling evaluation consider the maximum axial bearing clearance as shown in Table 6-1.
The axial clearance of the driven machine and coupling influence the maximum bearing clearance.

Table 6-1 *– Clearance used for sleeve bearings*

Bearing size	Total axial clearance (mm)
9*	3 + 3 = 6
11*	4 + 4 = 8
14*	5 + 5 =10
18	7,5 + 7,5 = 15

** For Motors in accordance with API 541, the total axial clearance is 12.7 mm*

The sleeve bearings used by WEG were not designed to support axial load continuously.
Under no circumstance must the motor be operated continuously at its axial clearance limits.

6.5. LEVELING

The motor must be leveled to correct any deviations in flatness arising from the manufacturing process and the material structure rearrangement. The leveling can be carried out by a leveling screw fixed on the motor foot or on the flange or by means of thin compensation plates. After the leveling process, the leveling height between the motor fixation base and the motor cannot exceed 0.1 mm.
If a metallic base is used to level the height of the motor shaft end and the shaft end of the driven machine, level only the metallic base relating to the concrete base.

Record the maximum leveling deviations in the installation report.

6.6. ALIGNMENT

The correct alignment between the motor and the driven machine is one of the most important variables that extends the useful service life of the motor. Incorrect coupling alignment generates high loads and vibrations reducing the useful life of the bearings and even resulting in shaft breakages. Figure 6-10 illustrates the misalignment between the motor and the driven machine.

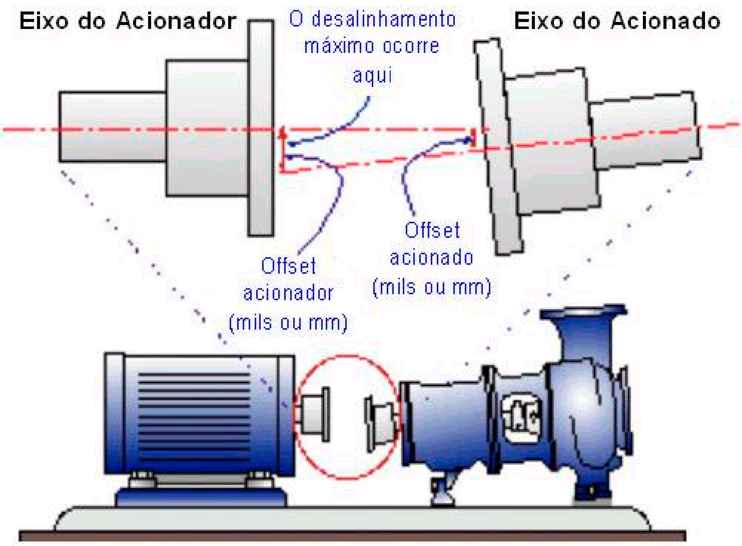

Figure 6-10 *– Typical misalignment condition*

Alignment procedures must be carried out using suitable tools and devices, such as dial gauge, laser alignment instruments, etc. The motor shaft must be aligned axially and radially with the driven machine shaft.

The maximum allowed eccentricity for a complete shaft turn should not exceed 0.03 mm, when alignment is made with dial gauges, as shown in Figure 6-11. Ensure a gap between couplings to compensate the thermal expansion between the shafts as specified by the coupling manufacturer.

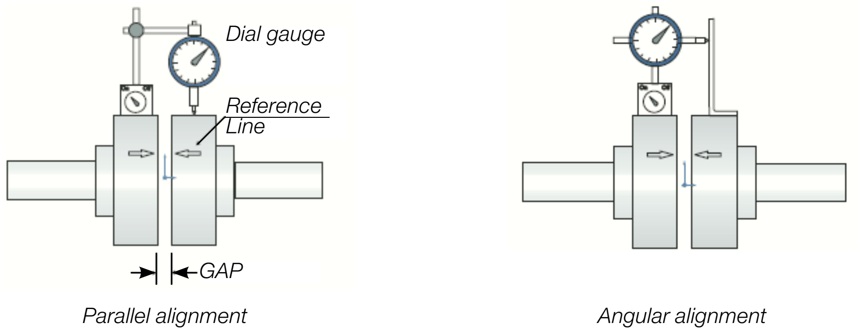

***Figure 6-11** – Alignment with dial gauge*

If alignment is made by a laser instrument, please consider the instructions and recommendations provided by the laser instrument manufacturer.
The alignment should be checked at ambient temperature with machine at operating temperature.

The coupling alignment must be checked periodically

Pulley and belt couplings must be so aligned that the driver pulley center lies in the same plane of the driven pulley center and the motor shaft and the shaft of the driven machine are perfectly parallel.
After completing the alignment procedures, ensure that mounting devices do not change the motor and machine alignment and leveling resulting into machine damage during operation.

It is recommended to record the maximum alignment deviation in the Installation Report.

6.7. CONNECTION OF OIL LUBRICATED OR OIL MIST LUBRICATED MOTORS

When oil lubricated or oil mist lubricated motors are installed, connect the existing lubricant tubes (oil inlet and oil outlet tubes and motor drain tube), as shown in Figure 6-12. The lubrication system must ensure continuous oil flow through the bearings as specified by the manufacturer of the installed lubrication system.

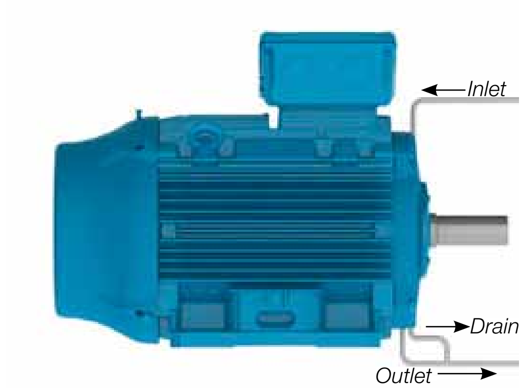

***Figure 6-12** – Oil supply and drain system of oil lubricated or oil mist lubricated motors*

6.8. CONNECTION OF THE COOLING WATER SYSTEM

When water cooled motors are installed, connect the water inlet and outlet tubes to ensure proper motor cooling. According to item 7.2, ensure correct cooling water flow rate and water temperature in the motor cooling system.

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6.9. ELECTRICAL CONNECTION

Consider the rated motor current, service factor, starting current, environmental and installation conditions, maximum voltage drop, etc. to select appropriate power supply cables and switching and protection devices. All motors must be installed with overload protection systems. Three-phase motors should be fitted with phase fault protection systems.

Before connecting the motor, check if the power supply voltage and the frequency comply with the motor nameplate data. All wiring must be made according to the connection diagram on the motor nameplate. To prevent accidents, check if motor has been solidly grounded in accordance with the applicable standards.

If motors are supplied without terminal blocks, insulate the cable terminals with suitable insulation material that meets the power supply voltage and the insulation class indicated on the motor nameplate.

Ensure correct tightening torque for the power cable and grounding connections as specified in Table 8-7 (Page 55).

The clearance distance (see Figure 6-13) between non-insulated live parts with each other and between grounded parts must be as indicated in Table 6-2.

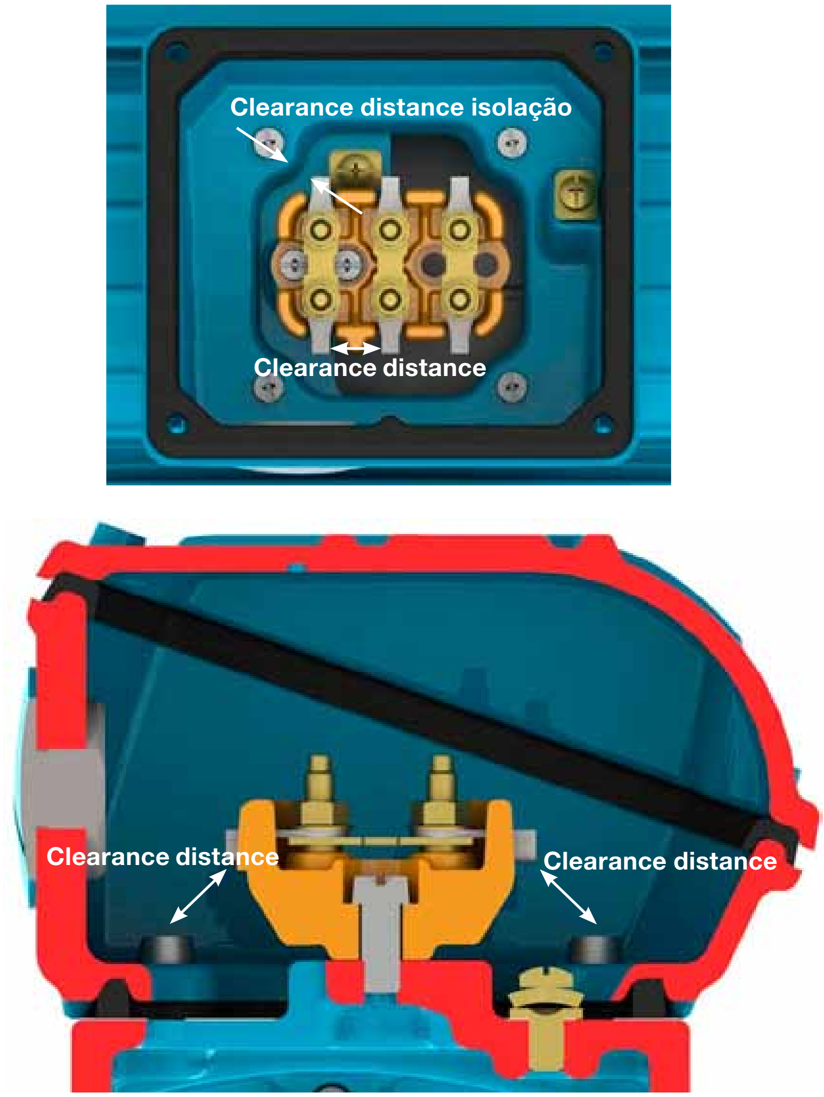

***Figure 6 -13** – Clearance distance representation*

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Table 6-2 *– Minimum clearance distance (mm) x supply voltage.*

Voltage	Minimum clearance distance (mm)
U ≤ 440 V	4
440 < U ≤ 690V	5.5
690 < U ≤ 1000V	8
1000 < U ≤ 6900V	45
6900 < U ≤ 11000V	70
11000<U ≤ 16500V	105

Even when the motor is off, dangerous voltages may be present inside the terminal box used for the space heater supply or winding energization when the winding is used as heating element.
Motor capacitors will hold a charge even after the power has been cut off. Do not touch the capacitors and/or motor terminals, before discharging the capacitors completely.

After the motor connection has been completed, ensure that no tool or foreign body has been left inside the terminal box.

Unused cable inlet holes in the terminal box must be properly closed to ensure the degree of protection indicated on the motor nameplate.
The cable inlets used for power supply and control must be fitted with components (for example, cable-glands and conduits) that meet the applicable standards and regulations in each country.

If the motor is fitted with accessories, such as brakes and forced cooling systems, these devices must be connected to the power supply according to the information provided on their nameplates and with special care as indicated above.

All protection devices, including overcurrent protection, must be set according to the rated machine conditions. These protection devices must protect the machine against short circuit, phase fault or locked rotor condition. The motor protections devices must be set according to the applicable standards.

Check the direction of rotation of the motor shaft. If there is no limitation for the use of unidirectional fans, the shaft rotation direction can be changed by reversing any two of the phase connections. For single-phase motor, check the connection diagram indicated on the motor nameplate.

6.10. CONNECTION OF THE THERMAL PROTECTION DEVICES

If the motor is supplied with temperature monitoring devices, such as, thermostat, thermistors, automatic thermal protectors, PT-100 (RTD), etc., they must be connected to the corresponding control devices as specified on the accessory nameplates. The non-compliance with this procedure may void the product warranty and cause serious material damages.

Do not apply test voltage above 2.5 V on thermistors and current above 5 mA on RTDs (PT-100).

Figure 6-14 and Figure 6-15 show the connection diagram of the bimetal thermal protector (thermostats) and thermistors, respectively.

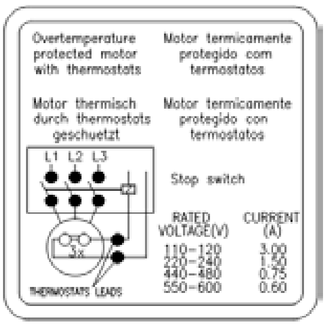

Figure 6-14 *– Connection of the bimetal thermal protectors (thermostats)*

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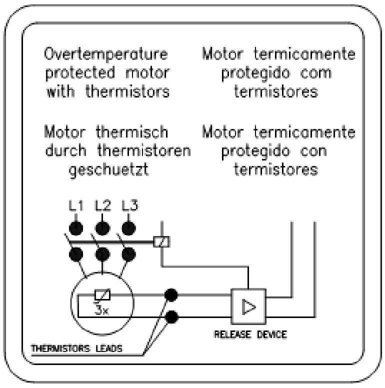

***Figure 6-15** – Thermistor connection*

The alarm temperature limits and thermal protection shutdowns can be defined according to the application; however these temperature limits can not exceed the values in Table 6-3.

***Table 6-3** – Maximum activation temperature of the thermal protections*

Component	Insulation class	Maximum temperature of the protection setting (°C)	
		Alarm	Tripping
Winding	B	-	130
	F	130	155
	H	155	180
Bearing	All	110	120

***Notes**:*
1) The number and type of the installed protection devices are informed on the accessory nameplate of the motor.
2) If the motor is supplied with calibrated resistance, (for example, Pt 100), the motor protection system must be set according to the operating temperatures indicated in Table 6-3.

6.11. THERMORESISTANCES (PT-100)

The thermocouples PT-100 are made of materials, whose resistance depends on the temperature variation, intrinsic property of some materials (usually platinum, nickel or copper), calibrated resistance. Its operation is based on the principle that the electric resistance of a metallic conductor varies linearly with the temperature, thus allowing a continuous monitoring of the motor warm-up through the controller display ensuring a high level of precision and answer stability. These devices are widely used for measuring temperatures in various industry sectors.
In general these devices are used in installations where precise temperature control is required, for example, in installation for irregular or intermittent duty.
The same detector may be used for alarm and tripping purposes.

Table 6-4 and Figure 6-16 show the equivalence between the PT-100 resistance and the temperature.

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Table 6-4 – *Equivalence between the PT-100 resistance and the temperature.*

°C	Ω	°C	Ω	°C	Ω	°C	Ω	°C	Ω
-29	88.617	17	106.627	63	124.390	109	141.908	155	159.180
-28	89.011	18	107.016	64	124.774	110	142.286	156	159.553
-27	89.405	19	107.404	65	125.157	111	142.664	157	159.926
-26	89.799	20	107.793	66	125.540	112	143.042	158	160.298
-25	90.193	21	108.181	67	125.923	113	143.420	159	160.671
-24	90.587	22	108.570	68	126.306	114	143.797	160	161.043
-23	90.980	23	108.958	69	126.689	115	144.175	161	161.415
-22	91.374	24	109.346	70	127.072	116	144.552	162	161.787
-21	91.767	25	109.734	71	127.454	117	144.930	163	162.159
-20	92.160	26	110.122	72	127.837	118	145.307	164	162.531
-19	92.553	27	110.509	73	128.219	119	145.684	165	162.903
-18	92.946	28	110.897	74	128.602	120	146.061	166	163.274
-17	93.339	29	111.284	75	128.984	121	146.438	167	163.646
-16	93.732	30	111.672	76	129.366	122	146.814	168	164.017
-15	94.125	31	112.059	77	129.748	123	147.191	169	164.388
-14	94.517	32	112.446	78	130.130	124	147.567	170	164.760
-13	94.910	33	112.833	79	130.511	125	147.944	171	165.131
-12	95.302	34	113.220	80	130.893	126	148.320	172	165.501
-11	95.694	35	113.607	81	131.274	127	148.696	173	165.872
-10	96.086	36	113.994	82	131.656	128	149.072	174	166.243
-9	96.478	37	114.380	83	132.037	129	149.448	175	166.613
-8	96.870	38	114.767	84	132.418	130	149.824	176	166.984
-7	97.262	39	115.153	85	132.799	131	150.199	177	167.354
-6	97.653	40	115.539	86	133.180	132	150.575	178	167.724
-5	98.045	41	115.925	87	133.561	133	150.950	179	168.095
-4	98.436	42	116.311	88	133.941	134	151.326	180	168.465
-3	98.827	43	116.697	89	134.322	135	151.701	181	168.834
-2	99.218	44	117.083	90	134.702	136	152.076	182	169.204
-1	99.609	45	117.469	91	135.083	137	152.451	183	169.574
0	100.000	46	117.854	92	135.463	138	152.826	184	169.943
1	100.391	47	118.240	93	135.843	139	153.200	185	170.313
2	100.781	48	118.625	94	136.223	140	153.575	186	170.682
3	101.172	49	119.010	95	136.603	141	153.950	187	171.051
4	101.562	50	119.395	96	136.982	142	154.324	188	171.420
5	101.953	51	119.780	97	137.362	143	154.698	189	171.789
6	102.343	52	120.165	98	137.741	144	155.072	190	172.158
7	102.733	53	120.550	99	138.121	145	155.446	191	172.527
8	103.123	54	120.934	100	138.500	146	155.820	192	172.895
9	103.513	55	121.319	101	138.879	147	156.194	193	173.264
10	103.902	56	121.703	102	139.258	148	156.568	194	173.632
11	104.292	57	122.087	103	139.637	149	156.941	195	174.000
12	104.681	58	122.471	104	140.016	150	157.315	196	174.368
13	105.071	59	122.855	105	140.395	151	157.688	197	174.736
14	105.460	60	123.239	106	140.773	152	158.061	198	175.104
15	105.849	61	123.623	107	141.152	153	158.435	199	175.472
16	106.238	62	124.007	108	141.530	154	158.808	200	175.840

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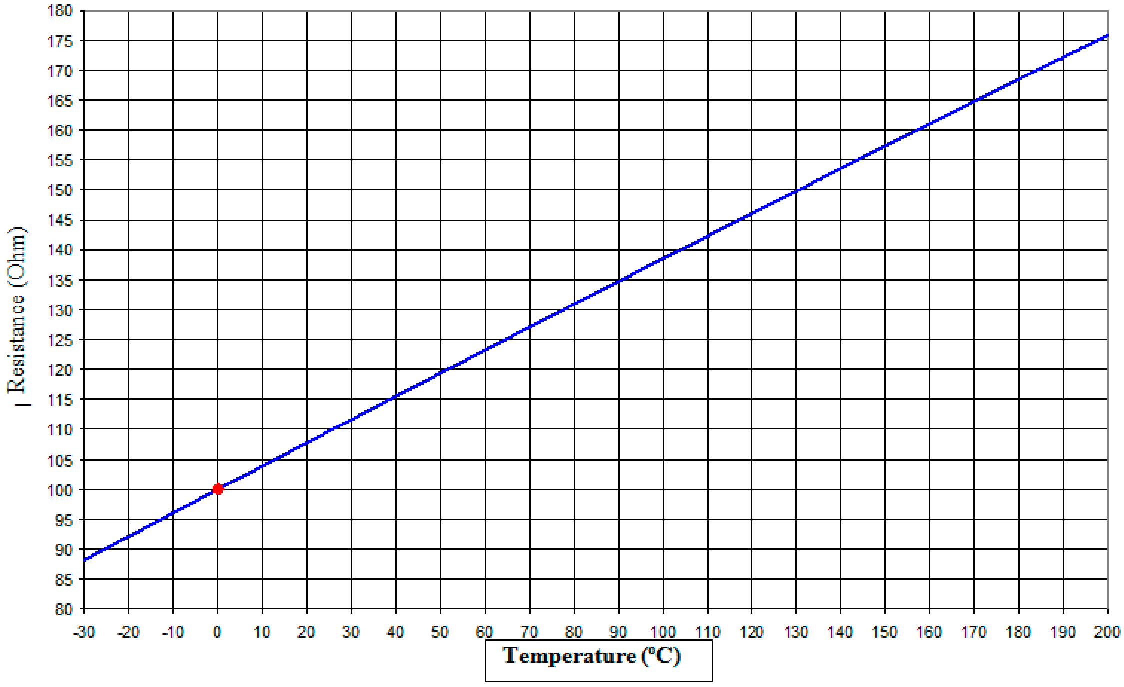

Figure 6-16 *– Ohmic resistance of the PT-100 x temperature*

6.12. STARTING METHODS

Whenever possible, the motor starting must be Direct On Line (DOL) at rated voltage. This is the most simple and feasible starting method. However, it must only be applied when the starting current does not affect the power supply. Please consider the local electric utility regulations when installing a motor.
High inrush current may result in:
a) high voltage drop in the power supply line creating unacceptable line disturbance on the distribution system;
b) requiring oversized protection system (cables and contactor) increasing the installation costs.

If DOL starting is not allowed due to the reasons mentioned above, an indirect starting method compatible with the load and motor voltage to reduce the starting current may be used.
If reduced voltage starters are used for starting, the motor starting torque will also be reduced.

Table 6-5 shows the possible indirect starting methods that can be used depending on the number of the motor leads.

Table 6-5 *– Starting method x number of motor leads.*

Number of leads	Possible starting methods
3 leads	Autotransformer Soft-starter
6 leads	Star-Delta Switch Autotransformer Soft-Starter
9 leads	Series/Parallel Switch Autotransformer Soft-Starter
12 leads	Star-Delta Switch Series/Parallel Switch Soft-Starter

Table 6-6 shows examples of possible indirect starting methods to be used according to the voltage indicated on the motor nameplate and the power supply voltage.

***Table 6-6** – Starting methods x voltage*

Nameplate voltage	Operating voltage	Star-delta switch	Autotransformer Starting	Starting by series/ parallel switch	Starting by soft-starter
220/380 V	220 V 380 V	YES NO	YES YES	NO NO	YES YES
220/440 V	220 V 440 V	NO NO	YES YES	YES NO	YES YES
230/460 V	230 V 460 V	NO NO	YES YES	YES NO	YES YES
380/660 V	380 V	YES	YES	NO	YES
220/380/440 V	220 V 380 V 440 V	YES NO YES	YES YES YES	YES YES NO	YES YES YES

The WQuattro line motors must be started direct on-line (DOL) or driven by a frequency inverter in scalar mode.

6.13. MOTORS DRIVEN BY FREQUENCY INVERTER

The operation with frequency inverter must be stated in the Purchase Order since this drive type may require some changes of the motor design.

Wmagnet Motors must only be driven by WEG frequency inverter.

The frequency inverter used to drive motors up to 690 V must be fitted with Pulse With Modulation (PWM) with vector control.

When a motor is driven by a frequency inverter at lower frequencies than the rated frequency, you must reduce the motor torque to prevent motor overheating. The torque reduction (derating torque) can be found in the item 6.4 of the "Technical Guidelines for Induction Motors driven by PWM Frequency inverters" available on the site www.weg.net.

If the motor is operated above the rated frequency, please note:

- That the motor must be operated at constant output;
- That the motor can supply max. 95% of its rated output;
- Do not exceed the maximum speed and please consider:
  - max. operating frequency informed on the additional nameplate;
  - mechanical speed limitation of the motor;
  - max. motor torque, according to equation:

$$\frac{\text{Maximum speed} = \text{Rated speed x Cmax/Cn}}{1.5}$$

Information on the selection of the power cables between the frequency inverter and the motor can be found in the item 6.4 of the "Technical Guidelines for Induction Motors driven by PWM Frequency inverters" available at www.weg.net.

6.13.1. Use of dV/dt filter

6.13.1.1. Motor with enameled round wire

Motors designed for rated voltages up to 690 V, when driven by frequency inverter, do not require the use of dV/dT filters, provided that following criteria are considered.

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Criteria for the selection of motors with round enameled wire when driven by frequency inverter [1]				
Motor rated votage [2]	Peak voltage at the motor terminals (max)	dV/dt inverter output (max)	Inverter Rise Time [3] (min.)	MTBP [3] Time between pulses (min)
Vnon ≤ 460 V	≤ 1600 V	≤ 5200 V/μs	≥ 0,1 μs	≥ 6 μs
460 < Vnon ≤ 575 V	≤ 1800 V	≤ 6500 V/μs		
575 < Vnon ≤ 690 V [4]	≤ 1600 V	≤ 5200 V/μs		
575 < Vnon ≤ 690 V [5]	≤ 2200 V	≤ 7800 V/μs		

***Notes**:*
1. For the application of motors with round enameled wires designed for 690 < Vnom ≤ 1100 V, please contact WEG.
2. For the application of dual voltage motors, example 380/660 V, consider the lower voltage (380 V).
3. Information supplied by the inverter manufacturer.
4. When not stated in the Purchase Order that the motor will be driven by frequency inverter.
5. When stated in the Purchase Order that the motor will be driven by frequency inverter.

6.13.1.2. Motor with prewound coils

Motors with prewound coils (medium voltage motors regardless of frame sizes, and low voltage motors from IEC 500 / NEMA 80 frame on), designed for the use with frequency inverters, do not require the use of filters, provided they comply with the criteria in Table 6-7.

***Table 6-7** – Criteria to be considered when using motor with prewound coils to be drive by frequency inverters*

Motor rated voltage	Type of modulation	Turn to turn insulation (phase-phase)		Phase-ground insulation	
		Peak voltage at the motor terminals	dV/dt at the motor terminals	Peak voltage at the motor terminals	dV/dt at the motor terminals
690 < Vnon ≤ 4160 V	Sinusoidal	≤ 5900 V	≤ 500 V/μs	≤ 3400 V	≤ 500 V/μs
	PWM	≤ 9300 V	≤ 2700 V/μs	≤ 5400 V	≤ 2700 V/μs
4160 < Vnon ≤ 6600 V	Sinusoidal	≤ 9300 V	≤ 500 V/μs	≤ 5400 V	≤ 500 V/μs
	PWM	≤ 12700 V	≤ 1500 V/μs	≤ 7400 V	≤ 1500 V/μs

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6.13.2. Bearing insulation

Only the motors in IEC frame size 400 (NEMA 68) and larger are supplied, as standard, with insulated bearing. If motor must be driven by frequency inverter, insulate the bearing according to Table 6-8.

***Table 6-8** – Recommendation on the bearing insulation for inverter driven motors*

Frame size	Recommendation
IEC 315 and 355 NEMA 445/7, 447/9, L447/9, 504/5, 5006/7/8, 5009/10/11, 586/7, 5807/8/9, 5810/11/12 and 588/9	■ Insulated bearing/end shield ■ Grounding between shaft and frame by grounding brush
IEC 400 and larger NEMA 6800 and larger	■ Insulated NDE bearing ■ Grounding between shaft and frame by grounding brush

When motors are supplied with shaft grounding system, monitor the grounding brush constantly during its operation and, when it reaches the end of its useful life, it must be replaced by another brush with the same quality.

6.13.3. Switching Frequency

The minimum inverter switching frequency must not be lower than 2.5 kHz and should not exceed 5 kHz.

The non-compliance with the criteria and recommendations indicated in this manual may void the product warranty.

6.13.4. Mechanical speed limitation

Table 6-9 shows the maximum speeds allowed for motors driven by frequency inverter.

***Table 6-9** – Maximum motor speed (in rpm).*

Frame size	2 poles	4 poles	6 poles	8 poles
90 – 100	7000	7000	7000	7000
112	7000	6000	6000	6000
132	6000	5500	5500	5500
160	5000	5000	5000	5000
180	4500	4000	4000	4000
200	4000	3800	3800	3800
225	3600	3600	3600	3600
250	3600	3600	3600	3600
280	3600	3000	3000	3000
315	3600	2500	2500	2500
355	3600	1800	1800	1800

***Note**:*
to select the maximum allowed motor speed, consider the motor torque derating curve.

For more information on the application of frequency inverters, contact WEG or check the “Technical Guidelines for Induction Motors driven by PWM Frequency inverters” available at www.weg.net.

7. COMMISSIONING

7.1. INITIAL START-UP

After finishing the installation procedures and before starting the motor for the first time or after a long period without operation, the following items must be checked:

- If the nameplate data (voltage, current, connection diagram, degree of protection, cooling system, service factor, etc.) meet the application requirements.
- If the machine set (motor + driven machine) has been mounted and aligned correctly.
- If the motor driving system ensures that the motor speed does not exceed the max. allowed speed indicated in Table 6-9.
- Measure the winding insulation resistance, making sure it complies with the specified values in item 5.4.
- Check the motor rotation direction.
- Inspect the motor terminal box for damage and ensure that it is clean and dry and all contacts are rust-free, the seals are in perfect operating conditions and all unused threaded holes are properly closed thus ensuring the degree of protection indicated on the motor nameplate.
- Check if the motor wiring connections, including grounding and auxiliary equipment connection, have been carried out properly and are in accordance with the recommendations in item 6.9.
- Check the operating conditions of the installed auxiliary devices (brake, encoder, thermal protection device, forced cooling system, etc.).
- Check bearing operating conditions. If signs of oxidation are detected, replace the bearings. If no sign of oxidation is detected, relubricate the bearings as described in item 8.2. If the motors are stored for more than two years, the bearings must be replaced before starting the motor.

- When motors are fitted with sleeve bearings, ensure:
  - correct oil level for the sleeve bearing. The oil level should be in the center of the sight glass (see Figure 6-9);
  - that the motor is not started or operated with axial or radial loads;
  - that if the motor is stored for a period equal or longer than the oil change interval, the oil must be changed before starting the motor.
- Inspect the capacitor operating condition, if any. If motors are installed for more than two years, but were never commissioned, it is recommended to change the start capacitors since they lose their operating characteristics.
- Ensure that the air inlet and outlet opening are not blocked. The minimum clearance to the nearest wall (L) should be at least ¼ of the fan cover diameter (D), see Figure 7-1. The intake air temperature must be at ambient temperature.

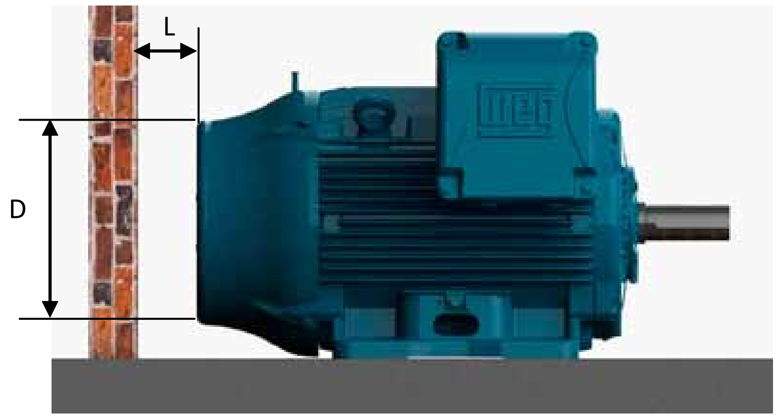

Figure 7-1- *Minimum clearance to the wall*

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Please consider the minimum distances shown in the Table 7-1 as reference value

Table 7-1 *– Minimum distance between the fan cover and wall*

Frame size		Distance between the fan cover and the wall (L)	
IEC	**NEMA**	**mm**	**inches**
63	-	25	0,96
71	-	26	1,02
80	-	30	1,18
90	143/5	33	1,30
100	-	36	1,43
112	182/4	41	1,61
132	213/5	50	1,98
160	254/6	65	2,56
180	284/6	68	2,66
200	324/6	78	3,08
225 250	364/5 404/5	85	3,35
280	444/5 445/7 447/9	108	4,23
315	L447/9 504/5	122	4,80
355	586/7 588/9	136	5,35

- ensure correct water flow rate and water temperature when water cooled motors are used. See item 7.2.
- ensure that all rotating parts, such as pulleys, couplings, external fans, shaft, etc. are protected against accidental contact.

Other tests and inspections not included in the manual may be required, depending on the specific installation, application and/or motor characteristics.

After all previous inspections have been carried out, proceed as follows to start the motor:

- Start the motor on no-load (if possible) and check the motor direction of rotation. Check for the presence of any abnormal noise, vibration or other abnormal operating conditions.
- Ensure the motor starts smoothly. If any abnormal operating condition is noticed, switch off the motor, check the assembly system and connections before the motor is started again.
- If excessive vibrations are noticed, check if the motor fixation bolts are well tightened or if the vibrations are not generated and transmitted from adjacent installed equipment. Check the motor vibration periodically and ensure that the vibration limits are as specified in item 7.2.1.
- Start the motor at rated load during a short time and compare the operating current with the rated current indicated on the nameplate.
- Continue to measure the following motor variables until thermal equilibrium is reached: current, voltage, bearing and motor frame temperature, vibration and noise levels.
- Record the measured current and voltage values on the Installation Report for future comparisons.

As induction motors have high inrush currents during start-up, the acceleration of high inertia load requires an extended starting time to reach full speed resulting in fast motor temperature rise. Successive starts within short intervals will result in winding temperature increases and can lead to physical insulation damage reducing the useful life of the insulation system. If the duty S1 is specified on the motor nameplate, this means that the motor has been designed for:
- two successive starts: first start from cold condition, i. e., the motor windings are at room temperature and the second start immediately after the motor stops.
- one start from hot condition, i. e., the motor windings are at rated temperature.

The Troubleshooting Chart in section 10 provides a basic list of unusual cases that may occur during motor operation with the respective corrective actions

7.2. OPERATING CONDITIONS

Unless otherwise stated in the Purchase Order, electric motors are designed and built to be operated at altitudes up to 1000 meters above sea level and in a temperature range from -20°C to +40°C. Any deviation from the normal condition of motor operation must be stated on the motor nameplate. Some components must be changed if the ambient temperature is different from the specified one. Please contact WEG to check the required special features.

Motors installed inside enclosures (cubicles) must be ensured an air renewal rate in the order of one cubic meter per second for each 100 kW installed power or fraction of installed power. Totally Enclosed Air Over motors - TEAO (fan and exhaust / smoke extraction) are supplied without cooling fan and the manufacturer of the driven machine is responsible for sufficient motor cooling. If no minimum required air speed between motor fins is indicated on the motor nameplate, ensure the air speed indicated in the table 7-2 is provided. The values shown in Table 7-2 are valid for 60 Hz motors. To obtain the minimum air speed for 50 Hz motors, multiply the values in the table by 0.83.

Table 7-2 *– Minimum required air speed between motor fins (metres/second)*

Frame		Poles			
IEC	**NEMA**	**2**	**4**	**6**	**8**
63 to 90	143/5	14	7	5	4
100 to 132	182/4 to 213/5	18	10	8	6
160 to 200	254/6 to 324/6	20	20	12	7
225 to 280	364/5 to 444/5	22	22	18	12
315 to 355	445/7 to 588/9	25	25	20	15

The voltage and frequency variations may affect the performance characteristics and the electromagnetic compatibility of the motor. The power supply variations should not exceed the values specified in the applicable standards. Examples.

- ABNT NBR-17094 - Parts 1 and 2. The motor has been designed to supply the rated torque for a combined variation in voltage and frequency:
  - Zone A: ±5% of the rated voltage and ±2% of the rated frequency.
  - Zone B: ±10% of the rated voltage and +3% -5% of the rated frequency.

When operated continuously in Zone A or B, the motor may show performance variations and the operating temperature may increase considerably. These performance variations will be higher in Zone B. Thus it is not recommended to operate the motor in Zone B during extended periods.

- IEC 60034-1. The motor has been designed to supply the rated torque for combined variation in voltage and frequency:
  - Zone A: ±5% of the rated voltage and ±2% of the rated frequency.
  - Zone B: ±10% of the rated voltage and +3% -5% of the rated frequency.

When operated continuously in Zone A or B, the motor may show performance variations and the operating temperature may increase considerably. These performance variations will be higher in Zone B. Thus it is not recommended to operate the motor in Zone B during extended periods. For multivoltage motors (example 380-415/660 V), a ±5% voltage variation from the rated voltage is allowed.

- NEMA MG-1 Part 12. The motor has been designed to be operated in one of the following variations:
  - ±10% of the rated voltage, with rated frequency;
  - ±5% of the rated frequency, with rated voltage;
  - A combined variation in voltage and frequency of ±10%, provided the frequency variation does not exceed ±5%.

If the motor is cooled by ambient air, clean the air inlet and outlet openings and cooling fins at regular intervals to ensure a free airflow over the frame surface. The hot air should never be returned to the motor. The cooling air must be at room temperature limited to the temperature range indicated on the motor nameplate (if no room temperature is specified, please consider a temperature range between -20°C and +40°C).

Table 7-3 shows the minimum required water flow for water cooled motors considering the different frame sizes and the maximum allowed temperature rise of the cooling water after circulating through the motor. The inlet water temperature should not exceed 40°C.

Table 7-3 *– Minimum required water flow and the maximum allowed temperature rise of the cooling water after circulating through the motor*

Frame size		Flow rate (litres/minute)	Maximum allowed water temperature rise (°C)
IEC	NEMA		
180	284/6	12	5
200	324/6	12	5
225	364/5	12	5
250	404/5	12	5
280	444/5 445/7 447/9	15	6
315	504/5	16	6
355	586/7 588/9	25	6

Motors fitted with oil mist lubrication systems can be operated continuously for a maximum of one hour after the failure of the oil pumping system. Considering the sun's heat increases the operating temperature, externally mounted motors should always be protected from direct sunlight exposure.

Each and every deviation from the normal operating condition (tripping of the thermal protection, noise and vibration level increase, temperature and current rise) should be investigated and corrected by WEG Authorized Service Centers.

Motors fitted with cylindrical roller bearings require a minimum radial load to ensure a normal operation. For information regarding the radial preload, please contact WEG.

7.2.1.Limits of vibration

The vibration severity is the maximum vibration value measured at all positions and in all directions as recommended in the standard IEC 60034-14. Table 7-4 below specifies the limits of the maximum vibrations magnitudes according to standard IEC 60034-14 for shaft heights IEC 56 to 400, for vibrations grades A and B. The vibration severity limits in Table 7-4 are given as RMS values (Root Mean Square values or effective values) of the vibration speed in mm/s measured in free suspension condition.

Table 7-4 *– Recommended limits for the vibration severity according to standard IEC 60034-14*

Shaft height [mm]	$56 \le H \le 132$	$132 \le H \le 280$	$H > 280$
Vibration Grade	Vibration severity on elastic base [mm/s RMS]		
A	1.6	2.2	2.8
B	0.7	1.1	1.8

Notes*:*
1 – The values in Table 7-4 are valid for measurements carried out with decoupled machines (without load) operated at rated voltage and frequency.
2 - The values in Table 7-4 are valid regardless of the direction of rotation of the machine.
3 – The values in Table 7-4 are not applicable to single-phase motors, three-phase motors powered by a single-phase system or to machines mounted in situ or coupled with inertia flywheels or to loads.

According to NEMA MG-1, the allowed vibration limit for standard motors is 0.15 in/s (peak vibration in in/s).

Note*:*
For the load operation condition, the use of the standard ISO 10816-3 is recommended for evaluating the motor vibration limits. In the load condition the motor vibration will be influenced by several factors, such as, type of the coupled load, condition of the motor fixation, alignment condition under load, structure or base vibration due to other equipments, etc.

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8. MAINTENANCE

The purpose of the maintenance is to extend the useful life of the equipment. The non-compliance with one of these previous items can cause unexpected machine failures.

If motors with cylindrical roller or angular contact bearings are to be transported during the maintenance procedures, the shaft locking device must always be fitted. All HGF motors, regardless of the bearing type, must always be transported with the shaft locking device fitted.

All repairs, disassembly and assembly related services must be carried out only by qualified and well-trained personnel by using proper tools and techniques. Make sure that the machine has stopped and it is disconnected from the power supply, including the accessory devices (space heater, brake, etc.), before any servicing is undertaken.
The company does not assume any responsibility or liability for repair services or maintenance operations executed by non-authorized Service Centers or by non qualified service personnel. The company shall have no obligation or liability whatsoever to the buyer for any indirect, special, consequential or incidental loss or damage caused or arising from the company's proven negligence

8.1. GENERAL INSPECTION

The inspection intervals depend on the motor type, application and installation conditions. Proceed as follows during inspection:

- Visually inspect the motor and coupling. Check if abnormal noises, vibrations, excessive heating, wear signs, misalignment or damaged parts are noticed. Replace the damaged parts as required.
- Measure the insulation resistance according to the item 5.4.
- Clean the motor enclosure. Remove oil spills and dust accumulation from the motor frame surface to ensure a better heat transfer to the surrounding ambient.
- Check cooling fan condition and clean the air inlet & outlet openings to ensure a free air flow over the motor.
- Investigate the actual condition of the seals and replace them, if required.
- Drain the condensed water from inside the motor. After draining, reinstall the drain plugs to ensure the degree of protection as indicated on the motor nameplate. The motor must always be positioned so the drain hole is at the lowest position (see item 6).
- Check the connections of the power supply cables, ensuring the correct clearance distance between live and grounded parts, as specified in Table 6-2.
- Check if the tightening torque of the bolted connections and fixation bolts meets the tightening torque specified in Table 8-7.
- Check the status of the cable passages, the cable gland seals and the seals inside the terminal box and replace them, if required.
- Check the bearing operating conditions. Check for the presence of any abnormal noise, vibration or other abnormal operating conditions, like motor temperature rise. Check the oil level, the lub oil condition and compare the workings hours with the informed life time.
- Record and file all changes performed on the motor.

Do not reuse damaged or worn parts. Damaged or worn parts must be replaced by parts supplied by the manufacturer and must be installed as if they were the original parts.

8.2. LUBRICATION

Proper lubrication plays a vital role in the motor performance. Only use the grease or oil types, amounts and lubrication intervals recommended for the bearings. This information is available on the motor nameplate and the lubrication procedures must be carried out according to the type of lubricant (oil or grease).
When the motor is fitted with thermal protection devices for bearing temperature control, consider the operating temperature limits shown in Table 6-3.
The maximum operating temperature of motors used in special applications may differ from those shown in Table 6-3. The grease and oil disposal should be made in compliance with applicable laws in each country

Please contact WEG when motors are to be installed in special environments or used for special applications.

8.2.1. Grease lubricated rolling bearings

Excess grease causes bearing overheating, resulting in bearing failure.

The lubrication intervals specified in Table 8-1, Table 8-2, Table 8-3 and Table 8-4 consider a room temperature of 40°C, the motor running at rated speed, a motor mounted in horizontal position, greased with Mobil Polyrex EM grease. The lubrication intervals are determined according to the standard ISO 281 and they estimate for the basic rating life that 90% of a group of identical bearings will theoretically meet or exceed the calculated value with 90% reliability. Any variation of the parameters listed above must be evaluated.

Table 8-1 *– Lubrication intervals for ball bearings*

<table>
<tr><th colspan="2" rowspan="2">Frame</th><th rowspan="3">Poles</th><th rowspan="3">Bearing designation</th><th rowspan="3">Amount of grease (g)</th><th colspan="6">LUBRICATION INTERVALS (hours)</th></tr>
<tr><th colspan="2">ODP
(Open Drip Proof)</th><th colspan="2">W21 TEFC
(Totally Enclosed Fan Cooled)</th><th colspan="2">W22 TEFC
(Totally Enclosed Fan Cooled)</th></tr>
<tr><th>IEC</th><th>NEMA</th><th>50 Hz</th><th>60 Hz</th><th>50 Hz</th><th>60 Hz</th><th>50 Hz</th><th>60 Hz</th></tr>
<tr><td rowspan="4">160</td><td rowspan="4">254/6</td><td>2</td><td rowspan="4">6309</td><td rowspan="4">13</td><td rowspan="4">20000</td><td rowspan="4">20000</td><td>18100</td><td>15700</td><td>22000</td><td>20000</td></tr>
<tr><td>4</td><td rowspan="3">20000</td><td rowspan="3">20000</td><td rowspan="3">25000</td><td rowspan="3">25000</td></tr>
<tr><td>6</td></tr>
<tr><td>8</td></tr>
<tr><td rowspan="4">180</td><td rowspan="4">284/6</td><td>2</td><td rowspan="4">6311</td><td rowspan="4">18</td><td rowspan="4">20000</td><td rowspan="4">20000</td><td>13700</td><td>11500</td><td>17000</td><td>14000</td></tr>
<tr><td>4</td><td rowspan="3">20000</td><td rowspan="3">20000</td><td rowspan="3">25000</td><td rowspan="3">25000</td></tr>
<tr><td>6</td></tr>
<tr><td>8</td></tr>
<tr><td rowspan="4">200</td><td rowspan="4">324/6</td><td>2</td><td rowspan="4">6312</td><td rowspan="4">21</td><td rowspan="4">20000</td><td rowspan="4">20000</td><td>11900</td><td>9800</td><td>15000</td><td>12000</td></tr>
<tr><td>4</td><td rowspan="3">20000</td><td rowspan="3">20000</td><td rowspan="3">25000</td><td rowspan="3">25000</td></tr>
<tr><td>6</td></tr>
<tr><td>8</td></tr>
<tr><td rowspan="15">225
250
280
315
355</td><td rowspan="15">364/5
404/5
444/5
445/7
447/9
L447/9
504/5
5008
5010/11
586/7
588/9</td><td>2</td><td rowspan="4">6314</td><td rowspan="4">27</td><td>18000</td><td>14400</td><td>4500</td><td>3600</td><td>5000</td><td>4000</td></tr>
<tr><td>4</td><td rowspan="3">20000</td><td rowspan="3">20000</td><td>11600</td><td>9700</td><td>14000</td><td>12000</td></tr>
<tr><td>6</td><td>16400</td><td>14200</td><td>20000</td><td>17000</td></tr>
<tr><td>8</td><td>19700</td><td>17300</td><td>24000</td><td>20000</td></tr>
<tr><td>2</td><td rowspan="4">6316</td><td rowspan="4">34</td><td>14000</td><td>*Upon request</td><td>3500</td><td>*Upon request</td><td>4000</td><td>*Upon request</td></tr>
<tr><td>4</td><td rowspan="3">20000</td><td rowspan="3">20000</td><td>10400</td><td>8500</td><td>13000</td><td>10000</td></tr>
<tr><td>6</td><td>14900</td><td>12800</td><td>18000</td><td>16000</td></tr>
<tr><td>8</td><td>18700</td><td>15900</td><td>20000</td><td>20000</td></tr>
<tr><td>2</td><td rowspan="4">6319</td><td rowspan="4">45</td><td>9600</td><td>*Upon request</td><td>2400</td><td>*Upon request</td><td>3000</td><td>*Upon request</td></tr>
<tr><td>4</td><td rowspan="3">20000</td><td rowspan="3">20000</td><td>9000</td><td>7000</td><td>11000</td><td>8000</td></tr>
<tr><td>6</td><td>13000</td><td>11000</td><td>16000</td><td>13000</td></tr>
<tr><td>8</td><td>17400</td><td>14000</td><td>20000</td><td>17000</td></tr>
<tr><td>4</td><td rowspan="3">6322</td><td rowspan="3">60</td><td rowspan="3">20000</td><td rowspan="3">20000</td><td>7200</td><td>5100</td><td>9000</td><td>6000</td></tr>
<tr><td>6</td><td>10800</td><td>9200</td><td>13000</td><td>11000</td></tr>
<tr><td>8</td><td>15100</td><td>11800</td><td>19000</td><td>14000</td></tr>
</table>

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Table 8-2 – *Lubrication intervals for cylindrical roller bearings*

<table>
<tr><th colspan="2">Frame</th><th rowspan="2">Poles</th><th rowspan="2">Bearing designation</th><th rowspan="2">Amount of grease (g)</th><th colspan="6">LUBRICATION INTERVALS (hours)</th></tr>
<tr><th colspan="2"></th><th colspan="2">ODP (Open Drip Proof)</th><th colspan="2">W21 TEFC (Totally Enclosed Fan Cooled)</th><th colspan="2">W22 TEFC (Totally Enclosed Fan Cooled)</th></tr>
<tr><th>IEC</th><th>NEMA</th><th></th><th></th><th></th><th>50 Hz</th><th>60 Hz</th><th>50 Hz</th><th>60 Hz</th><th>50 Hz</th><th>60 Hz</th></tr>
<tr><td rowspan="4">160</td><td rowspan="4">254/6</td><td>2</td><td rowspan="4">NU309</td><td rowspan="4">13</td><td rowspan="4">20000</td><td>19600</td><td>13300</td><td>9800</td><td>16000</td><td>12000</td></tr>
<tr><td>4</td><td rowspan="3">20000</td><td rowspan="3">20000</td><td rowspan="3">20000</td><td rowspan="3">25000</td><td rowspan="3">25000</td></tr>
<tr><td>6</td></tr>
<tr><td>8</td></tr>
<tr><td rowspan="4">180</td><td rowspan="4">284/6</td><td>2</td><td rowspan="4">NU311</td><td rowspan="4">18</td><td>18400</td><td>12800</td><td>9200</td><td>6400</td><td>11000</td><td>8000</td></tr>
<tr><td>4</td><td rowspan="3">20000</td><td rowspan="3">20000</td><td rowspan="3">20000</td><td>19100</td><td rowspan="3">25000</td><td rowspan="3">25000</td></tr>
<tr><td>6</td><td rowspan="2">20000</td></tr>
<tr><td>8</td></tr>
<tr><td rowspan="4">200</td><td rowspan="4">324/6</td><td>2</td><td rowspan="4">NU312</td><td rowspan="4">21</td><td>15200</td><td>10200</td><td>7600</td><td>5100</td><td>9000</td><td>6000</td></tr>
<tr><td>4</td><td rowspan="3">20000</td><td rowspan="3">20000</td><td rowspan="3">20000</td><td>17200</td><td rowspan="3">25000</td><td>21000</td></tr>
<tr><td>6</td><td rowspan="2">20000</td><td rowspan="2">25000</td></tr>
<tr><td>8</td></tr>
<tr><td rowspan="12">225
250
280
315
355</td><td rowspan="12">364/5
404/5
444/5
445/7
447/9
L447/9
504/5
5008
5010/11
586/7
588/9</td><td>4</td><td rowspan="3">NU314</td><td rowspan="3">27</td><td>17800</td><td>14200</td><td>8900</td><td>7100</td><td>11000</td><td>9000</td></tr>
<tr><td>6</td><td rowspan="2">20000</td><td rowspan="2">20000</td><td>13100</td><td>11000</td><td>16000</td><td>13000</td></tr>
<tr><td>8</td><td>16900</td><td>15100</td><td>20000</td><td>19000</td></tr>
<tr><td>4</td><td rowspan="3">NU316</td><td rowspan="3">34</td><td>15200</td><td>12000</td><td>7600</td><td>6000</td><td>9000</td><td>7000</td></tr>
<tr><td>6</td><td rowspan="2">20000</td><td>19000</td><td>11600</td><td>9500</td><td>14000</td><td>12000</td></tr>
<tr><td>8</td><td>20000</td><td>15500</td><td>13800</td><td>19000</td><td>17000</td></tr>
<tr><td>4</td><td rowspan="3">NU319</td><td rowspan="3">45</td><td>12000</td><td>9400</td><td>6000</td><td>4700</td><td>7000</td><td>5000</td></tr>
<tr><td>6</td><td>19600</td><td>15200</td><td>9800</td><td>7600</td><td>12000</td><td>9000</td></tr>
<tr><td>8</td><td>20000</td><td>20000</td><td>13700</td><td>12200</td><td>17000</td><td>15000</td></tr>
<tr><td>4</td><td rowspan="3">NU322</td><td rowspan="3">60</td><td>8800</td><td>6600</td><td>4400</td><td>3300</td><td>5000</td><td>4000</td></tr>
<tr><td>6</td><td>15600</td><td>11800</td><td>7800</td><td>5900</td><td>9000</td><td>7000</td></tr>
<tr><td>8</td><td>20000</td><td>20000</td><td>11500</td><td>10700</td><td>14000</td><td>13000</td></tr>
</table>

Table 8-3 – *Lubrication intervals for ball bearings – HGF line*

<table>
<tr><th colspan="2">Frame</th><th rowspan="2">Poles</th><th rowspan="2">Bearing designation</th><th rowspan="2">Amount of grease (g)</th><th colspan="2">Lubrication intervals (hours)</th></tr>
<tr><th>IEC</th><th>NEMA</th><th>50Hz</th><th>60Hz</th></tr>
<tr><td rowspan="3">315L/A/B and 315C/D/E</td><td rowspan="3">5006/7/8T and 5009/10/11T</td><td>2</td><td>6314</td><td>27</td><td>3100</td><td>2100</td></tr>
<tr><td rowspan="2">4 – 8</td><td>6320</td><td>50</td><td>4500</td><td>4500</td></tr>
<tr><td>6316</td><td>34</td><td>4500</td><td>4500</td></tr>
<tr><td rowspan="3">355L/A/B and 355C/D/E</td><td rowspan="3">5807/8/9T and 5810/11/12T</td><td>2</td><td>6314</td><td>27</td><td>3100</td><td>2100</td></tr>
<tr><td rowspan="2">4 – 8</td><td>6322</td><td>60</td><td>4500</td><td>4500</td></tr>
<tr><td>6319</td><td>45</td><td>4500</td><td>4500</td></tr>
<tr><td rowspan="3">400L/A/B and 400 C/D/E</td><td rowspan="3">6806/7/8T and 6809/10/11T</td><td>2</td><td>6315</td><td>30</td><td>2700</td><td>1800</td></tr>
<tr><td rowspan="2">4 – 8</td><td>6324</td><td>72</td><td>4500</td><td>4500</td></tr>
<tr><td>6319</td><td>45</td><td>4500</td><td>4500</td></tr>
<tr><td rowspan="5">450</td><td rowspan="5">7006/10</td><td>2</td><td>6220</td><td>31</td><td>2500</td><td>1400</td></tr>
<tr><td rowspan="2">4</td><td>6328</td><td>93</td><td>4500</td><td>3300</td></tr>
<tr><td>6322</td><td>60</td><td>4500</td><td>4500</td></tr>
<tr><td rowspan="2">6 – 8</td><td>6328</td><td>93</td><td>4500</td><td>4500</td></tr>
<tr><td>6322</td><td>60</td><td>4500</td><td>4500</td></tr>
<tr><td rowspan="4">500</td><td rowspan="4">8006/10</td><td rowspan="2">4</td><td>6330</td><td>104</td><td>4200</td><td>2800</td></tr>
<tr><td>6324</td><td>72</td><td>4500</td><td>4500</td></tr>
<tr><td rowspan="2">6 – 8</td><td>6330</td><td>104</td><td>4500</td><td>4500</td></tr>
<tr><td>6324</td><td>72</td><td>4500</td><td>4500</td></tr>
<tr><td rowspan="4">500</td><td rowspan="4">8006/10</td><td rowspan="2">4</td><td>6330</td><td>104</td><td>4200</td><td>2800</td></tr>
<tr><td>6324</td><td>72</td><td>4500</td><td>4500</td></tr>
<tr><td rowspan="2">6 – 8</td><td>6330</td><td>104</td><td>4500</td><td>4500</td></tr>
<tr><td>6324</td><td>72</td><td>4500</td><td>4500</td></tr>
<tr><td>560</td><td>8806/10</td><td>4 - 8</td><td rowspan="2" colspan="4">*Upon request</td></tr>
<tr><td>630</td><td>9606/10</td><td>4 - 8</td></tr>
</table>

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Table 8-4 – *Lubrication intervals for cylindrical roller bearings – HGF line*

Frame		Poles	Bearing designation	Amount of grease (g)	Lubrication intervals (hours)	
IEC	NEMA				50 Hz	60 Hz
315L/A/B and 315C/D/E	5006/7/8 and 5009/10/11	4	NU320	50	4300	2900
		6 - 8			4500	4500
355L/A/B and 355C/D/E	5807/8/9 and 5810/11/12	4	NU322	60	3500	2200
		6 - 8			4500	4500
400L/A/B and 400C/D/E	6806/7/8 and 6809/10/11	4	NU324	72	2900	1800
		6 - 8			4500	4500
450	7006/10	4	NU328	93	2000	1400
		6			4500	3200
		8			4500	4500
500	8006/10	4	NU330	104	1700	1000
		6			4100	2900
		8			4500	4500
560	8806/10	4	NU228 + 6228	75	2600	1600
		6 - 8		106	4500	4500
630	9606/10	4	NU232 + 6232	92	1800	1000
		6		120	4300	3100
		8		140	4500	4500

For each increment of 15 ºC above the room temperature, the relubrication intervals given in the Table must be halved. The relubrication interval of motors designed by the manufacturer for mounting in horizontal position, but installed in vertical position (with WEG authorization), must be halved.
For special applications, such as: high and low temperatures, aggressive environments, driven by frequency inverter (VFD – frequency inverter), etc., please contact WEG about the required amount of grease and the relubrication intervals.

8.2.1.1. Motor without grease fitting

Motors without grease fittings must be lubricated in accordance with the existing Maintenance Plan. Motor disassembly must be carried out as specified in Item 8.3. If motors are fitted with shielded bearings (for example, ZZ, DDU, 2RS, VV), these bearings must be replaced at the end of the grease service life.

8.2.1.2. Motor with grease fitting

Motors with grease fittings must be stopped to be lubricated. Proceed as follows:

- Before lubricating, clean the grease nipple and immediate vicinity thoroughly
- Lift grease inlet protection;
- Remove the grease outlet plug;
- Pump in approximately half of the total grease and run the motor for about 1 (one) minute at rated speed;
- Switch-off the motor and pump in the remaining grease;
- Lower again the grease inlet protection and reinstall the grease outlet protection

For lubrication, use only manual grease gun.

If Motors are provided with a spring device for grease removal, the grease excess must be removed by pulling the rod and cleaning the spring until the spring does not remove more grease.

8.2.1.3. Compatibility of the Mobil Polyrex EM grease with other greases

The Mobil Polyrex EM grease has a polyurea thickener and a mineral oil thus being compatible with greases that contain:
- Lithium based thickener, lithium-based complex thickener, polyurea thickener and refined mineral oil;
- The used grease must have in its formulation corrosion and oxidation inhibitors.

In general terms, greases with the same type of soap are compatible to each other. However, depending on the proportion of the mixture there may be incompatibility. In such a case, it is not recommended to mix different types of greases without contacting the supplier or WEG beforehand.

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8.2.2. Oil lubricated bearings

To change the oil of oil lubricated motor proceed as follows:
- switch-off the motor;
- remove threaded oil drain plug;
- open the valve and drain the oil;
- close the drain vale again;
- reinstall the threaded oil drain plug;
- fill-up with the type and amount of oil as specified on the nameplate;
- check oil level. The oil level is OK when the lubricant can be viewed approximately in the center of the sight glass;
- reinstall oil inlet plug;
- check for oil leaks and ensure that all not used threaded plugs are closed with plugs.

The bearing lubricating oil must be replaced as specified on the nameplate or whenever changes on the oil properties are noticed. The oil viscosity and pH must be checked periodically. The oil level must be checked every day and must be kept in the center of the sight glass.
Please contact WEG, when oils with different viscosities should be used.

Note:
The HGF vertical mounted motors with high axial thrust are supplied with grease lubricated DE-bearings and with oil lubricated NDE-bearings. The DE-bearings must be lubricated according to recommendations in item 8.2.1. Table 8-5 specifies the oil type and the amount of oil required for this motor lubrication.

Table 8-5 *– Oil properties for HGF vertical mounted motors with high axial thrust*

Mounting - High axial thrust	Frame		Poles	Bearing designation	Oil (liters)	Interval (h)	Lubricant	Lubricant specification
	IEC	NEMA						
	315L/A/B e 315C/D/E	5006/7/8T e 5009/10/11T	4 - 8	29320	20	8000	Renolin DTA 40 / SHC 629	ISO VG150 mineral oil with antifoam and antioxidant additives
	355L/A/B e 355C/D/E	5807/8/9T e 5810/11/12T	4 - 8	29320	26			
	400L/A/B e 400C/D/E	6806/7/8T e 6809/10/11T	4 - 8	29320	37			
	450	7006/10	4 - 8	29320	45			

8.2.3. Oil mist lubricated bearings

Check the service conditions of the seals and if replacement is required use only original components. Clean the seal components before assembly (bearing caps, end shields, etc.).
Apply joint sealant between the bearing caps and end shields. The joint sealant must be compatible with the used lubricating oil. Connect the oil lubricant tubes (oil inlet and oil outlet tubes and motor drain tube), as shown in Figure 6-12.

8.2.4. Sleeve bearings

The lubricating oil of sleeve bearings must be changed at the intervals specified in Table 8-6. To replace the oil, proceed as follows:
- NDE-bearing: remove the protection plate from the fan cover
- Drain the oil through the drain hole located at the bottom of the bearing (see Figure 8-1)
- Close the oil drain hole
- Remove the oil inlet plug
- Fill the sleeve bearing with the specified oil and with the amount of oil specified in
- Check the oil level and ensure it is kept close to the center of the sight glass
- Install the oil inlet plug
- Check for oil leaks

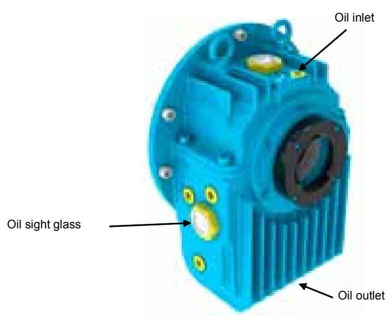

Figure 8-1 – *Sleeve bearing*

Table 8-6 *– Oil properties for sleeve bearings.*

<table>
<tr><th colspan="2">Frame</th><th rowspan="2">Poles</th><th rowspan="2">Bearing designation</th><th rowspan="2">Oil (liters)</th><th rowspan="2">Interval (h)</th><th rowspan="2">Lubricant</th><th rowspan="2">Lubricant Specification</th></tr>
<tr><th>IEC</th><th>NEMA</th></tr>
<tr><td>315L/A/B and 315C/D/E</td><td>5006/7/8T and 5009/10/11T</td><td rowspan="4">2</td><td rowspan="4">9-80</td><td rowspan="4">2.8</td><td rowspan="4">8000</td><td rowspan="4">Renolin DTA 10</td><td rowspan="4">ISO VG32 mineral oil with antifoam and antioxidant additives</td></tr>
<tr><td>355L/A/B and 355C/D/E</td><td>5807/8/9T and 5810/11/12T</td></tr>
<tr><td>400L/A/B and 400C/D/E</td><td>6806/7/8 and 6809/10/11T</td></tr>
<tr><td>450</td><td>7006/10</td></tr>
<tr><td>315L/A/B and 315C/D/E</td><td>5006/7/8T and 5009/10/11T</td><td rowspan="5">4 - 8</td><td>9-90</td><td rowspan="2">2.8</td><td rowspan="5">8000</td><td rowspan="5">Renolin DTA 15</td><td rowspan="5">ISO VG46 mineral oil with antifoam and antioxidant additives</td></tr>
<tr><td>355L/A/B and 355C/D/E</td><td>5807/8/9T and 5810/11/12T</td><td>9-100</td></tr>
<tr><td>400L/A/B and 400C/D/E</td><td>6806/7/8 and 6809/10/11T</td><td>11-110</td><td rowspan="3">4.7</td></tr>
<tr><td>450</td><td>7006/10</td><td rowspan="2">11-125</td></tr>
<tr><td>500</td><td>8006/10</td></tr>
</table>

The lubricating oil must be replaced as specified on the nameplate or whenever changes on the oil properties are noticed. The oil viscosity and pH must be checked periodically. The oil level must be checked every day and kept in the center of the sight glass.
Please contact WEG, when oils with different viscosities are to be used.

8.3. MOTOR ASSEMBLY AND DISASSEMBLY

All repair services on motors should be always performed by qualified personnel and in accordance with the applicable laws and regulations in each country. Always use proper tools and devices for motor disassembly and assembly.

Disassembly and assembly services can be carried out only after the motor has been disconnected from the power supply and is completely stopped.

Dangerous voltages may be present at the motor terminals inside the terminal box since capacitors can retain electrical charge for long periods of time even when they are not connected directly to a power source or when space heaters are connected to the motor or when the motor windings are used as space heaters. Dangerous voltages may be present at the motor terminals when they are driven by frequency inverter even when they are completely stopped.

Record the installation conditions such as terminal connection diagram, alignment / leveling conditions before starting the disassembly procedures. These records should be considered for later assembly.

Disassemble the motor carefully without causing scratches on machined surfaces or damaging the threads.

Assemble the motor on a flat surface ensuring a good support base. Footless motors must be fixed/locked on the base to prevent accidents.

Handle the motor carefully to not damage the insulated components such as windings, insulated rolling bearings, power cables etc.

Seal elements, such as joint seals and bearing seals should always be replaced when wear or damage is noticed.

Motors with degree of protection higher than IP 55 are supplied with joint and screw seal Loctite 5923 (Henkel) Clean the components and apply a new coat of Loctite 5923 on the surfaces before assembly.

8.3.1. Terminal box

Proceed as follows to remove the terminal box cover and to disconnect/connect the power supply cables and the cables of the accessory devices:

- Ensure that during the screw removal the terminal box cover does not damage the components installed inside the terminal box.
- If the terminal box cover is fitted with lifting eyebolt, lift the terminal box cover always by its lift eyebolt.
- If motors are supplied with terminal blocks, ensure the correct tightening torque on the motor terminals as specified in Table 8-7.
- Ensure that the cables do not contact sharp edges.
- Ensure that the original IP degree of protection is not changed and is maintained as indicate on the motor nameplate. The power supply cables and the control cables must always be fitted with components (cable glands, conduits) that meet the applicable standards and regulations of each country.
- Ensure that the pressure relief device is in perfect operating condition, if provided. The seals in the terminal box must be in perfect condition for reuse and must be reinstalled correctly to ensure the specified degree of protection.
- Ensure the correct tightening torque for the securing bolts of the terminal box cover as specified in Table 8-7.

Table 8-7 *– Tightening torque for the securing bolts [Nm]*

Hex bolt/hex socket bolt (without seal)	-	4 to 7	7 to 12	16 to 30	30 to 50	55 to 85	120 to 180	230 to 360
Combined slotted screw (without seal)	-	3 to 5	5 to 10	10 to 18	-	-	-	-
Hex bolt/hex socket bolt (with seal with metallic stop/cord)	-	-	-	13 to 20	25 to 37	40 to 55	50 to 65	-
Combined slotted screw (with flat seal and/or mettallic stop/ cord)	-	3 to 5	4 to 8	8 to 15	-	-	-	-
Hex bolt/hex socket bolt (with flat seal)	-	-	-	8 to 15	18 to 30	25 to 40	35 to 50	-
Terminal blocks	1 to 1,5	1,5 to 4	4 to 6,5	6,5 to 9	10 to 18	18 to 30	35 to 50	-
Grounding terminals	-	3 to 5	5 to 10	10 to 18	30 to 50	55 to 85	120 to 180	-

8.4. DRYING THE STATOR WINDING INSULATION

Dismantle the motor completely. Remove the end shields, the rotor with the shaft, the fan cover, the fan and the terminal box before the wound stator with the frame is transferred to the oven for the drying process. Store the wound stator during two hours in the oven heated to max. 120 ºC. For larger motors a longer drying time may be required. After the drying process has been concluded, allow the stator to cool to room temperature. Measure the insulation resistance again as described in item 5.4. Repeat the stator drying process if the required insulation resistance does not meet the values specified in Table 5-3. If the insulation resistance does not improve despite several drying processes, evaluate the causes of the insulation resistance drop carefully and an eventual replacement of the motor winding may be required. If in doubt contact WEG.

To prevent electrical shock, discharge the motor terminals immediately before, and after each measurement. If the motor is equipped with capacitors, these must be discharged before beginning any repair.

8.5. SPARE PARTS

When ordering spare parts, always provide complete motor designation, indicating the motor type, the code number and the serial number, which are stated on the motor nameplate.

Spare parts must always be purchased from WEG authorized Service Centers. The use of non-original spare parts can cause motor failure, performance drop and void the product warranty.

The spare parts must be stored in a clean, dry and properly ventilated room, with relative air humidity not exceeding 60%, with ambient temperature between 5°C and 40°C, free of dust, vibrations, gases, corrosive smokes and at constant temperature. The spare parts must be stored in their normal mounting position without placing other components onto them.

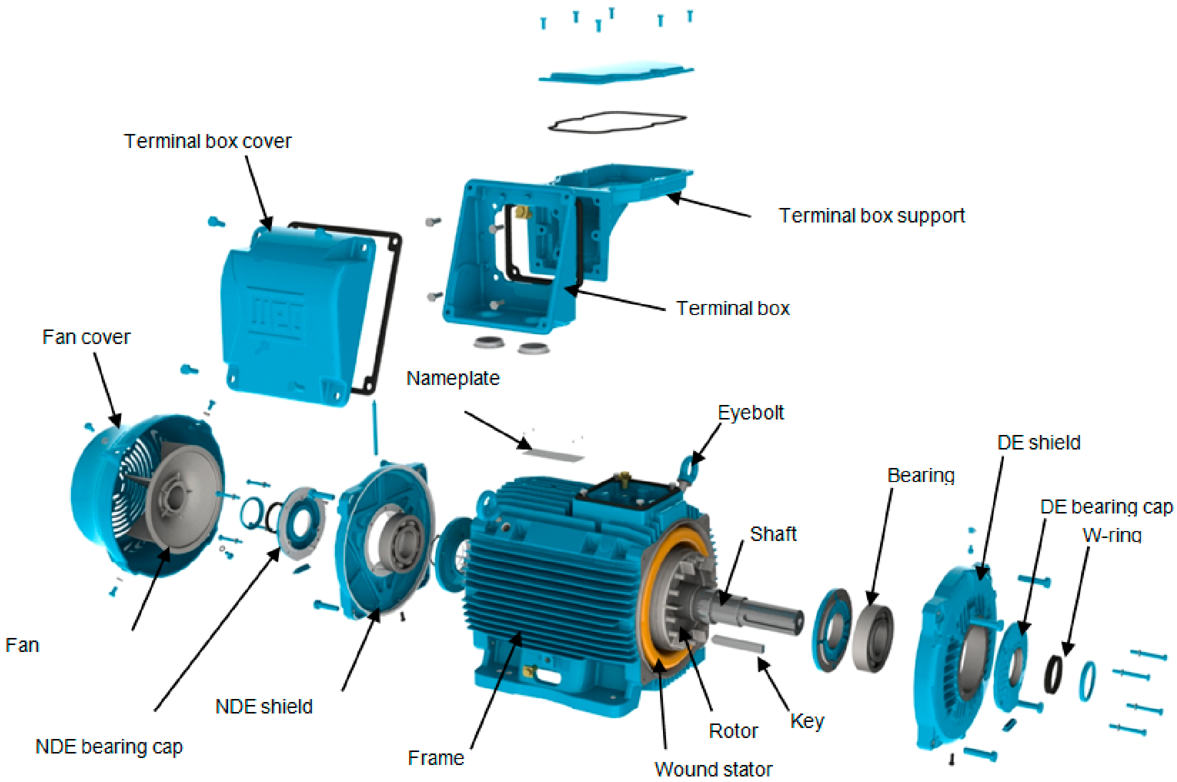

Figure 8-2 - Exploded view of the components of a W22 motor

9. ENVIRONMENTAL INFORMATION

9.1. PACKAGING

WEG electric motors are supplied in cardboard, plastic or wooden packaging. These materials can be recycled and must be disposed according to the applicable laws and regulations in each country. All wood used in the packaging of WEG motors come from the company reforestation program and is not submitted to any chemical conservation treatment.

9.2. PRODUCT

Electric motors consist mainly of ferrous metals (steel plates and cast iron), non ferrous metals (cooper and aluminum) and plastic materials.

In general, electric motors have relatively long service live. However when they must be discarded, WEG recommends to dismantle the motor, sort the different materials and send them for recycling.

No-recyclable materials should be disposed of at industrial landfills according to the applicable environmental laws and regulations in each country, or co-processed in cement kilns or incinerated.

The recycling service providers, the disposal in industrial landfills, the waste co-processing or the incineration process must be properly authorized by the state environment agency to carry out these activities.

10. TROUBLESHOOTING CHART X SOLUTIONS

This troubleshooting chart provides a basic list of problems that may occur during motor operation, possible causes and recommended corrective actions. In case of doubts, please contact WEG Service Center.

Problem	Possible cause	Corrective action
Motor does not start, neither coupled nor decoupled	Power cables are interrupted.	Check the control panel and the motor power supply cables.
	Blown fuses.	Replace blown fuses.
	Wrong motor connection.	Correct the motor connection according to connection diagram.
	Locked rotor.	Check motor shaft to ensure that it rotates freely.
The motor starts at no-load, but fails when load is applied. It starts very slowly and does not reach the rated speed.	Load toque is too high during start-up.	Do not start the motor on load.
	Too high voltage drop in the power cables	Check the installation dimensioning (transformer, cable cross section, relays, circuit breakers, etc.)
Abnormal / excessive noise	Defective transmission component or defective driven machine.	Check the transmission force, the coupling and the alignment.
	Misaligned / unleveled base.	Align / level the motor with the driven machine
	Unbalanced components or unbalanced driven machine	Balance the machine set again
	Different balancing methods used for motor and coupling balancing (halve key, full key)	Balance the motor again
	Wrong motor direction of rotation	Reverse the direction of rotation
	Loose bolts	Retighten the bolts
	Foundation resonance	Check the foundation design
	Damaged bearings	Replace the bearings
Motor overheating	Insufficient cooling	Clean air inlet and outlet and cooling fins
		Check the minimum required distance between the fan cover and nearest walls. See item 7
		Check air temperature at inlet
	Overload	Measure motor current, evaluate motor application and if required, reduce the load
	Number of starts per hour is too high or the load inertia moment is too high	Reduce the number of starts per hour
	Power supply voltage too high	Check the motor power supply voltage. Power supply voltage must not exceed the tolerance specified in item 7.2
	Power supply voltage too low	Check the motor power supply voltage and the voltage drop. Power supply voltage must not exceed the tolerance specified in item 7.2
	Interrupted power supply	Check the connection of the power cables
	Voltage unbalance at the motor terminals	Check for blown fuses, wrong commands, voltage unbalance in the power line, phase fault or interrupted power cables
	Direction of rotation is not compatible with the unidirectional fan	Check if the direction of rotation matches the rotation arrow indicated on end shield
Bearing overheating	Excessive grease / oil	Clean the bearing and lubricate it according to the provided recommendations
	Grease / oil aging	
	The used grease / oil does not matches the specified one	
	Lack of grease / oil	Lubricate the bearing according to the provided recommendations
	Excessive axial or radial forces due to the belt stretching	Reduce the belt stretching
		Reduce the load applied to the motor

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11. WARRANTY TERM

WEG Equipamentos Elétricos S/A, Motor Unit, offers warranty against defects in workmanship and materials for their products for a period of 18 months from the invoice issue date by factory or distributor / dealer, limited to 24 months from date of manufacture. Motors of the HGF Line are covered for a period of 12 months from the invoice issue date by the factory or distributor / dealer, limited to 18 months from the date of manufacture.

The paragraph above contains the legal warranty periods. If a warranty period is defined in a different way in the commercial, technical proposal of a particular sale, that will override the time limits set out above.
The periods above are independent of installation date and provided that the following requirements are met: proper transportation, handling and storage; correct installation in specified environmental conditions free of aggressive agents; operation within the capacity limits and observation of the Installation, Operation and Maintenance Manual; execution of regular preventive maintenance; execution of repairs and/or changes only by personnel with WEG's written authorization; in the occurrence of an anomaly, the product must be available to the supplier for the minimum period necessary to identify the cause of the anomaly and to repair it properly; the buyer must immediately notify WEG of any defects occurred and they must be later confirmed as manufacturing defects by WEG. The warranty does not include assembly and disassembly services at the buyer's premises, costs of product transportation, as well as travel, lodging and meals expenses for the technical assistance staff when requested by the customer. The warranty service will be provided exclusively at a WEG authorized Technical Assistance or at the plant.
Components, parts and materials whose useful life is usually less than 12 (twelve) months are not covered by the warranty.
Under no circumstance will warranty services extend the warranty period of the equipment. However, new warranty equivalent to the original one will be due only to the components repaired or replaced by WEG.
The present warranty is limited to the product supplied. WEG will not be liable for damages to people, third parties, other equipment and facilities, loss of profits or other incidental or consequential damages.

12. EC DECLARATION OF CONFORMITY

WEG Equipamentos Elétricos S/A
Av. Prefeito Waldemar Grubba, 3000
89256-900 - Jaraguá do Sul – SC – Brazil,

and its authorised representative established in the European Community,
WEGeuro – Industria Electrica SA
Rua Eng Frederico Ulrich, Apartado 6074
4476-908 – Maia – Porto – Portugal

hereby declare that the products:

WEG induction motors and components for using in these motors:

Three-phase
IEC frames 63 to 630
Nema frames 42, 48, 56 and 143 to 9610
…………..

Single-phase
IEC frames 63 to 132
Nema frames 42, 48, 56 and 143 to 215
…………..

when installed, maintained and used in applications for which they were designed, and in compliance with the relevant installation standards and manufacturer's instructions, comply with the requirements of the following European Directives and standards where applicable:

Directives:
Low Voltage Directive 2006/95/EC
Regulation (EC) No 640/2009
Directive 2009/125/EC
EMC Directive 2004/108/EC (induction motors are considered inherently benign in terms of electromagnetic compatibility)

Standards:
EN 60034-1/2-1/5/6/7/8/9/11/12/14/30 and 60204-1

From 29/12/2009 on low voltage electric motors are no longer considered under the scope of the current Machinery Directive 2006/42/EC.

CE marking in: 1996

Milton Oscar Castella
Engineering Director

Jaraguá do Sul, May 31st, 2011

ENGLISH

Manual General de Instalación, Operación y Mantenimiento de Motores Eléctricos

Este manual presenta informaciones referentes a los motores eléctricos WEG de inducción con rotor de jaula, con rotor de imanes permanentes o híbridos, de baja y alta tensión, en las carcasas IEC 56 a 630 y NEMA 42 a 9606/10.
Las líneas listadas abajo poseen informaciones adicionales, encontradas en manuales específicos:

- Motores para extracción de humo *(Smoke Extraction Motor)*;
- Motores con freno electromagnético;
- Motores para Áreas Clasificadas.

Estos productos están de acuerdo con las siguientes normas, cuando son aplicables:

- NBR 17094-1: Máquinas Eléctricas Giratorias - Motores de Inducción - Parte 1:
  - Trifásicos
- NBR 17094-2: Máquinas Eléctricas Giratorias - Motores de Inducción - Parte 1:
  - Monofásicos
- IEC 60034-1: Rotating Electrical Machines - Part 1:
  - Rating and Performance
- NEMA MG 1: Motors and Generators
- CSA C 22.2 N°100: Motors and Generatorss
- UL 1004-1: Rotating Electrical Machines – General Requirements

En caso de dudas sobre la aplicabilidad de este material, contacte a WEG.

INDICE

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1. DEFINICIONES

Balanceo: procedimiento por el cual la distribución de masa de un cuerpo es verificada y, si es necesario, ajustada para garantizar que el desbalance residual o las vibraciones y fuerzas en los cojinetes en la frecuencia de rotación mecánica estén dentro de los límites especificados en las normas internacionales.

Grado de balanceo: indica la amplitud de pico de la velocidad de vibración, expresada en mm/s, de un rotor girando libre en el espacio y es producto de un desbalance específico y la velocidad angular del rotor a la velocidad máxima de operación.

Parte puesta a tierra: partes metálicas eléctricamente conectadas al sistema de puesta a tierra.

Parte viva: Conductor o parte conductora destinada a ser energizada en condiciones normales de uso, incluyendo el conductor neutro.

Personal autorizado: trabajador que tiene anuencia formal de la empresa.

Personal capacitado: trabajador que atienda las siguientes condiciones, simultaneamente:
- reciba capacitación bajo orientación y responsabilidad de profesional habilitado y autorizado;
- bajo responsabilidad de profesional habilitado y autorizado.

Nota: *La capacitación sólo es válida para la empresa que lo capacitó y en las condiciones establecidas por el profesional habilitado y autorizado responsable por la capacitación.*

Personal habilitado: trabajador previamente calificado y con registro en el consejo de clase competente.

Personal calificado: trabajador que compruebe conclusión de curso específico en el área eléctrica por el sistema oficial de enseñanza.

2. RECOMENDACIONES INICIALES

Los motores eléctricos poseen circuitos energizados, componentes giratorios y superficies calientes, durante su operación normal, que pueden causar daños personales. De esta forma, todas las actividades relacionadas a su transporte, almacenado, instalación, operación y mantenimiento deben ser realizadas por personal capacitado.
Deben ser observadas las normas y procedimientos vigentes en el país de instalación.
La no observación de las instrucciones indicadas en este manual y demás referencias en el sitio web: www.weg.net puede resultar en serios daños personales y materiales y anular la garantía del producto.

En este manual no son presentadas todas las informaciones detalladas sobre posibles variantes constructivas ni considerados todos los casos de montaje, operación o mantenimiento. Este documento contiene informaciones necesarias para que las personas capacitadas puedan ejecutar el servicio. Las imágenes presentadas son meramente ilustrativas.

Para motores utilizados para extracción de humo (*Smoke Extraction Motors*), consulte también las instrucciones del manual 50026367 (inglés) disponible en el sitio web www.weg.net.

Para operación de motores con freno, consultar las informaciones del manual del motofreno WEG 50000701 (portugués) / 50006742 (inglés) o motofreno Intorq 50021505 (portugués) / 50021973 (inglés) disponibles en el sitio web www.weg.net.

La correcta definición de las características del ambiente y de la aplicación es de responsabilidad del usuario.

Durante el período de garantía del motor, los servicios de reparación, revisión y recuperación deben ser realizadas por Asistentes Técnicos autorizados WEG para continuidad del término de garantía.

2.1. SENALES DE ADVERTENCIA

Advertencia sobre seguridad y garantía.

2.2. VERIFICACION EN LA RECEPCION

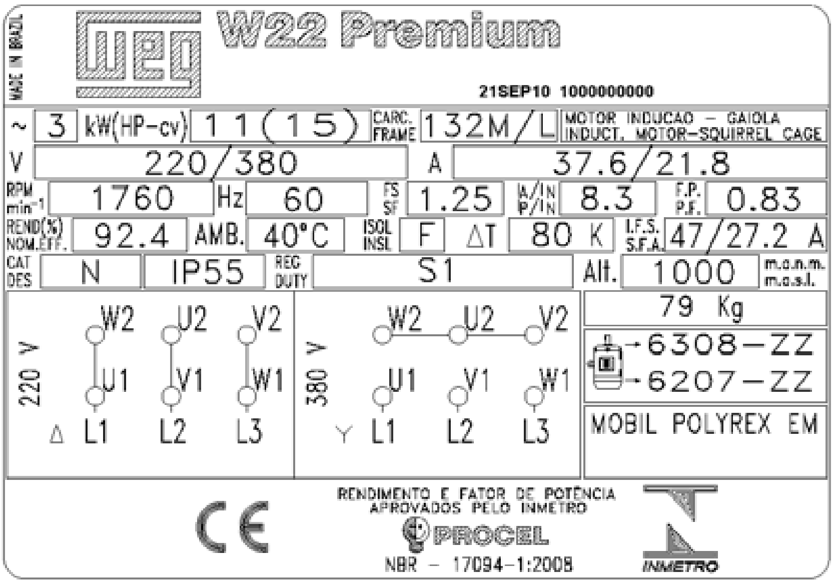
Todos los motores son testeados durante el proceso de fabricación.
En la recepción del motor, verifique si ocurrieron daños durante el transporte. Ante la ocurrencia de cualquier daño, regístrelo por escrito junto al agente transportador, y comuníquelo inmediatamente a la compañía aseguradora y a WEG. La no comunicación puede resultar en la cancelación de la garantía.
Se debe realizar una inspección completa en el producto:

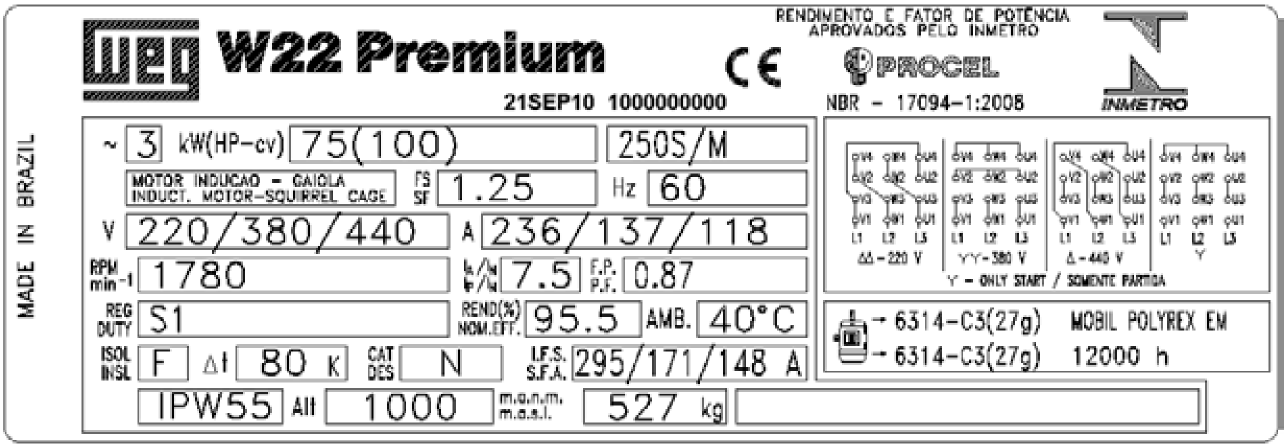
- Verifique si los datos contenidos en la placa de identificación están de acuerdo con el pedido de compra;
- Remueva los dispositivos de trabado del eje (en caso que existan) y gire manualmente el eje para verificar si el mismo gira libremente.
- Asegúrese que el motor no haya sido expuesto a polvareda y humedad excesiva durante el transporte.

No remueva la grasa de protección de la punta del eje, ni los tapones que cierran los agujeros de la caja de conexión, si existen. Estos ítems de protección deben ser mantenidos hasta que la instalación completa sea concluída.

2.3. PLACAS DE IDENTIFICACION

La placa de identificación contiene las informaciones que describen las características constructivas y el desempeño del motor. En la Figura 2-1 y Figura 2-2 son presentados ejemplos de diseños de placas de identificación.





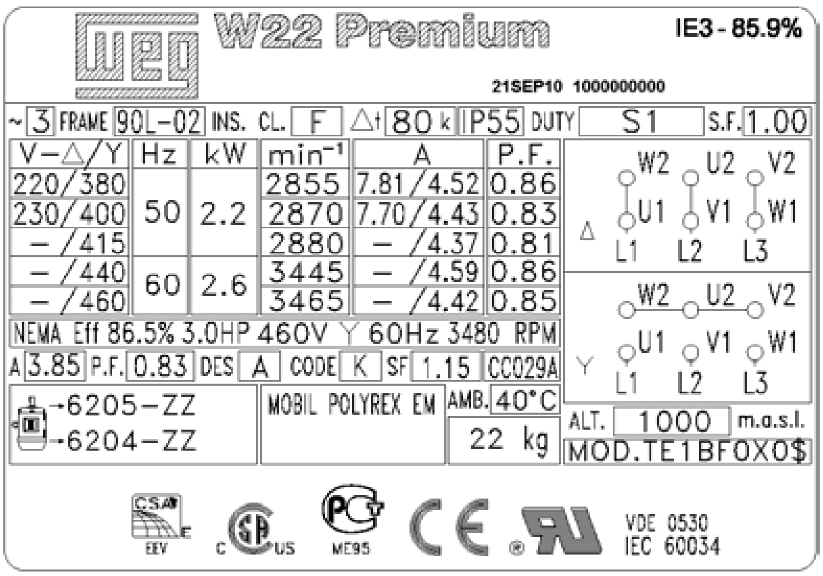


***Figura 2.1** - Placa de identificación de motores IEC*

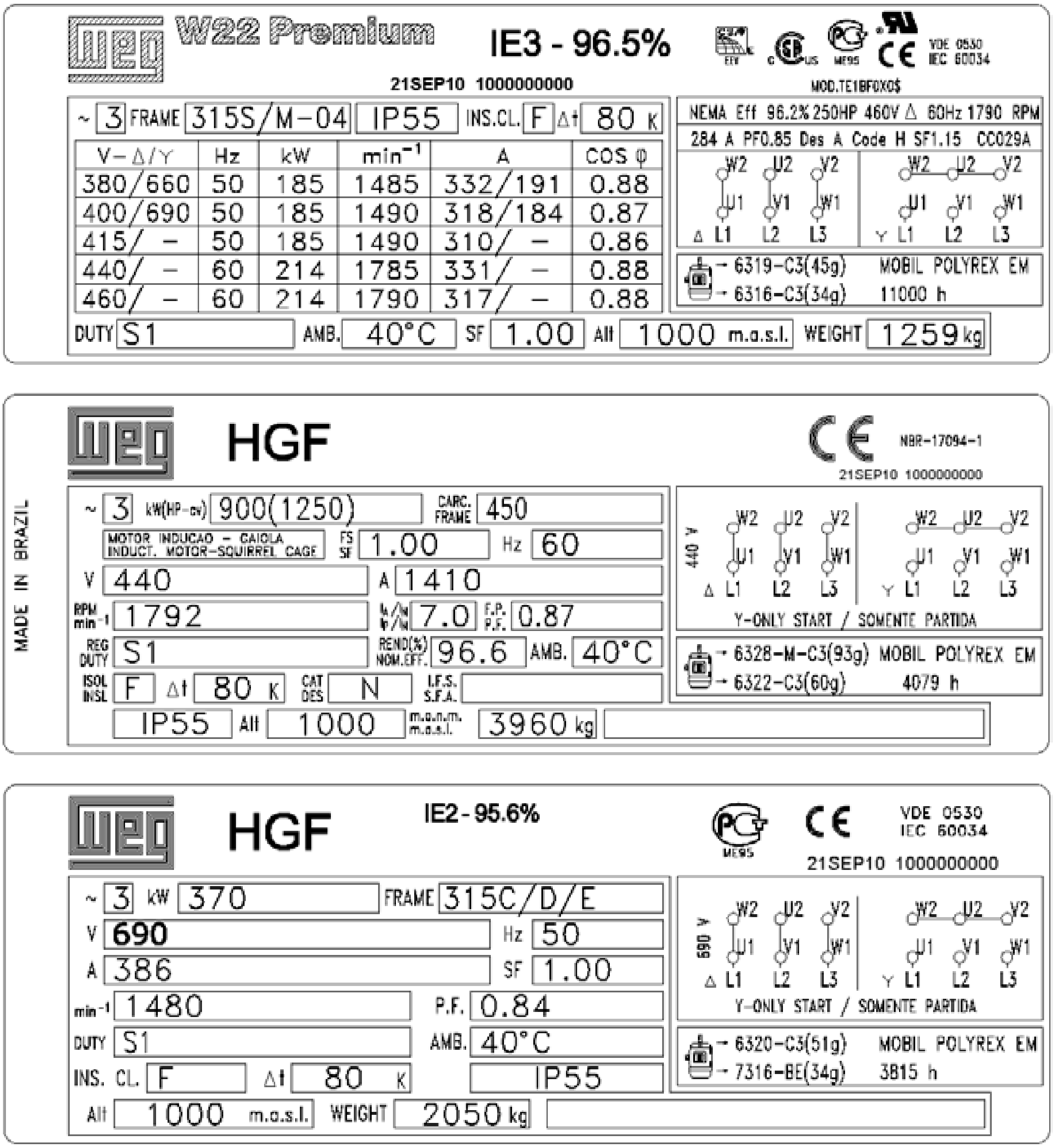


Figura 2.1 *- Placa de identificación de motores IEC*

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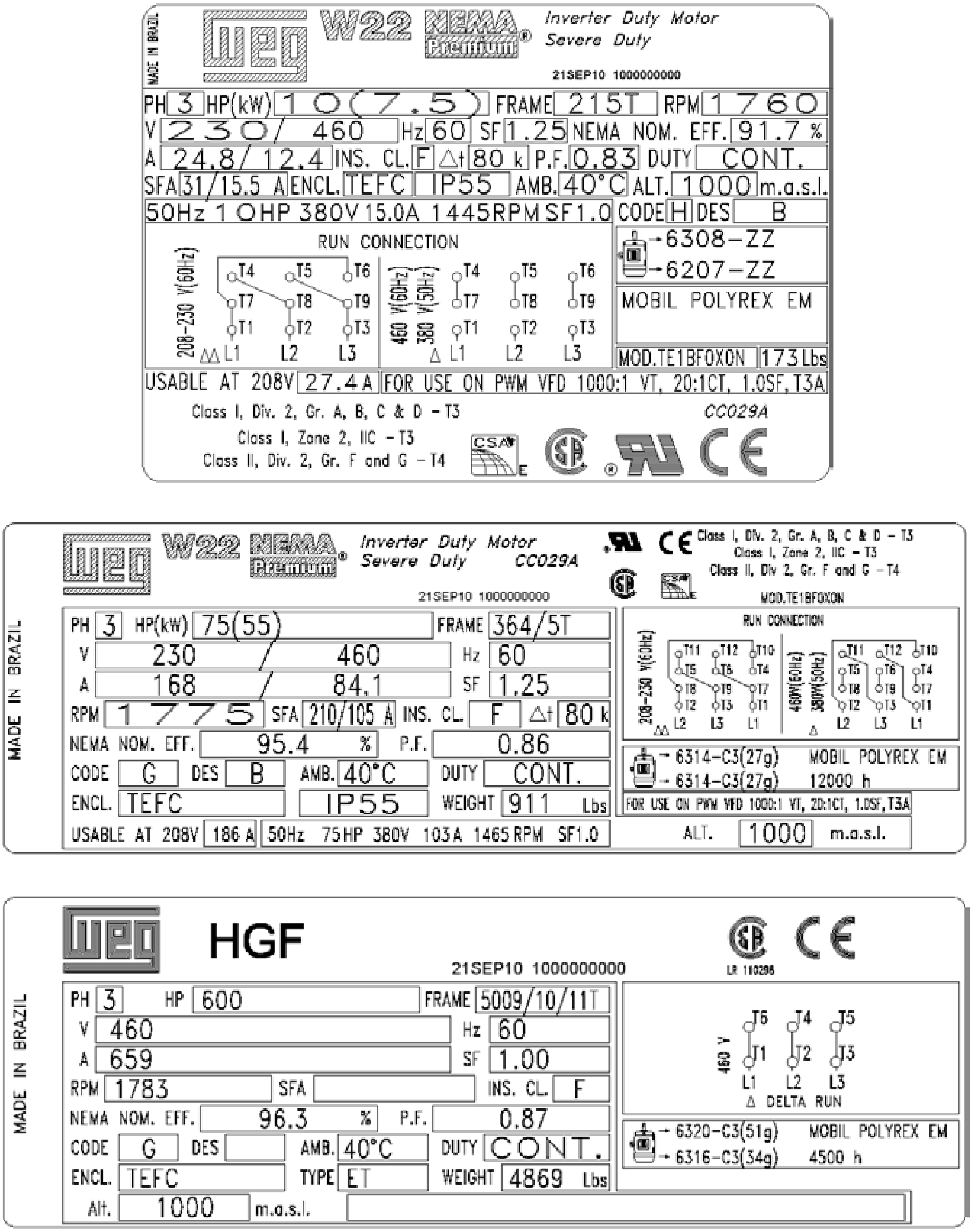

Figura 2.2 - *Placa de identificación de motores NEMA*

3. SEGURIDAD

Durante la instalación y mantenimiento, los motores deben estar desconectados de la red, completamente parados y deben ser tomados cuidados adicionales para evitar partidas accidentales.

Los profesionales que trabajan en instalaciones eléctricas, sea en el montaje, en la operación o en el mantenimiento, deben utilizar herramientas apropiadas y ser instruidos sobre la aplicación de las normas y prescripciones de seguridad, inclusive sobre el uso de Equipamientos de Protección Individual (EPI), los que deben ser cuidadosamente observados.

Los motores eléctricos poseen circuitos energizados, componentes giratorios y superficies calientes, durante su operación normal, que pueden causar daños personales. De esta forma, todas las actividades relacionadas a su transporte, almacenado, instalación, operación y mantenimiento deben ser realizadas por personal capacitado.

Deben ser seguidas las instrucciones sobre seguridad, instalación, mantenimiento e inspección de acuerdo con las normas vigentes en cada país.

4. MANIPULACION Y TRANSPORTE

Los motores embalados individualmente no deben ser izados por el eje o por el embalaje, sino por el(los) ojal(es) de izamiento (cuando existan) y con dispositivos adecuados. Los ojales de izamiento son dimensionados para soportar tan solo la masa del motor indicada en la placa de identificación. Los motores suministrados en palés deben ser izados por la base de palé.
El embalaje no debe ser tumbado bajo ninguna circunstancia.

No utilice los ojales de izamiento para suspender el motor en conjunto con otros equipamientos, como por ejemplo: bases, poleas, ventiladores, bombas, reductores, etc.

No deben ser utilizados ojales damnificados, por ejemplo, con rajaduras, deformaciones, etc. Verificar sus condiciones antes de utilizarlos.

Los ojales de izamiento en componentes como tapas, kit de ventilación forzada, entre otros, deben ser utilizados solamente para el izamiento de estos componentes de manera aislada, nunca del motor completo.

Todo el movimiento debe ser realizado de forma suave, sin impactos, en caso contrario los rodamientos pueden ser dañados, así como los ojales ser expuestos a esfuerzos excesivos, pudiendo provocar el rompimiento de los mismos.

Los dispositivos de trabado del eje (utilizados para protección durante el transporte), en motores con rodamientos de rodillos o contacto angular, deben ser utilizados para todo y cualquier transporte del motor, aunque eso requiera el desplazamiento de la máquina accionada.
Todos los motores HGF, independientemente del tipo de cojinete, deben tener su rotor trabado para transporte.

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4.1. IZAMIENTO

Antes de iniciar cualquier proceso de izamiento, asegúrese de que los ojales estén adecuadamente fijados, totalmente atornillados y con su base en contacto con la superficie a ser izada, conforme Figura 4-1. La Figura 4-2 ejemplifica el uso incorrecto.
Asegúrese de que el equipamiento utilizado en el izamiento y sus dimensiones sean adecuados al tamaño del ojal y de la masa del motor.

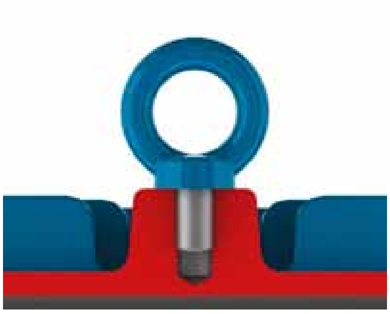

Figura 4.1 – *Manera correcta de fijación del ojal de izamiento.*

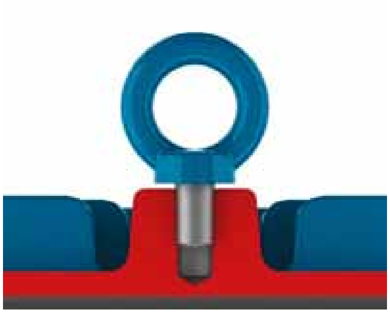

Figura 4.2 – *Manera incorrecta de fijación del ojal de izamiento.*

El centro de gravedad de los motores varía en función de la potencia y los accesorios instalados. Respete los ángulos máximos, durante el izamiento, informados en los subtópicos a seguir.

4.1.1. Motores horizontales con un ojal de izamiento

Para motores con un ojal de izamiento, el ángulo máximo resultante durante el proceso de izamiento no podrá exceder 30° en relación al eje vertical, conforme Figura 4.3.

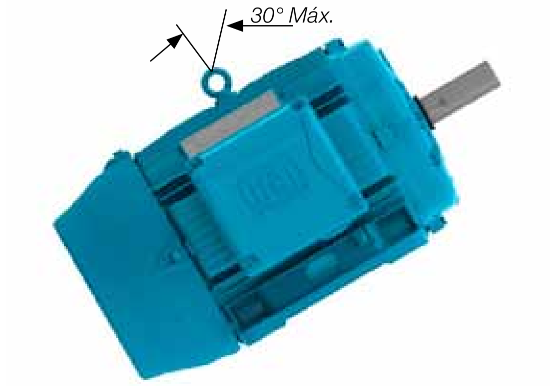

Figura 4.3 *– Ángulo máximo resultante para motores con un ojal de izamiento.*

4.1.2. Motores horizontales con dos o más ojales de izamiento

Para motores que poseen dos o más ojales para el izamiento, todos los ojales suministrados deben ser utilizados simultáneamente para el izamiento.

Existen dos disposiciones de ojales posibles (verticales e inclinados), conforme son presentadas a seguir:

- Motores con ojales verticales, conforme Figura 4.4, el ángulo máximo resultante debe ser de 45° en relación al eje vertical. Se recomienda la utilización de una barra separadora (*spreader bar*), para mantener el elemento de izamiento (corriente o cable) en el eje vertical y evitar daños a la superficie del motor.

Figura 4.4 *– Ángulo máximo resultante para motores con dos o más ojales de izamiento.*

Para motores HGF, conforme Figura 4.5, el ángulo máximo resultante debe ser de 30° en relación al eje vertical.

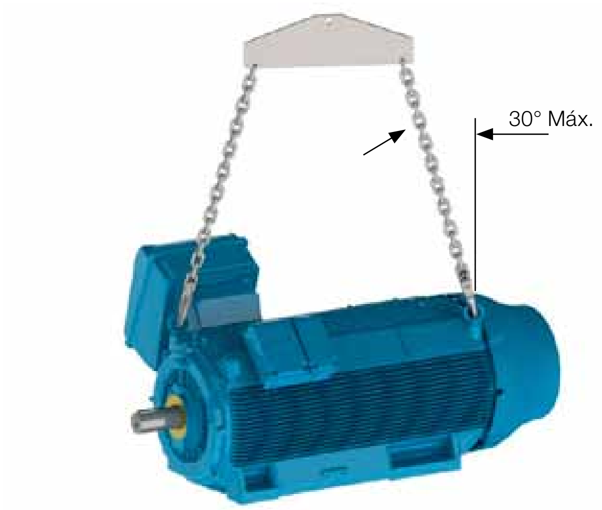

Figura 4.5 *– Ángulo máximo resultante para motores HGF horizontales.*

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- Motores con ojales inclinados, conforme Figura 4.6, es necesaria la utilización de una barra separadora *(spreader bar)*, para mantener el elemento de izamiento (corriente, cable, etc.) en el eje vertical y así también evitar daños a la superficie del motor.

Figura 4.6 – *Uso de barra separadora en el izamiento.*

4.1.3. Motores verticales

Para motores verticales, conforme Figura 4.7, es necesaria la utilización de una barra separadora *(spreader bar)*, para mantener el elemento de izamiento (corriente, cable) en el eje vertical y así también evitar daños a la superficie del motor.

Figura 4.7 *– Izamiento de motores verticales.*

Utilice siempre los ojales que están dispuestos en la parte superior del motor en relación a la posición de montaje y diametralmente opuestos. Ver Figura 4.8.

Figura 4.8 *– Izamiento de motores HGF.*

4.1.3.1. Procedimiento para colocación de motores W22 en posición vertical

De forma general, por cuestiones de seguridad durante el transporte, los motores verticales son embalados y suministrados en la posición horizontal.

Para la colocación de motores W22 con ojales inclinados (ver Figura 4.6) en la vertical, deben ser seguidos los pasos abajo descritos:

1. Asegúrese de que los ojales están adecuadamente fijos, conforme Figura 4.1;
2. Remover el motor del embalaje, utilizando los ojales superiores, conforme Figura 4.9;

Figura 4.9 *– Remoción del motor del embalaje.*

3. Instalar el segundo par de ojales, conforme Figura 4.10;

Figura 4.10 *– Instalación del segundo par de ojales.*

4. 4. Reducir la carga sobre el primer par de ojales para iniciar a rotación del motor, conforme Figura 4.11. Este procedimiento debe ser realizado de forma lenta y cautelosa.

Figura 4.11 *– Resultado final: motor posicionado de forma vertical.*

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4.1.3.2. Procedimiento para colocación de motores HGF en posición vertical

Los motores verticales HGF son suministrados con ocho puntos de izamiento, cuatro en la parte delantera y cuatro en la parte trasera, generalmente son transportados en la posición horizontal, no obstante, para la instalación precisan ser colocados en la posición vertical.

Para la colocación de motores HGF en la posición vertical, deben ser seguidos los pasos de abajo:

1. Levante el motor a través d los cuatro ojales laterales, utilizando dos grúas, ver Figura 4.12;

Figura 4.12 *– Izamiento del motor HGF utilizando dos grúas.*

2. Baje la grúa que está sujeta a la parte delantera del motor y al mismo tempo levante la grúa que está sujeta al lado trasero del motor hasta que el motor se equilibre, ver Figura 4.13.

Figura 4.13 *- Colocación de motor HGF en posición vertical.*

3. Suelte la grúa sujeta a la parte delantera del motor y gire el motor 180° para posibilitar la fijación de la grúa suelta en los otros dos ojales de la parte trasera del motor, ver Figura 4.14.

Figura 4.14 *–Suspensión de motor HGF por los ojales traseros.*

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4. Fije la grúa suelta a los otros dos ojales de la parte trasera del motor y levántela hasta que el motor quede en la posición vertical, ver Figura 4.15.

Figura 4.15 *- Motor HGF en posición vertical.*

Estos procedimientos sirven para movimientos de motores construidos con montaje en posición vertical. Estos mismos procedimientos pueden ser utilizados para la colocación del motor de posición horizontal a posición vertical y viceversa.

4.2 PROCEDIMIENTO PARA VIRADA DE MOTORES W22 VERTICALES

Para realizar la virada de motores W22 originalmente en la posición vertical, siga los pasos mostrados abajo:

1. Asegúrese que los ojales estén fijados adecuadamente, conforme ítem 4.1;

2. Instale el primer par de ojales y suspenda el motor, ver Figura 4.16;

Figura 4.16 *– Instalación del primer par de ojales.*

3. Instalar el segundo par de ojales, ver Figura 4.17;

Figura 4.17 *– Instalación del segundo par de ojales.*

4. Reduzca la carga sobre el primer par de ojales para iniciar la rotación del motor, conforme Figura 4.18. Este procedimiento debe ser realizado de forma lenta y cautelosa.

Figura 4.18 *– Motor posicionado de forma vertical.*

5. Remueva el primer par de ojales, ver Figura 4.19

Figura 4.19 *– Resultado final: motor posicionado de forma horizontal.*

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5. ALMACENADO

Si los motores no fueran instalados de inmediato, se recomienda almacenarlos en local seco con humedad relativa del aire de hasta 60%, con temperatura ambiente por encima de 5°C y por debajo de 40°C, libre de polvo, vibraciones, gases, agentes corrosivos, con temperatura uniforme, en posición normal y sin apoyar otros objetos sobre los mismos. Remueva las poleas, en caso que existan, de la punta del eje, la que debe ser mantenida libre y con grasa protectora para evitar corrosión. Los motores deben ser almacenados de tal modo que el drenaje de agua condensada sea facilitado.

En caso que el motor posea resistencia de calentamiento, ésta deberá ser energizada siempre que el motor no esté en operación. Esto se aplica también a los casos en que el motor está instalado, pero fuera de uso por un largo período. En estas situaciones, dependiendo de las condiciones del ambiente, podrá ocurrir condensación de agua en el interior del motor, provocando una caída en la resistencia de aislamiento.

Las resistencias de calentamiento nunca deben estar energizadas mientras el motor esté operando.

5.1. SUPERFICIES MECANIZADAS EXPUESTAS

Todas las superficies mecanizadas expuestas (por ejemplo, punta de eje y brida) son protegidas en la fábrica por un inhibidor de oxidación temporario. Esta película protectora debe ser reaplicada periódicamente durante el período de almacenado (por lo menos a cada seis meses) o cuando fuera removida o estuviera deteriorada.

5.2. APILAMIENTO

El apilamiento de embalajes durante el almacenado no debe sobrepasar los 5 metros de altura, obedeciendo los criterios de la Tabla 5.1:

Tabela 5.1 *- Apilamiento máximo recomendado.*

Tipo de Embalaje	Carcasas	Cantidad máxima de apilamiento
Caja de Cartón	IEC 63 a 132 NEMA 143 a 215	Indicada en la pestaña superior de la caja de cartón
Jaula de madera	IEC 63 a 315 NEMA 48 a 504/5	06
	IEC 355 NEMA 586/7 y 588/9	03
	HGF IEC 315 a 630 HGF NEMA 5000 a 9600	Indicado en el propio embalaje

Notas:
1) No apile embalajes mayores sobre menores.
2) Posicione correctamente un embalaje sobre el otro (ver Figura 5.1 y Figura 5.2).

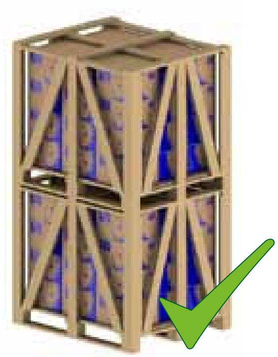

Figura 5.1 *- Montaje adecuado.*

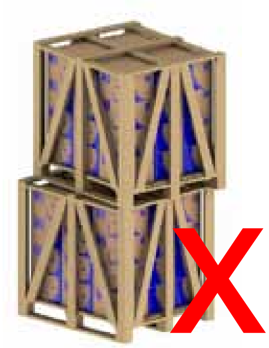

Figura 5.2 *- Montaje inadecuado.*

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3) Las patas de los embalajes superiores deben estar apoyadas sobre calces de madera (Figura 5.3) no sobre cintas de acero ni pueden permanecer sin apoyo (Figura 5.4).

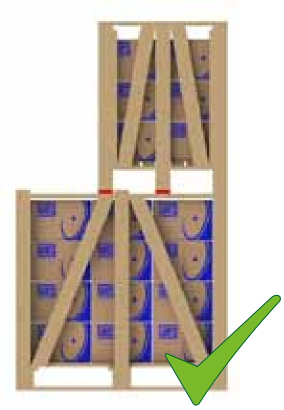

Figura 5.3 *- Apilamiento adecuado.*

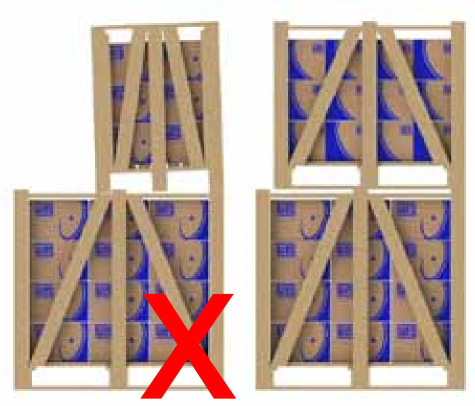

Figura 5.4 *- Apilamiento inadecuado.*

4) Para el apilamiento de un volumen menor sobre un volumen mayor, agregue varas transversales entre los mismos cuando el mayor no ofrezca resistencia al peso del menor (ver Figura 5.5). Esta situación normalmente ocurre con los volúmenes de los motores de carcasa por encima de la IEC 225S/M (NEMA 364/5T).

Figura 5.5 *- Utilización de varas adicionales para apilamiento.*

5.3. COJINETES

5.3.1. Cojinetes de rodamiento lubricados a grasa

Se recomienda girar el eje del motor por lo menos una vez al mes (manualmente, al menos cinco vueltas, dejando el eje en posición diferente de la original). Obs.: en caso que el motor posea dispositivo de trabado del eje, el mismo debe ser retirado antes de girar el eje y ser colocado una vez más antes de levantar el motor.
Los motores verticales pueden ser almacenados en posición vertical o en posición horizontal.
Para motores con rodamiento abierto almacenados por más de seis meses, los rodamientos deben ser relubricados, conforme el ítem 8.2, antes de la entrada en operación.
En caso que el motor permanezca almacenado por un período superior a dos años, se recomienda sustituir los rodamientos, o de otra forma, deben ser removidos, lavados, inspeccionados y relubricados conforme el ítem 8.2.

5.3.2. Cojinetes de rodamiento con lubricación a aceite

El motor debe ser almacenado en su posición original de funcionamiento, y con aceite en los cojinetes. El nivel de aceite debe ser respetado, permaneciendo en la mitad del visor de nivel.
Durante el período de almacenado, se debe, retirar el dispositivo de trabado del eje y, mensualmente, rotar el eje manualmente cinco vueltas, para hacer circular el aceite y conservar el cojinete en buenas condiciones. Siendo necesario mover el motor, el dispositivo de trabado del eje debe ser reinstalado.
Para motores almacenados por más de seis meses, los rodamientos deben ser relubricados, conforme el ítem 8.2, antes de su puesta en operación.
En caso que el motor permanezca almacenado por un período superior a dos años, se recomienda sustituir los rodamientos o entonces removerlos, lavarlos, inspeccionarlos y relubricarlos conforme el ítem 8.2.
El aceite de los cojinetes de los motores verticales, que son transportados en posición horizontal, es retirado para evitar derramamiento durante el transporte. Tras la recepción, estos motores deben ser puestos en posición vertical y sus cojinetes deben ser lubricados.

5.3.3. Cojinetes de rodamiento con lubricación de tipo Oil Mist

El motor debe ser almacenado en su posición horizontal. Rellene los cojinetes con aceite mineral ISO VG 68 con la cantidad de aceite indicada en la Tabla 5.2 (también válida para rodamientos con dimensiones equivalentes). Tras a colocación de aceite en los cojinetes, gire el eje (como mínimo cinco vueltas).
Durante el período de almacenado, se debe retirar el dispositivo de trabado del eje (cuando es suministrado) y semanalmente rotar el eje manualmente 5 vueltas, dejando el mismo en posición diferente de la original. Siendo necesario mover el motor, el dispositivo de trabado del eje debe ser reinstalado.
En caso que el motor permanezca almacenado por un período superior a dos años, se recomienda sustituir los rodamientos o entonces removerlos, lavarlos, inspeccionarlos y relubricarlos conforme el ítem 8.2.

Tabela 5.2 - *Cantidad de aceite por rodamiento*

Tamaño de Rodamiento	Cantidad de Aceite (ml)	Tamaño de Rodamiento	Cantidad de Aceite (ml)
6201	15	6309	65
6202	15	6311	90
6203	15	6312	105
6204	25	6314	150
6205	25	6315	200
6206	35	6316	250
6207	35	6317	300
6208	40	6319	350
6209	40	6320	400
6211	45	6322	550
6212	50	6324	600
6307	45	6326	650
6308	55	6328	700

Durante cualquier manipulación del motor, los cojinetes deben estar sin aceite. De esa forma, antes de la entrada en operación, todo el aceite de los cojinetes debe ser drenado. Luego de la instalación, en caso que el sistema de niebla no esté en operación, el aceite debe ser recolocado para garantizar la conservación del cojinete. En este caso, se debe también proceder con el giro semanal del eje.

5.3.4. Cojinetes de deslizamiento

El motor debe ser almacenado en su posición original de funcionamiento, y con aceite en los cojinetes. El nivel de aceite debe ser respetado, permaneciendo en la mitad del visor de nivel.
Durante el período de almacenado, se debe, retirar el dispositivo de trabado del eje y, mensualmente, rotar el eje manualmente 5 vueltas, para hacer circular el aceite y conservar el cojinete en buenas condiciones. En caso que sea necesario mover el motor, el dispositivo de trabado del eje debe ser reinstalado.
Para motores almacenados por más de seis meses, los rodamientos deben ser relubricados, conforme el ítem 8.2, antes de su puesta en operación.
En caso que el motor permanezca almacenado por un período mayor que el intervalo de cambio de aceite, o no sea posible rotar el eje del motor, el aceite debe ser drenado y debe ser aplicada una protección anticorrosiva y deshumidificadores.

5.4. RESISTENCIA DE AISLAMIENTO

Se recomienda medir periódicamente la resistencia de aislamiento de los motores, para de esa forma evaluar las condiciones de almacenado bajo el punto de vista eléctrico. Si fueran observadas caídas en los valores de Resistencia de Aislamiento, las condiciones del almacenado deben ser analizadas, evaluadas y corregidas, cuando sea necesario.

5.4.1. Procedimiento para medición de la resistencia de aislamiento

La medición de la resistencia de aislamiento debe ser realizada en área segura.

La resistencia de aislamiento debe ser medida con un megóhmetro y con el motor parado, frío y completamente desconectado de la red eléctrica.

Para evitar el riesgo de shock eléctrico, descargue los terminales inmediatamente antes y después de cada medición. En caso que el motor posea capacitores, éstos deben ser descargados.

Es recomendable que cada fase sea aislada y testeada separadamente, permitiendo que sea hecha una comparación entre la resistencia de aislamiento entre cada fase. Para testear una de las fases, las demás fases deben estar puestas a tierra.
El test de todas las fases simultáneamente evalúa solamente la resistencia de aislamiento contra tierra. En este caso no es evaluada la resistencia de aislamiento entre las fases.
Los cables de alimentación, llaves, condensadores, y otros equipamientos externos conectados al motor pueden influenciar considerablemente la medición de la resistencia de aislamiento. Al realizar estas mediciones, todos los equipamientos externos deben estar desconectados y puestos a tierra.
La lectura de la resistencia de aislamiento debe ser realizada luego de ser aplicada la tensión ser por el período de un minuto (1 min). La tensión a ser aplicada debe obedecer la Tabla 5.3.

Tabela 5.3 *– Tensión para medición de la resistencia de aislamiento.*

Tensión nominal del motor (V)	Tensión aplicada para la medición de la resistencia de aislamiento (V)
< 1000V	500
1000 - 2500	500 - 1000
2501 - 5000	1000 - 2500
5001 - 12000	2500 - 5000
> 12000	5000 - 10000

La medición de la resistencia de aislamiento debe ser corregida para la temperatura de 40°C conforme Tabla 5.4.

Tabela 5.4 *- Factor de Corrección de la Resistencia de Aislamiento para 40°C.*

Temperatura de Medición de la Resistencia de Aislamiento (°C)	Factor de corrección de la Resistencia de Aislamiento para 40°C	Temperatura de Medición de la Resistencia de Aislamiento (°C)	Factor de corrección de la Resistencia de Aislamiento para 40°C
10	0,125	30	0,500
11	0,134	31	0,536
12	0,144	32	0,574
13	0,154	33	0,616
14	0,165	34	0,660
15	0,177	35	0,707
16	0,189	36	0,758
17	0,203	37	0,812
18	0,218	38	0,871
19	0,233	39	0,933
20	0,250	40	1,000
21	0,268	41	1,072
22	0,287	42	1,149
23	0,308	43	1,231
24	0,330	44	1,320
25	0,354	45	1,414
26	0,379	46	1,516
27	0,406	47	1,625
28	0,435	48	1,741
29	0,467	49	1,866
30	0,500	50	2,000

La condición del aislamiento del motor deberá ser evaluada comparándose el valor medido con los valores de la Tabla 5 5 (referenciados a 40°C):

Tabela 5.5 *– Avaliação do sistema de isolamento.*

Valor Límite para tensión nominal hasta 1,1 kV (MΩ)	Valor Límite para tensión nominal por encima de 1,1 kV (MΩ)	Situación
Hasta 5	HASTA 100	Peligroso, el motor no debe operar en esa condición.
Entre 5 y 100	Entre 100 y 500	Regular
Entre 100 y 500	Por encima de 500	Bueno
Por encima de 500	Por encima de 1000	Excelente

Los dados indicados en la tabla sirven simplemente como valores de referencia. Se sugiere mantener el histórico de la resistencia de aislamiento del motor durante toda su vida.
Si la resistencia de aislamiento estuviera baja, el estator del motor puede estar húmedo. En ese caso, se recomienda llevarlo a un Asistente Técnico Autorizado WEG para que sean realizadas la evaluación y la reparación adecuadas. Este servicio no está cubierto por el Término de Garantía.
Para procedimiento de adecuación de la resistencia de aislamiento, ver ítem 8.4.

6. INSTALACION

La instalación de motores debe ser hecha por profesionales capacitados con conocimientos sobre las normas y las prescripciones de seguridad.

Antes de continuar con el procedimiento de instalación deben ser evaluados algunos puntos:

1. Resistencia de aislamiento: debe estar dentro de los valores aceptables. Ver ítem 5.4.
2. Cojinetes:
   a. rodamientos: si presentan señales de oxidación, deben ser sustituidos. En caso que no presenten oxidación, realice el procedimiento de relubricación conforme es descrito en el ítem 8.2. Motores almacenados por un período superior a dos años deben tener sus rodamientos sustituidos antes de ser puestos en operación.
   b. cojinetes de deslizamiento: para motores almacenados por un período igual o mayor que el intervalo de cambio de aceite, deben tener su aceite sustituido. En caso que el aceite haya sido retirado, es necesario retirar el deshumificador y recolocar el aceite en el cojinete. Por mayores informaciones vea el ítem 8.2.
3. Condición de los condensadores de partida: para motores monofásicos almacenados por un período mayor a dos años, es recomendado que sus condensadores de partida sean sustituidos.
4. Caja de conexión:
   a. deben estar limpias y secas en su interior.
   b. los elementos de contacto deben estar libres de oxidación y correctamente conectados. Ver ítems 6.9 y 6.10.
   c. las entradas de cables no utilizadas deben estar correctamente selladas, la tapa de la caja de conexión debe ser cerrada y los sellados deben estar en condiciones apropiadas para atender el grado de protección del motor.
5. Ventilación: las aletas, la entrada y la salida de aire deben estar limpias y desobstruidas. La distancia de instalación recomendada entre las entradas de aire del motor y la pared no debe ser inferior a ¼ (un cuarto) del diámetro de la entrada de aire. Se debe asegurar espacio suficiente para la realización de servicios de limpieza. Ver ítem 7.
6. Acoplamiento: remover el dispositivo de trabado del eje (si existe) y la grasa de protección contra corrosión de la punta del eje y de la brida solamente puco antes de instalar el motor. Ver ítem 6.4.
7. Drenaje: Siempre deben estar posicionados de forma que el drenaje sea facilitado (en el punto más bajo. En caso que exista una flecha indicadora, el drenaje debe ser montado para que la misma apunte hacia abajo).
   Para motores con grado de protección IP55, los drenajes de goma (si están disponibles) pueden permanecer en la posición abierta (ver Figura 6.1).
   Para grados de protección más elevados (por ejemplo, IP56, IP65 y IP66), los drenajes (independientemente del tipo) deben permanecer en la posición cerrada (ver Figura 6.2), siendo abiertos solamente durante el mantenimiento del motor para permitir el drenaje del agua condensada (ver ítem 8.1).
   Los motores con lubricación de tipo Oil Mist deben tener sus drenajes conectados a un sistema de recolección específico (ver Figura 6.12).

Figura 6.1 - Detalle del drenaje de goma montado en la posición abierto.

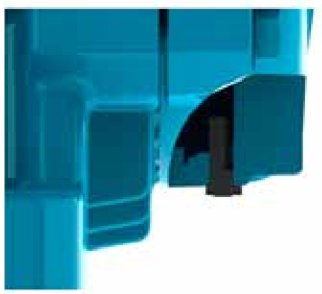

***Figura 6.2** - Detalle del drenaje de goma montado en posición cerrado.*

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8. Recomendaciones adicionales
   a. verifique el sentido de rotación del motor, encendiéndolo a vacío antes de acoplarlo a la carga.
   b. para motores montados en posición vertical con la punta de eje hacia abajo, se recomienda el uso de sombrerete para evitar a penetración de cuerpos extraños en el interior del motor.
   c. para motores montados en la posición vertical con la punta de eje hacia arriba, se recomienda el uso de un deflector de agua *(water slinger ring)* para evitar la penetración de agua por el eje.

Remueva o fije completamente la chaveta antes de encender el motor.

6.1. CIMIENTOS PARA EL MOTOR

El cimiento es el elemento estructural, base natural o preparada, destinada a soportar los esfuerzos producidos por los equipamientos instalados, permitiendo la operación de éstos con estabilidad, desempeño y seguridad.
El proyecto de cimientos debe considerar las estructuras adyacentes para evitar influencia de un equipamiento sobre el otro, a fin de que no ocurra propagación de vibraciones.

Los cimientos deben ser planos y su elección, detallado y ejecución, exige las características:

a) De la construcción del propio equipamiento, implicando no solamente los valores y forma de actuación de las cargas, sino que también su finalidad y los límites máximos de las deformaciones y vibraciones compatibles en cada caso (ejemplo, motores con valores reducidos de: nivel de vibración, planicidad de las patas, concentricidad de la brida, pulso de la brida, etc.); .

b) De las construcciones vecinas, comprendiendo el estado de conservación, estimativa de las cargas máximas aplicadas, tipo de cimiento y fijación empleadas, así como los niveles de vibración transmitidos por estas construcciones.

Cuando el motor sea suministrado con tornillo de alineamiento/nivelación, deberá ser prevista en la base una superficie que permita el alineamiento/nivelación.

Los esfuerzos generados durante la operación, por la carga accionada, deben ser considerados como parte del dimensionamiento de los cimientos.
El usuario es totalmente responsable por el proyecto, preparación y ejecución de los cimientos.

Los motores pueden ser montados sobre:
- Bases de concreto: más recomendadas y usuales para los motores de gran porte (ver Figura 6.3);
- Bases metálicas: más comunes para motores de pequeño porte (ver Figura 6.4).

Figura 6.3 *– Motor instalado sobre base de concreto.*

Figura 6.4 *– Motor instalado sobre base metálica.*

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En las bases metálicas y de concreto puede existir un sistema de deslizamiento. Normalmente son utilizados en aplicaciones en que el accionamiento ocurre por poleas y correas. Son más flexibles permitiendo montajes y desmontajes más rápidas, además de permitir ajustes en la tensión de la correa. Otro aspecto importante es la posición de los tornillos de trabado de la base, que deben ser opuestos y en posición diagonal. El riel más cercano a la polea motora es colocado de forma que el tornillo de posicionamiento permanezca entre el motor y la máquina accionada. El otro riel debe ser colocado con el tornillo en posición opuesta (diagonal), como es presentado en la Figura 6.5.

Para facilitar el montaje, las bases pueden poseer características como:
- resaltes y/o huecos;
- tornillos de anclaje con placas sueltas;
- tornillos fundidos en el concreto;
- tornillos de nivelación;
- tornillos de posicionamiento;
- bloques de hierro o de acero, placas con superficies planas.

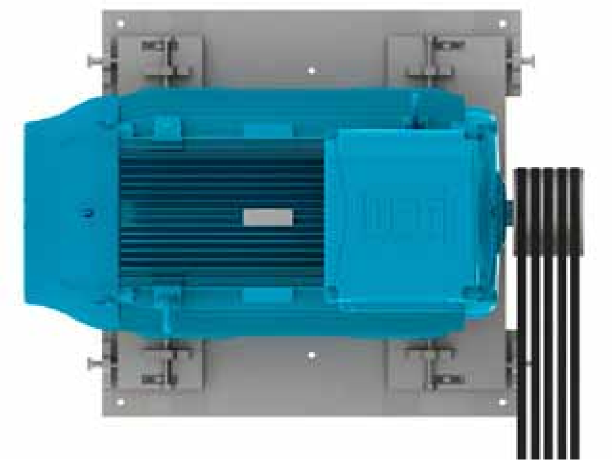

Figura 6.5 *– Motor instalado sobre base deslizante.*

También se recomienda que luego de la instalación del motor, las partes metálicas expuestas sean protegidas contra oxidación.

6.2. FIJACION DEL MOTOR

6.2.1. Fijación por las patas

El dimensional de la perforación de las patas, basado en las normas IEC o NEMA, es informado en el catálogo técnico del producto.
El motor debe ser apoyado sobre la base, alineado y nivelado a fin de que no provoque vibraciones ni esfuerzos excesivos en el eje o en los cojinetes. Para más detalles, consulte El ítem 6.3 y 6.6.
Se recomienda que el tornillo de fijación tenga longitud roscada libre de 1,5 veces el diámetro del tornillo. En aplicaciones severas, puede ser necesaria la utilización de una longitud roscada libre mayor. La Figura 6.4 representa la fijación del motor con patas indicando la longitud libre mínima del tornillo.

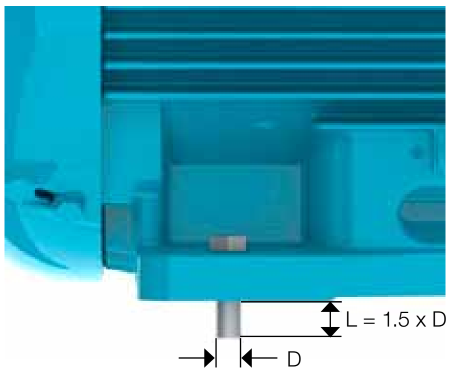

Figura 6.6 *– Representación de la fijación del motor por patas.*

6.2.2. Fijación por brida

El dimensional de la brida, basado en las normas IEC o NEMA, es informado en el catálogo electrónico o en el catálogo técnico del producto.
La brida del motor debe ser apoyada en la base, que debe poseer un dimensional de encaje adecuado para el tamaño de la brida del motor y así asegurar la concentricidad del conjunto.
Dependiendo del tipo de brida, la fijación puede ser realizada desde el motor hacia la base (brida FF(IEC) o D (NEMA)) o desde la base hacia el motor (brida C (DIN o NEMA)).
Para fijación desde la base hacia el motor, la determinación de la longitud del tornillo debe tomar en consideración la espesura de la base del usuario y la profundidad de la rosca de la brida del motor.

En los casos que el agujero de la brida es pasante, la longitud del tornillo de fijación del motor no debe exceder la longitud roscada de la brida para evitar contacto con la bobina del motor.

Para fijación del motor a la base, se recomienda que el tornillo de fijación tenga longitud roscada libre de 1,5 veces el diámetro del tornillo. En aplicaciones severas, puede ser necesaria la utilización de una longitud roscada libre mayor.
Para fijación de motores de gran porte y/o en aplicaciones severas, se recomienda que, además de la fijación por brida, el motor sea apoyado (por patas o pad). El motor nunca puede ser apoyado sobre sus aletas. Ver Figura 6.7.

Figura 6.7 *– Representación de la fijación del motor con brida y apoyo en la base de la carcasa.*

Para aplicación de motores con la presencia de líquidos en el interior de la brida (ej.: aceite), el sellado del motor debe ser adecuado para impedir la penetración de líquidos en el interior del motor.

6.2.3. Fijación por pad

Este tipo de fijación es normalmente utilizado en ductos de ventilación. La fijación del motor es hecha a través de perforaciones roscadas en la estructura del motor, cuyo dimensional es informado en el catálogo electrónico o en el catálogo técnico del producto.
El dimensionamiento de la varilla de fijación/tornillo del motor debe tomar en consideración el dimensional del ducto de ventilación o base de instalación y la profundidad de la rosca en el motor. Las varillas de fijación y la pared del ducto deben tener rigidez suficiente para evitar la vibración excesiva del conjunto (motor y ventilador).
La Figura 6.8 representa la fijación por pad's.

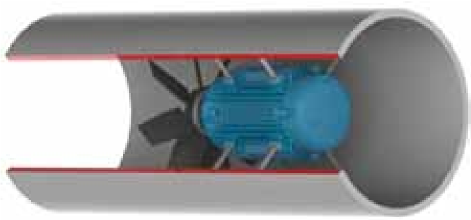

Figura 6.8 *– Representación de la fijación del motor en el interior de un ducto de ventilación.*

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6.3. BALANCEO

Equipamientos desbalanceados generan vibraciones que pueden causar daños al motor. Los motores WEG son balanceados dinámicamente con “media chaveta” en vacío (desacoplados). Deben ser solicitados balanceos especiales en el momento de la compra.

Los elementos de transmisión tales como poleas, acoplamientos, etc., deben ser balanceados antes de ser instalados en los ejes de los motores.

El grado de calidad de balanceo del motor sigue las normas vigentes para cada línea de producto.

Se recomienda que los desvíos máximos de balanceo sean registrados en el informe de instalación.

6.4. ACOPLAMIENTOS

Los acoplamientos son utilizados para la transmisión del torque del motor hacia la máquina accionada. Al utilizar un acoplamiento, deben ser observados los tópicos abajo:

- Utilice herramientas apropiadas para el montaje y desmontaje de los acoplamientos y así evitar daños al motor.
- Se recomienda la utilización de acoplamientos flexibles, capaces de absorber pequeños desalineamientos durante la operación del equipamiento.
- Las cargas máximas y límites de velocidad informados en los catálogos de los fabricantes de los acoplamientos y del motor no deben ser excedidos.
- Realice la nivelación y el alineamiento del motor conforme ítems 6.5 y 6.6, respectivamente.

Los motores accionados sin elementos de transmisión acoplados deben tener su chaveta firmemente fijada o removida, para prevenir accidentes.

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6.4.1. Acoplamiento directo

Cuando el eje del motor está acoplado directamente al eje de la carga accionada, sin el uso de elementos de transmisión, presenta acoplamiento directo. El acoplamiento directo ofrece menor costo, mayor seguridad contra accidentes y ocupa menos espacio.

En aplicaciones con acoplamiento directo, se recomienda el uso de rodamientos de esferas.

6.4.2. Acoplamiento por engranaje

El acoplamiento por engranajes es utilizado cuando existe la necesidad de una reducción de velocidad.
Es imprescindible que los ejes estén perfectamente alineados, rigurosamente paralelos (en caso de engranajes rectos) y en el ángulo de engranaje (en caso de engranajes cónicos o helicoidales).

6.4.3. Acoplamiento por poleas y correas

Es un tipo de transmisión utilizado cuando existe la necesidad de una relación de velocidades entre el motor y la carga accionada.

Una tensión excesiva en las correas damnifica los rodamientos y puede provocar la ruptura del eje del motor.

6.4.4. Acoplamiento de motores equipados con cojinetes de deslizamiento

Los motores equipados con cojinetes de deslizamiento deben estar acoplados directamente a la máquina accionada o por medio de un reductor. Los cojinetes de deslizamiento no permiten el acoplamiento a través de poleas y correas.

Los motores equipados con cojinetes de deslizamiento poseen 3 (tres) marcas en la punta del eje, donde la marca central es la indicación del centro magnético y las otras 2 (dos) marcas externas indican los límites de movimiento axial permitidos para el rotor, conforme Figura 6.9.
El motor debe ser acoplado de manera que la flecha fijada en la carcasa del cojinete quede posicionada sobre la marca central, cuando el motor esté en operación. Durante la partida, o incluso en operación, el rotor puede moverse libremente entre las dos ranuras externas, en caso que la máquina accionada ejerza algún esfuerzo axial sobre el eje del motor. No obstante, el motor no puede operar de manera constante con esfuerzo axial sobre el cojinete, bajo ningún concepto.

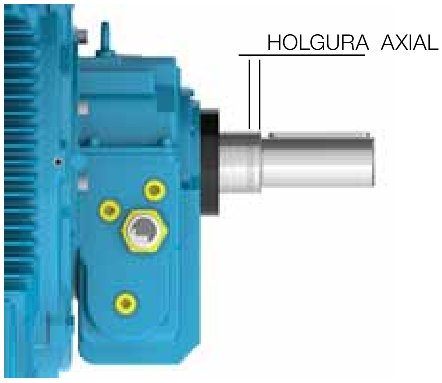

Figura 6.9 *- Holgura axial en motor equipado con cojinete de deslizamiento.*

Al evaluar el acoplamiento, se debe considerar la holgura axial máxima del cojinete conforme la Tabla 6.1. Las holguras axiales de la máquina accionada y del acoplamiento influencian en la holgura máxima del cojinete.

Tabela 6.1 *Holguras utilizadas en cojinetes de deslizamiento.*

Tamaño del cojinete	Holgura axial total (mm)
9*	3 + 3 = 6
11*	4 + 4 = 8
14*	5 + 5 =10
18	7,5 + 7,5 = 15

** para motores conforme la norma API 541, la holgura axial total es 12.7 mm.*

Los cojinetes de deslizamiento utilizados por WEG no fueron proyectados para soportar un esfuerzo axial continuo. La operación continua de la máquina, en sus límites de holgura axial, no es recomendada.

6.5. NIVELACION

La nivelación del motor debe ser realizada para corregir eventuales desvíos de planicidad, que puedan existir provenientes de otros procesos y acomodaciones de los materiales. La nivelación puede ser realizada por medio de un tornillo de nivelación fijado a la pata o brida del motor, o por medio de finas chapas de compensación. Tras la nivelación, la diferencia de altura entre la base de fijación del motor y el motor no debe exceder 0,1 mm.
En caso que sea utilizada una base metálica para ajustar la altura de la punta de eje del motor con la punta de eje de la máquina accionada, ésta debe ser nivelada en la base de concreto.
Se recomienda que los desvíos máximos de nivelación sean registrados y almacenados en el informe de instalación.

6.6. ALINEAMIENTO

El alineamiento entre la máquina motora y la accionada es una de las variables que más contribuyen para prolongar la vida del motor. El desalineamiento entre los acoplamientos genera elevadas cargas que reducen la vida útil de los cojinetes, provocan vibraciones y, en casos extremos, pueden causar la ruptura del eje. La Figura 6.10 ilustra el desalineamiento entre el motor y el equipamiento accionado.

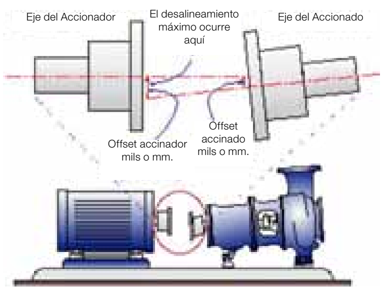

Figura 6.10 *– Condición típica de desalineamiento.*

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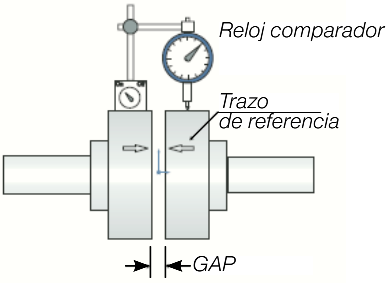
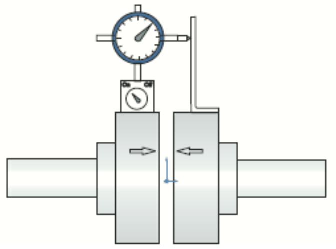
Para efectuar un buen alineamiento del motor, se deben utilizar herramientas y dispositivos adecuados, tales como reloj comparador, instrumento de alineamiento a laser, entre otros. El eje debe ser alineado axialmente y radialmente con el eje de la máquina accionada

El valor leído en relojes comparadores para el alineamiento, de acuerdo con la Figura 6.11, no debe exceder 0,03 mm, considerando un giro completo del eje. Debe existir una holgura entre los acoplamientos, para compensar la dilatación térmica de los ejes, conforme especificación del fabricante del acoplamiento.



Alineamiento paralelo



Alineamiento angular

***Figura 6.11** – Alineamiento con reloj comparador*

En caso que el alineamiento sea realizado a través de un instrumento a laser, deben ser seguidas las instrucciones y recomendaciones suministradas por el fabricante del instrumento.

La verificación del alineamiento debe ser realizada a temperatura ambiente y a la temperatura de trabajo de los equipamientos.

Es recomendado que el alineamiento de los acoplamientos sea verificado periódicamente.

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Para acoplamiento por poleas y correas, el alineamiento debe ser realizado de tal modo que el centro de la polea motora esté en el mismo plano del centro de la polea movida y los ejes del motor y de la máquina estén perfectamente paralelos.

Luego de la realización de los procedimientos descritos anteriormente, se debe certificar que los dispositivos de montaje del motor no permitan alteraciones en el alineamiento y en la nivelación y no causen daños al equipamiento.

Se recomienda que los desvíos máximos de alineamiento sean registrados y almacenados en el informe de instalación.

6.7. CONEXION DE MOTORES LUBRICADOS A ACEITE O DE TIPO OIL MIST

En motores con lubricación a aceite o de tipo *oil mist*, se debe conectar los tubos de lubricación existentes (entrada, salida del cojinete y drenaje del motor), conforme es indicado en la Figura 6.12.
El sistema de lubricación debe garantizar lubricación continua del cojinete, de acuerdo con las especificaciones del fabricante de este sistema.

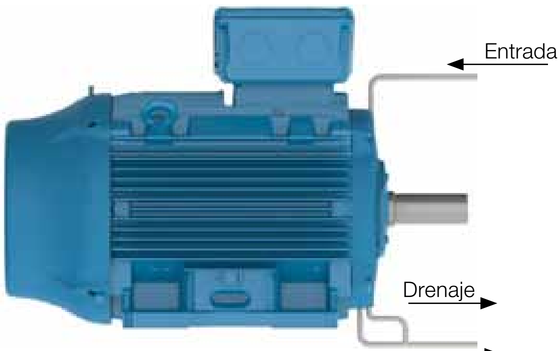


***Figura 6.12** – Sistema de alimentación y drenaje para motores lubricados por aceite o de tipo Oil Mist.*

6.8. CONEXION DEL SISTEMA DE REFRIGERACION A AGUA

En motores con refrigeración a agua, debe ser prevista la instalación de ductos en la entrada y salida de agua del motor para garantizar su refrigeración. Se debe observar, conforme el ítem 7.2, el flujo mínimo y la temperatura del agua en la instalación.

6.9. CONEXION ELECTRICA

Para el dimensionamiento de los cables de alimentación y dispositivos de maniobra y protección deben ser considerados: corriente nominal del motor, factor de servicio, corriente de partida, condiciones del ambiente y de la instalación, la máxima caída de tensión, etc. conforme las normas vigentes.

Todos los motores deben ser instalados con sistemas de protección contra sobrecarga. Para motores trifásicos se recomienda la instalación de sistemas de protección contra falta de fase.

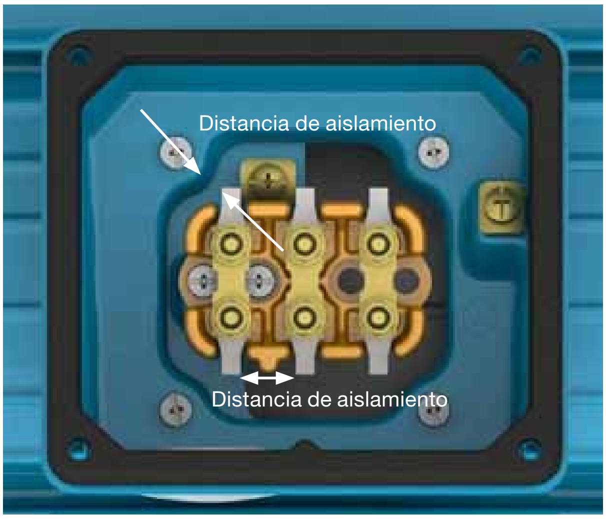
Antes de conectar el motor, verifique si la tensión y la frecuencia de la red son las mismas marcadas en la placa de identificación del motor. Siga el diagrama de conexión indicado en la placa de identificación del motor.
Para evitar accidentes, verifique si la puesta a tierra fue realizada conforme las normas vigentes.

Asegúrese que el motor esté conectado correctamente a la red de alimentación eléctrica a través de contactos seguros y permanentes.

Para motores sin placa de bornes, aísle los cables terminales del motor, utilizando materiales aislantes compatibles con la tensión de alimentación y con la clase de aislamiento informada en la placa de identificación.

Para la conexión del cable de alimentación y del sistema de puesta a tierra deben ser respetados los torques de apriete indicados en la Tabla 8.7.

La distancia de aislamiento (ver Figura 6.13) entre partes vivas no aisladas entre sí y entre partes vivas y partes puestas a tierra debe respetar los valores indicados en la Tabla 6.2.



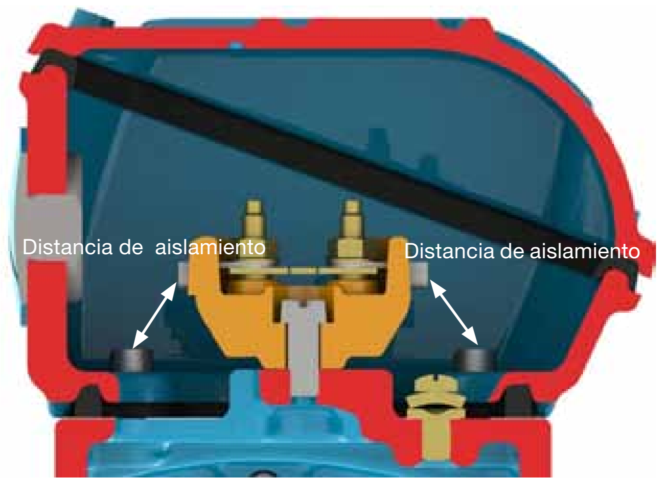


Figura 6.13 *- Representación de la distancia de aislamiento.*

Tabela 6.2 *- Distancia mínima de aislamiento (mm) x tensión de alimentación.*

Tensión	Distancia mínima de aislamiento (mm)
U ≤ 440 V	4
440 < U ≤ 690V	5.5
690 < U ≤ 1000V	8
1000 < U ≤ 6900V	45
6900 < U ≤ 11000V	70
11000<U ≤ 16500V	105

Aunque el motor esté apagado, puede existir energía eléctrica en el interior de la caja de conexión utilizada para la alimentación de las resistencias de calentamiento o inclusive para energizar el devanado, cuando éste esté siendo utilizado como elemento de calentamiento.
Los condensadores de motores pueden retener energía eléctrica, incluso con el motor apagado. No toque los condensadores ni los terminales del motor sin antes verificar la existencia de tensión en los mismos.

Luego de efectuar la conexión del motor, asegúrese de que ningún cuerpo extraño haya permanecido en el interior de la caja de conexión.

Las entradas de la(s) caja(s) de conexión deben ser cerradas/protegidas para de esa forma garantizar el grado de protección del indicado en la placa de identificación del motor.
Las entradas de cables utilizadas para alimentación y control deben emplear componentes (como, por ejemplo, prensacables y electroductos) que cumplan las normas y reglamentaciones vigentes en cada país.

En caso que existan accesorios, como freno y ventilación forzada, los mismos deben ser conectados a la red de alimentación, siguiendo las informaciones de sus placas de identificación y los cuidados indicados anteriormente.

Todas las protecciones, inclusive las contra sobretensión, deben ser ajustadas tomando como base las condiciones nominales de la máquina. Esta protección también tendrá que proteger el motor en caso de cortocircuito, falta de fase, o rotor bloqueado.
Los ajustes de los dispositivos de seguridad de los motores deben ser hechos según las normas vigentes.

Verifique el sentido de rotación del motor. En caso que no haya ninguna limitación debido a la utilización de ventiladores unidireccionales, es posible cambiar el sentido de giro de motores trifásicos, invirtiendo dos fases de alimentación. Para motores monofásicos, verifique el esquema de conexión en la placa de identificación.

6.10. CONEXION DE LOS DISPOSITIVOS DE PROTECCIÓN TERMICA

Cuando es suministrado con dispositivos de protección o de monitoreo de temperatura, como: protector térmico bimetálico (termostatos), termistores, protectores térmicos del tipo Automático, PT-100 (RTD), etc., sus terminales deben ser conectados a los dispositivos de control correspondientes, de acuerdo con las placas de identificación de los accesorios. La no observación de este procedimiento puede resultar en la cancelación de la garantía y riesgo para la instalación.

No aplique tensión de test superior a 2,5 V para termistores y corriente mayor a 5 mA para RTDs (PT-100).

El esquema de conexión de los protectores térmicos bimetálicos (termostatos) y termistores es mostrado en la Figura 6.14 y Figura 6.15, respectivamente.

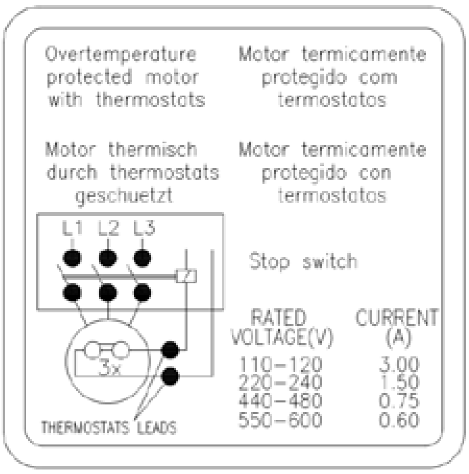


Figura 6.14 - Conexión de los protectores térmicos bimetálicos (termostatos).

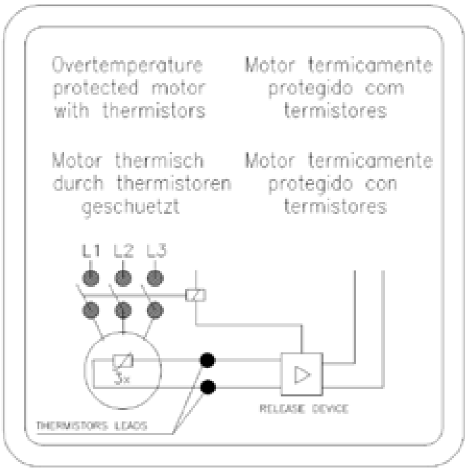


Figura 6.15 *- Conexión de los termistores.*

Los límites de temperatura de alarma y apagado de las protecciones térmicas pueden ser definidos de acuerdo con la aplicación, no obstante, no deben sobrepasar los valores indicados en la Tabla 6.3.

Tabela 6.3 *- Temperatura máxima de actuación de las protecciones térmicas.*

Componente	Clase de Aislamiento	Temperatura máxima de operación (°C)	
		Alarma	Apagado
Devanado	B	-	130
	F	130	155
	H	155	180
Cojinete	Todas	110	120

Notas:
1) La cantidad y el tipo de protección térmica instalados en el motor son informados en las placas de identificación de los accesorios del mismo.
2) En el caso de protección térmica con resistencia calibrada (por ejemplo, PT-100), el sistema de protección debe ser ajustado a la temperatura de operación indicada en la Tabla 6.3.

6.11. TERMORESISTORES (PT-100)

Son elementos, cuya operación está basada en la característica de variación de la resistencia con la temperatura, intrínseca en algunos materiales (generalmente platina, níquel o cobre).
Poseen resistencia calibrada, que varía linealmente con la temperatura, posibilitando un acompañamiento continuo del proceso de calentamiento del motor por el display del controlador, con alto grado de precisión y sensibilidad de respuesta. Su aplicación es amplia en los diversos sectores de técnicas de medición y automatización de temperatura de las industrias. Generalmente, se aplica en instalaciones de gran responsabilidad como, por ejemplo, en régimen intermitente muy irregular. El mismo detector puede servir tanto para alarma como para apagado.
La equivalencia entre la resistencia del PT-100 y la temperatura es presentada en la Tabla 6.4 y Figura 6.16.

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Tabela 6.4 - *Equivalencia entre la resistencia del PT-100 y la temperatura.*

°C	Ω	°C	Ω	°C	Ω	°C	Ω	°C	Ω
-29	88.617	17	106.627	63	124.390	109	141.908	155	159.180
-28	89.011	18	107.016	64	124.774	110	142.286	156	159.553
-27	89.405	19	107.404	65	125.157	111	142.664	157	159.926
-26	89.799	20	107.793	66	125.540	112	143.042	158	160.298
-25	90.193	21	108.181	67	125.923	113	143.420	159	160.671
-24	90.587	22	108.570	68	126.306	114	143.797	160	161.043
-23	90.980	23	108.958	69	126.689	115	144.175	161	161.415
-22	91.374	24	109.346	70	127.072	116	144.552	162	161.787
-21	91.767	25	109.734	71	127.454	117	144.930	163	162.159
-20	92.160	26	110.122	72	127.837	118	145.307	164	162.531
-19	92.553	27	110.509	73	128.219	119	145.684	165	162.903
-18	92.946	28	110.897	74	128.602	120	146.061	166	163.274
-17	93.339	29	111.284	75	128.984	121	146.438	167	163.646
-16	93.732	30	111.672	76	129.366	122	146.814	168	164.017
-15	94.125	31	112.059	77	129.748	123	147.191	169	164.388
-14	94.517	32	112.446	78	130.130	124	147.567	170	164.760
-13	94.910	33	112.833	79	130.511	125	147.944	171	165.131
-12	95.302	34	113.220	80	130.893	126	148.320	172	165.501
-11	95.694	35	113.607	81	131.274	127	148.696	173	165.872
-10	96.086	36	113.994	82	131.656	128	149.072	174	166.243
-9	96.478	37	114.380	83	132.037	129	149.448	175	166.613
-8	96.870	38	114.767	84	132.418	130	149.824	176	166.984
-7	97.262	39	115.153	85	132.799	131	150.199	177	167.354
-6	97.653	40	115.539	86	133.180	132	150.575	178	167.724
-5	98.045	41	115.925	87	133.561	133	150.950	179	168.095
-4	98.436	42	116.311	88	133.941	134	151.326	180	168.465
-3	98.827	43	116.697	89	134.322	135	151.701	181	168.834
-2	99.218	44	117.083	90	134.702	136	152.076	182	169.204
-1	99.609	45	117.469	91	135.083	137	152.451	183	169.574
0	100.000	46	117.854	92	135.463	138	152.826	184	169.943
1	100.391	47	118.240	93	135.843	139	153.200	185	170.313
2	100.781	48	118.625	94	136.223	140	153.575	186	170.682
3	101.172	49	119.010	95	136.603	141	153.950	187	171.051
4	101.562	50	119.395	96	136.982	142	154.324	188	171.420
5	101.953	51	119.780	97	137.362	143	154.698	189	171.789
6	102.343	52	120.165	98	137.741	144	155.072	190	172.158
7	102.733	53	120.550	99	138.121	145	155.446	191	172.527
8	103.123	54	120.934	100	138.500	146	155.820	192	172.895
9	103.513	55	121.319	101	138.879	147	156.194	193	173.264
10	103.902	56	121.703	102	139.258	148	156.568	194	173.632
11	104.292	57	122.087	103	139.637	149	156.941	195	174.000
12	104.681	58	122.471	104	140.016	150	157.315	196	174.368
13	105.071	59	122.855	105	140.395	151	157.688	197	174.736
14	105.460	60	123.239	106	140.773	152	158.061	198	175.104
15	105.849	61	123.623	107	141.152	153	158.435	199	175.472
16	106.238	62	124.007	108	141.530	154	158.808	200	175.840

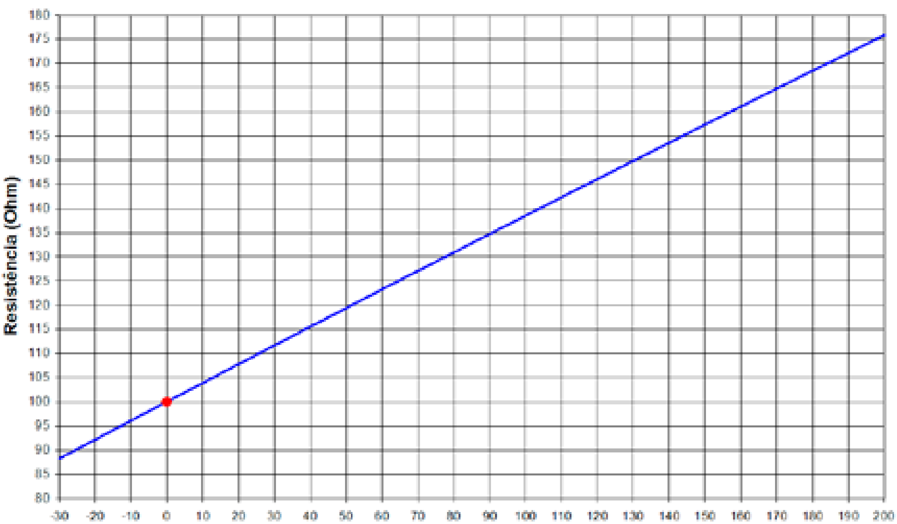

Figura 6.16 *– Resistencia óhmica del PT-100 - temperatura.*

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6.12. METODOS DE PARTIDA

Siempre que sea posible, la partida del motor debe ser directa (en plena tensión). Es el método más simple, sin embargo, solamente es viable cuando la corriente de partida no afecta la red de alimentación. Es importante seguir las reglas vigentes de la concesionaria de energía eléctrica.
En los casos en que la corriente de partida del motor es alta, pueden ocurrir las siguientes consecuencias:
a) Elevada caída de tensión en el sistema de alimentación de la red, provocando interferencia en los equipamientos instalados en este sistema;
b) El superdimensionamiento del sistema de protección (cables, contactores), lo que eleva los costos de la instalación.
En caso que la partida directa no sea posible debido a los problemas citados arriba, se puede usar el método de partida indirecta compatible con la carga y la tensión del motor, para reducir la corriente de partida.
Cuando es utilizado un método de partida con tensión reducida, el torque de partida del motor también será reducido.

La Tabla 6.5 indica los métodos de partida indirecta posibles de ser utilizados, de acuerdo con la cantidad de cables del motor.

Tabela 6.5 *- Métodos de partida - cantidad de cables.*

Cantidad de cables	Métodos de partidas posibles
3 cables	Llave Compensadora Soft – Starter
6 cables	Llave Estrella - Triángulo Llave Compensadora Soft - Starter
9 cables	Llave Serie - Paralela Llave Compensadora Soft - Starter
12 cables	Llave Estrella - Triángulo Llave Serie - Paralela Llave Compensadora Soft - Starter

La Tabla 6.6 indica ejemplos de métodos de partida indirecta posibles de ser utilizados, de acuerdo con la tensión indicada en la placa de identificación del motor y la tensión de la red eléctrica.

Tabela 6.6 *- Métodos de partida x tensión.*

Tensión de la placa de identificación	Tensión de Servicio	Partida con llave Estrella - Triángulo	Partida con llave Compensadora	Partida con llave Serie - Paralela	Partida con Soft-Starter
220/380 V	220 V 380 V	SÍ NO	SÍ SÍ	NO NO	SÍ SÍ
220/440 V	220 V 440 V	NO NO	SÍ SÍ	SÍ NO	SÍ SÍ
230/460 V	230 V 460 V	NO NO	SÍ SÍ	SÍ NO	SÍ SÍ
380/660 V	380 V	SÍ	SÍ	NO	SÍ
220/380/440 V	220 V 380 V 440 V	SÍ NO SÍ	SÍ SÍ SÍ	SÍ SÍ NO	SÍ SÍ SÍ

Los motores WQuattro deben ser accionados directamente a partir de la red o por convertidor de frecuencia en modo escalar.

Otro método de partida posible que no sobrecargue la red de alimentación es la utilización de un convertidor de frecuencia. Para más informaciones sobre motores alimentados con convertidor de frecuencia ver ítem 6.13.

6.13. MOTORES ALIMENTADOS POR CONVERTIDOR DE FRECUENCIA

La operación con convertidor de frecuencia debe ser informada en el momento de la compra debido a posibles diferencias constructivas necesarias para ese tipo de accionamiento.

Los motores Wmagnet deben ser accionados solamente por convertidor de frecuencia WEG.

El convertidor utilizado para accionar motores con tensión de alimentación hasta 690V debe poseer modulación PWM con control vectorial.

Cuando un motor opera con convertidor de frecuencia por debajo de la frecuencia nominal, es necesario reducir el torque suministrado por el motor, a fin de evitar sobrecalentamiento. Los valores de reducción de torque *(derating torque)* pueden ser encontrados en el ítem 6.4 de la "Guía Técnica Motores de Inducción Alimentados por Convertidores de Frecuencia PWM" disponible en www.weg.net.

Para operación por encima de la frecuencia nominal debe ser observado:
- Operación con potencia constante;
- El motor puede suministrar como máximo 95% de la potencia nominal;
- Respetar la rotación máxima, considerando los siguientes criterios:
  - máxima frecuencia de operación informada en la placa adicional;
  - límite de rotación mecánica del motor.
  - torque máximo del motor, conforme la ecuación:

$$\text{Rotación máxima} = \frac{\text{Rotación nominal x Cmáx/Cn}}{1.5}$$

Los recomendaciones para los cables de conexión entre motor y convertidor son indicadas en el ítem 6.8 de la "Guía Técnica de Motores de Inducción alimentados por Convertidores de Frecuencia PWM" disponible en www.weg.net.

6.13.1. Uso de Filtros (dV/dt)

6.13.1.1. Motor con alambre circular esmaltado

Los motores con tensión nominal de hasta 690 V, cuando son alimentados por convertidores de frecuencia, no requieren filtros, cuando son observados los criterios de abajo:

Criterios para utilización de motores de alambre circular esmaltado alimentados por convertidor de frecuencia [1]				
Tensión de operación del motor[2]	**Tensión de pico en el motor (máx.)**	**dV/dt en la salida del convertidor (máx.)**	**Rise Time[3] del convertidor (mín.)**	**MTBP[3] Tiempo entre pulsos (min)**
Vnon ≤ 460 V	≤ 1600 V	≤ 5200 V/µs	≥ 0,1 µs	≥ 6 µs
460 < Vnon ≤ 575 V	≤ 1800 V	≤ 6500 V/µs		
575 < Vnon ≤ 690 V[4]	≤ 1600 V	≤ 5200 V/µs		
575 < Vnon ≤ 690 V[5]	≤ 2200 V	≤ 7800 V/µs		

1. Para motores con alambre circular esmaltado con tensión 690 < Vnon ≤ 1100 V, consulte a WEG.
2. Para motores con doble tensión, ejemplo 380/660V, deben ser observados los criterios de la tensión menor (380V).
3. Informaciones suministradas por el fabricante del convertidor.
4. Cuando no es informado en el momento de la compra que el motor operará con convertidor de frecuencia.
5. Cuando es informado en el momento de la compra que el motor operará con convertidor de frecuencia.

6.13.1.2. Motor con bobina preformada

Los motores con bobina preformada (media tensión, independientemente del tamaño de la carcasa y baja tensión a partir de la carcasa IEC 500 / NEMA 80) especificados para utilización con convertidor de frecuencia no requieren filtros, si son observados los criterios de la Tabla 6.7.

Tabela 6.7 - Criterios para utilización de motores con bobina preformada alimentados con convertidor de frecuencia.

Tensión de operación del motor	Tipo de modulación	Aislamiento de la espira (fase-fase)		Aislamiento principal (fase-tierra)	
		Tensión de pico en los terminales del motor	dV/dt en los terminales del motor	Tensión de pico en los terminales del motor	dV/dt en los terminales del motor
690 < Vnon ≤ 4160 V	Senoidal	≤ 5900 V	≤ 500 V/µs	≤ 3400 V	≤ 500 V/µs
	PWM	≤ 9300 V	≤ 2700 V/µs	≤ 5400 V	≤ 2700 V/µs
4160 < Vnon ≤ 6600 V	Senoidal	≤ 9300 V	≤ 500 V/µs	≤ 5400 V	≤ 500 V/µs
	PWM	≤ 12700 V	≤ 1500 V/µs	≤ 7400 V	≤ 1500 V/µs

6.13.2. Aislamiento de los Cojinetes

Como modelo, solamente motores en carcasa IEC 400 (NEMA 68) y superiores son suministrados con cojinete aislado. Se recomienda aislar los cojinetes para operación con convertidor de frecuencia de acuerdo con la Tabla 6.8.

Tabela 6.8 - Recomendación sobre el aislamiento de los cojinetes para motores accionados por convertidor de frecuencia.

Carcasa	Recomendación
IEC 315 e 355 NEMA 445/7, 447/9, L447/9, 504/5, 5006/7/8, 5009/10/11, 586/7, 5807/8/9, 5810/11/12 e 588/9	Un cojinete aislado Puesta a tierra entre eje y carcasa por medio de escobilla
IEC 400 y superior NEMA 6800 y superior	Cojinete trasero aislado Puesta a tierra entre eje y carcasa por medio de escobilla

Para motores suministrados con sistema de puesta a tierra del eje, debe ser observado constantemente el estado de conservación de la escobilla y, al llegar al fin de su vida útil, la misma debe ser sustituida por otra de su misma calidad.

6.13.3. Frecuencia de Conmutación

La frecuencia mínima de conmutación del convertidor deberá ser de 2,5 kHz.
Se recomienda que la frecuencia máxima de conmutación del convertidor sea de 5 kHz.

La no observación de los criterios y recomendaciones expuestos en este manual puede resultar en la anulación de la garantía del producto.

6.13.4. Límite de la rotación mecánica

La Tabla 6.9 muestra las rotaciones máximas permitidas para motores accionados por convertidor de frecuencia.

Tabela 6.9 - Rotación máxima del motor (en RPM).

Carcasa	2 polos	4 polos	6 polos	8 polos
90 – 100	7000	7000	7000	7000
112	7000	6000	6000	6000
132	6000	5500	5500	5500
160	5000	5000	5000	5000
180	4500	4000	4000	4000
200	4000	3800	3800	3800
225	3600	3600	3600	3600
250	3600	3600	3600	3600
280	3600	3000	3000	3000
315	3600	2500	2500	2500
355	3600	1800	1800	1800

Nota: *para seleccionar la rotación máxima permitida para el motor, considere la curva de reducción de torque del motor.*

Para más informaciones sobre el uso de convertidor de frecuencia, o acerca de cómo dimensionarlo correctamente para su aplicación, favor contacte a WEG o consulte la "Guía Técnica de Motores de Inducción Alimentados por Convertidores de Frecuencia PWM" disponible en www.weg.net.

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7. OPERACION

7.1. PARTIDA DEL MOTOR

Luego de ejecutar los procedimientos de instalación, algunos aspectos deben ser verificados antes de la partida inicial del motor, principalmente si el motor no fue colocado inmediatamente en operación tras su instalación. Aquí deben ser verificados los siguientes ítems:

- Si los datos que constan en la placa de identificación (tensión, corriente, esquema de conexión, grado de protección, refrigeración, factor de servicio, entre otras) están de acuerdo con la aplicación.
- El correcto montaje y alineamiento del conjunto (motor + máquina accionada).
- El sistema de accionamiento del motor, considerando que la rotación del motor no sobrepase la velocidad máxima establecida en la Tabla 6.9.
- La resistencia de aislamiento del motor, conforme ítem 5.4.
- El sentido de rotación del motor.
- La integridad de la caja de conexión, que debe estar limpia y seca, sus elementos de contacto libres de oxidación, sus sellados en condiciones apropiadas de uso y sus entradas de cables correctamente cerradas/protegidas de acuerdo con el grado de protección.
- Las conexiones del motor, verificando si fueron correctamente realizadas, inclusive puesta a tierra y cables auxiliares, conforme recomendaciones del ítem 6.9.
- El correcto funcionamiento de los accesorios (freno, encoder, protección térmica, ventilación forzada, etc.) instalados en el motor.
- La condición de los rodamientos. Si presentan señales de oxidación, deben ser substituidos. En caso que no presenten oxidación, realice el procedimiento de relubricación conforme descrito en el ítem 8.2. Aquellos motores instalados hace más de dos años, que no entraron en operación, deben tener sus rodamientos substituidos antes de ser puestos en operación.
- En motores con cojinetes de deslizamiento debe ser verificado:
  - el nivel correcto de aceite del cojinete. El mismo debe estar en la mitad del visor (ver Figura 6.9).
  - que el motor no parta ni opere con cargas radiales o axiales.
  - que cuando el motor sea almacenado por un período igual o mayor al intervalo de cambio de aceite, el aceite deberá ser cambiado antes de la puesta en funcionamiento.
- El análisis de la condición de los condensadores, si existen. Para motores instalados por un período superior a dos años, pero que no entraron en operación, se recomienda la substitución de sus condensadores de partida de motores monofásicos.
- Que entradas y salidas de aire estén completamente desobstruidas. El mínimo espacio libre hasta la pared más próxima (L) debe ser ¼ del diámetro de la entrada de aire de la deflectora (D), ver Figura 7.1. El aire en la entrada del motor debe estar a temperatura ambiente.

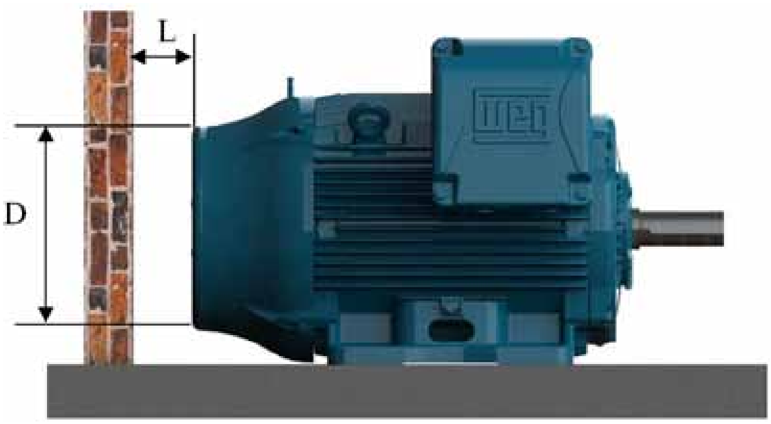

***Figura 7.1** - Distancia mínima del motor hasta la pared.*

Como referencia, pueden ser seguidas las distancias mínimas presentadas en la Tabla 7.1.

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Tabela 7.1 *- Distancia mínima entre la tapa deflectora y la pared.*

Carcasa		**Distancia entre la tapa deflectora y la pared (L)**	
IEC	NEMA	mm	pulgadas
63	-	25	0,96
71	-	26	1,02
80	-	30	1,18
90	143/5	33	1,30
100	-	36	1,43
112	182/4	41	1,61
132	213/5	50	1,98
160	254/6	65	2,56
180	284/6	68	2,66
200	324/6	78	3,08
225 250	364/5 404/5	85	3,35
280	444/5 445/7 447/9	108	4,23
315	L447/9 504/5	122	4,80
355	586/7 588/9	136	5,35

- que los flujos y las temperaturas del agua estén correctas, cuando es utilizada en la refrigeración del motor. Ver ítem 7.2.
- que todas las partes giratorias, como poleas, acoplamientos, ventiladores externos, eje, etc., estén protegidas contra toques accidentales.

Otros testes y verificaciones que no constan en esta relación pueden hacerse necesarios, en función de las características específicas de la instalación, aplicación y/o del motor.

Luego de haber sido realizadas todas las verificaciones, siga el procedimiento de abajo para efectuar la partida de motor:
- Encienda la máquina sin ninguna carga (cuando sea posible), accionando la llave de partida como si fuese un pulso, verificando el sentido de rotación, la presencia de ruido, vibración u otra condición anormal de operación.
- Encienda nuevamente el motor, debiendo partir y funcionar de manera suave. En caso que eso no ocurra, apáguelo y verifique nuevamente el sistema de montaje y las conexiones antes de una nueva partida.
- En caso de vibraciones excesivas, verifique si los tornillos de fijación están adecuadamente apretados o si la vibración es proveniente de máquinas adyacentes. Verifique periódicamente la vibración, respetando los límites presentados en el ítem 7.2.1.
- Opere el motor bajo carga nominal por un pequeño período de tiempo y compare la corriente de operación con la corriente indicada en la placa de identificación.
- Se recomienda que algunas variables del motor sean acompañadas hasta su equilibrio térmico: corriente, tensión, temperatura en los cojinetes y en la superficie externa de la carcasa, vibración y ruido.
- Se recomienda que los valores de corriente y tensión sean registrados en el informe de instalación.

Debido al valor elevado de la corriente de partida de los motores de inducción, el tiempo gastado en la aceleración en las cargas de inercia apreciable resulta en la elevación rápida de la temperatura del motor. Si el intervalo entre partidas sucesivas es muy reducido, resultará en un aumento de la temperatura en los devanados, damnificándolos o reduciendo su vida útil. En caso que no sea especificado régimen de servicio diferente a S1 en la placa de identificación del motor, los motores están aptos para:
- dos partidas sucesivas, siendo la primera hecha con el motor frío, es decir, con sus devanados a temperatura ambiente y una segunda partida a seguir, no obstante, luego que el motor haya sido desacelerado hasta alcanzar su reposo.
- una partida con el motor a caliente, o sea, con los devanados a la temperatura de régimen.

El ítem 10 lista algunos problemas de mal funcionamiento del motor, con sus posibles causas.

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7.2. CONDICIONES DE OPERACION

En caso que ninguna otra condición sea informada en el momento de la compra, los motores eléctricos son proyectados para operar a una altitud limitada a 1000 m por encima del nivel del mar y en temperatura ambiente entre -20°C y +40°C. Cualquier variación de las condiciones del ambiente, donde el motor operará, debe estar indicada en la placa de identificación del motor.
Algunos componentes precisan ser cambiados, cuando la temperatura ambiente es diferente de la indicada arriba. Favor contactar a WEG para verificar las características especiales.

El ambiente en el local de instalación deberá tener condiciones de renovación de aire del orden de 1m³ por segundo para cada 100 kW o fracción de potencia del motor. Para motores ventilados, que no poseen ventilador propio, la ventilación adecuada del motor es de responsabilidad del fabricante del equipamiento. En caso que no haya especificación de la velocidad de aire mínima entre las aletas del motor en una placa de identificación, deben ser seguidos los valores indicados en la Tabla 7.2. Los valores presentados en la Tabla 7.2 son válidos para motores aleteados alimentados en la frecuencia de 60 Hz. Para obtención de las velocidades mínimas de aire en 50 Hz se deben multiplicar los valores de la tabla por 0,83.

***Tabela 7.2** - Velocidad mínima de aire entre las aletas del motor (m/s).*

Carcasa		Polos			
IEC	**NEMA**	**2**	**4**	**6**	**8**
63 a 90	**143/5**	14	7	5	4
100 a 132	**182/4 y 213/5**	18	10	8	6
160 a 200	**364/5 to 444/5**	20	20	12	7
225 a 280	**364/5 to 444/5**	22	22	18	12
315 a 355	**445/7 to 588/9**	25	25	20	15

Las variaciones de la tensión y frecuencia de alimentación pueden afectar las características de desempeño y la compatibilidad electromagnética del motor. Estas variaciones de alimentación deben seguir los valores establecidos en las normas vigentes. Ejemplos:

- ABNT NBR-17094 - Partes 1 y 2. El motor está apto para proveer torque nominal, bajo las siguientes zonas de variación de tensión y frecuencia:
- Zona A: ±5% de tensión y ±2% de frecuencia
- Zona B: ±10% de tensión y +3% -5% de frecuencia

Cuando es operado en la Zona A o B, el motor puede presentar variaciones de desempeño y alcanzar temperaturas más elevadas. Estas variaciones son mayores para la operación en la zona B. No es recomendada una operación prolongada del motor en la zona B.

- IEC 60034-1. El motor está apto para proveer torque nominal, bajo las siguientes zonas de variación de tensión y frecuencia:
- Zona A: ±5% de tensión y ±2% de frecuencia
- Zona B: ±10% de tensión y +3% -5% de frecuencia.

Cuando es operado en la Zona A o B, el motor puede presentar variaciones de desempeño y alcanzar temperaturas más elevadas. Estas variaciones son mayores para la operación en la zona B. No es recomendada la operación prolongada del motor en la zona B. Para motores multitensión (ejemplo 380-415/660 V) es permitida una variación de tensión de ±5%.

- NEMA MG-1 Parte 12. El motor está apto para operar en una de las siguientes variaciones:
- ±10% de tensión, con frecuencia nominal;
- ±5 de frecuencia, con tensión nominal;
- Una combinación de variación de tensión y frecuencia de ±10%, desde que la variación de frecuencia no sea superior a ±5%..

Para motores que son enfriados a través del aire ambiente, las entradas y salidas de aire deben ser limpiadas en intervalos regulares para garantizar una libre circulación del aire. El aire caliente no debe retornar hacia el motor. El aire utilizado para refrigeración del motor debe estar a temperatura ambiente, limitada a la franja de temperatura indicada en la placa de identificación del motor (cuando no sea indicado, considere una franja de temperatura entre -20°C y +40°C).

Para motores refrigerados a agua, los valores del flujo de agua para cada tamaño de carcasa, así como la máxima elevación de temperatura del agua luego de circular por el motor, son mostrados en la Tabla 7 3. La temperatura del agua en la entrada no debe exceder 40°C.

Tabela 7.3 - *Flujo y máxima elevación de temperatura del agua.*

Carcasa		Flujo (litros/minuto)	Máxima Elevación de temperatura del agua (°C)
IEC	NEMA		
180	284/6	12	5
200	324/6	12	5
225	364/5	12	5
250	404/5	12	5
280	444/5 445/7 447/9	15	6
315	504/5	16	6
355	586/7 588/9	25	6

Para motores con lubricación de tipo *Oil Mist*, en caso de falla del sistema de bombeo de aceite, es permitida una operación en régimen continuo con el tiempo máximo de una hora de operación.

Considerando que el calor del sol causa aumento de la temperatura de operación, los motores instalados externamente deben siempre estar protegidos contra la incidencia directa de los rayos solares.

Posibles desvíos en relación a la operación normal (actuación de protecciones térmicas, aumento del nivel de ruido, vibración, temperatura y corriente) deben ser examinados y eliminados por personal capacitado. En caso de dudas, apague el motor inmediatamente y contacte a un Asistente Técnico Autorizado WEG.

Motores equipados con rodamiento de rodillos necesitan de una carga radial mínima para asegurar su operación normal. En caso de dudas, contacte a WEG.

7.2.1. Límites de la severidad de vibración

La severidad de vibración es el máximo valor de vibración encontrada, entre todos los puntos y direcciones recomendados.
La Tabla 7.4 indica los valores admisibles de la severidad de vibración recomendados en la norma IEC 60034-14 para las carcasas IEC 56 a 400, para los grados de vibración A y B.
Los límites de severidad de la Tabla 7.4 son presentados en términos del valor medio cuadrático (= valor RMS o valor eficaz) de la velocidad de vibración en mm/s medidos en condición de suspensión libre (base elástica).

Tabela 7.4 - *Limites recomendados para la severidad de vibración de acuerdo con la norma IEC 60034-14.*

Altura del eje [mm]	56 ≤ H ≤ 132	132 < H ≤ 280	H > 280
Grado de vibración	**Severidad de vibración en base elástica [mm/s RMS]**		
A	1,6	2,2	2,8
B	0,7	1,1	1,8

Notas:
1 - Los valores de la Tabla 7.4 son válidos para mediciones realizadas con la máquina desacoplada y sin carga, operando en la frecuencia y tensión nominales.
2 - Los valores de la Tabla 7.4 son válidos independientemente del sentido de rotación de la máquina.
3 - La Tabla 7.4 no se aplica para motores trifásicos con conmutador, motores monofásicos, motores trifásicos con alimentación monofásica o para máquinas fijadas en el local de instalación, acopladas en sus cargas de accionamiento o cargas accionadas.

Para motor estándar, de acuerdo con la norma NEMA MG-1, el límite de vibración es de 0.15 in/s (pulgadas/segundo pico), en la misma condición de suspensión libre y desacoplado.

Nota:
Para condición de operación en carga se recomienda el uso de la norma ISO 10816-3 para evaluación de los limites de vibración del motor. En la condición en carga, la vibración del motor será influenciada por varios factores, entre ellos, tipo de carga acoplada, condición de fijación del motor, condición de alineamiento con la carga, vibración de la estructura o base debido a otros equipamientos, etc.

8. MANTENIMIENTO

La finalidad del mantenimiento es prolongar lo máximo posible la vida útil del equipamiento. La no observancia de uno de los ítems relacionados a seguir puede llevar a paradas no deseadas del equipamiento.

En caso que, durante el mantenimiento, hubiera necesidad de transporte de los motores con rodamientos de rodillos o contacto angular, deben ser utilizados los dispositivos de trabado del eje suministrados con el motor. Todos los motores HGF, independientemente del tipo de cojinete, deben ter su eje trabado durante el transporte.

Cualquier servicio en máquinas eléctricas debe ser realizado solamente por personal capacitado, utilizando sólo herramientas y métodos adecuados. Antes de iniciar cualquier servicio, las máquinas deben estar completamente paradas y desconectadas de la red de alimentación, inclusive los accesorios (resistencia de calentamiento, freno, etc.).
Asistentes técnicos o personal no capacitado, sin autorización para hacer mantenimiento y/o reparar motores, son totalmente responsables por el trabajo ejecutado y por los eventuales daños que puedan ocurrir durante su funcionamiento.

8.1. INSPECCION GENERAL

La frecuencia con que deben ser realizadas las inspecciones depende del tipo de motor, de la aplicación y de las condiciones del local de la instalación. Durante la inspección, se recomienda:

- Hacer una inspección visual del motor y del acoplamiento, observando los niveles de ruido, de la vibración, alineamiento, señales de desgastes, oxidación y piezas damnificadas. Substituir las piezas, cuando fuera necesario.
- Medir la resistencia de aislamiento conforme descrito en el ítem 5.4.
- Mantener la carcasa limpia, eliminando toda acumulación de aceite o de polvo en la parte externa del motor para de esta forma facilitar el intercambio de calor con el medio ambiente.
- Verificar la condición del ventilador y de las entradas y salidas de aire, asegurando un libre flujo del arie;
- Verificar el estado de los sellados y efectuar el cambio, si fuera necesario.
- Drenar el motor. Tras el drenaje, recolocar los drenajes para garantizar nuevamente el grado de protección del motor. Los drenajes deben estar siempre posicionados de tal forma que el drenaje sea facilitado (ver ítem 6).
- Verificar la conexión de los cables de alimentación, respetando las distancias de aislamiento entre partes vivas no aisladas entre sí y entre partes vivas y partes puestas a tierra de acuerdo con la Tabla 6.2.
- Verificar si el apriete de los tornillos de conexión, sustentación y fijación está de acuerdo con lo indicado en la Tabla 8.7
- Verificar el estado del pasaje de los cables en la caja de conexión, los sellados de los prensacables y los sellados en las cajas de conexión y efectuar el cambio, se fuera necesario.
- Verificar el estado de los cojinetes, observando la aparición de ruidos y niveles de vibración no habituales, verificando la temperatura de los cojinetes, el nivel del aceite, la condición del lubricante y el monitoreo de las horas de operación versus la vida útil informada.
- Registrar y archivar todas las modificaciones realizadas en el motor.

No reutilice piezas dañadas o desgastadas. Substitúyalas por nuevas, originales de fábrica.

8.2. LUBRICACION

La correcta lubricación es de vital importancia para el buen funcionamiento del motor.
Utilice el tipo y cantidad de grasa o aceite especificados y seguir los intervalos de relubricación recomendados para los cojinetes. Estas informaciones pueden ser encontradas en la placa de identificación y este procedimiento debe ser realizado conforme el tipo de lubrificante (aceite o grasa).
Cuando el motor utilice protección térmica en el cojinete, deben ser respetados los límites de temperatura de operación indicados en la Tabla 6.3.
Los motores para aplicaciones especiales pueden presentar temperaturas máximas de operación diferentes a las indicadas en la tabla.
El descarte de la grasa y/o aceite debe seguir las recomendaciones vigentes de cada país.

La utilización de motor en ambientes y/o aplicaciones especiales siempre requiere una consulta previa a WEG.

8.2.1. Cojinetes de rodamiento lubricados a grasa

Grasa en exceso provoca calentamiento del cojinete y su consecuente falla.

Los intervalos de lubricación especificados en las Tabla 8.1, Tabla 8.2, Tabla 8.3 y Tabla 8.4 consideran una temperatura ambiente de 40°C, rotación nominal del motor, instalación horizontal, grasa Mobil Polyrex EM, y son determinados siguiendo el criterio de la norma ISO 281, o sea, se estima que 90% de los rodamientos atienden los valores calculados. Cualquier variación de los parámetros indicados arriba debe ser evaluada puntualmente.

Tabela 8.1- *Intervalo de lubricación para rodamientos de esferas.*

Carcasa		Polos	Rodamiento	Cantidad de grasa (g)	Intervalos de relubricación (horas)					
					ODP (Envoltorio abierto)		W21 (Envoltorio cerrado)		W22 (Envoltorio Cerrado)	
IEC	NEMA				50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz
160	254/6	2	6309	13	20000	20000	18100	15700	22000	20000
		4					20000	20000	25000	25000
		6								
		8								
180	284/6	2	6311	18	20000	20000	13700	11500	17000	14000
		4					20000	20000	25000	25000
		6								
		8								
200	324/6	2	6312	21	20000	20000	11900	9800	15000	12000
		4					20000	20000	25000	25000
		6								
		8								
225 250 280 315 355	364/5 404/5 444/5 445/7 447/9 L447/9 504/5 5008 5010/11 586/7 588/9	2	6314	27	18000	14400	4500	3600	5000	4000
		4			20000	20000	11600	9700	14000	12000
		6					16400	14200	20000	17000
		8					19700	17300	24000	20000
		2	6316	34	14000	*Mediante consulta	3500	*Mediante consulta	4000	*Mediante consulta
		4			20000	20000	10400	8500	13000	10000
		6					14900	12800	18000	16000
		8					18700	15900	20000	20000
		2	6319	45	9600	*Mediante consulta	2400	*Mediante consulta	3000	*Mediante consulta
		4			20000	20000	9000	7000	11000	8000
		6					13000	11000	16000	13000
		8					17400	14000	20000	17000
		4	6322	60	20000	20000	7200	5100	9000	6000
		6					10800	9200	13000	11000
		8					15100	11800	19000	14000

Tabela 8.2*- Intervalo de lubricación para rodamientos de rodillos.*

Carcasa		Polos	Rodamiento	Cantidad de grasa (g)	Intervalos de relubricación (horas)					
					ODP (Envoltorio abierto)		W21 (Envoltorio Cerrado)		W22 (Envoltorio Cerrado)	
IEC	NEMA				50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz
160	254/6	2	NU309	13	20000	19600	13300	9800	16000	12000
		4				20000	20000	20000	25000	25000
		6								
		8								
180	284/6	2	NU311	18	18400	12800	9200	6400	11000	8000
		4			20000	20000	20000	19100	25000	25000
		6						20000		
		8								
200	324/6	2	NU312	21	15200	10200	7600	5100	9000	6000
		4			20000	20000	20000	17200	25000	21000
		6						20000		25000
		8								
"225 250 280 315 355"	364/5 404/5 444/5 445/7 447/9 L447/9 504/5 5008 5010/11 586/7 588/9	4	NU314	27	17800	14200	8900	7100	11000	9000
		6			20000	20000	13100	11000	16000	13000
		8					16900	15100	20000	19000
		4	NU316	34	15200	12000	7600	6000	9000	7000
		6			20000	19000	11600	9500	14000	12000
		8				20000	15500	13800	19000	17000
		4	NU319	45	12000	9400	6000	4700	7000	5000
		6			19600	15200	9800	7600	12000	9000
		8			20000	20000	13700	12200	17000	15000
		4	NU322	60	8800	6600	4400	3300	5000	4000
		6			15600	11800	7800	5900	9000	7000
		8			20000	20000	11500	10700	14000	13000

Tabela 8.3 *- Intervalo de lubricación para rodamiento de esferas - línea HGF.*

Carcasa		Polos	Rodamiento	Cantidad de grasa (g)	Intervalos de Lubricación (horas)	
IEC	NEMA				50 Hz	60 Hz
315L/A/B e 315C/D/E	5006/7/8T e 5009/10/11T	2	6314	27	3100	2100
		4 – 8	6320	50	4500	4500
			6316	34	4500	4500
355L/A/B e 355C/D/E	5807/8/9T e 5810/11/12T	2	6314	27	3100	2100
		4 – 8	6322	60	4500	4500
			6319	45	4500	4500
400L/A/B e 400 C/D/E	6806/7/8T e 6809/10/11T	2	6315	30	2700	1800
		4 – 8	6324	72	4500	4500
			6319	45	4500	4500
450	7006/10	2	6220	31	2500	1400
		4	6328	93	4500	3300
			6322	60	4500	4500
		6 – 8	6328	93	4500	4500
			6322	60	4500	4500
500	8006/10	4	6330	104	4200	2800
			6324	72	4500	4500
		6 – 8	6330	104	4500	4500
			6324	72	4500	4500
500	8006/10	4	6330	104	4200	2800
			6324	72	4500	4500
		6 – 8	6330	104	4500	4500
			6324	72	4500	4500
560	8806/10	4 - 8	*Mediante consulta			
630	9606/10	4 - 8				

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Tabela 8.4 *- Intervalo de lubricación para rodamiento de rodillos - línea HGF.*

Carcasa		Polos	Rodamiento	Cantidad de grasa (g)	Intervalos de Lubricación (horas)	
IEC	NEMA				50 Hz	60 Hz
315L/A/B e 315C/D/E	5006/7/8 e 5009/10/11	4	NU320	50	4300	2900
		6 - 8			4500	4500
355L/A/B e 355C/D/E	5807/8/9 e 5810/11/12	4	NU322	60	3500	2200
		6 - 8			4500	4500
400L/A/B e 400C/D/E	6806/7/8 e 6809/10/11	4	NU324	72	2900	1800
		6 - 8			4500	4500
450	7006/10	4	NU328	93	2000	1400
		6			4500	3200
		8			4500	4500
500	8006/10	4	NU330	104	1700	1000
		6			4100	2900
		8			4500	4500
560	8806/10	4	NU228 + 6228	75	2600	1600
		6 - 8		106	4500	4500
630	9606/10	4	NU232 + 6232	92	1800	1000
		6		120	4300	3100
		8		140	4500	4500

Para cada incremento de 15°C en la temperatura ambiente, el intervalo de relubricación deberá ser reducido por la mitad.
Los motores originales de fábrica, para posición horizontal, pero instalados en posición vertical (con autorización de WEG), deben tener su intervalo de relubricación reducido por la mitad.

Para aplicaciones especiales, tales como: altas y bajas temperaturas, ambientes agresivos, variación de velocidad (accionamiento por convertidor de frecuencia), etc., entre en contacto con WEG para obtener informaciones referentes al tipo de grasa e intervalos de lubricación a ser utilizados.

8.2.1.1. Motores sin grasera

En motores sin grasera, la lubricación debe ser efectuada conforme el plano de mantenimiento preventivo existente. El desmontaje y montaje del motor deben ser hechos conforme el ítem 8.3.
En motores con rodamientos blindados (por ejemplo, ZZ, DDU, 2RS, VV), los rodamientos deben ser substituidos al final de la vida útil de la grasa.

8.2.1.2. Motores con grasera

En motores con grasera, es recomendado lubricar los rodamientos con el motor parado, procediendo de la siguiente manera:
- Limpie las proximidades del orificio de entrada de grasa;
- Retire la protección de salida de grasa;
- Coloque aproximadamente mitad de la grasa total recomendada y gire el motor durante aproximadamente 1 (un) minuto en la rotación nominal;
- Apague el motor y coloque el resto de la grasa;
- Recoloque las protecciones de entrada y salida de grasa.

Para lubricación, es indicado el uso de lubricador manual.

En motores suministrados con dispositivo de resorte, el exceso de grasa debe ser removido, halando la varilla del resorte y limpiándolo, hasta que no presente más grasa.

8.2.1.3. Compatibilidad de la grasa Mobil Polyrex EM con otras grasas

La grasa Mobil Polyrex EM posee espesante de poliurea y aceite mineral, siendo compatible con otras grasas que contengan:
- Espesante de litio o complejo de litio o poliurea y aceite mineral altamente refinado;
- La grasa aplicada debe poseer, en su formulación, aditivos inhibidores de corrosión y oxidación.

A pesar de que la grasa Mobil Polyrex EM es compatible con los tipos de grasa indicados arriba, no es recomendada la mezcla de grasas.
En caso que necesite de otro tipo de grasa, contacte a WEG.

8.2.2. Cojinetes de rodamiento lubricados a aceite

En motores con rodamientos lubricados a aceite, el cambio de aceite debe ser hecho con el motor parado, siguiendo los procedimientos abajo:
- abra la respiración de entrada de aceite;
- retire el tapón de salida de aceite
- abra la válvula y drene todo el aceite;
- cierre la válvula;
- recoloque el tapón;
- abastezca con la cantidad y especificación de aceite indicadas en la placa de identificación;
- verifique si el nivel del aceite está en la mitad del visor;
- cierre la respiración de la entrada de aceite;
- asegúrese de que no hay pérdida y que todos los orificios roscados no utilizados estén cerrados.

El cambio de aceite de los cojinetes debe ser realizado en el intervalo indicado en la placa de identificación o siempre que el lubrificante presente alteraciones en sus características (viscosidad, pH, etc.).
El nivel de aceite debe ser mantenido en la mitad del visor de aceite y acompañado diariamente.
El uso de lubricantes con otras viscosidades requiere contacto previo con WEG.

Obs.: los motores HGF verticales para alto empuje son suministrados con cojinetes delanteros lubricados a grasa y con cojinetes traseros, a aceite. Los cojinetes delanteros deben seguir las recomendaciones del ítem 8.2.1. La Tabla 8.5 presenta la cantidad y especificación de aceite para esa configuración.

Tabla 8 5 – *Características de lubricación para motores HGF vertical de alto empuje.*

	Carcasa		Polos	Rodamiento	Aceite (L)	Intervalo (h)	Lubricante	Especificación Lubricante
	IEC	NEMA						
Montaje Alto Empuje	315L/A/B e 315C/D/E	5006/7/8T e 5009/10/11T	4 - 8	29320	20	8000	Renolin DTA 40 / SHC 629	Aceite mineral ISO VG150 con aditivos antiespuma y antioxidantes
	355L/A/B e 355C/D/E	5807/8/9T e 5810/11/12T	4 - 8	29320	26			
	400L/A/B e 400C/D/E	6806/7/8T e 6809/10/11T	4 - 8	29320	37			
	450	7006/10	4 - 8	29320	45			

8.2.3. Cojinetes de rodamiento con lubricación de tipo Oil Mist

Verifique el estado de los sellados y, siempre que fuera necesario algún cambio, use solamente piezas originales. Realice la limpieza de los componentes antes del montaje (anillos de fijación, tapas, etc.).
Aplique sellajuntas resistente al aceite lubricante utilizado, entre los anillos de fijación y las tapas.
A conexión de los sistemas de entrada, salida y drenaje de aceite deben ser realizados conforme la Figura 6.12.

8.2.4. Cojinetes de deslizamiento

Para los cojinetes de deslizamiento, el cambio de aceite debe ser hecho en los intervalos indicados en la Tabla 8.6 y debe ser realizado, adoptando los siguientes procedimientos:
- para el cojinete trasero, retire la tapa de inspección de la deflectora.
- drene el aceite a través del drenaje localizado en la parte inferior de la carcasa del cojinete (ver Figura 8 1).
- cierre la salida de aceite.
- retire el tapón de la entrada de aceite.
- abastezca con el aceite especificado y con la cantidad indicada en la Tabla 8.6.
- verifique si el nivel del aceite está en la mitad del visor.
- cierre la entrada de aceite.
- asegúrese de que no existe pérdida

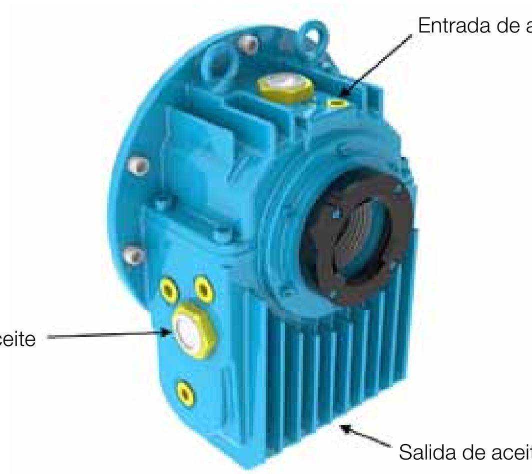

Figura 8.1 - *Cojinete de deslizamiento.*

***Tabla 8.6** – Características de lubricación para cojinetes de deslizamiento.*

Carcasa		Polos	Cojinete	Aceite (L)	Intervalo (h)	Lubricante	Especificación Lubrificante
IEC	NEMA						
315L/A/B y 315C/D/E	5006/7/8T y 5009/10/11T	2	9-80	2.8	8000	Renolin DTA 10	Aceite mineral ISO VG32 con aditivos antiespuma y antioxidantes
355L/A/B y 355C/D/E	5807/8/9T y 5810/11/12T						
400L/A/B y 400C/D/E	6806/7/8 y 6809/10/11T						
450	7006/10						
315L/A/B y 315C/D/E	5006/7/8T y 5009/10/11T	4 - 8	9-90	2.8	8000	Renolin DTA 15	Aceite mineral ISO VG46 con aditivos antiespuma y antioxidantes
355L/A/B y 355C/D/E	5807/8/9T y 5810/11/12T		9-100				
400L/A/B y 400C/D/E	6806/7/8 y 6809/10/11T		11-110	4.7			
450	7006/10		11-125				
500	8006/10						

El cambio de aceite de los cojinetes debe ser realizado en el intervalo indicado en la placa de identificación o siempre que el lubricante presente alteraciones en sus características (viscosidad, pH, etc.).
El nivel de aceite debe ser mantenido en la mitad del visor y seguido diariamente.
No podrán ser usados lubrificantes con otras viscosidades sin antes consultar a WEG.

8.3. DESMONTAJE Y MONTAJE

Los servicios de reparación en motores deben ser efectuados solamente por personal capacitado siguiendo las normas vigentes del país. Sólo deben ser utilizadas herramientas y métodos adecuados.

Cualquier servicio de desmontaje y montaje debe ser realizado con el motor totalmente desenergizado y completamente parado.

El motor apagado también puede presentar energía eléctrica en el interior de la caja de conexión:, en las resistencias de calentamiento, en el devanado y en los capacitores.

Los motores accionados por convertidor de frecuencia pueden estar energizados incluso con el motor parado.

Antes de iniciar el procedimiento de desmontaje, registre las condiciones actuales de la instalación, tales como conexiones de los terminales de alimentación del motor y alineamiento / nivelación, los que deben ser considerados durante el montaje posterior.

Realice el desmontaje de manera cuidadosa, sin causar impactos contra las superficies mecanizadas y / o en las roscas.

Monte el motor en una superficie plana para garantizar una buena base de apoyo. Los motores sin patas deben ser calzados/trabados para evitar accidentes.

Deben ser tomados cuidados adicionales para no dañar las partes aisladas que operan bajo tensión eléctrica, como por ejemplo, devanados, cojinetes aislados, cables de alimentación, etc.

Los elementos de sellado, como por ejemplo, juntas y sellados de los cojinetes deben ser cambiados siempre que presenten desgaste o estén damnificados.

Los motores con grado de protección superior a IP55 son suministrados con producto sellante Loctite 5923 (Henkel) en las juntas y tornillos. Antes de montar los componentes, limpie las superficies y aplique una nueva camada de este producto.

8.3.1. Caja de conexión

Al retirar la tapa de la caja de conexión para la conexión/desconexión de los cables de alimentación y accesorios, deben ser adoptados los siguientes cuidados:

- Asegúrese que durante la remoción de los tornillos, la tapa de la caja no dañe los componentes instalados en su interior.
- En caso que la caja de conexión sea suministrada con ojal de suspensión, éste debe ser utilizado para mover la tapa de la caja de conexión.
- Para motores suministrados con placa de bornes, deben ser asegurados los torques de apriete especificados en la Tabla 8.7.
- Verifique que los cables no entren en contacto con superficies con esquinas vivas.
- Adopte los debidos cuidados para garantizar que el grado de protección inicial, indicado en la placa de identificación del motor no sea alterado. Las entradas de cables para la alimentación y control deben utilizar siempre componentes (como, por ejemplo, prensacables y electroductos) que atiendan las normas y reglamentaciones vigentes de cada país.
- Asegúrese que la ventana de alivio de presión, cuando exista, no esté dañada. Las juntas de sellado de la caja de conexión deben estar en perfecto estado para reutilización y deben ser posicionadas correctamente para garantizar el grado de protección.
- Verifique los torques de apriete de los tornillos de fijación de la tapa de la caja conforme Tabla 8 7.

***Tabela 8.7** – Torques de apriete para elementos de fijación [Nm].*

Tipo de tornillo y Junta	M4	M5	M6	M8	M10	M12	M16	M20
Tornillo sextavado externo/interno (s/ junta)		4 a 7	7 a 12	16 a 30	30 a 50	55 a 85	120 a 180	230 a 360
Tornillo ranura combinada (s/ junta)		3 a 5	5 a 10	10 a 18	-	-	-	-
Tornillo sextavado externo/interno (c/ junta con batiente metálica/cordón)		-	-	13 a 20	25 a 37	40 a 55	50 a 65	-
Tornillo ranura combinada (c/ junta plana y/o batiente metálica/cordón)		3 a 5	4 a 8	8 a 15	-	-	-	-
Tornillo sextavado externo/interno (c/ junta plana)		-	-	8 a 15	18 a 30	25 a 40	35 a 50	-
Placa de bornes		1,5 a 4	4 a 6,5	6,5 a 9	10 a 18	18 a 30	35 a 50	-
Puesta a tierra		3 a 5	5 a 10	10 a 18	30 a 50	55 a 85	120 a 180	-

8.4. PROCEDIMIENTO PARA ADECUACION DE LA RESISTENCIA DE AISLAMIENTO

El motor debe ser desmontado y sus tapas, rotor completo (con eje), ventilador, deflectora y caja de conexión deben ser separados, de modo que apenas la carcasa con el estator pase por un proceso de secado en una horno apropiado, por un período de dos horas, a una temperatura no superior a 120ºC. Para motores mayores, puede ser necesario aumentar el tiempo de secado. Luego de ese período de secado, deje el estator enfriar hasta que llegue a temperatura ambiente y repita la medición de la resistencia de aislamiento, conforme ítem 5.4. En caso necesario, se debe repetir el proceso de secado del estator.
Si, luego de repetidos los procesos de secado del estator, la resistencia de aislamiento no vuelve a los niveles aceptables, se recomienda hacer un análisis exhaustivo de las causas que llevaron a la caída del aislamiento del devanado y, eventualmente podrá culminar con el rebobinado del motor.

Para evitar el riesgo de shock eléctrico, descargue los terminales inmediatamente antes y después de cada medición. En caso que el motor posea condensadores, éstos deben ser descargados.

8.5. PARTES Y PIEZAS

Al solicitar piezas para reposición, informe la designación completa del motor, así como su código y número de serie, que pueden ser encontrados en la placa de identificación del motor.

Las partes y piezas deben ser adquiridas de la red de Asistencia Técnica Autorizada WEG. El uso de piezas no originales puede resultar en la caída de desempeño y causar falla en el motor.

Las piezas sobresalientes deben ser almacenadas en local seco con una humedad relativa del aire de hasta 60%, con temperatura ambiente mayor a 5°C y menor a 40°C, libre de polvo, vibraciones, gases, agentes corrosivos, sin variaciones bruscas de temperatura, en su posición normal y sin apoyar otros objetos sobre las mismas.

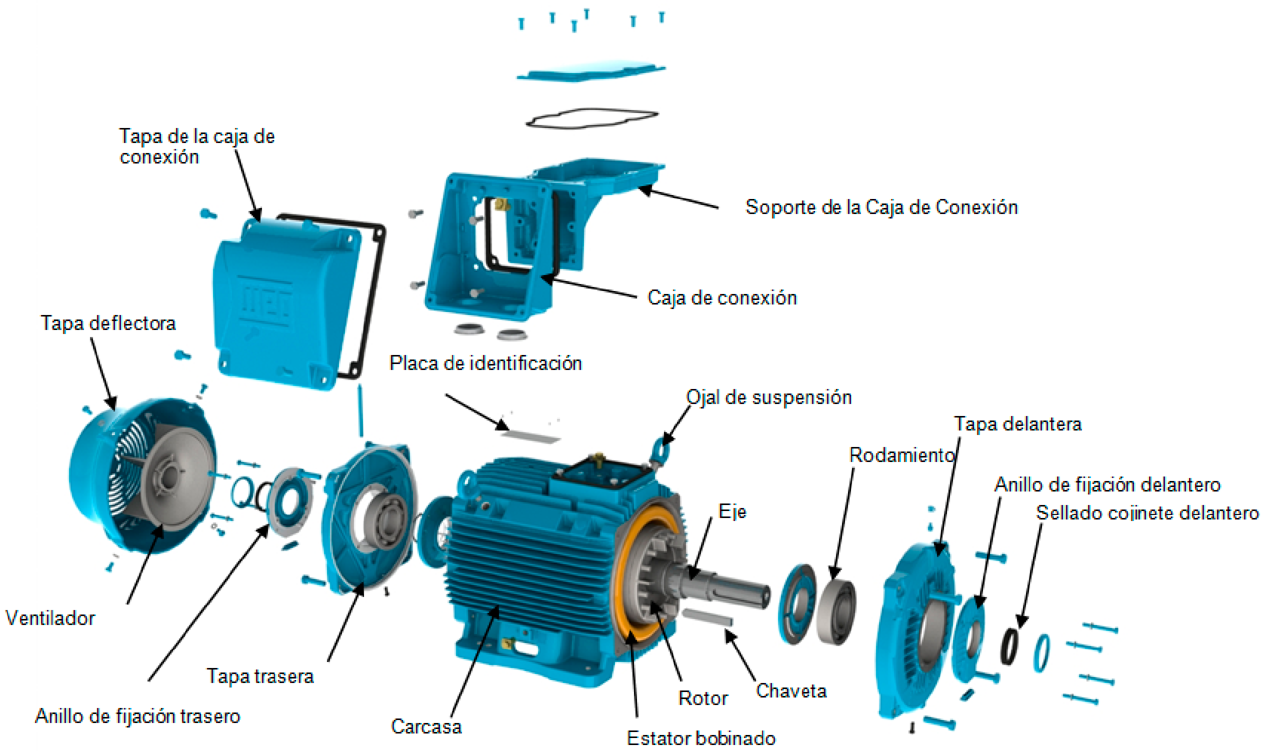

Figura 8.2 - Vista explotada de los componentes de un motor W22.

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9. INFORMACIONES AMBIENTALES

9.1. EMBALAGEM

Los motores eléctricos son suministrados en embalajes de cartón, plástico o madera. Estos materiales son reciclables o reutilizables y deben recibir el destino correcto, conforme las normas vigentes de cada país. Toda la madera utilizada en los embalajes de los motores WEG proviene de reforestación y no es sometida a ningún tratamiento químico para su conservación.

9.2. PRODUCTO

Los motores eléctricos, bajo el aspecto constructivo, son fabricados esencialmente con metales ferrosos (acero, hierro fundido), metales no ferrosos (cobre, aluminio) y plástico.

El motor eléctrico, de manera general, es un producto que posee una vida útil larga, no obstante en cuanto a su descarte, WEG recomienda que los materiales del embalaje y del producto sean debidamente separados y enviados a reciclaje.
Los materiales no reciclables deben, como determina la legislación ambiental, ser dispuestos de forma adecuada, o sea, en aterramientos industriales, coprocesados en hornos de cemento o incinerados. Los prestadores de servicios de reciclaje, disposición en aterramiento industrial, coprocesamiento o incineración de residuos deben estar debidamente licenciados por el órgano ambiental de cada estado para realizar estas actividades.

10. PROBLEMAS Y SOLUCIONES

Las instrucciones a seguir presentan una relación de problemas comunes con posibles soluciones. En caso de duda, contacte al Asistente Técnico Autorizado, o a WEG.

Problema	Posibles Causas	Solución
El motor no parte, ni acoplado ni desacoplado	Interrupción en la alimentación del motor	Verifique el circuito de comando y los cables de alimentación del motor
	Fusibles quemados	Substituya los fusibles
	Error en la conexión del motor	Corrija las conexiones del motor conforme el diagrama de conexión
	Cojinete trabado	Verifique si el cojinete gira libremente.
Cuando acoplado con carga, el motor no parte o parte muy lentamente y no alcanza la rotación nominal	Carga con torque muy elevado durante la partida	No aplique carga en la máquina accionada durante la partida
	Caída de tensión muy alta en los cables de alimentación	Verifique el dimensionamiento de la instalación (transformador, sección de los cables, relés, disyuntores, etc.)
Ruido elevado / anormal	Defecto en los componentes de transmisión o en la máquina accionada	Verifique la transmisión de fuerza, el acoplamiento y el alineamiento
	Base desalineada/desnivelada.	Realinee/nivele el motor y la máquina accionada
	Desbalance de los componentes o de la máquina accionada	Rehaga el balanceo
	Tipos diferentes de balanceo entre motor y acoplamiento (media chaveta, chaveta entera)	Rehaga el balanceo
	Sentido de rotación del motor incorrecto	Invierta el sentido de rotación del motor
	Tornillos de fijación sueltos	Reapriete los tornillos
	Resonancia de los cimientos	Verifique el proyecto de los cimientos
	Rodamientos damnificados	Substituya el rodamiento
Calentamiento excesivo en el motor	Refrigeración insuficiente	Limpie las entradas y salidas de aire de la deflectora, y de la carcasa
		Verifique las distancias mínimas entre la entrada de la deflectora de aire y las paredes cercanas. Ver ítem 7
		Verifique la temperatura del aire en la entrada
	Sobrecarga	Mida la corriente del motor, analizando su aplicación y, si fuera necesario, disminuya la carga
	Excesivo número de partidas o momento de inercia de la carga muy elevado	Reduzca el número de partidas
	Tensión muy alta	Verifique la tensión de alimentación del motor. No sobrepase la tolerancia conforme ítem 7.2
	Tensión muy baja	Verifique la tensión de alimentación y la caída de tensión en el motor. No sobrepase la tolerancia conforme ítem 7.2
	Interrupción de un cable de alimentación	Verifique la conexión de todos los cables de alimentación
	Desequilibrio de tensión en los terminales de alimentación del motor	Verifique si hay fusibles quemados, comandos incorrectos, desequilibrio en las tensiones de la red de alimentación, falta de fase o en los cables de conexión
	Sentido de rotación no compatible con el ventilador unidireccional	Verifique el sentido de rotación conforme la marcación del motor
Calentamiento del cojinete	Grasa / aceite en demasía	Realice la limpieza del cojinete y lubríquelo según las recomendaciones
	Envejecimiento de la grasa / aceite	
	Utilización de grasa / aceite no especificados	
	Falta de grasa / aceite	Lubrique según las recomendaciones
	Excesivo esfuerzo axial o radial	Reduzca la tensión en las correas
		Redimensione la carga aplicada al motor

11. TERMINO DE GARANTIA

WEG Equipamentos Elétricos S/A, Unidad Motores, ofrece garantía contra defectos de fabricación y de materiales para sus productos por un período de 18 meses, contados a partir de la fecha de emisión de la factura de la fábrica o del distribuidor/revendedor, limitado a 24 meses de la fecha de fabricación. Para motores de la línea HGF, la garantía ofrecida es por un período de 12 meses, contados a partir de la fecha de emisión de la factura de la fábrica o del distribuidor/revendedor, limitado a 18 meses de la fecha de fabricación.

El párrafo anterior cuenta con los plazos de garantía legal. En caso de que un plazo de garantía diferenciado estuviese definido en la propuesta técnica comercial para un determinado suministro, éste prevalecerá por sobre los plazos definidos anteriormente.

Los plazos establecidos anteriormente no dependen de la fecha de instalación, y se aplican siempre y cuando se cumpla con los siguientes requisitos: transporte, manoseo y almacenamiento adecuado; instalación correcta y en condiciones ambientales especificadas y sin presencia de agentes agresivos; operación dentro de los límites de sus capacidades y observación el Manual de Instalación, Operación y Mantenimiento; realización periódica de las debidas manutenciones preventivas; realización de reparaciones y/o modificaciones solamente por personas autorizadas por escrito por WEG; que el producto, de ocurrir alguna anomalía, esté disponible al proveedor por un período mínimo necesario para identificar la causa de la anomalía y sus debidas reparaciones; aviso inmediato por parte del comprador de los defectos ocurridos y posterior comprobación de los mismos por WEG como defectos de fabricación. La garantía no incluye servicios de instalación y desmantelamiento en las instalaciones del comprador, costos de transporte del producto y gastos de locomoción, hospedaje y alimentación del personal de Asistencia Técnica, de ser solicitado por el cliente. Los servicios en garantía se prestarán exclusivamente en oficinas de Asistencia Técnica autorizadas por WEG o en la propia fábrica.

También quedan excluidos de las garantías los componentes, partes y materiales, cuya vida útil sea generalmente inferior a los 12 (doce) meses.

En ninguna hipótesis la atención en garantía prorrogará los plazos de garantía del equipamiento. Aún así, el nuevo plazo de garantía equivalente al original se aplicará solamente para los componentes reparados y sustituidos por WEG.

La presente garantía se limita al producto suministrado, sin que WEG se responsabilice por los daños a personas, a terceros, a otros equipamientos e instalaciones, lucros cesantes o cualquier otro daño emergente o consecuente.

12. DECLARACIÓN DE CONFORMIDAD CE

WEG Equipamentos Elétricos S/A
Av. Prefeito Waldemar Grubba, 3000
89256-900 - Jaraguá do Sul – SC – Brasil,

y su representante autorizado establecido en la Comunidad Europea,

WEGeuro – Industria Electrica SA
Rua Eng Frederico Ulrich, Apartado 6074
4476-908 – Maia – Porto – Portugal

Declaran por medio de esta, que los productos:

Motores de inducción WEG y componentes para utilización en estos motores:

Trifásicos
Carcasas IEC 63 a 630
Carcasas Nema 42, 48, 56 y 143 a 9610
....

Monofásicos
Carcasas IEC 63 a 132
Carcasas Nema 42, 48, 56 y 143 a 215
....

Cuando instalados, mantenidos y utilizados en aplicaciones para los cuales fueron proyectados y cuando consideradas las normas debidas de instalación e instrucciones del proveedor, los mismos atienden los requisitos de las siguientes Directivas Europeas y normas donde aplicables:

Directivas:
Directiva de Baja Tensión 2006/95/CE
Reglamento (CE) No 640/2009
Directiva 2009/125/CE
Directiva de Compatibilidad Electromagnética 2004/108/CE (motores de inducción son considerados intrínsecamente favorables en términos de compatibilidad electromagnética)

Normas:
EN 60034-1/2-1/5/6/7/8/9/11/12/14/30 y EN 60204-1

A partir de 29/12/2009, motores eléctricos de baja tensión no son más considerados bajo escopo de la actual **Directiva de Máquinas 2006/42/CE.**

Marca CE en: **1996**

Milton Oscar Castella
Director de Ingeniería

Jaraguá do Sul, 12 de Febrero de 2010

ESPAÑOL

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www.weg.net

Cod: 50033244 | Rev: 00 | Date (m/y): 08/2011

14.12 Speed measuring device

14.12.1 Sensor

Voith Article No: 4 178979 0

Type: A5 S31 B90

Description . . . . Braun

14.12.2 Measuring transmitter

Voith Article No: 4 179305 001

Type: D124.1 S2 U2M

(85-265V AC/DC; 4-20 mA)

Description . . . . Braun

Overall wiring . . . . „Terminal Plan Sheet 1-12/ 215001154-0040“

BRAUN GMBH
INDUSTRIE-ELEKTRONIK

Postfach 11 06, D-71301 Waiblingen
WN-Hegnach, Esslinger Straße 26
Tel. (0 71 51) 95 62 30
Fax (0 71 51) 95 62 50

Sensor Series A5S31B for speed and sense of rotation Instructions

Application Characteristics

By non-contact sensing of a rotating (or linear moving) steel profile, the sensor provides a pulse train with its frequency proportional to the speed, and a dc-voltage signal indicating the sense of rotation.

Profile Requirements

Material must be (standard) steel. Non-ferrous material, stainless steel, or plastics does not work. Minimum size = module 2 (pitch No.12) of a gear wheel, or slot and pole width > 3mm each, with depth > 4mm.
This information refers to scanning in radial direction. Axial sensor positioning (i.e. parallel to the shaft) requires a profile of a much larger size, and a side shift or oscillation may cause problems.

How the profile is to look like

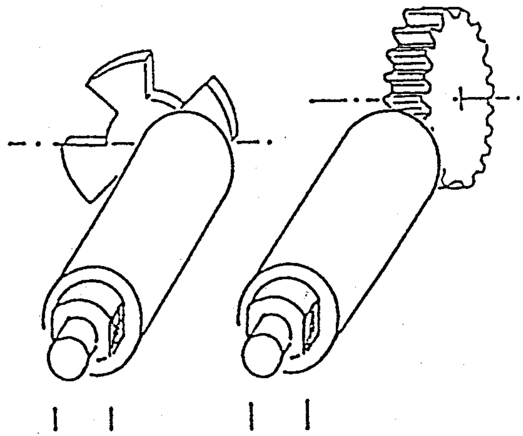
Positioning of the sensor

One positioning requirement refers to the profile edge, with the wrench planes at the sensor end serving as definition: they must be vertical in respect to the profile edge – see drawings in the margin. A deviation of max. ± 20 ° is acceptable. A 90 ° dislocation disables the function entirely. A turn by 180 ° reverses the direction output in its respect to the sense of rotation. See also instructions on next page.

A further requirement concerns the scanning gap between sensor and profile disk. The allowable gap depends on the profile size, according to the diagrams below. For the definitions of the size see General Instructions KA0-017E.

The sensor may be flush mounted within any material, and without distance to a neighbor sensor.

Adjustment to the profile edges



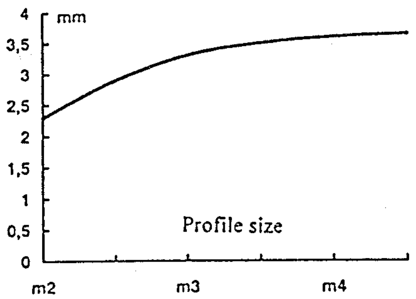
Wrench planes aiding to proper positioning

Mounting

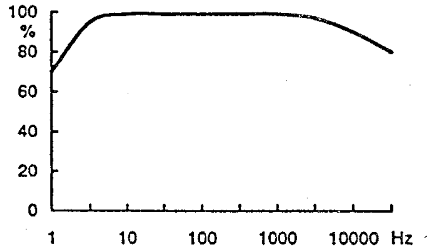
For a convenient mounting, a threaded bore M14x1,5 should be provided in the sensor support. Screw the sensor to the required position, and fix by the nut supplied with.

Allowable sensing gap

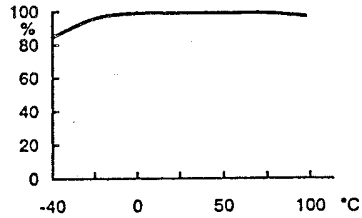
Gap width



derating of the allowable gap with the operating frequency

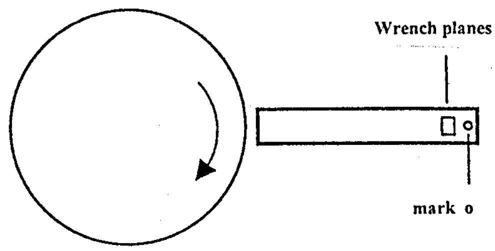


derating of the allowable gap with the ambient temperature



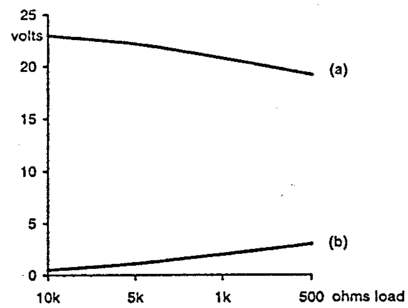
Direction Output
The sensor signalizes the direction by a DC-voltage. It switches between high and low with the sense of rotation, immediately after one pole has passed in reversed sense of rotation (definition of high and low see below). When the motion comes to stop, the existing signal will be maintained. A hysteresis between forward/reverse, or the conjunction to forward/reverse *run* must be achieved by a subsequent evaluation.
Positioning of the probe defines whether high or low level is assigned to clockwise or counter-clockwise motion. For a repeatable positioning, the probe carries a **o** mark on its type label. If this mark is visible on top, the probe output will be high, if the object turns clockwise; otherwise it is low.
Note: The Speed and Direction Monitor units CDE124.1S2 allow a further assignment between direction signal and the actual sense of rotation.

Relation between sensor position and sense of rotation



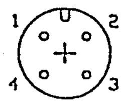
Output Level
The diagrams on the margin show the output voltage level versus the output load, valid for both direction and frequency output.
Diagram (a) indicates the high level of the output, if the load is inserted between output and common zero. The low level stays < 0.2 volts under this condition, with any load.
Diagram (b) indicates the low level of the output, if the load is inserted between output and + supply. Under this condition, the high level is always at supply voltage.
The evaluation module series CDE124.1S2 is recommended, when the direction signal is required as a relay contact, also in conjunction with a low speed limit to result in a signal switching at reverse *run* only.
The output power of the frequency signal allows its transmission up to 1000 meters, if adequately powered, as by the modules CDE124.1S2, or E15, or the C724 totalizers, available as panel meter, in snap-on-track enclosure or as 19-inch rack module. Observe the cable recommendations given below.

Sensor output under load at 24 volts supply



Connection
Straight (Bi4F/01) and angular (Bi4F/02) connectors are available, also cables in any required length, ready to plug-in. Pin connections are shown on the margin.
Wiring must use a shielded cable, leads with min $0.5mm^2$ (AWG20), typ. 36 ohms/km, 150 pF/m. Do not run the cable in bundles with cables to any interference sources, specifically to motors, inverters, power switches, magnets.
The cable screen shall not be connected to the sensor.
The circuit within the sensor is isolated from the sensor body.
The outputs are protected against short-circuiting.
Protection against supply polarity error is incorporated.

Pin No.	Function
1	+ supply
2	direction output
3	common zero
4	frequency output



view on soldering side of connector

Supply
DC 8....28 volts, approx. 20 ma plus load consumption. Transmission of high frequency signals over a wide distance may require more current in supply, up to 60 ma.
The supply source must not carry any interfering voltages.

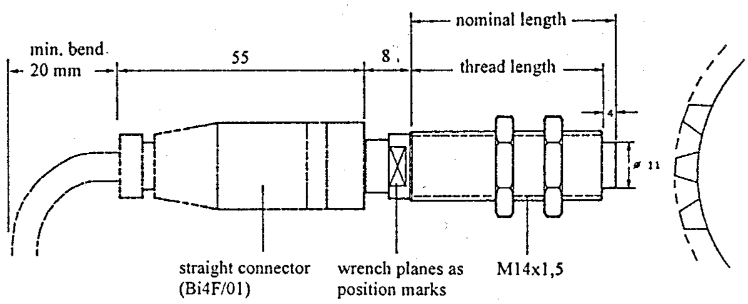
Sensor supply

CE
The sensor complies with the requirements for the **CE** sign, as given by Standards EN50081/50082, provided that these instructions are carefully observed. For space reasons, the sensor is marked by its model No. but does not carry the CE-mark.

Dimensions (mm)
shown with straight connector

Allowable ambient temperature
- 40 °C ....+ 85 °C (sensor tip max. 125°C).

Protection grade
IP 67, with firmly tightened connector.



Subject to change without further notice

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SPEED AND FREQUENCY

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Speed and Direction Monitor Series C124.1S2/D124.1S2/E124.1S2
with analog output and setpoint alarm

Instructions and Operation Manual

Contents

page

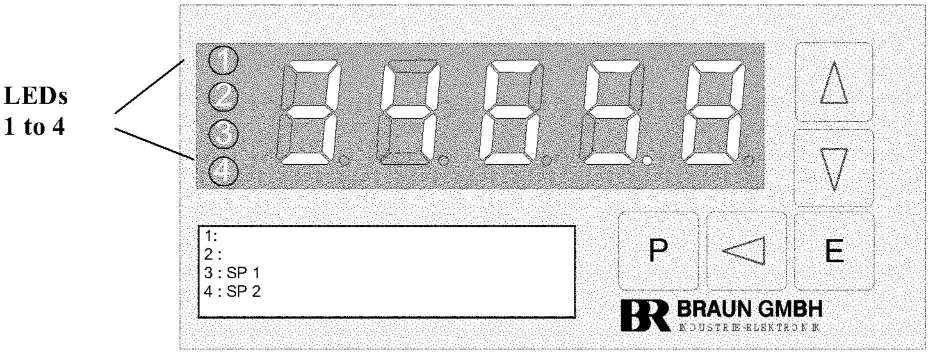
Specifications

Design	
series C...	panel mount enclosure DIN 43700, front size 96 x 48 mm, enclosure depth length 125 mm. Panel cut-out 92x45 mm, flaps mounting for panel thickness 1.5 up to 10 mm. weight .... approx. 400 g enclosure material .... plastics terminals size .... 2.5 mm^2
series D....	snap-on track enclosure for DIN 50022 rail 35 mm, Dimensions: length 100 mm, width 75 mm, height 111 mm.
series E...	19-inch module (3 HE x 8 TE). Connector matching socket DIN 41612, series F, 32 poles b+z.
Installation Conditions	Ambient temperature in operation Standard model: .... 0°C...+50°C Model with suffix M (extended range): .... -20°C...+65°C Ambient temperature in storage .... -40°C....+85°C Electrical insulation grade .... I Voltage grade .... I Protection grade .... series C...IP40 for front side series D...IP20 for terminals
Power Supply	Supply voltage version U1: .... 18....40Vac/dc version U1M : .... 20....40Vac/dc version U2: .... 85..265Vac/dc version U2M : .... 85..265Vac/dc Consumption 5 W resp. 5 VA
Signal input	matching speed/direction sensors series A5S3.. to other sources: response level on/off >7 volts/<4 volts input impedance 100 kohms sensor supply approx. 12 volts/max. 60 ma speed measurement sequence 30 msec..10 sec (programmable)
Accuracy	$\pm$ 0.005 % of measurement $\pm$ 1 in LSD
Analog output	isolated and programmable .... 10volts/20ma resolution .... 12 bit max. load .... 500 ohms(with ma), 3 ma (with volts) linearity error .... 0.1 %
Relay outputs	2, each SPDT Breaking capacity voltage min 10 mv, max 250 v AC/DC current min. 10 ua, max 2 amp AC, 1 amp DC power rating max 100 W, 250 VA into ohmic load only. Inductive load must be equipped with spark extinguisher
Display	5 digits LED red, with adjustable decimal point, programmable
Data Interface	(optional only) RS 232 or RS 485

Application and Functions

In connection with the Speed/Direction Sensors series A5S3... the instrument provides:
Speed display, Direction signal output, Speed setpoint alarm output, Analog output proportional to the speed

Display and Operating Elements



Operating Instructions

Display

Display readings in operation

In normal operation the display reads the speed in programmed unit and decimals. LED 1 is permanently on, LED 2 is permanently off.
LED 3 indicates the excess of speed setpoint SP1(resp. reverse rotation)
LED 4 indicates reverse rotation sense of the object
In the programming phase the display indicates program step No., resp. the corresponding parameter.
Error signal:
-E1- : unauthorized access with incorrect code No.

Display Step-Down after Input Interrupt

Display performance at input signal interrupt

In normal operation, the display closely tracks the input sequence, with the programmed performance. After a sudden interrupt of the input pulses, the instrument reduces the readings following an automatic step-down sequence. This starts as fast as the most recent measuring sequence before interrupt, but then decreases slower and slower (reciprocal) until it meets the programmed low end.

Programming procedure

Short form programming instructions

To enter the programming phase, press both E and P keys simultaneously.
Select program group or step No. by keys △ (for next), ▽ (for previous).
Switch between group and step select by key ◁.
Enter parameter by key E.
Select digit by key ◁.
Adjust figure by key △ (to increase), or ▽ (to decrease).
Acknowledge by key E.
Return to operation by key P.
Summary of parameters on next page, and detailed information in section "Programming".

Summary of programming steps and their initial parameters as set on delivery

program-Step No.	comments on page	parameter function		data set on delivery *) (initial data)
P00 .00	6	access code request		0000
.01	6	new code figure		0000
.02	6	lock status (1= unlocked, 0=locked)		1 = unlocked
.03	6	minimum measuring time (see table)		3 = 0.4s
P01 .00	7	scaling	decimals of input signal frequency	0 = none
.01	7		value of nominal input frequency (Hz)	00100
.02	7		decimals of corresponding speed	0 = none
.03	7		corresponding speed (unit as desired)	00100
.04	7		low end of speed range	00001
P02 .00	8	LSDs on zero		0 = none
.01	8	Display updating sequence		0.3 (sec)
.02	8	Direction output assigned to no-power condition (0 = forw., 1 = rev.)		1 = reverse
.03	8	minimum no of reverse pulses to release reverse alarm		05
.04	8	time period for reset of reverse pulse counter (xxx seconds)		010 sec
.05	8	forced direction at zero speed (0 = no, 1 = forw, 2 = rev)		0 = no
.06	8	reverse alarm latched until resetted (0 = no, 1= yes)		0 = no
P03 .00	9	analog output	high end speed value	10000
.01	9		low end speed value	00000
.02	9		zero level (0 = dead zero, 1 = live zero)	0
.03	9		signal voltage (0), current (1) (do not fail to set DIP switch accordingly)	1 = current
P04 .00	9	setpoint (SP1) in unit as programmed for display		01000
.01	9	hysteresis bandwidth (XX % of SP1)		05 (%)
.02	9	hysteresis location (0=above, 1=below, 2=symm)		1 = below SP
.03	10	alarm output assigned to "no-power" (see table)		0 = < SP
.04	10	alarm output assigned to starter phase		0 = < SP
.05	10	time elapse of starter phase (XXX sec)		000 (sec)
.06	10	function of output SP1(0 = setpoint SP1, 1 = reverse alarm SP2		0 = setpoint
P05 .00	10	Data Interface	baud rate (see table)	0 = 9600
.01	10		"my name" in communication	001

Note: Program group P05...is irrelevant without the data interface option.

*) unless stated otherwise in extra sheet.

Installation

Safety Notes
This instrument has been designed and inspected according to standards DIN 57 411 / VDE 0411Sect 1, and IEC 348. Observe these instructions and wiring diagrams carefully, to ensure this protection. The installation must only be done by adequately qualified personnel.

General information and instructions to installation and wiring.

See last pages for specific wiring diagrams and dimension sheet.

General Instructions
Specifically, connect the ground terminal of the instrument to a safe ground potential.
Do not open the instrument. Connections and all programming are done from outside. When removing it from its enclosure however, from whatever reason, make sure that power is switched off.
The instrument may be installed in any position, but not in the immediate neighborhood of interfering sources.

Signal leads must be carefully shielded, and should not be run in bundles with power or relay control leads.

The ground terminal (PE) is internally separated from common zero, but tied by a 100 k resistor to it.

EMI
The unit complies with all relevant regulations, as determined by the Policy of the European Committee for Electrotechnical Standardization (CENELEC), for the Electromagnetic Compatibility (89/336/EWG). Testing and inspection has been performed according to Standards DIN-EN 50081-2 and DIN-EN 50082-2 with status November 1994. Thereby, the product meets all requirements to be marked by the CE sign.
Strict observance of these instruction during installation and use is an indispensable precondition hereto. Specifically to be observed:
Terminals must be kept off all undue access;
power supply and all input and output leads must be protected against voltage interference, higher than specified operation data, and they must be protected against electrostatic discharge.

Label pocket
A pocket behind the transparent section of the front foil accepts a label to indicate ,for instance, the measured quantity and its unit, tag No and such. To insert a new label, remove the front frame. Remove the screws at the rear of the meter, and push the insert somewhat to the front. Insert the new label through the pocket opening at the low edge of the front. Return meter insert into original position, fasten rear screws and front frame.
Size of label sheet: max. 48,5 x 15 mm.
Visible section of label : 47 x 11.2 mm with upper end 0,5 mm below label rim.

Labelling facility

Programming

Program Structure

Program steps grouping

PXX.xx

group step

A program step No. is assigned to each parameter.
The entire steps are divided into program groups, to facilitate the addressing. Therefore, the address appears as PXX.xx , where XX is the group No., and xx the No. of the specific step in this group.

Programming Procedure

programming procedure

To enter the programming phase, keep key $\boxed{P}$ depressed when touching key $\boxed{E}$. The display switches to P00.00, indicating the first program step. The group No. blinks, indicating that it may be increased or decreased, using $\boxed{\triangle}$ or $\boxed{\triangledown}$.
Once in the desired group, touch $\boxed{\triangleleft}$, to switch to step No selection. Increase or decrease the same way. Return to group selection by $\boxed{\triangleleft}$ again. When in the desired step, touch $\boxed{E}$. The display now reads the actual parameter of this step. It may be varied, if data access is authorized, or access key unlocked. Programming a new parameter is done digit by digit. The digit ready to receive a new number blinks in display. Select a higher value by key $\boxed{\triangle}$, or a lower one by key $\boxed{\triangledown}$. Move to the next digit at left (if necessary) by key $\boxed{\triangleleft}$, and proceed accordingly. With the entire parameter ready prepared, touch $\boxed{E}$ again. Not before then it will become valid.
$\boxed{P}$ touched instead leaves the parameter at its previous value.
Leave the programming phase by again touching $\boxed{P}$. The display returns to process readings.

Programmable Parameters

Group P00.xx
Data Access and Minimum Measuring Period

Key figure to access

Step P00.00
Code figure to access

Programming access to all parameters can be locked by a password number. If not properly served, the parameters may be called to display but not varied. If not properly served, the display reads -E1-,and any programming in a later program step will be rejected.

Step P00.01
new code figure

Note:
If the knowledge of the password number went lost it may be recalled to display by a procedure, as described in a separate sheet K0-095 (not included into these instructions). The code figure than appears by 4 digits, headed by a _ sign.
In a subsequent program step, a new code may be established, substituting the one previously valid.

Step P00.02
unlock access key

The key function may be disengaged by a next program step. With authorized access, set parameter to 1 in step No .02, to generally unlock the key. This may prove practical during the installation phase to facilitate the adjustments. Once installed, the key function should be reactivated, by programming parameter 0 in this step.

Minimum Measuring Period

Step P00.03
minimum measuring time

All rate measurements are based on a time interval measurement over a (variable) number of input signal pulses. A programmable minimum measuring period thus will be maintained, automatically including more input pulses into every measurement with increasing input frequency. This establishes an averaging over the programmed period of time, which helps to stabilize the measurements, specifically with fluctuating variables. As a standard, a minimum time of 0.4 sec is recommended. A shorter period should only be selected to trace a fast variation (by the analog signal or alarm). A longer period however reduces the maximum allowable input frequency, as listed below.
The parameter of P00.03 defines the minimum measuring period:of time, with a number of steps available:

parameter	minimum time	max input frequency
0 =	0.03 s	100 kHz
1 =	0.07 s	100 kHz
2 =	0.1 s	100 kHz
3 =	0.4 s	100 kHz
4 =	0.8 s	75 kHz
5 =	2.0 s	30 kHz
6 =	5.0 s	12 kHz
7 =	10.0 s	6 kHz

Note:
The updating sequence for the display will be defined in a separate program step (P02.01).

Group P01.xx
Measurement Configuration
Input Scaling

Step P01.00
decimals for input frequency

Step P01.01
signal frequency at reference

Step P01.02
decimals for display

Step P01.03
speed value at reference

Scaling defines the relation between the input signal frequency (in terms of Hz), and the corresponding display (in the unit term and decimal position as required by the application). Both values are free programmable by their decimals and numerical amount. Of course, they must refer to the same operation level. This reference point is recommended at the high end of the intended operation range, but can be surpassed in the later operation without error.
Example:
A signal frequency of 13250 Hz corresponds to a speed of 5000 RPM.

Program as follows:	in step P01.00	parameter 0
	in step P01.01	parameter 13250
	in step P01.02	parameter 0
	in step P01.03	parameter 5000

General Note to the resolution:
Do not use too many decimals! If there are more decimals than justified by the operational fluctuation of the variable, and the transmitter resolution, the minor digits in display will fluctuate accordingly.
Note:
The parameters as set on delivery, apply to 60 pulses per revolution.

Low end level

The parameter of this step defines the low end of active measurement, by the same terms as selected for the speed display in the previous steps P01.02 and .03.

Step P01.04
Low end definiton

When the speed is below this level – and this is the most important function of this step – the direction output can be forced into a preselected sense, either forward or reverse or not changed (defined by step P02.03). The direction sensor by nature detects the sense of rotation and maintains its last state when the motion comes to stop (which might be an arbitrary condition). This function step however allows to assign, for instance, a forward signal to zero speed, thereby giving the "reverse" output a true *reverse run* meaning.

When the speed is below this level, the measurement will be set to zero, in display, analog output, and alarm condition.,

Group P02.xx
Display Performance and Direction Signal

Zeroing lesser significant digits

To eliminate a fluctuation in the last digit(s), as caused by fluctuations in the variable or signal source, these digits can be kept at zero reading. Set the number of those as the parameter of this step.
Note: If the paramter is set to 5, the display of the speed value will be totally blanked.

Step P02.00
number of LSDs to be kept at zero

Display updating sequence

Independent from the measuring period as programmed in step P00.03, the display may have its own up-dating, programmable in steps of 0.1 seconds, up to 9.9 sec. Set the parameter to the desired time sequence.
A recommended value is 0.3 sec.

Step P02.01
display up-date sequence

Direction Output assigned to "No-Power" condition

The wiring diagram shows the direction output relay in its deenergized position. To consider safety or other aspects of the application, this position may either be assigned to "forward" or to "reverse" signal by:
Parameter 0 = forward, parameter 1 = reverse

Step P02.02
"no power" direction output

Minimum number of reverse pulses to release reverse alarm

Reverse alarm is released, if during a given time period (refer to P02.04) a subsequent number reverse pulses have been counted. The amount of pulses is adjustable from 01 to 99 pulses.

Step P02.03
minimum number of reverse pulses

Time period for reset of reverse pulse counter

A slow reverse motion could trigger an inadvertent reverse alarm. To prevent this, the reverse pulse counter is periodically resetted after an adjustable time period (001 to 999 seconds).

Step P02.04
time period for reset of reverse pulse counter

Direction signal at low speed

When the speed is below the threshold set by program step P01.04, the direction output can be set to a signal position determined by the parameter: 0 = no change, 1 = forward, 2 = reverse.
Note: Settings 1 or 2 override the direction signal prevailing in the sensor output under this condition.

Step P02.05
direction signal at "low speed"

Reverse alarm latched/not latched

A reverse alarm can be latched. It must be then resetted by control input S2. Parameter 0 = alarm not latched, 1 = alarm is latched.

Step P02.06
reverse alarm latched/not latched

Program Group P03.xx
Analog output

High and low end of analog output span
High and low end of the analog output will be assigned to speed values by two program steps:
P03.00 defines the high end, P03.01 defines the low end of the analog output. Both limits are set by the same terms as already defined for the display.
Note:
This allows the low end to be set as high as 90 % of the high end, resulting in a 10 times spreading (enhancement) of the converted band. Further enhancement is not recommended.

Step P03.00
high end of analog output

Step P03.01
Low end of analog output

Analog output zero level
The parameter of step P03.02 defines:
0: without live zero
1: with live zero
This selection determines both ma or voltage output.

Step P03.02
analog output zero level

Output Signal Mode
The output is available as either dc-current (max. value = 20 ma) or voltage (max value = 10 volts). The selection requires a corresponding parameter in this program step, and also the positioning of the DIP-switches as shown in the wiring diagram.
Parameter 0 = voltage output
parameter 1 = ma-output
The DIP switches are accessible as shown in the diagrams.

Step P03.02
output mode

Program Range P04.xx
Defining the Speed Setpoint Alarm SP1

Alarm Setpoint
The setpoint SP1 is programmed by the same terms as selected for the display of the speed.

Step P04.00
setpoint SP1

Alarm Hysteresis
The hysteresis is the margin between condition "excess" (>) and "no excess" (<), defined by its bandwidth and its position in reference to the setpoint. The hysteresis bandwidth is set as a percentage of the setpoint.
The hysteresis band may be placed above setpoint, below setpoint, or symmetrically around the setpoint.
"Above" means, the alarm goes to excess state (>) when the speed exceeds the setpoint plus tolerance bandwidth, and it returns to no-excess (<), when the variable drops below setpoint.
Set parameter 0 for this performance.
"Below" means, the alarm goes to excess (>) when the variable exceeds the setpoint, and it cancels to no-excess (<), when the variable drops below setpoint minus tolerance.
Set parameter to 1 for this performance.
In "symmetrical" mode, the alarm goes to > when the variable exceeds the setpoint by half the tolerance band, and it cancels to < at half the tolerance below setpoint.
Set parameter to 2 for this performance.

Step P04.01
Alarm hysteresis bandwidth

Step P04.02
Alarm hysteresis position

0 = above setpoint
1 = below setpoint
2 = around setpoint

No-Power condition of the setpoint alarm

Step P04.03:
Alarm output at “no-power”

Without power supply to the unit, the alarm relay is de-energized. To consider safety aspects of the application, this No-Power condition can be assigned to either alarm > or < condition, by a corresponding parameter selection in this step:
0 = < setpoint
1 = > setpoint

Starter condition of alarms

Step P04.04
Alarm output during starter phase

A control signal to the Starter input (see diagram) throws the alarm output to a programmable condition for an adjustable period of time. This may be required for the starting period of a machine, specifically if monitored for low speed alarm.
Parameter 0 sets output to > setpoint during starter phase,
parameter 1 sets output to < setpoint during starter phase,

Starter time elapse

Step P04.05
starter time period

The starter time elapse is adjusted in program step P04.05 with range 000...999 sec.

Relay output SP1 assigned to setpoint SP1 or to reverse alarm SP2

Step P04.06
assignment of relay output SP2

The relay SP1 can be assigned either to the setpoint SP1 or to the reverse alarm SP2. If assigned to SP2, relay SP1 has identical function as relay SP2.
Assignment is adjusted in step P04.06:
Parameter 0 = relay SP1 assigned to setpoint SP1
Parameter 1 = relay SP1 assigned to reverse alarm SP2

Program Range P05

Defining Data Interface Parameters (option)

data interface definitions

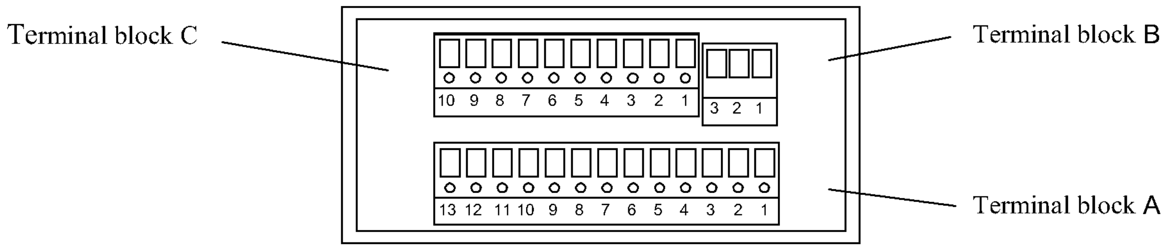
For the operation of the serial data interface (RS 485 or RS 232) these parameters are adjustable:
by program step P05.00: baud-rate.
by program step P05.01: "my device" No (address).
Further details see special instructions.

Initial parameters

initial parameters

The unit comes programmed to initial parameters, as listed on page 4. In course of the installation however, the specific adjustment to the application conditions is indispensable.

Location of Terminals



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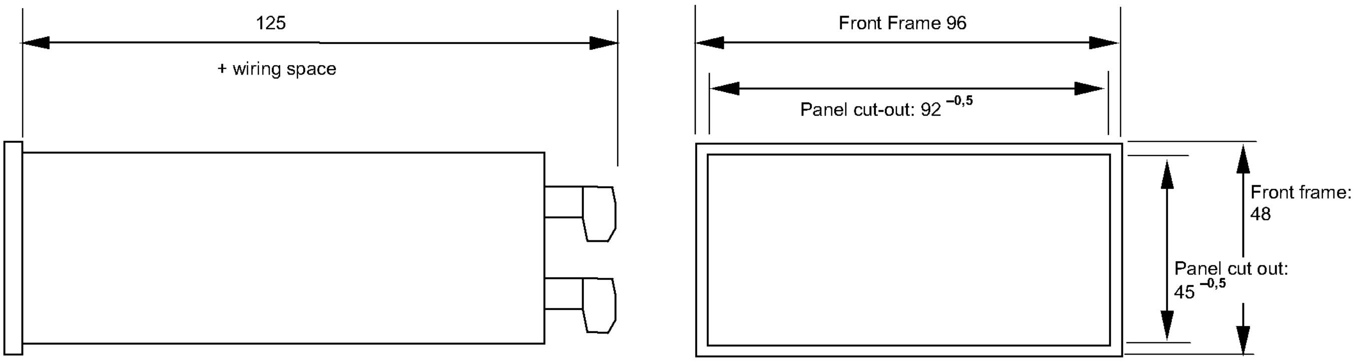
Dimensions C124.1S2 (mm)



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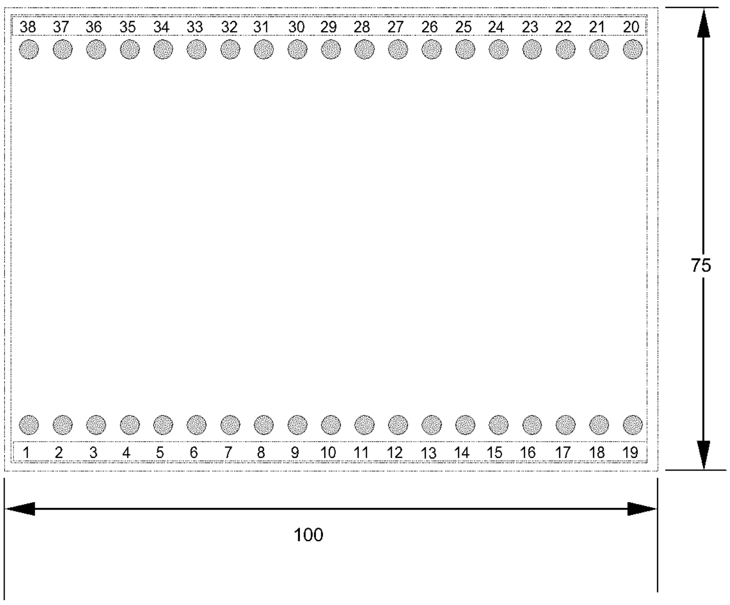
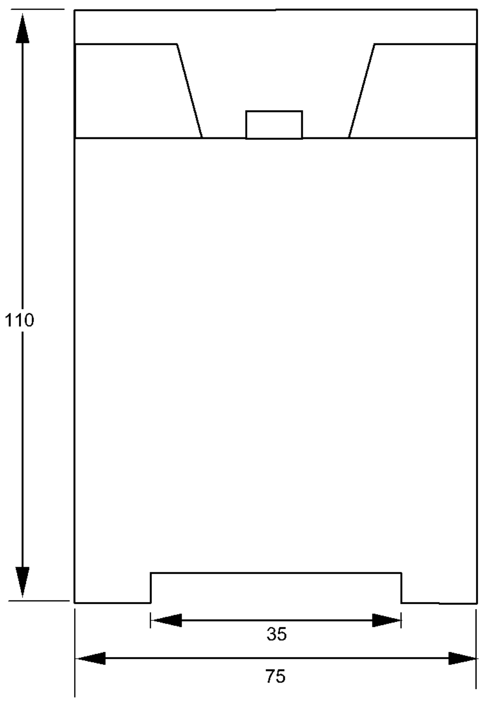
Dimensions D124.1S2 (mm)





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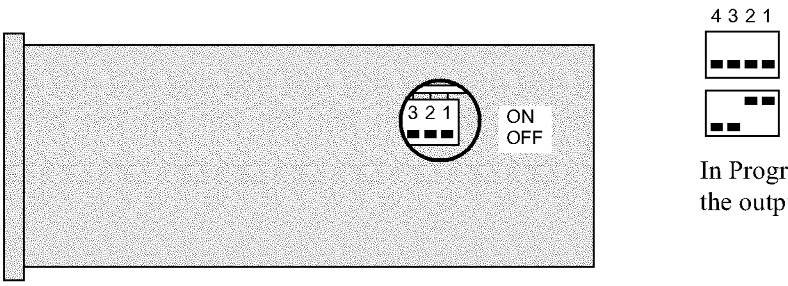
Selection of the analog output mode

Adjustment of "C.." series



1 + 2 OFF : ma output

1 + 2 ON : Volt output

In Programming set parameter for the output mode accordingly

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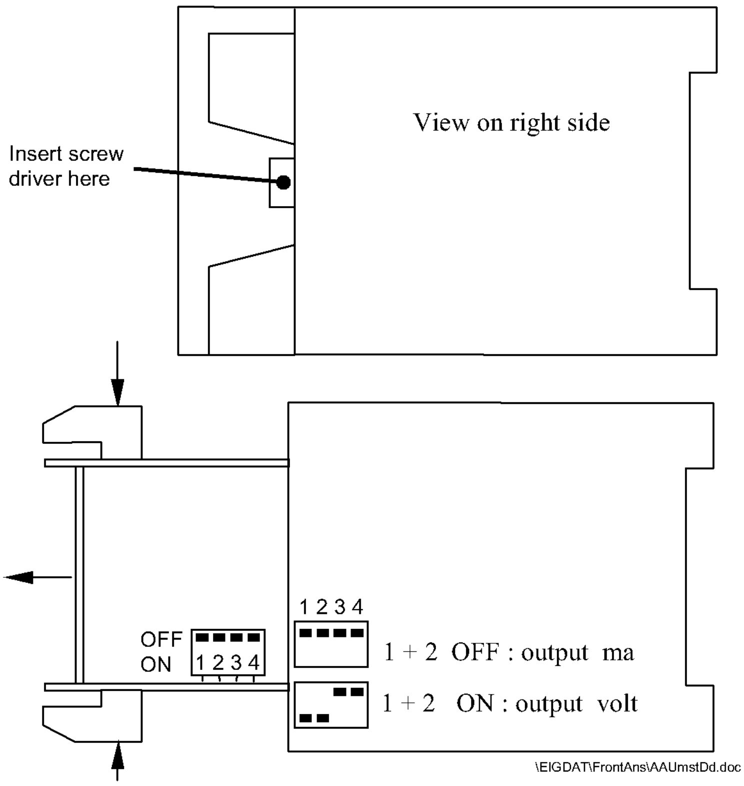
Adjustment of "D..." series

1. Prior to opening switch off power supply.
   Insert screwdriver blade at right side of cabinet, turn, and remove cover
2. Grip terminal blocks to pull unit out of enclosure for 3 cm, until DIP switches get accessible
3. SetDIP-switches to requested mode.
4. Re-assemble unit into enclosure.
5. Set parameter accordingly



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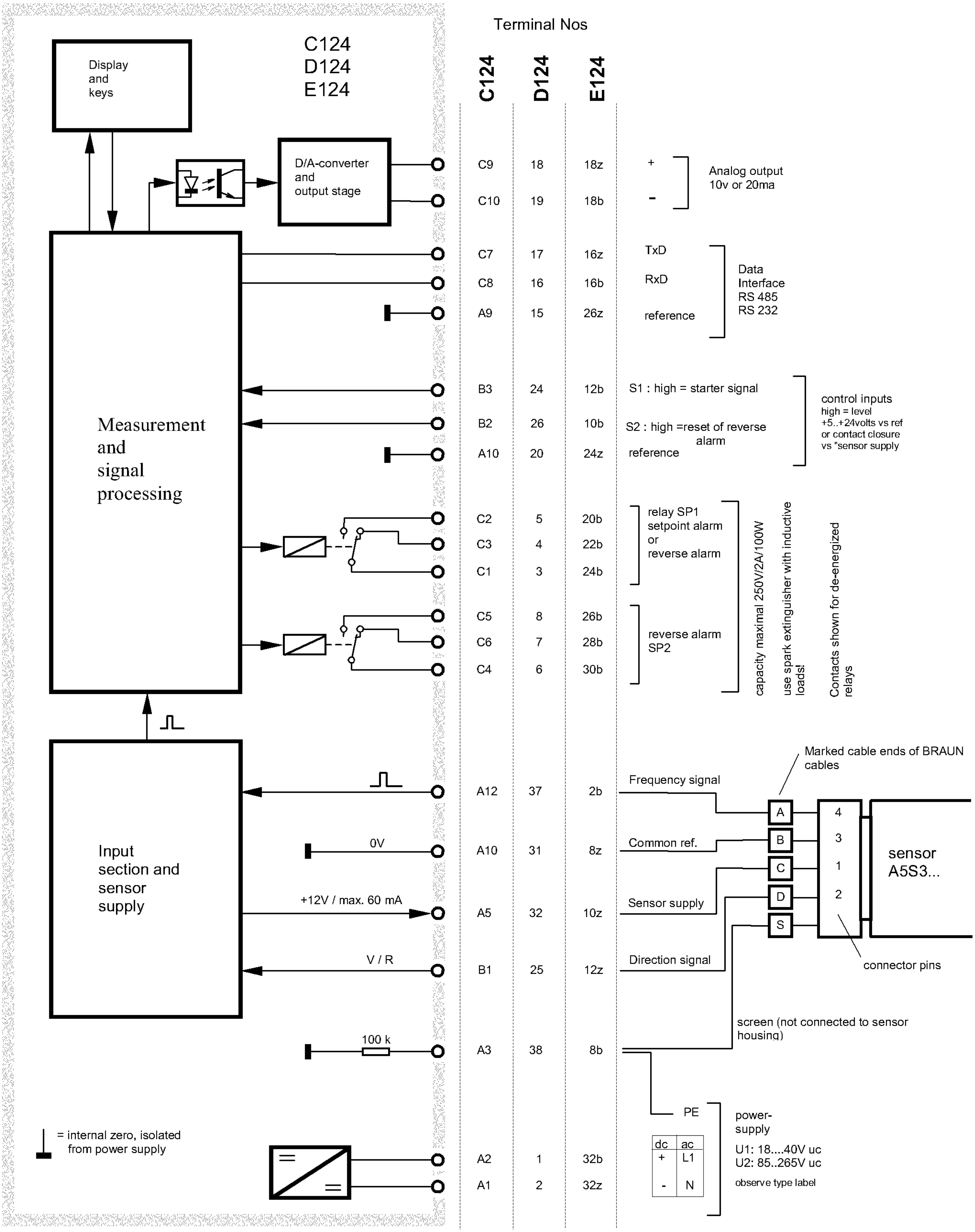
Function diagram and terminal nos.



Revision notes

11.2001
Changes versus edition of 4.1999
Opterating temperature range for version M extended to –20°C to +65°C.
Supply voltage for version U1M: 20...40Vac/dc

14.13 Level switch

Voith Article No: 204.01091010

Type: LT 255.XX (4-20 mA)

Description . . . . VOITH

Operating Instructions

OnC LevelSens 255

4 … 20 mA/HART - two-wire

Contents

38803-EN-140324

Supplementary documentation

Information:
Supplementary documents appropriate to the ordered version come with the delivery. You can find them listed in chapter "*Product description*".

Instructions manuals for accessories and replacement parts

Tip:
- 33927 - External adjustment unit OnC UniCom 961
- 33931 - Oscillator OnC LevelSens series 25X

Editing status: 2014-03-11

38803-EN-140324

1 About this document

1.1 Function

This operating instructions manual provides all the information you need for mounting, connection and setup as well as important instructions for maintenance and fault rectification. Please read this information before putting the instrument into operation and keep this manual accessible in the immediate vicinity of the device.

1.2 Target group

This operating instructions manual is directed to trained specialist personnel. The contents of this manual should be made available to these personnel and put into practice by them.

1.3 Symbols used

Information, tip, note
This symbol indicates helpful additional information.

Caution: If this warning is ignored, faults or malfunctions can result.

Warning: If this warning is ignored, injury to persons and/or serious damage to the instrument can result.

Danger: If this warning is ignored, serious injury to persons and/or destruction of the instrument can result.

Ex applications
This symbol indicates special instructions for Ex applications.

SIL **SIL applications**
This symbol indicates instructions for functional safety which must be particularly taken into account for safety-relevant applications.

• **List**
The dot set in front indicates a list with no implied sequence.

→ **Action**
This arrow indicates a single action.

1 **Sequence of actions**
Numbers set in front indicate successive steps in a procedure.

Battery disposal
This symbol indicates special information about the disposal of batteries and accumulators.

2 For your safety

2.1 Authorised personnel

All operations described in this operating instructions manual must be carried out only by trained specialist personnel authorised by the plant operator.

During work on and with the device the required personal protective equipment must always be worn.

2.2 Appropriate use

OnC LevelSens 255 is a sensor for continuous level measurement.

You can find detailed information about the area of application in chapter "*Product description*".

Operational reliability is ensured only if the instrument is properly used according to the specifications in the operating instructions manual as well as possible supplementary instructions.

For safety and warranty reasons, any invasive work on the device beyond that described in the operating instructions manual may be carried out only by personnel authorised by the manufacturer. Arbitrary conversions or modifications are explicitly forbidden.

2.3 Warning about incorrect use

Inappropriate or incorrect use of the instrument can give rise to application-specific hazards, e.g. vessel overfill or damage to system components through incorrect mounting or adjustment.

2.4 General safety instructions

This is a state-of-the-art instrument complying with all prevailing regulations and guidelines. The instrument must only be operated in a technically flawless and reliable condition. The operator is responsible for the trouble-free operation of the instrument.

During the entire duration of use, the user is obliged to determine the compliance of the necessary occupational safety measures with the current valid rules and regulations and also take note of new regulations.

The safety instructions in this operating instructions manual, the national installation standards as well as the valid safety regulations and accident prevention rules must be observed by the user.

For safety and warranty reasons, any invasive work on the device beyond that described in the operating instructions manual may be carried out only by personnel authorised by the manufacturer. Arbitrary conversions or modifications are explicitly forbidden.

The safety approval markings and safety tips on the device must also be observed.

2.5 Safety label on the instrument

The safety approval markings and safety tips on the device must be observed.

2.6 CE conformity

This device fulfills the legal requirements of the applicable EC guidelines. By attaching the CE mark, we provide confirmation of successful testing.

2.7 Fulfillment of NAMUR recommendations

NAMUR is the automation technology user association in the process industry in Germany. The published NAMUR recommendations are accepted as the standard in field instrumentation.

The device fulfills the requirements of the following NAMUR recommendations:

- NE 21 – Electromagnetic compatibility of equipment
- NE 43 – Signal level for malfunction information from measuring transducers
- NE 53 – Compatibility of field devices and display/adjustment components

For further information see www.namur.de.

2.8 Safety instructions for Ex areas

Please note the Ex-specific safety information for installation and operation in Ex areas. These safety instructions are part of the operating instructions manual and come with the Ex-approved instruments.

3 Product description

3.1 Configuration

Scope of delivery

The scope of delivery encompasses:

- Level sensor OnC LevelSens 255
- Documentation
  - this operating instructions manual
  - Operating instructions manual "*Display and adjustment module*" (optional)
  - Ex-specific "*Safety instructions*" (with Ex versions)
  - if necessary, further certificates

Constituent parts

The OnC LevelSens 255 consists of the components:

- Process fitting with probe
- Housing with electronics
- Housing cover, optionally available with display and adjustment module

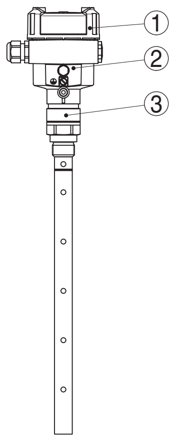


Fig. 1: OnC LevelSens 255

1 Housing cover with integrated display and adjustment module (optional)
2 Housing with electronics
3 Process fitting

Type label

The type label contains the most important data for identification and use of the instrument:

- Article number
- Serial number
- Technical data

3.2 Principle of operation

Application area

OnC LevelSens 255 is a level sensor with pipe probe for continuous level measurement.

It is designed for industrial use in all areas of process technology and can be used in liquids.

Functional principle

High frequency microwave pulses are guided along a steel rope or a rod. Upon reaching the product surface, the microwave pulses are reflected. The running time is evaluated by the instrument and outputted as distance.

Voltage supply

4 … 20 mA/HART two-wire electronics for voltage supply and measured value transmission on the same cable.

The supply voltage range can differ depending on the instrument version. The exact range is stated in chapter "*Technical data*".

The backlight of the display and adjustment module is powered by the sensor. The prerequisite for this is a supply voltage at a certain level. The exact voltage specifications are stated in chapter "*Technical data*".

3.3 Operation

The instrument can be adjusted with the following adjustment media:

- With the display and adjustment module
- With a HART handheld

The entered parameters are generally saved in OnC LevelSens 255, optionally also in the indicating/adjustment module.

3.4 Packaging, transport and storage

Packaging

Your instrument was protected by packaging during transport. Its capacity to handle normal loads during transport is assured by a test based on ISO 4180.

The packaging of standard instruments consists of environment-friendly, recyclable cardboard. For special versions, PE foam or PE foil is also used. Dispose of the packaging material via specialised recycling companies.

Transport

Transport must be carried out in due consideration of the notes on the transport packaging. Nonobservance of these instructions can cause damage to the device.

Transport inspection

The delivery must be checked for completeness and possible transit damage immediately at receipt. Ascertained transit damage or concealed defects must be appropriately dealt with.

Storage

Up to the time of installation, the packages must be left closed and stored according to the orientation and storage markings on the outside.

Unless otherwise indicated, the packages must be stored only under the following conditions:

- Not in the open
- Dry and dust free
- Not exposed to corrosive media

- Protected against solar radiation
- Avoiding mechanical shock and vibration

Storage and transport temperature

- Storage and transport temperature see chapter "*Supplement - Technical data - Ambient conditions*"
- Relative humidity 20 … 85 %

4 Mounting

4.1 General instructions

Suitability for the process conditions

Make sure that all parts of the instrument coming in direct contact with the process, especially the sensor element, process seal and process fitting, are suitable for the existing process conditions, such as process pressure, process temperature as well as the chemical properties of the medium.

You can find the specifications in chapter "*Technical data*" and on the nameplate.

Installation position

Select an installation position you can easily reach for mounting and connecting as well as later retrofitting of a display and adjustment module. The housing can be rotated by 330° without the use of any tools. You can also install the display and adjustment module in four different positions (each displaced by 90°).

Welding work

Before beginning the welding work, remove the electronics module from the sensor. By doing this, you avoid damage to the electronics through inductive coupling.

Handling

With threaded versions, the housing must not be used to screw in the instrument. Applying tightening forces on the housing can damage its internal parts.

Use the hexagon for screwing in.

Moisture

Use the recommended cables (see chapter "*Connecting to power supply*") and tighten the cable gland.

You can give your OnC LevelSens 255 additional protection against moisture penetration by leading the connection cable downward in front of the cable entry. Rain and condensation water can thus drain off. This applies mainly to outdoor mounting as well as installation in areas where high humidity is expected (e.g. through cleaning processes) or on cooled or heated vessels.

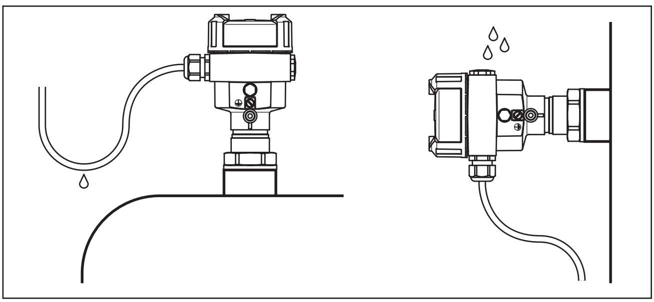


Fig. 2: Measures against moisture penetration

Measuring range

The reference plane for the measuring range of the sensors is the seal surface of the thread.

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Keep in mind that a min. distance must be maintained below the reference plane and possibly also at the end of the probe - measurement in these areas is not possible. These min. distances are listed in chapter "*Technical data*" in the "*Supplement*". Keep in mind for the adjustment that the default setting for the measuring range refers to water.

Pressure

The process fitting must be sealed if there is gauge or low pressure in the vessel. Before use, check if the seal material is resistant against the measured product and the process temperature.

The max. permissible pressure is specified in chapter "*Technical data*" or on the type label of the sensor.

4.2 Mounting instructions

Installation position

Mount OnC LevelSens 255 in such a way that the probe does not touch any installations or the vessel wall during installation.

In vessels with conical bottom it can be advantageous to mount the sensor in the center of the vessel, as measurement is then possible down to the lowest point of the vessel bottom.

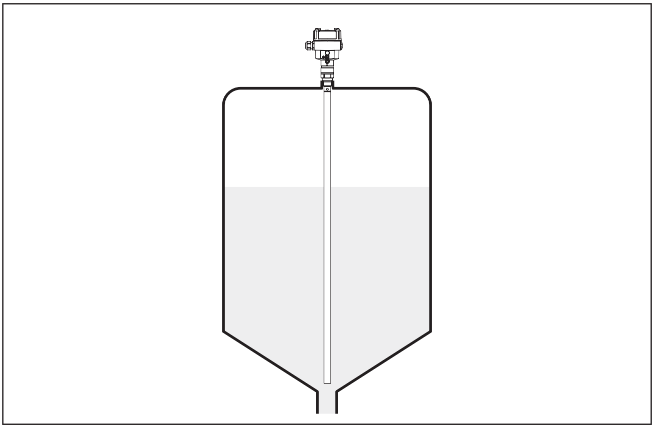

Fig. 3: Vessel with conical bottom

Inflowing medium

Make sure that the probe is not subjected to strong lateral forces. Mount OnC LevelSens 255 at a position in the vessel where no disturbances, e.g. from filling openings, agitators, etc., can occur.

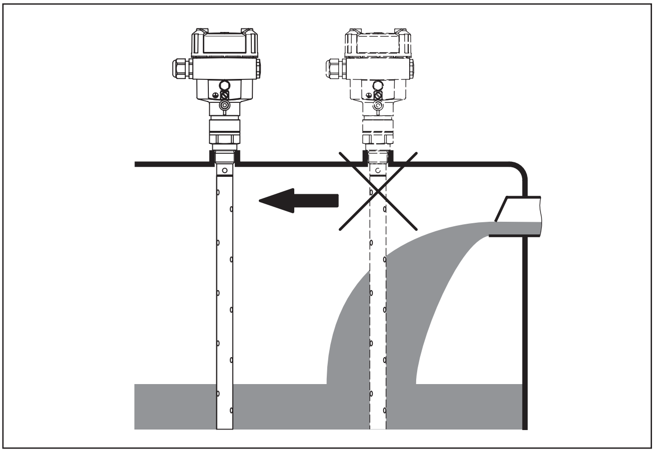

Fig. 4: Lateral load

Extreme vibration caused by the system, e.g. due to agitators or turbulence in the vessel from inflowing medium, can cause the coax probe of OnC LevelSens 255 to vibrate in resonance. With coax probes of more than 1 m (3.281 in) length, you must secure the probe by fastening a suitable insulated brace or guy directly above the end of the rod.

5 Connecting to power supply

5.1 Preparing the connection

Note safety instructions

Always keep in mind the following safety instructions:

- Connect only in the complete absence of line voltage
- If overvoltage surges are expected, overvoltage arresters should be installed

Take note of safety instructions for Ex applications

In hazardous areas you must take note of the respective regulations, conformity and type approval certificates of the sensors and power supply units.

Voltage supply

Power supply and current signal are carried on the same two-wire cable. The voltage supply range can differ depending on the instrument version.

The data for power supply are specified in chapter "*Technical data*".

Provide a reliable separation between the supply circuit and the mains circuits according to DIN EN 61140 VDE 0140-1.

Keep in mind the following additional factors that influence the operating voltage:

- Output voltage of the power supply unit can be lower under nominal load (with a sensor current of 20.5 mA resp. 22 mA in case of fault message)
- Influence of additional instruments in the circuit (see load values in chapter "*Technical data*")

Connection cable

The instrument is connected with standard two-wire cable without screen. If electromagnetic interference is expected which is above the test values of EN 61326 for industrial areas, screened cable should be used.

Use cable with round cross-section. A cable outer diameter of 5 … 9 mm (0.2 … 0.35 in) ensures the seal effect of the cable gland. If you are using cable with a different diameter or cross-section, exchange the seal or use a suitable cable gland.

Cable screening and grounding

If screened cable is necessary, connect the cable screen on one or both ends to ground potential depending on the plant installation. In the sensor, the screen must be connected directly to the internal ground terminal. The ground terminal on the outside of the housing must be connected to the potential equalisation (low impedance).

If potential equalisation currents are expected, the connection on the processing side must be made via a ceramic capacitor (e. g. 1 nF, 1500 V). The low-frequency potential equalisation currents are thus suppressed, but the protective effect against high frequency interference signals remains.

Warning:
Considerable potential differences exist inside galvanic plants as well as vessels with cathodic corrosion protection. Very large equalisation currents can flow through the cable screen when the screen

is grounded on both ends. To avoid this, the cable screen must be connected to ground potential only on one end (inside the switching cabinet) in such applications. The cable screen must **not** be connected to the internal ground terminal in the sensor and the outer ground terminal on the housing **not** to potential equalisation!

Information:
The metallic parts of the instrument (antenna, transmitter, concentric tube, etc.) are conductively connected with the inner and outer ground terminal on the housing. This connection exists either as a direct metallic contact or via the shielding of the special connection cable on instruments with external electronics. You can find specifications on the potential connections within the instrument in chapter "*Technical data*".

Connection cable for Ex applications

Take note of the corresponding installation regulations for Ex applications. In particular, make sure that no potential equalisation currents flow over the cable screen. In case of grounding on both sides this can be achieved by the use of a capacitor or a separate potential equalisation.

5.2 Connection procedure

Proceed as follows:

1. Unscrew the housing cover
2. If a display and adjustment module is installed, remove it by turning it slightly to the left.
3. Loosen compression nut of the cable entry gland
4. Remove approx. 10 cm of the cable mantle, strip approx. 1 cm insulation from the individual wires
5. Insert the cable into the sensor through the cable entry
6. Lift the opening levers of the terminals with a screwdriver (see following illustration)
7. Insert the wire ends into the open terminals according to the wiring plan

Fig. 5: Connection steps 6 and 7

8. Press down the opening levers of the terminals, you will hear the terminal spring closing
9. Check the hold of the wires in the terminals by lightly pulling on them
10. Connect the screen to the internal ground terminal, connect the outer ground terminal to potential equalisation
11. Tighten the compression nut of the cable entry gland. The seal ring must completely encircle the cable
12. Screw the housing cover back on

The electrical connection is finished.

5.3 Wiring plan, single chamber housing

The following illustrations apply to the non-Ex as well as to the Ex-ia version.

Electronics and terminal compartment

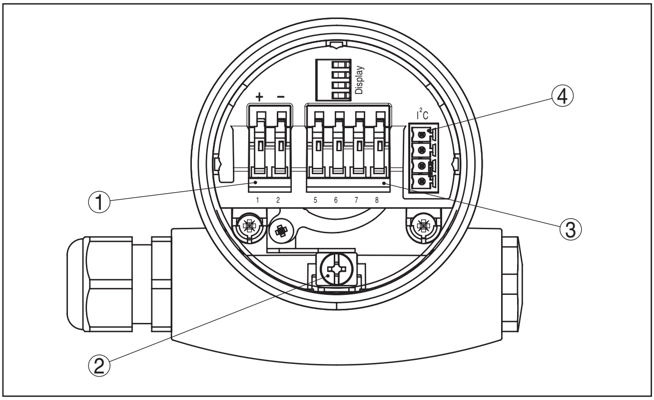

Fig. 6: Electronics and terminal compartment, single chamber housing

1 *Spring-loaded terminals for voltage supply*
2 *Ground terminal for connection of the cable screen*
3 *Spring-loaded terminals for connection of the external indication UniCom961*
4 *Plug connector for service interface*

Wiring plan

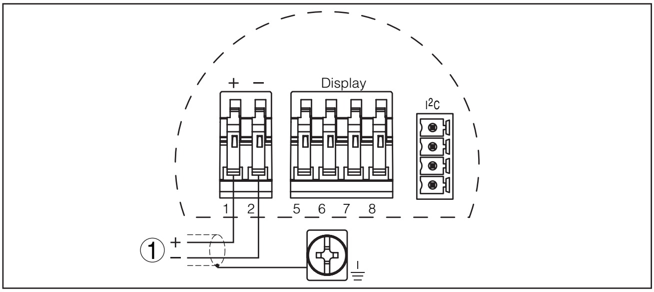

Fig. 7: Wiring plan, single chamber housing

1 *Voltage supply, signal output*

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6 Set up with the display and adjustment module

6.1 Short description

Function/Configuration

The display and adjustment module is used for measured value display, adjustment and diagnosis. It can be mounted in the following instruments:

- All sensors
- External display and adjustment unit

Note:
You can find detailed information on the adjustment in the operating instructions manual "*Display and adjustment module*".

6.2 Insert display and adjustment module

Mount/Dismount display and adjustment module

The display and adjustment module can be inserted into the sensor and removed again at any time. It is not necessary to interrupt the power supply.

Proceed as follows:

1. Unscrew the housing cover
2. Place the display and adjustment module in the desired position on the electronics (you can choose any one of four different positions - each displaced by 90°)
3. Press the display and adjustment module onto the electronics and turn it to the right until it snaps in.
4. Screw housing cover with inspection window tightly back on

Removal is carried out in reverse order.

The display and adjustment module is powered by the sensor, an additional connection is not necessary.

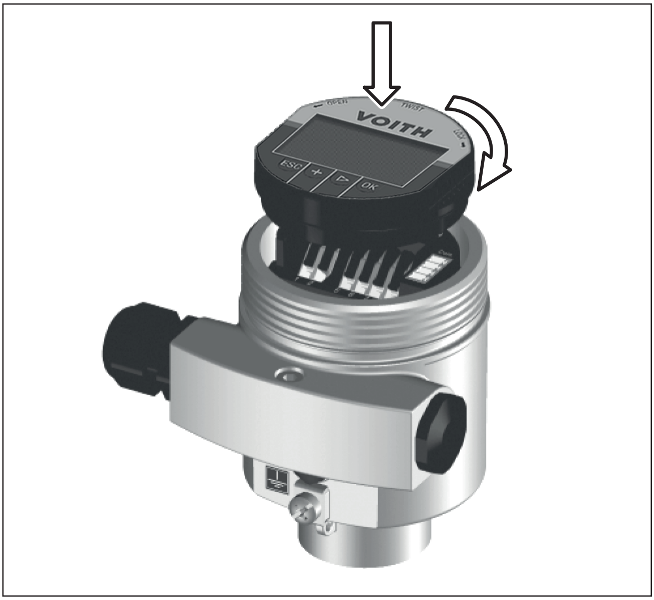

Fig. 8: Insert display and adjustment module

Note:
If you intend to retrofit the instrument with a display and adjustment module for continuous measured value indication, a higher cover with an inspection glass is required.

6.3 Adjustment system

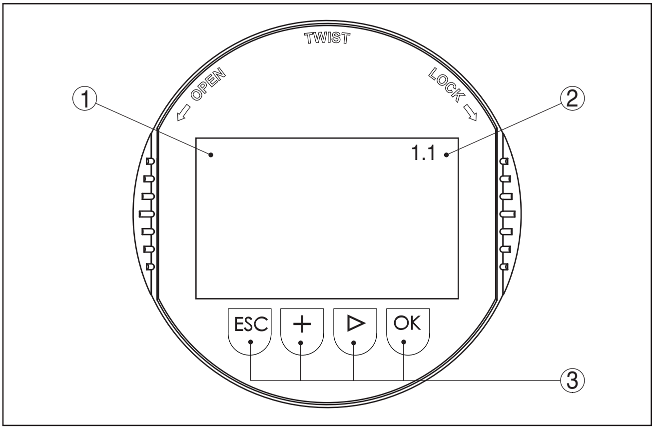

Fig. 9: Display and adjustment elements

1. *LC display*
2. *Indication of the menu item number*
3. *Adjustment keys*

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Key functions

- ***[OK]*** key:
  - Move to the menu overview
  - Confirm selected menu
  - Edit parameter
  - Save value
- ***[->]*** key to select:
  - Menu change
  - Select list entry
  - Select editing position
- ***[+]*** key:
  - Change value of the parameter
- ***[ESC]*** key:
  - Interrupt input
  - Jump to the next higher menu

Adjustment system

The sensor is adjusted via the four keys of the display and adjustment module. The LC display indicates the individual menu items. The functions of the individual keys are shown in the above illustration. Approx. 10 minutes after the last pressing of a key, an automatic reset to measured value indication is triggered. Any values not confirmed with ***[OK]*** will not be saved.

6.4 Setup steps

Switch-on phase

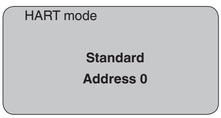
After connecting OnC LevelSens 255 to power supply or after a voltage recurrence, the instrument carries out a self-check for approx. 30 seconds:

- Internal check of the electronics
- Indication of the instrument type, the firmware as well as the sensor TAGs (sensor designation)
- Output signal jumps briefly (approx. 10 seconds) to the set fault current

Then the corresponding current is outputted to the cable (the value corresponds to the actual level as well as the settings already carried out, e.g. factory setting).

Address setting HART multidrop

In HART-Multidrop mode (several sensors on one input) the address must be set before continuing with the parameter adjustment. You will find a detailed description in the operating instructions manual of the "*Display and adjustment module*".



Parameter adjustment

As OnC LevelSens 255 is a distance measuring instrument, the distance from the sensor to the product surface is measured. To have the real product level displayed, an allocation of the measured distance to the percentage height must be made. To carry out this adjustment, the distance is entered with full and empty vessel. If these values are not known, an adjustment with the distance values, e.g. 10 % and 90 % is also possible. Starting point for these distance specifications is always the seal surface of the thread or flange. With these settings, the real level is calculated. Furthermore the operating range of the sensor is limited from maximum to the required range.

The real product level during this adjustment is not important, because the min./max. adjustment is always carried out without changing the product level. These settings can be made ahead of time without the instrument having to be installed.

In the main menu item "*Basic adjustment*", the individual submenu items should be selected one after the other and provided with the correct parameter values.

⚠ **Caution:**
If there is a separation of different liquids in the vessel, e.g. by condensation, OnC LevelSens 255 will always detect the medium with the higher dielectric constant (ε_r).

Keep in mind that interfaces can cause faulty measurements.

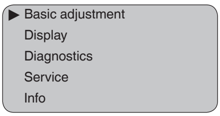
If you want to measure the total height of both liquids reliably, please contact our service department or use an instrument specially designed for interface measurement.

Start your parameter adjustment with the following menu items of the basic adjustment:

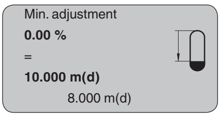
Carry out min. adjustment

Proceed as follows:

1. Move from the measured value display to the main menu by pushing ***[OK]***.



2. Select the menu item "*Basic adjustment*" with ***[->]*** and confirm with ***[OK]***. Now the menu item "*Min. adjustment*" is displayed.



3. Prepare the % value for editing with ***[OK]*** and set the cursor to the requested position with ***[->]***. Set the requested percentage value with ***[+]*** and save with ***[OK]***. The cursor jumps now to the distance value.
4. Enter the suitable distance value in m for the empty vessel (e.g. distance from the sensor to the vessel bottom) corresponding to the percentage value.
5. Save the settings with ***[OK]*** and move to "Max. adjustment" with ***[->]***.

Carry out max. adjustment

Proceed as follows:

Max. adjustment
100.00 %
=
1.000 m(d)
2.000 m(d)

1. Prepare the % value for editing with ***[OK]*** and set the cursor to the requested position with ***[->]***. Set the requested percentage value with ***[+]*** and save with ***[OK]***. The cursor jumps now to the distance value.
2. Enter the appropriate distance value in m (corresponding to the percentage value) for the full vessel. Keep in mind that the max. level must lie below the dead band.
3. Save the settings with ***[OK]***.

Application

Each product has different reflective properties. In addition, there are various interfering factors which have to be taken into account: agitated product surfaces and foam generation (with liquids); dust generation, material cones and echoes from the vessel wall (with solids). To adapt the sensor to these different conditions, you should first select in this menu item under "*Medium*" either "*Liquid*" or "*Solid*".

Application
Liquid

Standard
(dielectric constant ≥ 2)

Depending on the dielectric constant (dielectric constant or ε_r), measured products can have a different reflective property. Therefore an additional selection possibility is available.

Under "*Sensitivity*" you can select "*Standard (dielectric constant ≥ 2)*" or "*Increased sensitivity (dielectric constant < 2)*".

Through this the sensor is optimally adapted to the product and measurement reliability, particularly in products with poor reflective properties, is considerably increased.

Enter the requested parameters via the appropriate keys, save your settings and jump to the next menu item with the ***[->]*** key.

Damping

To suppress fluctuations in the measured value display, e. g. caused by an agitated product surface, a damping can be set. This time can be between 0 and 999 seconds. Keep in mind that the reaction time of the entire measurement will then be longer and the sensor will react to measured value changes with a delay. In general, a period of a few seconds is sufficient to smooth the measured value display.

Damping

0 s

Enter the requested parameters via the appropriate keys, save your settings and jump to the next menu item with the ***[->]*** key.

Linearisation curve

A linearisation is necessary for all vessels in which the vessel volume does not increase linearly with the level - e.g. in a horizontal cylindrical or spherical tank - and the indication or output of the volume is required. Corresponding linearisation curves are preprogrammed for these vessels. They represent the correlation between the level percentage and vessel volume. By activating the appropriate curve, the volume percentage of the vessel is displayed correctly. If the volume should not be displayed in percent but e.g. in l or kg, a scaling can be also set in the menu item "*Display*".

Linearisation curve

Linear

Enter the requested parameters via the appropriate keys, save your settings and jump to the next menu item with the ***[->]*** key.

Caution:
Note the following if the OnC LevelSens 255 with corresponding approval is used as part of an overfill protection system according to WHG (Water Resources Act):

If a linearization curve is selected, the measuring signal is no longer necessarily linear to the filling height. This must be considered by the user especially when adjusting the switching point on the limit signal transmitter.

Sensor-TAG

In this menu item you can enter an unambiguous designation for the sensor, e.g. the measurement loop name or the tank or product designation. In digital systems and in the documentation of larger plants, a singular designation should be entered for exact identification of individual measuring points.

Sensor-TAG

Sensor

With this menu item, the Basic adjustment is finished and you can now jump to the main menu with the ***[ESC]*** key.

False signal suppression

High sockets or vessel installations, such as e. g. struts or agitators as well as buildup and weld joints on the vessel walls, cause interfering reflections which can impair the measurement. A false echo storage detects and marks these false echoes, so that they are no longer taken into account for the level measurement. A false echo memory should be created with low level so that all potential interfering reflections can be detected.

False signal suppression

Change now?

Proceed as follows:

1. Move from the measured value display to the main menu by pushing ***[OK]***.
2. Select the menu item "*Service*" with ***[->]*** and confirm with ***[OK]***. Now the menu item "*False signal suppression*" is displayed.
3. Confirm "*False signal suppression - Change now*" with ***[OK]*** and select in the below menu "*Create new*". Enter the actual distance from the sensor to the product surface. All false signals in this area are detected by the sensor and saved after confirming with ***[OK]***.

Note:
Check the distance to the product surface, because if an incorrect (too large) value is entered, the existing level will be saved as a false echo. The filling level would then no longer be detectable in this area.

Copy sensor data

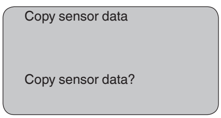
This function enables reading out parameter adjustment data as well as writing parameter adjustment data into the sensor via the display and adjustment module. A description of the function is available in the operating instructions manual "*Display and adjustment module*".

The following data are read out or written with this function:

- Measured value presentation
- Adjustment
- Medium
- Vessel form
- Damping
- Linearisation curve
- Sensor-TAG
- Displayed value
- Display unit
- Scaling
- Current output
- Unit of measurement
- Language
- Sensitivity

The following safety-relevant data are **not** read out or written:

- HART mode
- PIN
- SIL
- Sensor length/Sensor type
- False signal suppression



Reset

Basic adjustment
If the "*Reset*" is carried out, the sensor resets the values of the following menu items to the reset values (see chart):[1]

[1] Sensor-specific basic adjustment.

The following values will be reset:

Function	Reset value
Max. adjustment	Distance, upper dead zone
Min. adjustment - Rod/Coax version	Distance, supplied sensor length
Min. adjustment - Cable version	Distance, lower dead zone
Damping ti	0 s
Linearization	Linear
Sensor-TAG	Sensor
Display	Distance
Current output - characteristics	4 … 20 mA
Current output - max. current	20 mA
Current output - min. current	4 mA
Current output - failure	<3.6 mA
Application - rod/coax version	Liquid
Application - Cable version	Bulk solid

The values of the following menu items are *not* reset to the reset values (see chart) with "**Reset**":

Function	Reset value
Backlight	No reset
Language	No reset
HART mode	No reset

Default setting
Like basic adjustment, but in addition, special parameters are reset to default values.

Peak value indicator
The min. and max. values are reset to the actual value.

Optional settings

Additional adjustment and diagnosis options such as e.g. scaling, simulation or trend curve presentation are shown in the following menu schematic. You will find a detailed description of these menu items in the operating instructions manual "*Display and adjustment module*".

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6.5 Menu schematic

Basic adjustment

▶ Basic adjustment 1
Display
Diagnostics
Service
Info

Min. adjustment 1.1
0.00 %
=
10.000 m(d)
8.000 m(d)

Max. adjustment 1.2
100.00 %
=
1.000 m(d)
2.000 m(d)

Damping 1.3
0 s

Linearisation curve 1.4
Linear

Sensor-TAG 1.5
Sensor

Display

Basic adjustment 2
▶ Display
Diagnostics
Service
Info

Displayed value 2.1
Scaled

Unit 2.2
Volume
hl

Scaling 2.3
0 % = 000.5 hl
100 % = 005.0 hl

Backlight 2.4
Switched on

Diagnostics

Basic adjustment 3
Display
▶ Diagnostics
Service
Info

Peak value indicator 3.1
Distance min.: 0.234 m(d)
Distance max.: 5.385 m(d)

Sensor status 3.2
OK

Curve selection 3.3
Echo curve

Echo curve 3.4
Presentation of the echo curve

VOITH

Service

Basic adjustment 4
Display
Diagnostics
▶ Service
Info

Sensor 4.1
5.00 m(d) ▼
Rod ▼

Application 4.2
Liquid ▼
Standard
(DK ≥ 2) ▼

False signal suppression 4.3
Change now?

Current output 4.4
Characteristic: 4-20 mA ▼
Failure mode: 20.5 mA ▼
Min. current: 3.8 mA ▼
max. current: 20.5 mA ▼

Simulation 4.5
Start simulation?

Reset 4.6
Select reset?

Unit of measurement 4.7
m(d)
select?

Language 4.8
Deutsch ▼

SIL 4.9
Activated! ▼

HART mode 4.10
Standard
Address 0

Copy sensor data 4.11
Copy sensor data?

PIN 4.12
Enable?

Info

Basic adjustment 5
Display
Diagnostics
Service
▶ Info

Instrument type 5.1
Serial number
12345678

Date of manufacture 5.2
12. Dec. 2005
Software version
3.22

Last change using PC 5.3
04. March 2004

Sensor characteristics 5.4
Display now?

6.10 Saving the parameter adjustment data

We recommended noting the adjusted data, e.g. in this operating instructions manual, and archiving them afterwards. They are thus available for multiple use or service purposes.

If OnC LevelSens 255 is equipped with a display and adjustment module, the most important data can be read out of the sensor into the display and adjustment module. The procedure is described in the operating instructions manual "*Display and adjustment module*" in the menu item "*Copy sensor data*". The data remain there permanently even if the sensor power supply fails.

If it is necessary to exchange the sensor, the display and adjustment module is inserted into the replacement instrument and the data are written into the sensor under the menu item "*Copy sensor data*".

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7 Maintenance and fault rectification

7.1 Maintenance

If the instrument is used properly, no special maintenance is required in normal operation.

7.2 Rectify faults

Reaction when malfunctions occur

The operator of the system is responsible for taking suitable measures to rectify faults.

Failure reasons

OnC LevelSens 255 offers maximum reliability. Nevertheless, faults can occur during operation. These may be caused by the following, e.g.:

- Sensor
- Process
- Voltage supply
- Signal processing

Fault rectification

The first measures to be taken are to check the output signal and evaluate fault messages via the display/adjustment module. The procedure is described below.

Check the 4 … 20 mA signal

Connect a multimeter in the suitable measuring range according to the wiring plan. The following table describes possible errors in the current signal and helps to remove them:

Error	Cause	Rectification
4 … 20 mA signal not stable	Level fluctuations	Set damping via the display and adjustment module
4 … 20 mA signal missing	Electrical connection faulty	Check connection according to chapter "*Connection steps*" and if necessary, correct according to chapter "*Wiring plan*"
	Voltage supply missing	Check cables for breaks; repair if necessary
	Operating voltage too low or load resistance too high	Check, adapt if necessary
Current signal greater than 22 mA or less than 3.6 mA	Electronics module in the sensor defective	Exchange the instrument or send it in for repair

In Ex applications, the regulations for the wiring of intrinsically safe circuits must be observed.

Error messages via the display and adjustment module

The display and adjustment modules indicates faults via error codes and text messages. The following table describes the error codes with status according to NE 107 and gives information on the causes of failure and their removal:

Status according to NE 107	Error code	Text message	Cause/Rectification
Failure	E013	no measured value available	Sensor in boot phase
		no measured value available	Sensor does not find an echo, e.g. due to faulty installation or wrong parameter adjustment
		no measured value available	Wrong sensor length entered
	E017	Adjustment span too small	Adjustment not within the specification. Carry out the adjustment again, increasing the distance between min. and max. adjustment
	E036	No operable software	Failed or interrupted software update/Repeat software update
	E042	Hardware error, electronics defective	Exchange the instrument or send it in for repair
	E043	Hardware error, electronics defective	Exchange the instrument or send it in for repair

Reaction after fault rectification

Depending on the reason for the fault and the measures taken, the steps described in chapter "*Set up*" may have to be carried out again.

7.3 Exchanging the electronics module

If the electronics module is defective, it can be replaced by the user.

In Ex applications, only instruments and electronics modules with appropriate Ex approval may be used.

If there is no electronics module available on site, one can be ordered from the agency serving you.

7.4 Instrument repair

If it is necessary to repair the instrument, please contact Voith Paper Automation. You can find the locations on our homepage "www.voith.com".

8 Dismounting

8.1 Dismounting steps

Warning:
Before dismounting, be aware of dangerous process conditions such as e.g. pressure in the vessel or pipeline, high temperatures, corrosive or toxic products etc.

Take note of chapters "*Mounting*" and "*Connecting to power supply*" and carry out the listed steps in reverse order.

8.2 Disposal

The instrument consists of materials which can be recycled by specialised recycling companies. We use recyclable materials and have designed the parts to be easily separable.

WEEE directive 2002/96/EG
This instrument is not subject to the WEEE directive 2002/96/EG and the respective national laws. Pass the instrument directly on to a specialised recycling company and do not use the municipal collecting points. These may be used only for privately used products according to the WEEE directive.

Correct disposal avoids negative effects on humans and the environment and ensures recycling of useful raw materials.

Materials: see chapter "*Technical data*"

If you have no way to dispose of the old instrument properly, please contact us concerning return and disposal.

VOITH

9 Supplement

9.1 Technical data

General data

Material 316L corresponds to 1.4404 or 1.4435	
Materials, wetted parts	
− Process fitting	316L and TFM PCTFE +25 %GF, Hastelloy C22 (2.4602) and TFM PCTFE +25 %GF
− Process seal on the instrument side (tube leadthrough)	FKM (SHS FPM 70C3 GLT), FFKM (Kalrez 6375), EPDM (A+P 75.5/KW75F), silicone FEP coated (A+P FEP-O-SEAL)
− Process seal	On site (instruments with thread: Klingersil C-4400 is attached)
− Tube: ø 21.3 mm (0.839 in)	316L or Hastelloy C22 (2.4602)
Materials, non-wetted parts	
− Aluminium die-casting housing	Aluminium die-casting AlSi10Mg, powder-coated - basis: Polyester
− Seal between housing and housing cover	Silicone
− Inspection window in housing cover (optional)	Polycarbonate
− Ground terminal	316L
Process fittings	
− Pipe thread, cylindrical (DIN 3852-A)	G¾ A, G1 A, G1½ A
− American pipe thread, conical (ASME B1.20.1)	¾ NPT, 1 NPT, 1½ NPT
− Flanges	DIN from DN 25, ANSI from 1"
Weight	
− Instrument weight (depending on process fitting)	approx. 0.8 … 8 kg (0.176 … 17.64 lbs)
− Tube: ø 21.3 mm (0.839 in)	approx. 920 g/m (9.9 oz/ft)
Probe length L (from seal surface)	
− Tube: ø 21.3 mm (0.839 in)	up to 6 m (19.69 ft)
Trimming accuracy - tube	< 1 mm (0.039 in)
Lateral load - Tube: ø 21.3 mm (0.839 in)	60 Nm (44 lbf ft)

Input variable

Measured variable	Level of liquids
Min. dielectric constant of the medium	$\varepsilon_r > 1.4$

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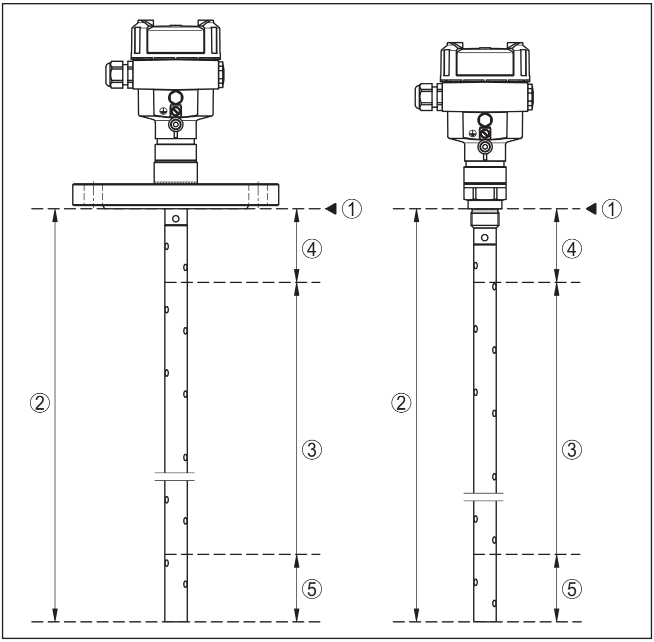

Fig. 10: Measuring ranges of OnC LevelSens 255

1 *Reference plane*
2 *Probe length L*
3 *Measuring range (default setting refers to the measuring range in water)*
4 *Upper dead band (see diagrams under Accuracy - section marked in grey)*
5 *Lower dead band (see diagrams under Accuracy - section marked in grey)*

Output variable	
Output signal	4 … 20 mA/HART
Cycle time	min. 1 s (dependent on the parameter setting)
Signal resolution	1.6 µA
Failure signal current output (adjustable)	mA value unchanged 20.5 mA, 22 mA, < 3.6 mA (adjustable)
Max. output current	22 mA
Load	see load diagram under Power supply
Damping (63 % of the input variable)	0 … 999 s, adjustable
Met NAMUR recommendation	NE 43
HART output values	
− 1. HART value (Primary Value)	Distance to the level
− 2. HART value (Secondary Value)	Distance to the level - scaled (for example hl, %)
Resolution, digital	> 1 mm (0.039 in)

Accuracy (according to DIN EN 60770-1)

Process reference conditions according to DIN EN 61298-1	
− Temperature	+18 … +30 °C (+64 … +86 °F)
− Relative humidity	45 … 75 %
− Air pressure	+860 … +1060 mbar/+86 … +106 kPa (+12.5 … +15.4 psig)
Installation reference conditions	
− Min. distance to installations	> 500 mm (19.69 in)
− Vessel	metallic, ø 1 m (3.281 ft), centric installation, process fitting flush with the vessel ceiling
− Medium	Water/Oil (dielectric constant ~2.0)
− Installation	Probe end does not touch the vessel bottom
Sensor parameter adjustment	False signal suppression carried out
Deviation	see diagrams Depending on the installation conditions, there can be deviations which can be rectified with an adaptation of the adjustment or a change of the measured value offset in the DTM service mode.

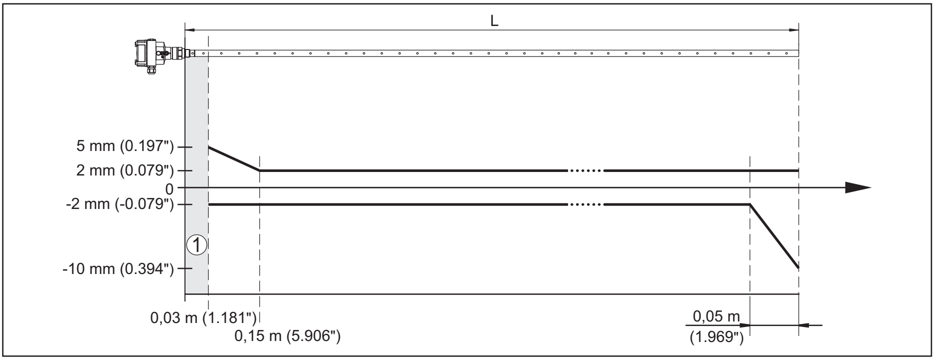

Fig. 11: Deviation OnC LevelSens 255 in coax version in water

1 Dead band - no measurement possible in this area
L Probe length

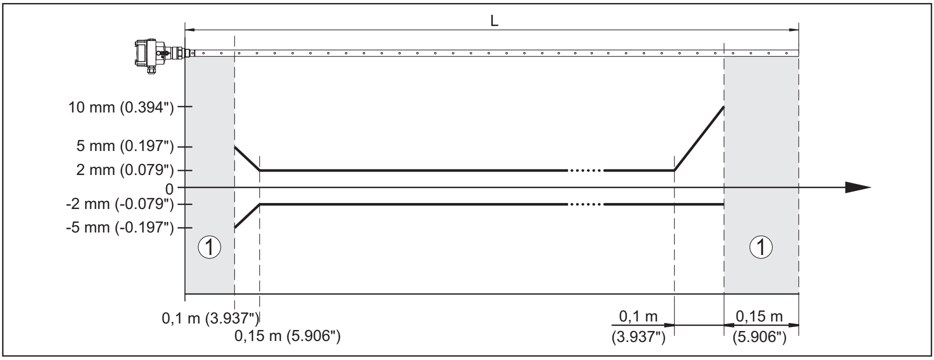

Fig. 12: Deviation OnC LevelSens 255 in coax version in oil

1 Dead band - no measurement possible in this area
L Probe length

Influence of the ambient temperature to the sensor electronics	
Temperature drift	0.03 %/10 K relating to the max. measuring range or max. 0.3 %
Temperature drift - Digital output	3 mm/10 K relating to the max. measuring range or max. 10 mm

Ambient conditions	
Ambient, storage and transport temperature	-40 … +80 °C (-40 … +176 °F)

Process conditions	
Process pressure	-1 … +40 bar/-100 … +4000 kPa (-14.5 … +580 psig), depending on the process fitting
Process temperature (thread or flange temperature)	
– FKM (Viton)	-40 … +150 °C (-40 … +302 °F)
– EPDM	-40 … +150 °C (-40 … +302 °F)
– FFKM (Kalrez 6375)	-20 … +150 °C (-4 … +302 °F)
	The measurement error from the process conditions is in the specified pressure and temperature range of below 1 %.

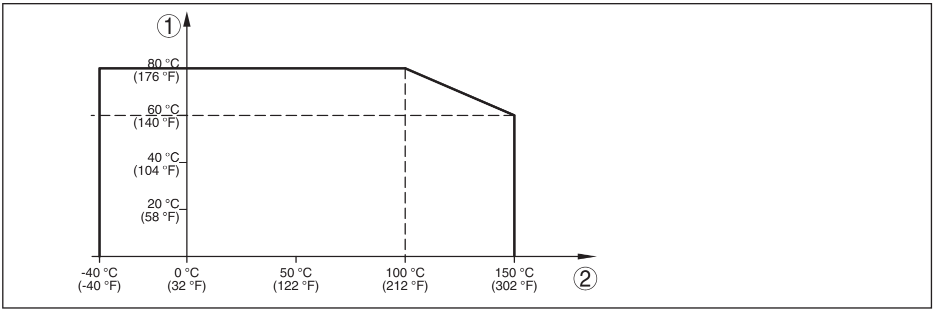

Fig. 13: Ambient temperature - Process temperature

1 Ambient temperature
2 Process temperature (depending on the seal material)

Electromechanical data - version IP 66/IP 67 and IP 66/IP 68; 0.2 bar	
Cable entry	
– Single chamber housing	– 1 x cable gland M20 x 1.5 (cable: ø 5 … 9 mm), 1 x blind plug M20 x 1.5 or: – 1 x closing cap ½ NPT, 1 x blind plug ½ NPT or: – 1 x plug (depending on the version), 1 x blind stopper M20 x 1.5
Spring-loaded terminals for wire cross-section up to	2.5 mm² (AWG 14)

Display and adjustment module	
Voltage supply and data transmission	through the sensor
Indication	LC display in dot matrix
Adjustment elements	4 keys
Protection rating	
– unassembled	IP 20
– mounted into the sensor without cover	IP 40
Material	
– Housing	ABS
– Inspection window	Polyester foil

Voltage supply	
Operating voltage	
– Non-Ex instrument	14 … 36 V DC
– EEx-ia instrument	14 … 30 V DC
Operating voltage with illuminated display and adjustment module	
– Non-Ex instrument	20 … 36 V DC
– EEx-ia instrument	20 … 30 V DC

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Permissible residual ripple	
– <100 Hz	U_{ss} <1 V
– 100 Hz … 10 kHz	U_{ss} <10 mV
Load	see diagram

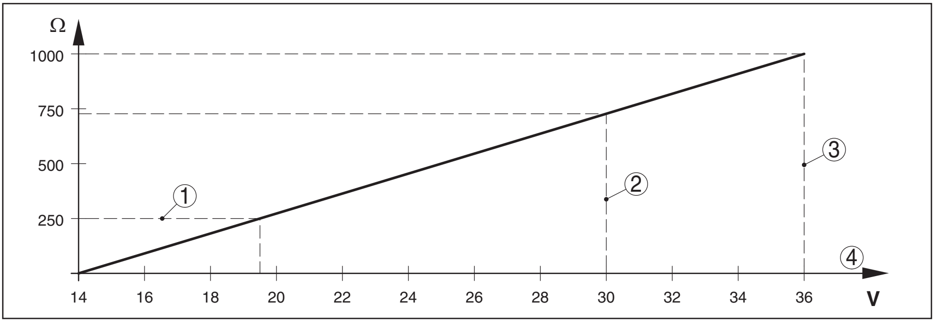

Fig. 14: Voltage diagram

1 HART load
2 Voltage limit EEx-ia instrument
3 Voltage limit non-Ex instrument
4 Operating voltage

Electrical protective measures

Protection rating	
– Aluminium housing	IP 66/IP 68 (0.2 bar), NEMA 6P[2)]
Overvoltage category	III
Protection class	II

Functional safety (SIL)

The functional safety is already activated ex factory on instruments with SIL qualification. For instruments without SIL qualification ex factory, the functional safety must be activated by the user via the display and adjustment module for applications according to SIL.

Functional safety according to IEC 61508-4	
– Single channel architecture (1oo1D)	up to SIL2
– double channel diversitary redundant architecture (1oo2D)	up to SIL3

You will find detailed information in the Safety Manual of the instrument series.

Approvals

Depending on the version, instruments with approvals can have different technical data. For these instruments, please note the corresponding approval documents. They are included in the scope of delivery.

2) A suitable cable is the prerequisite for maintaining the protection rating.

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9.2 Dimensions

Housing

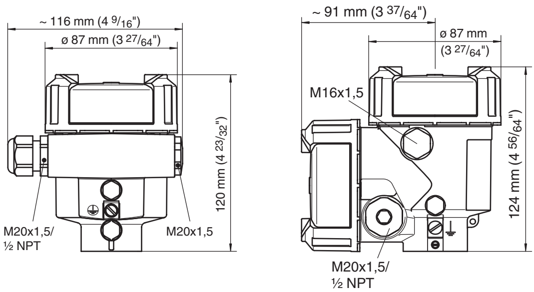

Fig. 15: Housing, with integrated display and adjustment module the housing is 9 mm (0.35 in) higher

OnC LevelSens 255

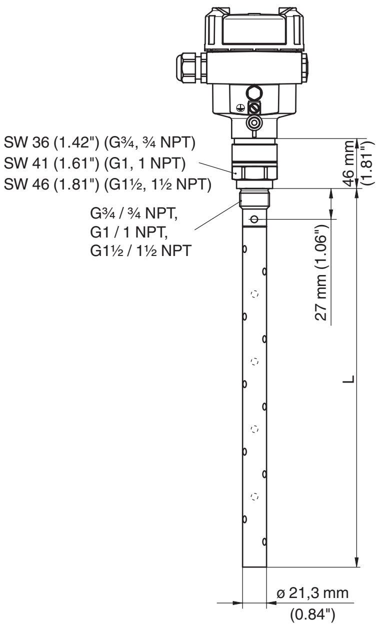

Fig. 16: OnC LevelSens 255

L Sensor length, see chapter "Technical data"

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Engineered Reliability

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14.14 Heater

Voith Article No: 204.00991810001

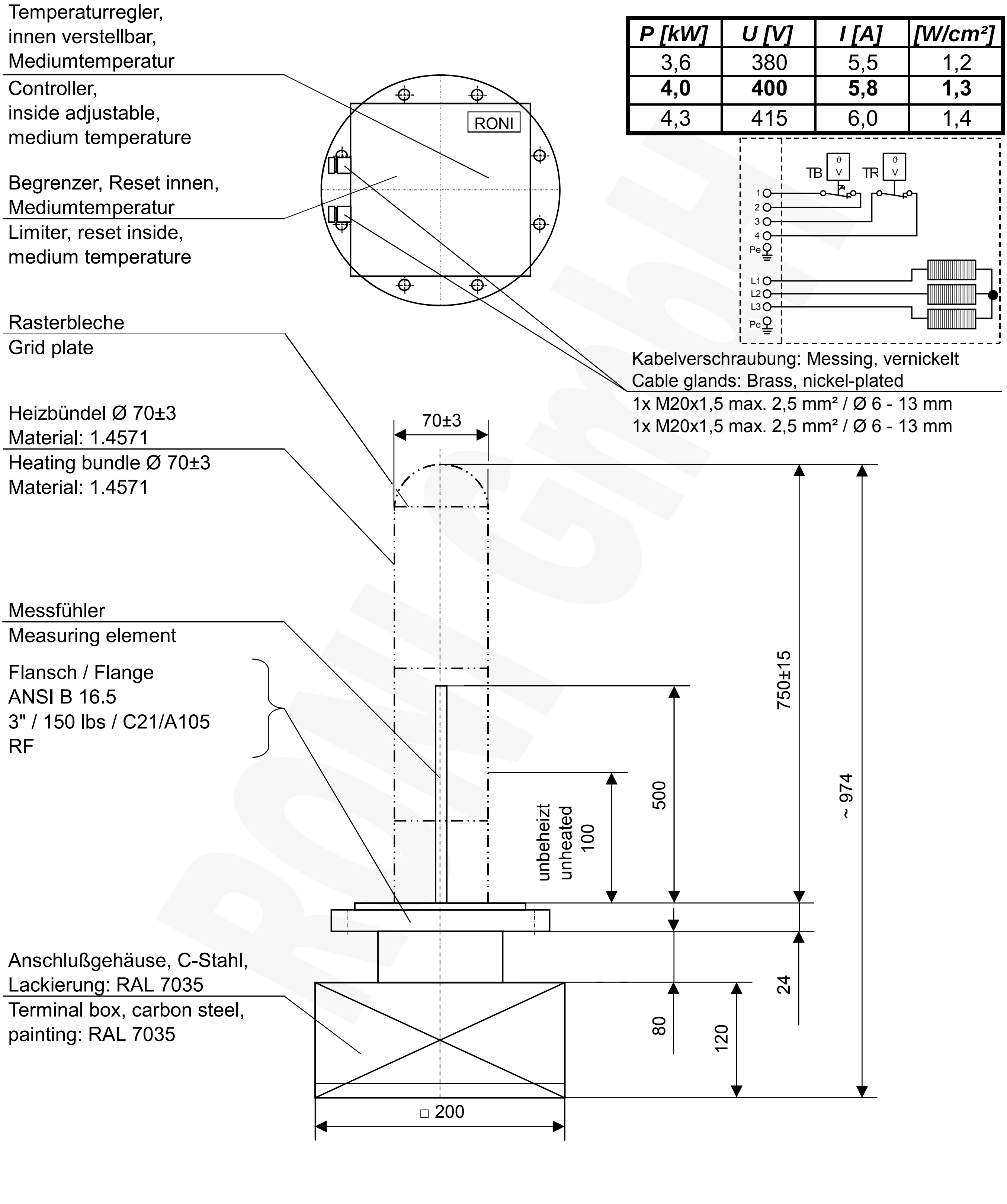
Type: NE-F-4-1.3-400 D-75 (2xSPDT)

(4 kW; 400 V; 50 Hz, IP 65)

Description . . . . Roni

RONI	**RONI-Elektrogerätebau GmbH** **Bokeler Weg 5** **D-29559 Nienwohlde**	Heizkörper zur Erwärmung von: Schmieröl Heater for warming of: Lube oil **K-1480310-1**	**Artikel - Nr.:** **26633** **26.11.14**

Typ / Type: **NE-F-4-1,3-400D-75**		Seriennummer / Serial number:	**24034 + 24035**
P: **4,0 kW** | U: **400 V 3~** | I: **5,8 A**		Oberflächenbelastung / Surface-load:	**1,3 W/cm²**
Temperaturregler / Controller:	**0 - +70°C (+15°C)**	Begrenzer / Limiter:	**+130°C**
Steuerspannung / Control voltage:	**230 V AC**		
Thermoelement / Thermocouple:	**-**	PT100: **-**	
Schutzart / Protection type:	**IP65**	**-20°C ≤ T_{AMB} ≤ +55°C**	
Bescheinigung / Certificate:	**-**	Schaltung / Wiring diagram:	**4**
Einbaulage / Mounting position:	**Waagerecht / Horizontal**	Gewicht / Weight:	**~ 14 kg**
Materialnummer / Material number:	**-**	Voith-Ident-No.:	**204.00991810001**



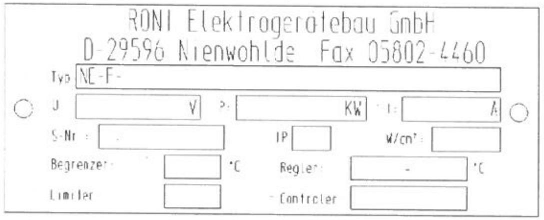
P [kW]	U [V]	I [A]	[W/cm²]
3,6	380	5,5	1,2
4,0	**400**	**5,8**	**1,3**
4,3	415	6,0	1,4

Alle Maße in mm / All dimensions in mm

Operating Instructions
Electric Heater for heating up fluid

Type : NE-F-...

Protection class	: See Name Plate
Rated voltage	: See Name Plate
Rated output	: See Name Plate
Medium	: See Data Sheet



Heating up fluid in:

- tanks which are open to the atmosphere
- tanks which are closed to the atmosphere but not under internal overpressure
- closed tanks under internal overpressure (pressure vessels)
- fitting as a heating insert in a pipe system which has fluid flowing through it (flow heater)

Construction:
Electrical heater consisting of a heating bundle with electrical heating elements, protection tubes with sensors, connection flange / threaded nipple and connection box with temperature-limiter and –controller or other measuring sensor, depending on version.

Storage instructions:
The devices must be stored in a dry warehouse with a regulated temperature acc. to storage directions for electrical appliances.

Mounting specifications:
Depending on the version, the heating insert must be fitted with a flange connection or screw-in thread (outside thread) in a tank or pipe system sealed against the atmosphere. The device must be provided with a roof as shelter against the rain or sun depending of the site of installation and the climatic conditions.
The heater is designed for an ambient temperature of –20°C to +40°C in acc. with EN 50014. Other heaters are marked with T_{amb} and the ambient temperature the heaters are designed for!

Flange connection:
The flange is connected into /onto a tank or pipe system by means of the heating insert flange, sealing between the heating insert and the tank flange and the bolts and the nuts suitable for the flange connection. The enterprise doing the assembly is responsible for choosing the right gasket, bolts and nuts to suit the medium to be heated, the pressure and the temperature. Before tightening the screwed connection (bolts with nuts), check that the gasket between the heating insert flange and the tank flange is positioned properly and if necessary correct the position of the gasket. Once the flange has been connected, check the gasket in accordance with the operating conditions for the tank or pipe system.
The bolts, nuts and gasket are not included in the scope of supply.

Screw-in connection:
By producing screw-in connections, suitable sealing material must be placed correctly at the outside threading of the heating insert's threaded nipple. Once the sealing material has been put on, the threaded nipple must be screwed into the threaded coupling in the tank or pipe system. As for the flange connection, select right materials and check the sealing.

Fitting position of the heating insert:
The correct position for fitting the heating insert is horizontal with the rating plate on "TOP". Respectively the vertical fitting position, with connection head on top or down. The precise mounting position is to be taken from the data sheet.

Temperature regulation:
The measuring sensors for the temperature limiter is accommodated in the top area of the heating bundle. Other sensors can be assembled (temperature controller, RTD, Thermocouple, capillary tube controller) too. The actual version of the heater can be seen in the data-sheet and the wiring diagram. The active parts of the sensors are in protection tubes (dip tube) and acquire the fluid temperature (see data sheet). The contact mechanisms, if any, of the temperature controller and limiter are inside the connecting box of the heating insert. It is not possible for the customer to adjust the temperature limiter. This may be done by the manufacturer only. It opens and interlocks a snap-action contact when the set temperature is exceeded. The temperature of the limiter has been fixed permanently in the factory and is secured against adjustment. All warranty and liability claims will be excluded if the seal is damaged. The temperature limiter can be unlocked only when the temperature has been reduced by about 10 K. If you "PRESS" the Reset-Button of the temperature limiter you unlock it. It does not occur automatically.

Temperature regulator:
This can be adjusted within its setting range. Turning the controller knob in a clockwise direction increases the temperature and turning in an anti-clockwise direction decreases the temperature. The scale indicates standard values only. Once the set temperature is reached, a snap-action contact opens. It closes again if the temperature drops by nearly 7K (Two-state controller). Output with potential free contact.

See type plate of the heater for set-up values of temperature-limiter and -controller.
The correct control voltage is shown in the data sheet.

	voltage	current	model
min.	24 V AC /DC	20 mA	Standard
max.	230 V AC	16 A	Standard
max.	230 V DC	0,25 A	Standard
min.	10 V AC / DC	10 mA	Au – contacts
max.	24 V AC / DC	0,1 A	Au – contacts

min. / max. control voltage with belonging contact rating

Level monitoring:
The top point of the heating bundle must be covered by at least 50 mm of fluid while the heating insert is being operated. The plant operator must take suitable measures to ensure this, for example by having an electrical interlock from the level monitor to the heating insert control.

WARNING!!
Depending on the medium, a fire and/or explosion may occur if the heating bundle is run in dry operation without being adequately covered by fluid. This can be expected to destroy the heating bundle. If the heating insert is integrated into a pipe system, the afore-said measures must also be taken or it must be ensured in terms of design and operation that fluid will flow through the heating bundle at all times and that the system unit will be subjected to forced ventilation always.

Electric connection:
The heating insert must be connected on site by authorised personnel in acc. with the local rules and regulations.
- Check the existing voltage against that specified on the rating plate.
- Open the connection compartment lid
- Lead in the power and control cable by cable glands and connect it the corresponding terminals in acc. with the wiring diagram.
- Close the connection compartment lid.
- It is important that the cables matches the screwed cable glands in terms of size and diameter because otherwise it will not be possible to conform to this type of protection.

Safety instruction:
Do not work on the device when it is energised!!!
Disconnect the voltage before opening the connection box and secure against restart.

Hot system parts, for example flange connection from the tank to the heating insert at surface temperatures above + 60°C must be provided with protection against accidental contact.

Electric actuation of the heating insert: see page 6

The temperature regulator and temperature limiter in the heating insert are designed as single-pole potential free control contacts. They are intended for integration into an electrical power control by means of power contactors. For safety reasons the regulator and limiter are each provided wit a separate power contactor and each actuated separately by means of the regulator- and limiter-contacts.
The level monitoring must also be integrated into the electric control so that the heater can be turned on if the heating is covered by minimum 50 mm of fluid only.

Hint:
We are not responsible for mounting the heating insert into the plant, connecting electric power to the heating insert or producing power control. This work must be done by the plant erector or operator on his own responsibility.

Maintenance:
The following service work should be done:
- check the sealing of the flanged joint
- check for deposits of settling sediment and suspended materials in the heating bundle (time intervals depending of the medium and deposit material).
- check for condensate in the electrical terminal box (check every 12 months)
- check the connection terminals for oxidation and tightness. (depending upon the climatic zone and ambient conditions)
- The device inspections interval is 3 years has to be done following the local laws and specifications

Exchangeable components:
- temperature limiter
- temperature regulator
- RTD/ Thermocouple

Exchange of parts at manufacturers site or by well trained and qualified personnel only.
Switch off main voltage before start of repair!

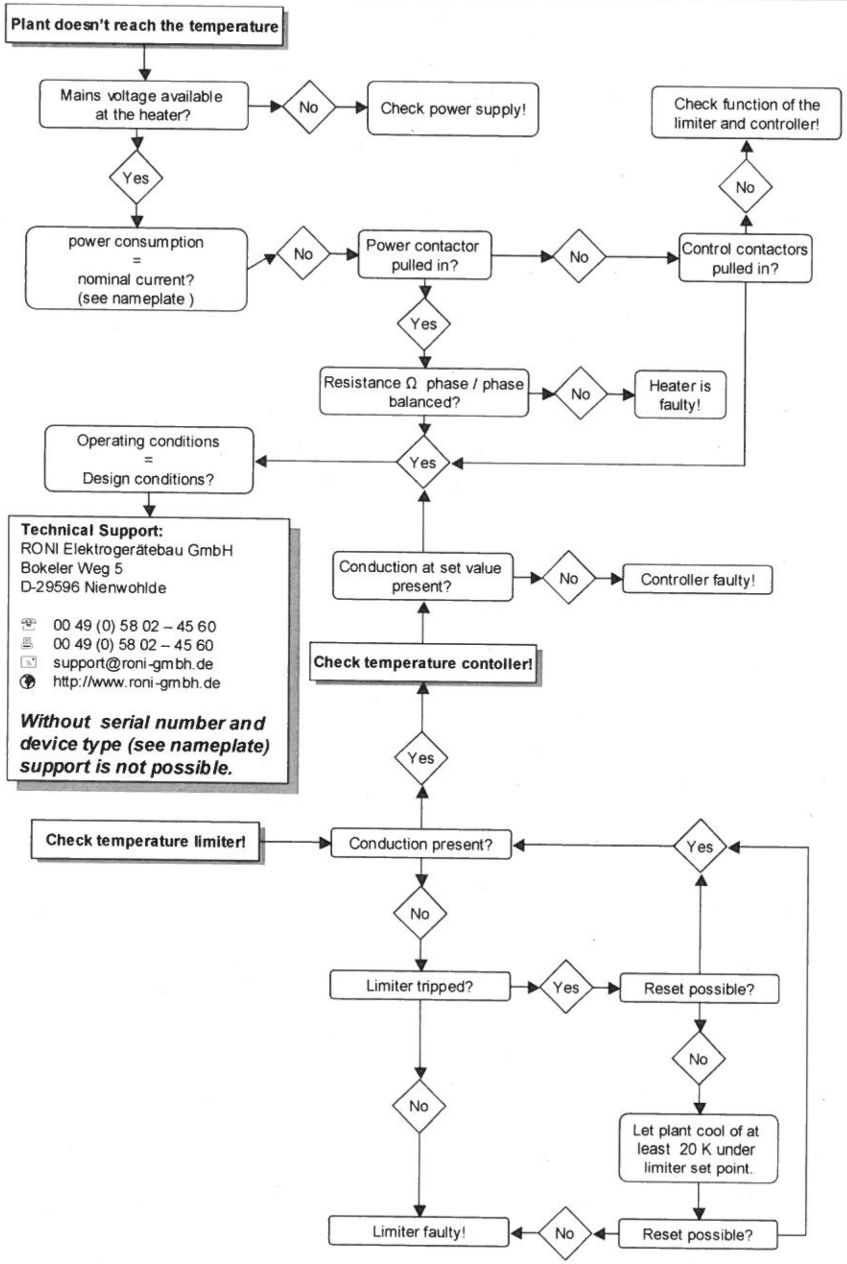
The electrical heating elements are soldered or welded tightly into the flange plate and cannot be replaced.

Changing components:
- Open the cover of the connection box
- Remove the regulator or limiter off it´s mounting plate
- Pull the capillary out of its protection tube.
- Insert new capillary into the protection tubes (be careful not to bend them)!!
- Reassembling in reverse sequence

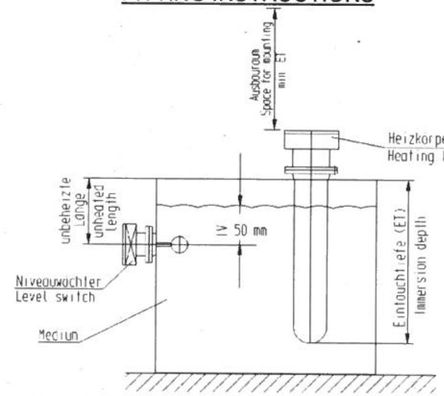
Troubleshooting
The plant does not reach the right temperature:
Check the following (page 5) in acc. with the local laws for an explosion-protected area!

Medium cannot be heated sufficiently although the heater is working.
Check the switch-on period of the heating unit. If the heating unit switches on and off constantly, this indicates there is poor heat transmission to the medium (for instance, if the liquid is resting without sufficient circulation from the switched on pumps).

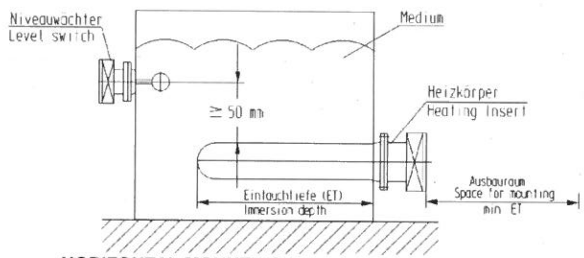
Interference in our appliances by unauthorised persons will release us from all liability or warranties!



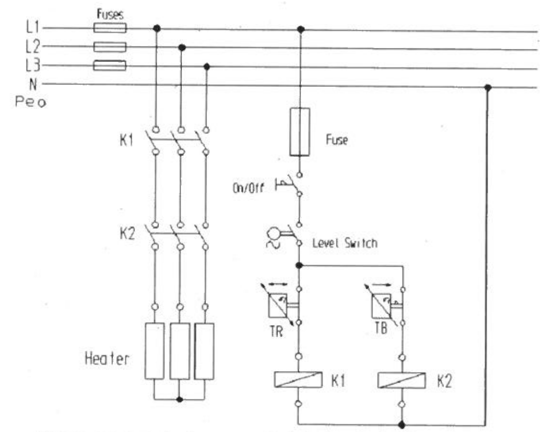
FITTING INSTRUCTIONS



VERTICAL MOUNTING



HORIZONTAL MOUNTING



Minimum requirements to power control (not part of delivery)

14.15 Heat exchanger

Voith Article No.:
Voith Article No.:

Type: **not supplied by Voith-Crailsheim**

Type: Working oil cooler vent (4 mm)

(Working oil cooler)

Voith Article No.:

Type: **not supplied by Voith-Crailsheim**

(Lube oil cooler)

Assembly Plan

Oil cooler venting

Installation and maintenance description

14.16 Connecting coupling

Voith Article No.:
Voith Article No.:

Type: (input)

not supplied by Voith-Crailsheim

Type: (output)

not supplied by Voith-Crailsheim

Description

Description

Contents

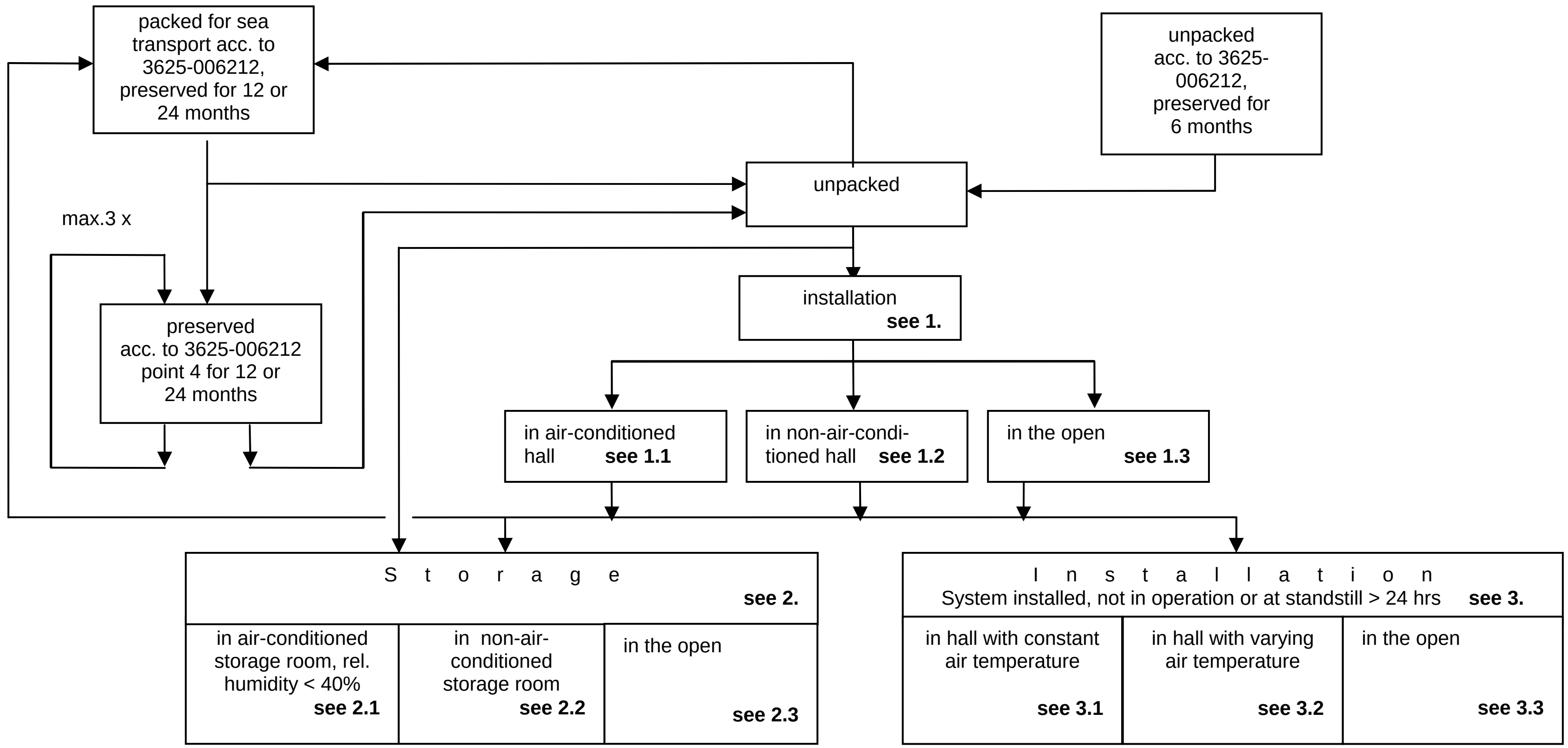
Appendix_A_

Preservation Method and Instructions for Storage after Delivery 3625-006714

VOITH

Preservation methods and storage instructions after delivery for coupling types R, RW, S, MDC and torque converters, as well as for assemblies

This regulation contains an overview of preservation methods, storage and inspections of machines and assemblies after delivery, as well as general instructions.



Replacing:
3625-006714, 2004-06-01

General

Voith units and their assemblies are high quality investment goods whose perfect condition is to be preserved during installation and assembly work, long periods of storage and after installation or in cases of standstill for operational reasons. The measures necessary during these phases and the necessary inspections are described in the following. The work carried out is to be documented.

When carried out carefully, the storage and preservation procedures described are suitable for maintaining the perfect condition of the deliveries in the period between dispatch from Voith Crailsheim and commissioning.

In addition to protection of the external corrodible surfaces by applying film forming, water displacing anticorrosive agents, the measures described are based on the creation of a dry, or alternatively a dry and oxygen-free climate in the interior of the units. The aim is to achieve and maintain relative air humidity in the interior =< 40%, as below this air humidity no corrosion occurs.

The following can be used to create the dry climate in the interior of the units:
- sorption air dehumidifiers
- dry compressed air
- technical nitrogen with a sufficiently low dew point

Assemblies, such as gear stages, are to be treated as exposed external iron parts and are generally to be stored packed in accordance with Voith no. 3625-006212 points 2 – 4 or in air-conditioned rooms, unless agreed otherwise, or delivered in special containers for long-term storage.

1. Installation of Voith units in a system: general instructions:

Special attention is to be paid to the efficacy of the preservation, as it is frequently subject to additional dangers due to water, severe dirt accumulation and mechanical damage.

During installation, maintenance of the efficacy of the preservation is to be checked regularly and documented.

- Installation is to be carried out preferably in buildings but at least under a roof or tent providing protection against weather conditions.
- For assembly purposes, cleaned exposed external iron surfaces are to be sprayed on the same day with a film forming anticorrosive agent, e.g. Shell Ensis Fluid S, or to be painted.
- Do not unpack cold units (below dew point) in warm rooms but only after temperature equalisation.

Attention: When installing in rooms, do not use nitrogen for protection against corrosion due to toxic hazard!

1.1 Installation of a Voith unit in a system in an air-conditioned hall

See also point 1.

The following measures apply to an air-conditioned hall which is defined as follows:
- Temperature range 18 to 26 °C
- Relative air humidity within the range 35 to 65 %
- Low airflow
- Temperature fluctuation within 24 hrs < 8°C

If one of the conditions stated is not met, the measures according to point 1.2 for “Non-air-conditioned hall” are to be applied.

Spray exposed iron parts with a film forming, water displacing anticorrosive agent, e.g. Shell Ensis Fluid S. (Clean surfaces of the units sprayed with preserving agents with a suitable cleaning agent, white spirit or paraffin before fitting or mounting parts, e.g. tightening hubs). After fitting or mounting parts, re-coat remaining exposed iron surfaces with anticorrosive agent, spray or coat with paint.

To protect the interiors of the units against corrosion during installation, the following methods are recommended:

a) Dehumidification of the air in the interior of the units with sorption air humidifier.*
- Provided no covers, flanges etc. of the units are opened, the air in the interior of the machine is to be dried every 3 days with a sorption air dehumidifier. Permissible relative residual humidity =< 20%. The ventilation filter is to be sealed with a plastic film.
- After opening the housing by removing covers, flanges etc., the interior of the unit is to be dried immediately with a sorption air dehumidifier. *
  Unscrewed covers, flanges etc. are to be refitted as quickly as possible, at least after ½ hour, or replaced by provisional covers, to reduce the penetration of humidity to an unavoidable minimum.

The permanent supply of the interior of the unit with dehumidified air via a sorption air dehumidifier is permitted. It is recommended to control the unit with a hygrostat. The relative air humidity in the interior of the machine should be =< 40%.

b) Supply of the interior of the unit with dry compressed air. Volume flow approx. 5 to 10 l/min (sufficient for up to 6m³ volume of the interior). The atmospheric dew point of the compressed air must be below -5°C.
- Provided no covers, flanges etc. of the unit are opened, the interior of the machine is to be filled after with dry compressed air every 3 days. The purging process is to be carried out with at least 5 times the volume of the interior.
- After opening covers, flanges etc., the interior of the unit is to be flowed through immediately with dry compressed air.

* see page 12

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Unscrewed covers, flanges etc. are to be refitted as quickly as possible, at least after ½ hour, or replaced by provisional covers, to reduce the penetration of humidity to an unavoidable minimum.

The permanent supply of the interior of the unit with dry compressed air is permitted. The atmospheric dew point of the compressed air must be below -5°C.

1.2 Installation of a Voith unit in a system in non-air-conditioned hall

See also point 1.

The following measures apply to a non-air-conditioned hall which is defined as follows:
- Temperature range 10 to 30 °C
- Relative air humidity within the range 35 to 70 %
- Moderate airflow
- Temperature fluctuation within 24 hrs < 15°C

If one of the conditions stated is not met, the measures according to point 1.3 for "In the open" are to be applied.

Spray exposed iron parts with a film forming, water displacing anticorrosive agent, e.g. Shell Ensis Fluid S. (Clean surfaces of the units sprayed with preserving agents with a suitable cleaning agent, white spirit or paraffin before fitting or mounting parts, e.g. tightening hubs). After fitting or mounting parts, re-coat remaining exposed iron surfaces with anticorrosive agent, spray or coat with paint.

To protect the interiors of the units against corrosion during installation, the following methods are recommended:
a) Dehumidification of the air in the interior of the units with sorption air humidifier.*
- Provided no covers, flanges etc. of the units are opened, the air in the interior of the machine is to be dried every 3 days with a sorption air dehumidifier. Permissible relative residual humidity =< 15%. The ventilation filter is to be sealed with a plastic film.
- After opening the housing by removing covers, flanges etc., the interior of the unit is to be dried immediately with a sorption air dehumidifier. *

Unscrewed covers, flanges etc. are to be replaced by provisional covers immediately to reduce the penetration of humidity to an unavoidable minimum.

The permanent supply of the interior of the unit with dehumidified air via a sorption air dehumidifier is permitted. It is recommended to control the unit with a hygrostat. The relative air humidity in the interior of the machine should be =< 40%.

b) Supply of the interior of the unit with dry compressed air. Volume flow approx. 10 to 15 l/min (sufficient for up to 6m³ volume of the interior). The atmospheric dew point of the compressed air must be below -10°C.

*see page 12

- Provided no covers, flanges etc. of the units are opened, the air in the interior of the machine is to be dried every 3 days with a sorption air dehumidifier. The ventilation

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filter is to be sealed with a plastic film. The purging process is to be carried out with at least 5 times the volume of the interior.
- After opening the housing by removing covers, flanges etc., the interior of the unit is to be dried immediately with dry compressed air.
  Unscrewed covers, flanges etc. are to be replaced by provisional covers immediately to reduce the penetration of humidity to an unavoidable minimum.

Permanent supply of the interiors of the unit with dry compressed air is permitted (10 – 15 l/min). The atmospheric dew point of the compressed air must be below -10°C.

1.3 Installation of a Voith unit in a system in the open

See also point 1.

Installation of the units and work during which covers, flanges etc. are unscrewed, are to be carried out under a roof or in a tent.
Spray exposed iron parts with a film forming, water displacing anticorrosive agent, e.g. Shell Ensis Fluid S. (Clean surfaces of the units sprayed with preserving agents with a suitable cleaning agent, white spirit or paraffin before fitting or mounting parts, e.g. tightening hubs). After fitting or mounting parts, re-coat remaining exposed iron surfaces with anticorrosive agent, spray or coat with paint.

To protect the interiors of the units against corrosion during installation, the following methods are recommended:

a) - permanent supply of the interiors of the units with dehumidified air with sorption air dehumidifier.*
   - Unscrewed covers, flanges etc. are to be replaced by provisional covers immediately to reduce the penetration of humidity to an unavoidable minimum.

b) - permanent supply of the interiors of the machines with dry compressed air. Atmospheric dew point of the compressed air =< - 40°C. Volume flow approx. 10-15 l/min (sufficient for up to 6m³ volume of the interior)
   - Unscrewed covers, flanges etc. are to be replaced by provisional covers immediately to reduce the penetration of humidity to an unavoidable minimum.

c) - permanent supply of the interiors of the machines with technical nitrogen, volume flow approx. 10 – 15 l/min. (sufficient for up to 6 m³ volume of the interior), required pressure approx. 0.002 bar. Dew point of nitrogen =< -70°C.

   Attention: All works on the unit must be performed under special safety measures when using nitrogen.
   Toxic hazard!

* see page 12

2. Storage, general instructions

Requirements for the storage of Voith units or systems in closed rooms:

- The storage room should be dry, with low dust levels, moderately ventilated and free of vibrations.
- The basic condition for storage is that no aggressive media, such as gases, vapours or aerosols of acids, alkaline solutions or salts can act upon the machines.
- Ensure sufficient stability, also on inclined surfaces.
- Packed machines must only be stacked or placed on top of one another in such a way that the air circulation is maintained.
- All machines must be easily accessible for inspection and maintenance work for:
  - reading off moisture indicators
  - inspection of the machines
  - repairs to packaging
- Do not unpack cold machines (below dew point) in warm rooms, but only after temperature equalisation.
- Filling or permanent supply of machines with nitrogen is not permitted in rooms due to toxic hazard.

For storage of assemblies, see page 2, “General”

Requirements for storage in the open:

- Unpacked machines may only be stored in the open if they are intended for outside installation.
- The storage temperature should be within the range 0 to 40 °C.
- The storage area must be free of vibrations. It should preferably have a sturdy foundation, e.g. concrete slab, it must at least be safe against flooding and fixed in such a way that the machines and components do not sink into the mud even during long periods of rain. The formation of puddles and stagnant water are to be avoided. Machines are to be placed on squared timbers.
- Direct sunlight is to be avoided, as apart from the damaging effect of the ultra-violet radiation, it leads to great temperature fluctuations.
- Tarpaulins are to be secured against gale-force winds. It must be ensured that no rain can accumulate and that air circulation is possible under the tarpaulins.
- The condition of the tarpaulins and packaging is to be inspected regularly for damage due to weather conditions, rotting and being eaten by animals. Defects are to be remedied immediately.

For storage of assemblies, see page 2, “General”.

2.1 Storage in air-conditioned storage room

See also 2.

The following measures apply to an air-conditioned hall which is defined as follows:
- Temperature range 18 to 26 °C
- Relative air humidity < 40%
- Low airflow
- Temperature fluctuation within 24 hrs < 8°C

Adherence to the storage conditions is to be checked regularly and documented.

unpacked units

The following measures are to be carried out during the period of storage:
- spray external exposed iron parts at least every 2 years with a film forming, water displacing anticorrosive agent, e.g. Shell Ensis Fluid S. (Clean sprayed surfaces with white spirit or paraffin before installing the machines).

- turn the shafts of roller bearing units at least every 2 years by approx. a quarter to a half turn in order to prevent standstill marks (false brinelling) in the roller bearings.
- spray interior surfaces every 2 years with solvent-free anticorrosive agent, e.g. Shell Ensis engine oil 20.

Storage in packing according to Voith no. 3626-006212 points 2 to 4 is permitted.

2.2 Storage in a non-air-conditioned storage room

See also 2.

The following regulation applies to a non-air-conditioned storage room which is defined as follows:
- Temperature range 10 to 30 °C
- Relative air humidity within the range 35 to 70 %
- Moderate airflow
- Temperature fluctuation within 24 hrs < 15°C

If one of the conditions stated is not met, the regulations according to point 2.3 for “Storage in the open” are to be applied.

The following methods can be used to protect the units against corrosion:

a) - Packing in accordance with Voith no. 3625-006212 point 4. It is recommended to check the efficacy of the drying agent regularly with moisture indicators, see table page 11
   - the condition of the packaging is to be checked regularly for damage. Defects are to be remedied immediately.
   - the aluminium compound foil is to be replaced after 2 years. (Aluminium compound foil is not UV-proof).
     The efficacy of the preservation of the exposed iron parts is to be checked.
     If necessary, the preservation is to be touched up with a film forming, water displacing anticorrosive agent, e.g. Shell Ensis Fluid S.

- turn the shafts of roller bearing units at least every 2 years by approx. a quarter to a half turn in order to prevent standstill marks (false brinelling) in the roller bearings.

b) Unpacked units
permanent supply of the interior of the unit with sorption air dehumidifier.*
- at least after 1 year check external parts for efficacy of the preservation, if necessary preserve exposed iron parts again with a film forming, water displacing anticorrosive agent, e.g. Shell Ensis Fluid S.
- turn the shafts of roller bearing units at least every 2 years by approx. a quarter to a half turn in order to prevent standstill marks (false brinelling) in the roller bearings.

Permanent supply of the interior of the units with dry compressed air may be used as alternative to the sorption air dehumidifier. Volume flow approx. 10 to 15 l/min (sufficient for up to 6m³ volume of the interior). The atmospheric dew point of the compressed air must be below -10°C.

2.3 Storage in the open

See also 2.

The following methods can be used to protect the units against corrosion:

a) Packaging in accordance with Voith no. 3625-006212 point 4. It is recommended to check the efficacy of the drying agent regularly with moisture indicators, see table page 11
- after at least 1 year, the exposed external iron parts are to be checked for efficacy of the preservation. If necessary, the preservation is to be restored with Shell Ensis Fluid S. (Clean sprayed surfaces with white spirit or paraffin before installing the machines)
- turn the shafts of roller bearing units at least every 2 years by approx. a quarter to a half turn in order to prevent standstill marks (false brinelling) in the roller bearings.
- the aluminium compound foil is to be replaced after 2 years (Aluminium compound foil is not UV-proof).

b) unpacked units:
- provide rain protection (roofing, tent, tarpaulin etc.)
- spray exposed iron parts with a film forming, water displacing anticorrosive agent, e.g. Shell Ensis Fluid S.

For preservation of the interior of the units, the following procedures can be used:
- permanent supply of the interior of the machine with a sorption air dehumidifier.*
- permanent supply of the interior of the machine with technical nitrogen, approx. 10 – 15 l/min (sufficient for up to 6 m³ volume of the interior), required pressure approx. 0.002 bar. Dew point of the nitrogen =< -70°C

* see page 12

- permanent supply of the interior of the unit with dry compressed air.
  Atmospheric dew point of the compressed air =< - 70°C.
  Volume flow approx. 10-15 l/min (sufficient for up to 6m³ volume of the interior)

3. <u>Mounted systems installed on the foundation; not yet in operation or at standstill</u>

Special attention is to be paid to the efficacy of the preservation, as it is frequently subject to additional dangers due to water, severe dirt accumulation and mechanical damage.

Spray exposed external iron parts with film forming, water displacing anticorrosive agent, e.g. Shell Ensis Fluid S. Grease and move functional parts, e.g. joints, monthly.
Fill systems with operating oil wherever possible, please refer to operating manual.

3.1 <u>The following measures apply to systems installed on the foundation in hall with constant temperature</u>

See also point 3.

The following methods can be used to protect the interiors of the units against corrosion:

a) Operable systems
   Start up system at least every 3 months and operate it briefly (approx. 5 minutes) for oil moistening of the internal parts and surfaces.

b) Non-operable systems
   - With operable electrical start-up lubrication pump, this is to be put into operation every 3 months for approx. 5 minutes. (Do not run up to hot condition!)
   - With a non-operable electrical start-up lubrication pump, remove oil from the sump every 3 months, spray through housing openings in the interior and circulate oil by pumping with separate oil pump through pipelines for approx. 5 minutes. Race system where possible.

c) Alternatively the following methods of internal anticorrosive protection can be used, especially for non-oil-filled systems:
   - dry air in the interior of the unit monthly. The permissible relative air humidity should be = < 40 % at the lowest expected ambient temperature.

d) Supply of the interior of the unit with dry compressed air. Volume flow approx. 10 to 15 l/min (sufficient for up to 6m³ volume of the interior). The atmospheric dew point of the compressed air must below 0°C.

* see page 12

3.2 The following measures apply to systems installed on the foundation in a hall with slightly varying air temperature

See also point 3.

The following methods can be used to protect the interiors of the units against corrosion:

a) Operable systems
Start up at least every 2 months and operate briefly (approx. 5 minutes) for oil moistening of the internal parts and surfaces.

b) Non-operable systems
- With operable electrical start-up lubrication pump, this is to be put into operation every 2 months for approx. 5 minutes. (Do not run up to hot condition!)
- With a non-operable electrical start-up lubrication pump, remove oil from the sump every 2 months, spray through housing openings in the interior and circulate oil by pumping with separate oil pump through pipelines for approx. 5 minutes. Race system where possible.

c) Alternatively the following methods of internal anticorrosive protection can be used, especially for non-oil-filled systems:
- dry air in the interior of the unit monthly. The permissible relative air humidity should be = < 40 % at the lowest expected ambient temperature. If this is not possible in one pass through the sorption dehumidifier due to the climatic conditions, the air must be dehumidified in a closed circuit.

In case of extensive temperature variations and/or high air humidity, measures d) or e) (optionally) are required in addition.

d) The permanent supply of the interior of the unit with dehumidified air via a sorption air dehumidifier is permitted. *

e) Supply of the interior of the unit with dry compressed air. Volume flow approx. 10 to 15 l/min (sufficient for up to 6m³ volume of the interior). The atmospheric dew point of the compressed air must be below -10°C.

3.3 The following measures apply to systems installed in the open on the foundation

See also point 3.

The following methods can be used to protect the interiors of the units against corrosion:

a) The permanent supply of the interior of the unit with dehumidified air via a sorption air dehumidifier is permitted. It is recommended to control the unit with a hygrostat. The relative air humidity in the interior of the machine must be =< 40%.

* see page 12

b) - Supply of the interior of the unit with dry compressed air. Volume flow approx. 10 to 15 l/min (sufficient for up to 6m³ volume of the interior). The atmospheric dew point of the compressed air must be below -40°C.

c) - permanent supply of the interiors of the machines with technical nitrogen, volume flow approx. 10 – 15 l/min. (sufficient for up to 6 m³ volume of the interior), required pressure approx. 0.002 bar. Dew point of nitrogen =< -70°C.

Attention: All works on the unit must be performed under special safety measures when using nitrogen.
Toxic hazard!

With operable electrical start-up lubrication pump, this is to be put into operation every 3 months for approx. 5 minutes.

Table for inspection intervals of humidity indicators to TL 6685..

Display value of the humidity indicators	Inspection intervals
Blue	every 8 weeks
30 % pink	every 2 weeks
40 % pink	Weekly
50 % pink	Correctly restore preservation

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* Anticorrosive protection with dehumidified air is based on the fact that no corrosion occurs below a relative air humidity of 40%. The relative air humidity depends on the temperature. Permissible residual humidity is to be determined in accordance with the lowest expected ambient temperature. At this temperature it should be = < 40 %.

The relative permissible air humidity at which the air in the interior of the units is to be dried is determined with the aid of the hx diagram for humid air (see example).

Example:
See hx diagram for humid air page 13
Assumptions:
- Ambient condition: temperature 30 °C, rel. air humidity 70%
- Lowest expected ambient temperature 18 °C, permissible relative air humidity =< 40%.

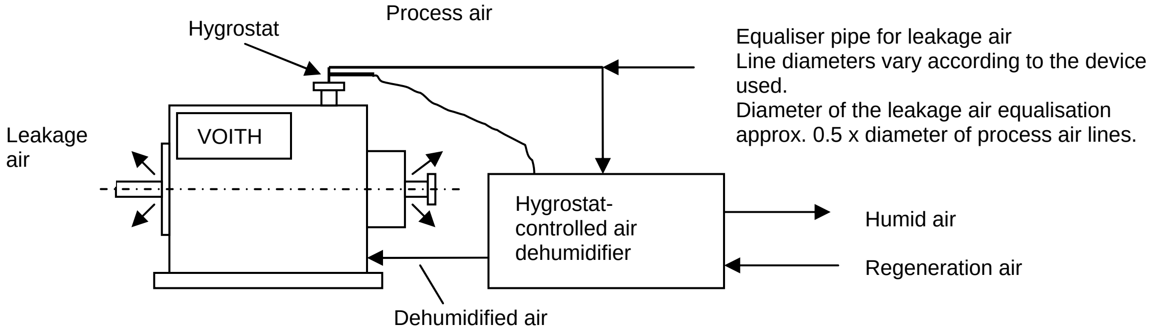
Determination of the permissible relative air humidity at which the air is to be dried at 30°C:
- Determine intersection of temperature 30°C and relative air humidity 70% (state of air before drying)
- Determine intersection of temperature 18°C and relative air humidity 40% (nominal state of air after drying)
- Read off the corresponding water vapour content for the nominal state of the air: 5g/kg air.
- Read off the intersection with the curve of the relative air humidity on the line for the water vapour content vertically upwards at approx. 2 to 4°C above the initial temperature (30°C), selected 34°C: 15%.

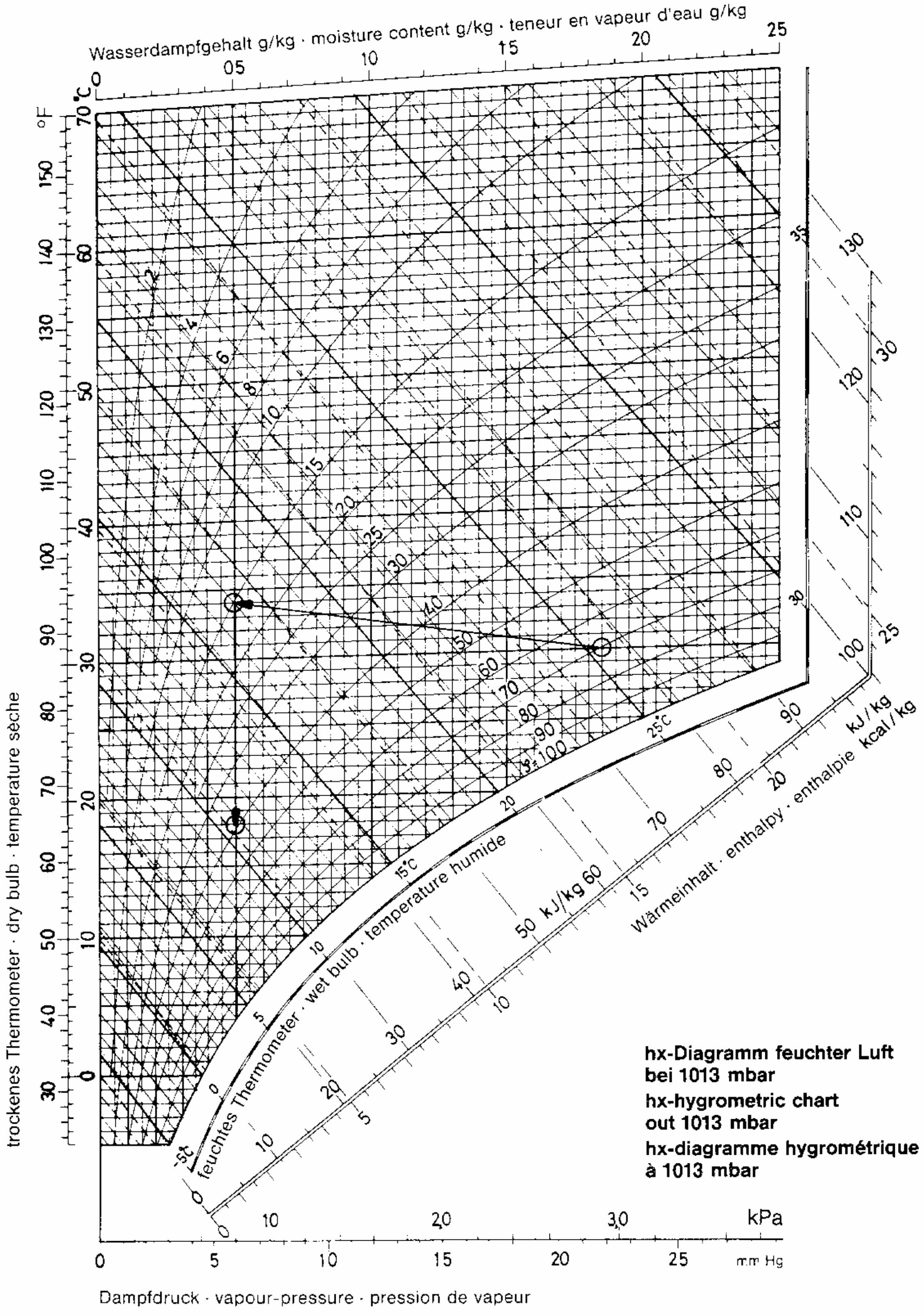
Result of the example:
The air is to be dried for a lowest expected ambient temperature of 18°C to a relative air humidity of 15%.

Connection of a sorption air dehumidifier to dry the air in the interior:

Pipe diameters vary according to the device used and are to be agreed with the manufacturer of the sorption dehumidifier.

Drying is carried out in a closed circuit:





hx-Diagramm feuchter Luft bei 1013 mbar
hx-hygrometric chart out 1013 mbar
hx-diagramme hygrométrique à 1013 mbar

Contents

Appendix_B_

Voith Turbo
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Operating Fluids ISO VG 32
for Voith Variable Speed Turbo Couplings and Torque Converters

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Media:	J:\Turbo\ai-VTCR\air\BA-Doku\3625		

1. Field of Application

This specification applies to:
- variable speed turbo couplings of type ”S” and
- torque converters of type ”E”.

This list may not be applicable in individual cases involving special requirements. In such cases, the appropriate specifications will be agreed when handling the order and/or stated in the instruction manual.

2. Requirements to be fulfilled by Operating Fluids

Characteristic value	Test procedure	Test conditions	Unit	Requirements
Kinematic viscosity	DIN ISO 3104 ASTM D 445	40°C (104°F)	$\mathrm{mm^2/s}$	ISO VG 32
Viscosity index	DIN ISO 2909 ASTM D 2270		-	$\geq$ 95
Density	DIN 51 757 ASTM D 1298	15°C (59°F)	$\mathrm{kg/m^3}$ $\mathrm{kg/l}$ °API	850 - 900 0,85 - 0,9 34.9 - 25.6
Pour point 1)	DIN ISO 3016 ASTM D 97		°C (°F)	$\leq$ -24 (-11.2)
Flash point	DIN EN ISO 2592 ASTM D 92		°C (°F)	> 175 (347)
Ignition temperature 2)	DIN 51794 ASTM E 659		°C (°F)	> 250 (482)
Corrosive effect on copper	DIN EN ISO 2160 ASTM D 130	3h at 100°C (212°F)	-	$\leq$ 2
Protection against corrosion of steel	DIN ISO 7120 ASTM D 665	Procedure A	-	passed
Demulsibility	DIN ISO 6614 ASTM D 1401	Time in minutes at 54°C (129.2°F)	min	$\leq$ 30
Aging characteristics 3)	DIN 51 587	1000 h at 95°C (203°F)	$\mathrm{mg\ KOH/g}$	ΔNZ_{max} = 2
Aging stability (TOST) 3)	ASTM D 943	$\Delta NZ=2\ \mathrm{mg\ KOH/g}$ at 95°C (203°F)	h	> 1000
Air release property	DIN ISO 9120 ASTM D 3427	0,2% at 50°C (122°F)	min	$\leq$ 5
Foaming behavior	ISO 6247 ASTM D 892	Sequence I Sequence II Sequence III	$\mathrm{ml/ml}$	$\leq$ 150/0 $\leq$ 75/0 $\leq$ 150/0
Neutralization number (new oil)	DIN 51 558 ASTM D 974		$\mathrm{mg\ KOH/g}$	to be indicated
Compatibility with sealing material SRE-NBR 1	DIN ISO 1817 (+ DIN 53505)	SRE-NBR 1 as per DIN 53 538-1 7 days at 100°C (212°F)	% Shore A	relative change in volume: 0 bis 12 change in hardness: 0 bis -7
Advantageous additional characteristics (for variable speed turbo couplings and torque converters mounted on anti-friction bearings):				
FE8-Test 4)	DIN 51819-3	D7,5/80-80	mg	wear of rollers: $\leq$ 30 wear of cage: indicate

1) Pourpoint is depending on the conditions at the installation site (ambient temperature).
Startup viscosity by oilsupply
- with centrifugal pumps: $\leq 250\ \mathrm{mm^2/s}$
- with positive displacement pumps with sufficient input power (to be enquired): $\leq 1000\ \mathrm{mm^2/s}$

2) to be fulfilled for explosion protection requirements as per EC Directive 94/9/EC (ATEX - Ex) Temperature Class T3 (max. surface temperature 200°C (392°F))

3) alternatively

4) Oils without the FE8-Test are acceptable.
By using oils with a passed FE8-Test wear of the anti-friction bearings could be reduced.

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3. Oil Selection by Operators and Mineral Oil Companies

Considering the requirements of section 2, the following types may be used:
- hydraulic oils HL to DIN 51524-1,
- hydraulic oils HLP to DIN 51524-2,
- turbine oils L-TD to DIN 51515-1 and -2.

4. Selection of Oils

The following list contains hydraulic oils to DIN 51524-1 and -2, turbine oils to DIN 51515-1 and -2 as well as oils which typical characteristic values meet the requirements according to section 2 and oils that have proven well in practice under normal operating conditions.

As the local conditions and the oil qualities vary, we cannot assume any liability for the oil itself mentioned in this list. In case of negative operating result, due to this oil selection, warranty claims made in this connection will not be accepted.

Supplier	**Designation**	**Ign.temp. > 250°C**	**FE8- Test passed**
ABC Maziva	INA Fluid V 32	yes	
Addinol Lube Oil GmbH	Strömungsgetriebeöl SGL 18	yes	
	Hydrauliköl HLP 32	yes	
	Turbinenöl TP 32 *)	yes	
AP Oil International	AP Torque Oil 32	yes	
Autol	Hydrauliköl HYS 32	yes	
Avia	Gear RSX 32-S	yes	yes
Bharat Petroleum Corp. Ltd.	MAK Hydrol HLP 32 *)	yes	
bp	Energol HLP-HM 32	yes	
Caltex	Torque Fluid 32	yes	
Castrol	Hyspin AWS 32	yes	
	Alpha EP 32	yes	yes
	Hyspin HL-XP 32	yes	
	Hyspin ZZ 32	n.s.	yes
Cepsa	Hidraulico HM 32	yes	
	EP 125	yes	
	Turbinas EP 32 *)	yes	
Chevron-Texaco	Chevron Hydraulic Oil AW 32	n.s.	
	Texaco Textran V 32	n.s.	
	Texaco Rando HD 32	yes	
	Chevron Clarity Hydraulic Oil AW 32	n.s.	
ConocoPhillips	Powerflow AW Hydraulic Oil 32	yes	
ENI	Agip OSO 32	yes	
	Agip OTE 32 GT *)	n.s.	
	Agip Blasia 32	yes	
ExxonMobil	Nuto H 32	yes	
	Mobil DTE 24	yes	
	Mobil DTE Oil Light *)	yes	
	Mobilfluid 125	yes	
Fuchs Europe	Renolin ZAF 32 B	yes	
	Renolin Eterna 32 *)	yes	
	Renofluid TF 1500	yes	
Fuchs Lubricants PTE Limited	Titan RR TF	yes	
Gulf Oil Corp. Ltd.	Crest EP 32	yes	
	Harmony AW 32	yes	
Hindustan Petroleum Corp.	Enklo HLP 32 *)	yes	
Idemitsu Oil	Daphne Super Hydraulic Fluid 32	n.s.	

Supplier	**Designation**	**Ign.temp. > 250°C**	**FE8- Test passed**
INA Maziva	INA Fluid V 32	n.s.	
Indian Oil Corp. Ltd.	Servosystem 32 *)	n.s.	
	Servosystem HLP 32 *)	yes	
	Servo Torque 10	yes	
Klüber	Lamora HLP 32 (New Generation) *)	yes	
Kuwait National Lubricant Oil Company (KNLOC)	Hydraulic Oil 32	yes	
Kuwait Petroleum International Lubricants (Q8 Oils)	Q8 Haydn 32	yes	
	Q8 Holst 32 *)	yes	yes
	Q8 van Gogh EP 32 *)	yes	
Lukoil LLK International	Geyser ST 32	yes	
Maziva Zagreb d.o.o.	INA Fluid V 32	yes	
MOL Hungarian Oil	Hydro HM 32 hydraulic oil *)	n.s.	
Morris Lubricants	Liquimatic No. 4	yes	
OEST	Hydrauliköl H-LP 32	yes	
	Turbo Hyd 32 S	yes	yes
OMV	hyd HLP 32	yes	
	fluid VWG 32	yes	
	power turb 32 *)	yes	
Orlen Oil	Transol V 32	yes	yes
	Hydrol L-HM / HLP 32	yes	
Paramo / Mogul	OT-HP 3	yes	
	HM 32	yes	
Petrobras	Lubrax Industial EGF 32 PS *)	n.s.	
	Lubrax Industrial HR 32 EP	n.s.	
	Lubrax Industrial Turbina EP 32 *)	n.s.	
Petro-Canada	Hydrex AW 32	yes	
	Environ AW 32	yes	
	Turboflo EP 32	yes	
Petrol Ofisi	Hydro Oil HD 32	yes	
Petronas	Jenteram HC 32 *)	yes	
	Hidraulik EP 32 *)	yes	
	Jenteram HC Extra 32 *)	yes	
Prista Oil	Prista MHP 32	yes	
PTT Public Company Limited	Votera 32	yes	
Repsol	Telex E 32	yes	
Shell	Tellus Oil S3 M 32 (alte Bezeichnung: Tellus Oil S 32)	yes (yes)	(yes)
	Turbo Oil CC 32 *)	yes	
	Tellus Oil S2 M 32 (alte Bezeichnung: Tellus Oil 32)	yes (yes)	
Sinopec	Greatwall L-TSA 32 *)	yes	
	Greatwall L-HM 32 *)	yes	
SK Lubricants	ZIC Supervis AW 32	n.s.	
SRS	Wiolan HF 32 DB	yes	
	Wiolan HF 32	yes	
	Wiolan HX 32	yes	
Statoil	HydraWay HMA 32	yes	
Tide Water Oil Co. (India) Limited	Veedol Avalon HLP 32 *)	n.s.	
TNK Oil	Turbo 32 *)	n.s.	

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Supplier	Designation	Ign.temp. > 250°C	FE8- Test passed
Total	Azolla AF 32 (New Generation)	yes	
	Azolla ZS 32	yes	
Valvoline Cummins Ltd.	Valvoline HLP 32 *)	n.s.	
Wisura	Kineta 32 V	yes	

*) Pour point higher than specified. Check viscosity on startup.
n.s. Ignitiontemperature **n**ot **s**pecified

This list does not claim to be complete.

For an updated oil selection list, please contact Voith Turbo GmbH & Co. KG.

Operating Instructions for SIGMA **Plate Heat Exchangers**

API HEAT TRANSFER

Content

1. General Remarks

API Schmidt-Bretten GmbH & Co. KG is in the business of solving thermal problems since 1879, and is producing the SIGMA series of plate heat exchangers since well over six decades.

We produce a wide assortment of heat exchangers with gaskets for a broad range of heat exchange applications.

Although our SIGMA heat exchangers are still being utilized in their traditional area of application, that is the milk and beverage industry, our wide selection of units are employed in nearly all industrial areas.

The wide scope of possible applications ranges from lubricating oil coolers on ships, to refrigerant evaporators, to hot water preparators, all the way to fruit products pasteurizing units.

The wide variety of unit sizes, as well as of available plate structures, are the basis for API Schmidt-Bretten’s optimum designed plate heat exchangers no matter for which application they are intended.

In the following text, you will find information concerning the assembly, the functioning, and the operating of a SIGMA plate heat exchanger.

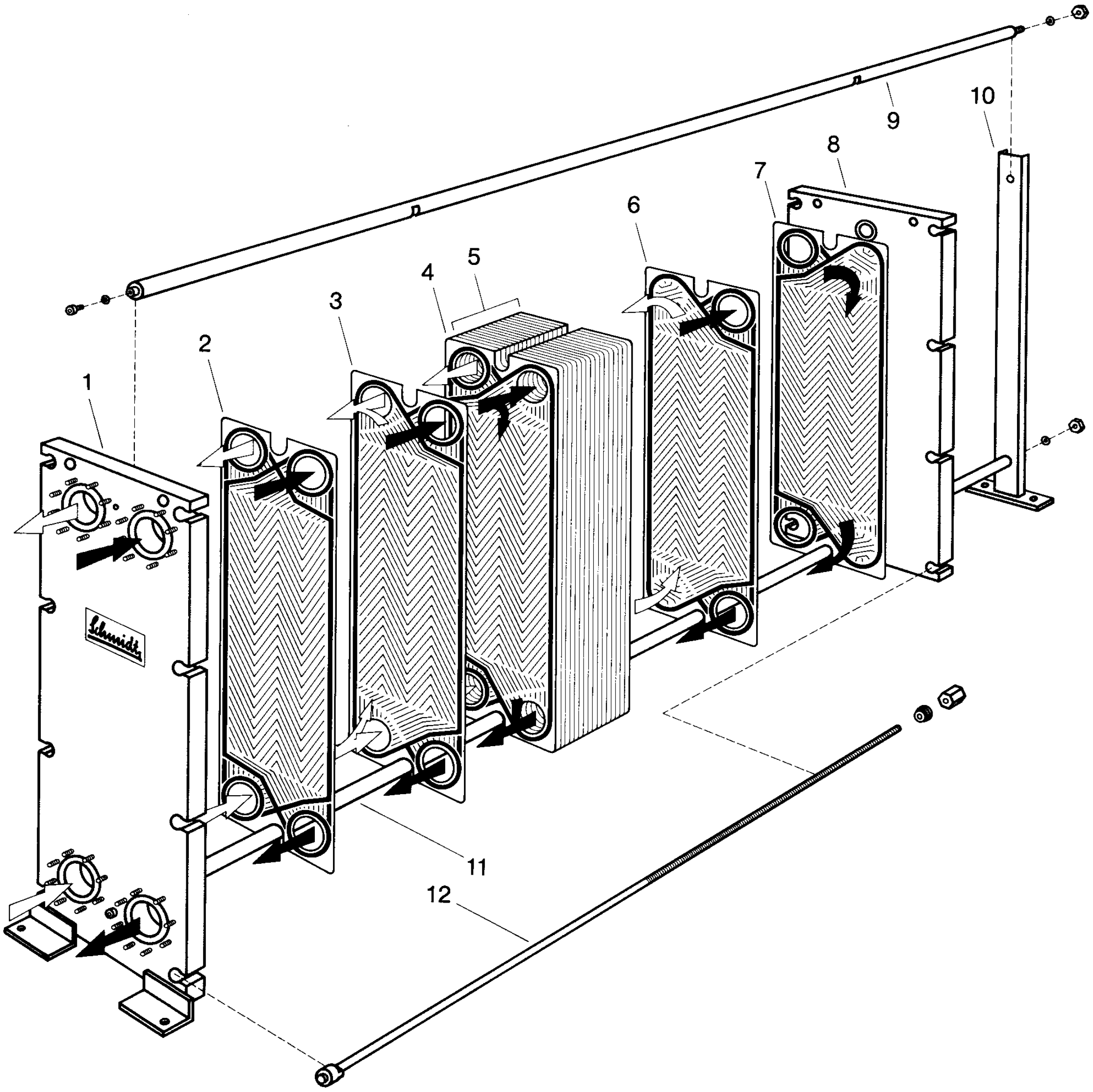
If you still have questions concerning our products after having read the information, one of our specialist will be happy to help you.

We wish you much success with the SIGMA plate heat exchangers.

Your API Schmidt-Bretten - Team

2. Assembly of Dismantled Units

A plate heat exchanger, as seen below, is a pressure vessel that is composed of pressure parts such as the lateral tie rods and the frame plates.



1 Fixed Frame Head w/ Flow Ports	5 Plate Pack	9 Upper carrying Bar
2 First Plate	6 Left-hand Flow Plate	10 End Support
3 Left Hand Flow Plate	7 Right-hand Flow Plate	11 Lower Carrying Bar
4 Right Hand Flow Plate	8 Movable Cover	12 Tie Rod w/ Locking Nut

Single corrugated heat exchanger plates are combined into a plate packet to form flow channels, which are enclosed with gaskets.

These flow channels make it possible for the liquids that enter and exit through the connecting holes consequently to undergo thermal treatment by conducting heat through the heat exchanger plates.

2.1 Frames

A variety of frames are available. Their differences consist in construction form, in the type of material used for their construction, as well as in their strength.

The dimensioning of the standard plate heat exchangers is based on the rules of the German “AD-Merkblätter”. The standard selection of materials refer to DIN.

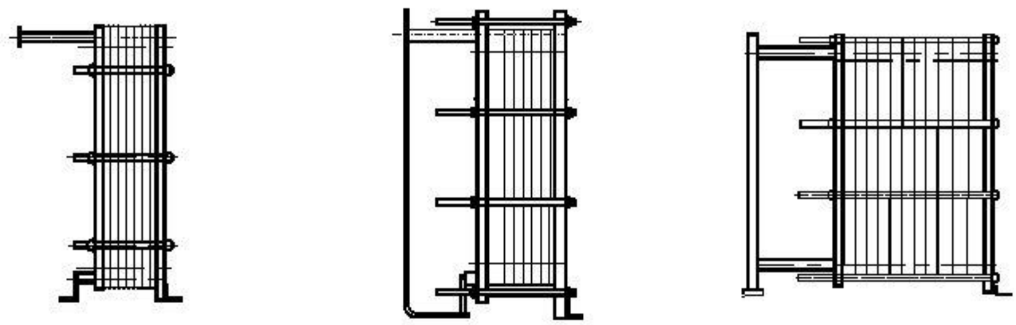
The designation of the frames consists of the following information:

SIGMA M 27 N B L

Series	Plate style	Type	Design	Pressure class	Construction material
SIGMA	M	27	N	B	L
			N, S, T	A, B, C, D	L Lacquered steel N Solid stainless steel V Steel covered with stainless steel sheets

Designs

“N” “S” “T”



2.2 Connections

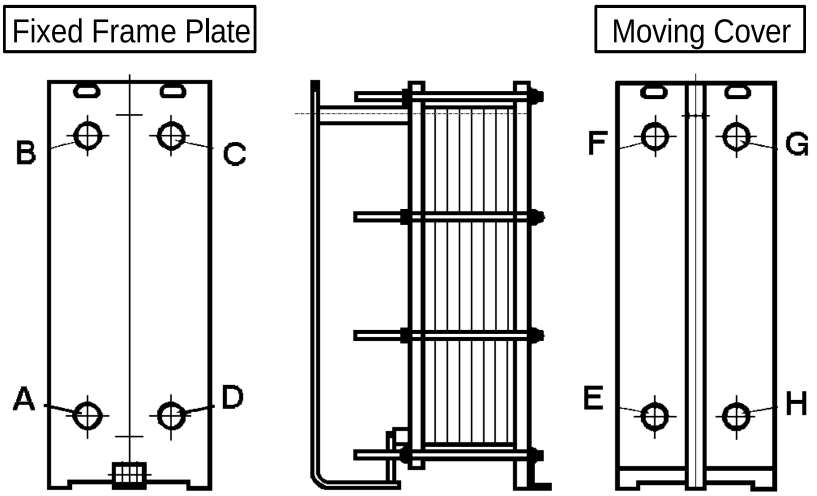
SIGMA plate heat exchangers come equipped with a range of different connection types according DIN-Standard.

The choice of corrosion-proof material used for the connections depends on the medium that is to undergo the thermal process. A higher alloyed and more resistant material is required for the connections and the lining, if a more aggressive medium is to be treated.

A cost-effective variation would be to employ the same material utilized in the plate gaskets for the lining of the connections.

Additional connections used for ventilation or draining usually have a smaller nominal width than the product connections.

The diagram below shows the letters attributed to the position of the connections.

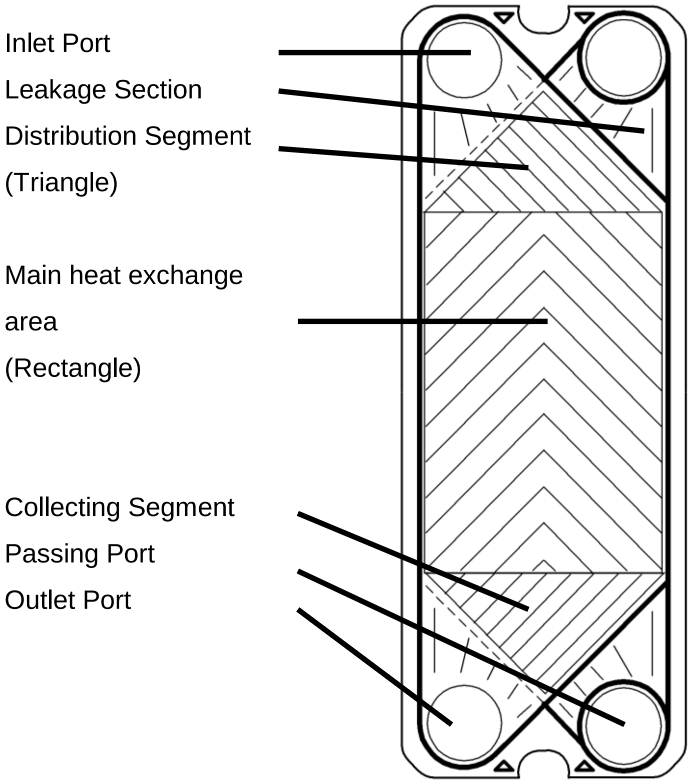


2.3 Plates

One of the main components of the heat exchanger is the plate package. The number of plates and the type of plate corrugation used in the heat exchanger unit depends on the type of thermal process that is to take place.

The flow path through the plate package also depends on the thermodynamic requirements of the plate heat exchanger.

All heat exchanger plates are in principle composed of a single plate segments.



The composition and the temperature of the media, which are to take part in the thermodynamic process, determine the type of materiel used for the manufacturing of the heat exchange plates.

As possible materials the following are used in general:

- Stainless Steel: AISI 304, AISI 316, AISI 316L, AISI 316TI, AISI 904L, SMO 254
- Nickel Alloys: 2.4066 (pure nickel), 2.4819 (Hastelloy C-276), 2.4858 (Incoloy), 2.4360 (Monel)
- Titanium / -alloys: 3.7025 (titanium Grade 1), 3.7225 (titanium-Pd)

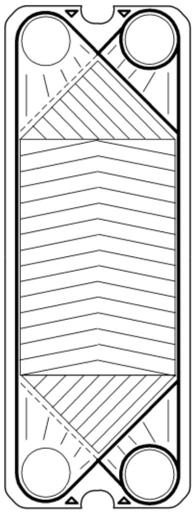
The thickness of the plate material is depending on the plate type and the required pressure resistance. It ranges between 0.4 mm and 1.15 mm.

The flow-characteristics of the plate gaps are interlocked with the profile of the plate corrugation.

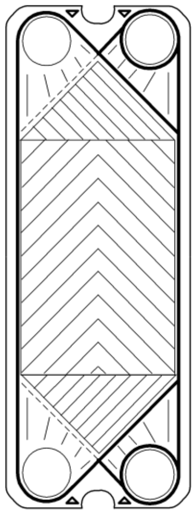
API Schmidt-Bretten disposes over a wide assortment of plates with varying corrugations. Each has its own specific hydraulic and thermodynamic properties, as well as in product distribution and cleaning behavior in relation to the product consistencies.

Plate packages can consist of plates with varying plate corrugation patterns. The following corrugation patterns are available for the optimizing of thermodynamic flow paths.

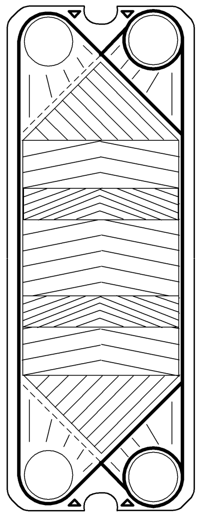
H-Corrugation



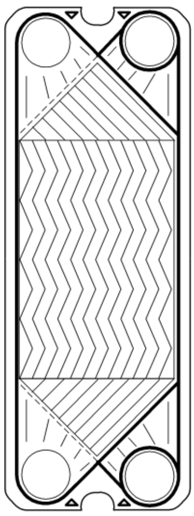
W- Corrugation



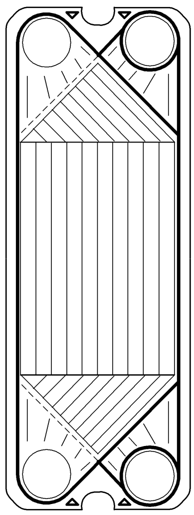
Y- Corrugation



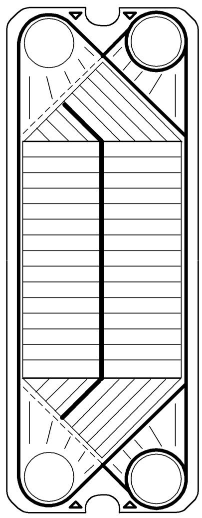
Z- Corrugation



V- Corrugation



F- Corrugation



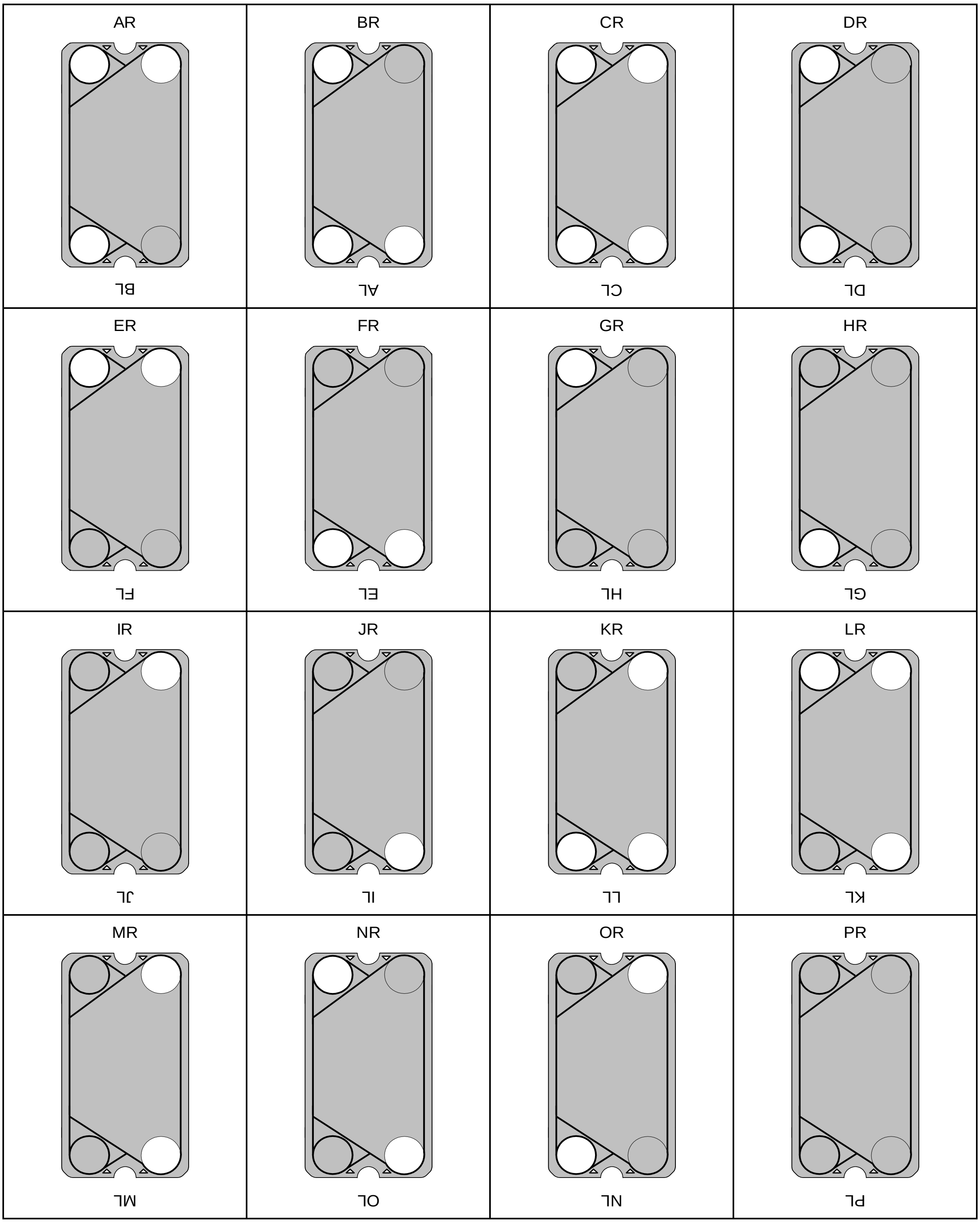
Each plate heat exchanger is optimized according to the specific use in mind. Consequently, various heat exchanger units have different arrangements and flow paths through which the product is fed.

A parallel or serial arrangement can be achieved by opening or closing the outlet ports.

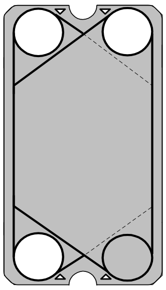
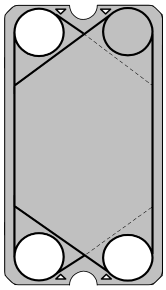
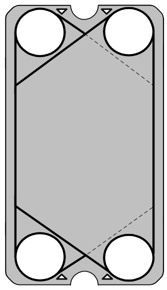
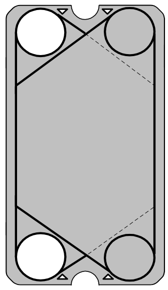
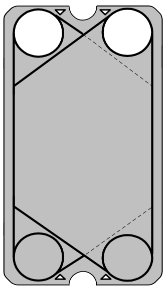
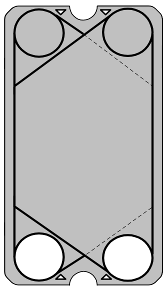
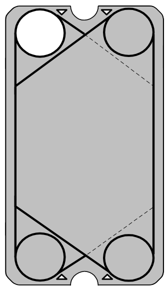
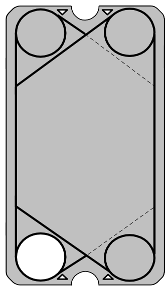
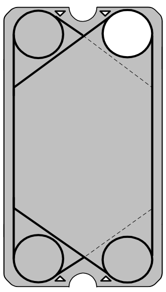
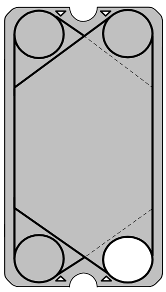
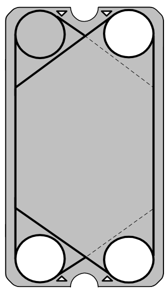
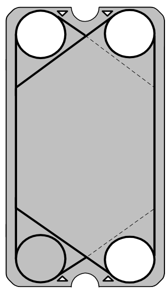
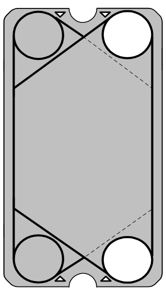
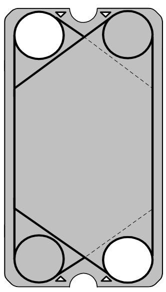
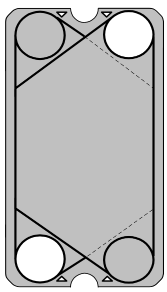
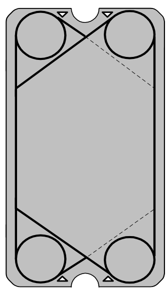
The plates, which do not have four open inlet / outlet ports, are called “turning plates”. For a clear identification of the turning plates, a nomenclature consisting of letters, which are attributed to the various inlet and outlet ports, is used (refer chapter 2.2).

When looking at a heat exchanger plate, with the plate side which holds the gasket facing towards you, if the inlet and outlet port are situated on the left side then this is a left plate. When the outlet ports are positioned on the right side this indicates that it is a right plate.

Turning Plates



Start Plates

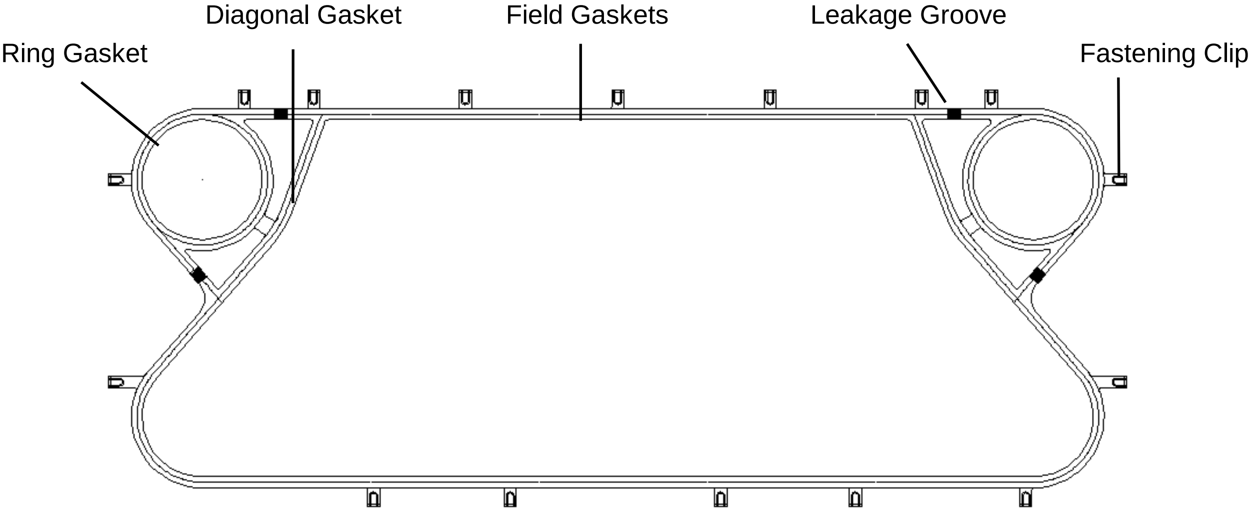
AAR/EAR  ABL/EBL	ABR/EBR  AAL/EAL	ACR/ECR  ACL/ECL	ADR/EDR  ADL/EDL
AER/EER  AFL/EFL	AFR/EFR  AEL/EEL	AGR/EGR  AHL/EHL	AHR/EHR  AGL/EGL
AIR/EIR  AJL/EJL	AJR/EJR  AIL/EIL	AKR/EKR  ALL/ELL	ALR/ELR  AKL/EKL
AMR/EMR  AML/EML	ANR/ENR  AOL/EOL	AOR/EOR  ANL/ENL	APR/EPR  APL/EPL

2.4 Gaskets

Every heat exchanger plate of a gasketed plate heat exchanger is fitted with a complete gasket.

The gaskets keep the fluids that flow through the heat exchanger separated from each other and contained within the unit.

Each heat exchanger plate is fitted with two ring- and two field gaskets. The only exceptions are the plates, which face the frame heads.



Within the gasket is a leakage area with a leakage groove. As soon as diagonal- or ring gasket is defective this leakage groove makes the leak visible on the outside.

The functioning of these leakage grooves is guaranteed as long as the gasket has not lost its original shape due to thermal influences, or that the leakage grooves have become congested due to the impurities contained in the product, or that the plate packet was not tightened properly below the given final clamping dimension.

In general, there are two ways of fixing the gaskets to the heat exchanger plates:

- The fixing of a gasket to a plate by means of adhesives:

  A special adhesive is placed as a complete layer into the heat exchanger plates' gasket groove. After the gasket has been fitted in and the adhesive has hardened, the gaskets and plates are joined permanently.

  This method of fixing the gasket to the plate is especially advantageous for systems, which have to be opened for cleaning on a regular basis.

  The gaskets loose their effectiveness with time and then have to be exchanged. When gaskets are changed, they have to be removed carefully and new ones have to be fixed to the plates.

  Depending on the gasket material and quality, this procedure may be performed directly on site.

  It is however highly recommended that the plates be returned to the manufacturer, who will then perform the gasket change.

* Adhesive free gasket fixing system

  When using an adhesive free gasket fixing system, in contrast to the adhesive fixing system, the gasket is held in place through a number of fixing points. The fixing points are determined by the size of the heat exchanger plate.

  The fixing of the gasket to the plate is achieved through lateral mounting clips, which are clamped into the recess on the plate edge.

  The changing of the gasket is easy and can be performed on site.

When choosing the material for the gaskets, the same criteria as for the choice of heat exchanger plate material has to be kept in mind. The choice of material depends on the type of medium to be treated as well as the temperature upon entering and exiting the heat exchanger unit.

The following are the standard elastomer gasket materials that are available:

NBR
EPDM
FPM
CSM
Chloroprene
Silicone

Apart from these, for certain plate types it is possible to employ compressed-fiber materials.

The service life of a plate heat exchanger gasket depends on a variety of factors.

The following factors have an influence on the service life of the gasket:

* the operation of the heat exchanger

  (continuous or discontinuous operation)
* the maximum operation pressure
* the maximum or minimum operation temperature
* temperature- or pressure load changes
* the composition of the products which undergo the thermal treatment, their additives as well as the mediums used during the cleaning processes
* mechanical stress due to irregular or to tightly adjusted frames

2.5 Accessories

2.5.1 Intermediate Frames and Intermediate Plates

For a range of applications several sections with varying thermodynamic functions can be installed within a plate heat exchanger, as is the case within a food stuff pasteurizer with a cooling, a heating, and a heat recovery section.

Nevertheless, each section requires its own inlet and outlet ports. Intermediate frames which are built-in to serve as separation between two adjacent sections can be equipped with the appropriate connections for the functioning of that section.

In contrast, intermediate plates without connections merely serve as separation between two adjacent sections.

2.5.2 Protection Cover and Insulation

Heat exchangers with operating temperatures of over 50 °C or under –10°C should be fitted with a protection cover in order to avoid any injuries through contact.

Direct contact with the heat source can be avoided through the mounting of protection covers. These protection covers, which are made out of thin stainless steel, are fitted over the plate pack.

Another safety feature of the protection cover is that it also serves as splash guard against the mediums contained within the heat exchanger in case of a gasket leak due to aging of the gasket.

Compared to the large internal heat exchange surface, the exterior of the heat exchangers is relatively small. Although the exterior surface is not very extensive, for some applications it would be advantageous to install an isolation barrier.

The plate heat exchange may be insulated using one of two methods. The unit can either be completely insulated using a solid insulation which encases the whole unit and which can be removed in one piece, or only the plate pack may be insulated so that any heat losses towards the outside are avoided. In this case, the plate pack is covered with a protection cover, which includes a layer of insulation on the inside.

It is the responsibility of the operator to ensure that the proper safety precautions are taken so that no injuries to persons, or damage to the environment occur in case of heat exchanger malfunction or damage leading to leakage.

2.5.3 Safety Precautions Against Outer Influences

In general, it is not possible to protect a heat exchanger from outside influences such as heat or other atmospheric influences.

It is however necessary to foresee certain safety measures. In case of a fire the heat exchanger unit must be depressurized through a built in automatic control system in order to avoid an increased risk of damage caused by the pressurized mediums contained within the unit.

As a preventive measure against possible damage from aggressive substances contained in the surrounding area, all parts of the heat exchange unit, such as the pressure frames, the heat exchange plates, and the gaskets must be pre-treated accordingly.

When choosing the location of the heat exchanger unit it should be kept in mind that, UV or other rays can have a negative effect on the gaskets and thus shortening the service life of the seal.

3. Installation

3.1 Unpacking of the Heat Exchanger Unit

Units, for which the net weight is to found in the technical documentation, usually are delivered lying flat on a pallet.

When transporting these pallets with a fork lift it is important to verify that the supporting surface of the forks is long enough to support the pallet in order to avoid possible braking of the pallet and damage the heat exchanger unit.

The unloading of the unit may only be done with the proper machinery such as flat lifting slings, which can be fastened to the securely bolted frame and/or to the loops, which are foreseen especially for the transport of the unit. Under no circumstances are the connection tubes or intermediate frames to be used in the unloading and transporting of the unit.

All lifting loops must be used during the transport in order to avoid a warping of the unit caused by improper transport.

3.2 Mounting of the Plate Heat Exchanger

Generally gasketed plate heat exchangers are not allowed to be installed in explosive atmosphere zones 0. If the plate heat exchanger will be mounted in all other explosive atmosphere zones, it has to be ensured that all metallic parts are low-impedancly connected. Despite of electric grounding, static electricity on painted surfaces may still be caused as a result of external occurrences e.g. rubbing.

First of all the unit has to be aligned in the proper assembly order.

Then the floor supports for the frame and the end support must be set up.

For units that have an additional supporting leg on the lower-carrying bar, the supporting leg must be adjusted so that it has a proper contact with the floor.

After mounting of the plate heat exchanger, the electric grounding of the pressure frame has to be secured.

Enough space should be foreseen around the heat exchanger unit. Depending on the model about 1,5 m of space is needed, so that during the servicing of the unit by our erecting engineers, plates can be removed from the plate pack and spanners can be used without any spatial restrictions.

Tubular connections situated on the movable pressure plates as well as on the intermediate-frames must be easily accessible for servicing.

Under certain circumstances, it may not be possible to deliver the heat exchanger as an assembled unit. Even if the unit is delivered in a disassembled state, before it left the production plant it was tested for quality of build and underwent all the required pressure tests. However, after the unit is assembled within your facilities before it is put into operation it must undergo another pressure test. All the required information is to be found in the technical documentation.

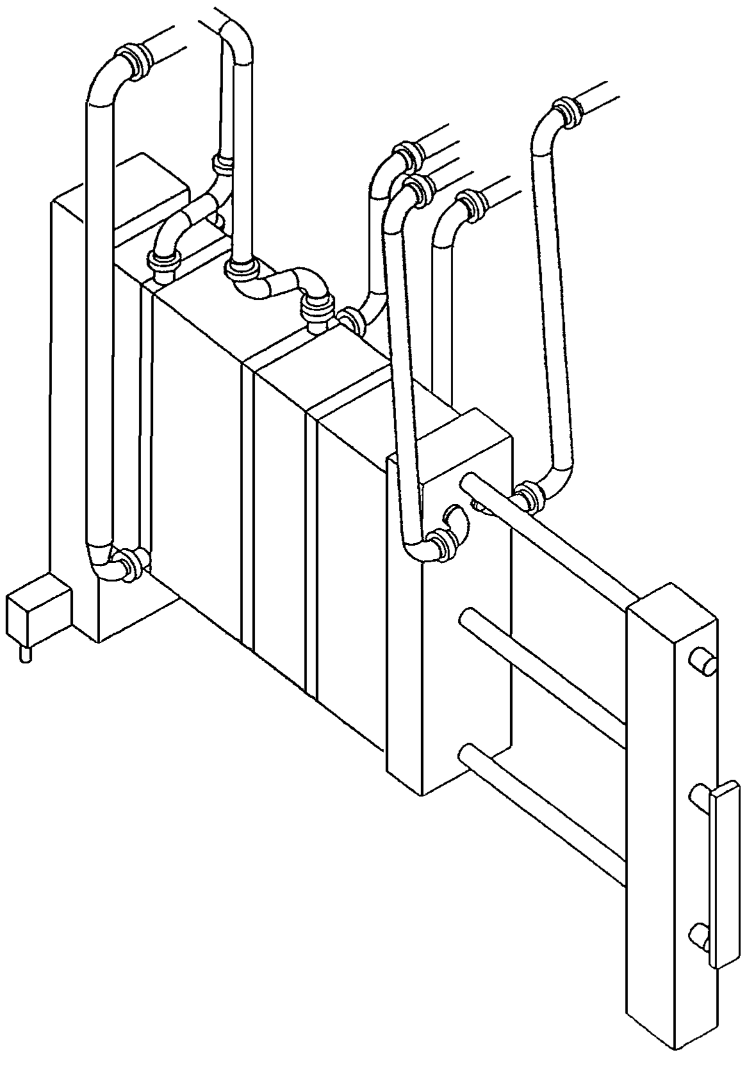
3.3 Connecting of the Unit

The connecting tubes must be installed without any stress and tensions.

The connections leading through the movable cover or through one of the intermediate frames must remain movable within the theoretic maximum and minimum dimensions.

If pressure would be absorbed by the tubes during a re-tightening of the plate pack a complete seal of the unit could no longer be guaranteed.

In order to avoid any stresses on the tubes, expansion joints such as pipe swing bends, made up of several movable tube bends can be incorporated into the pipeline.



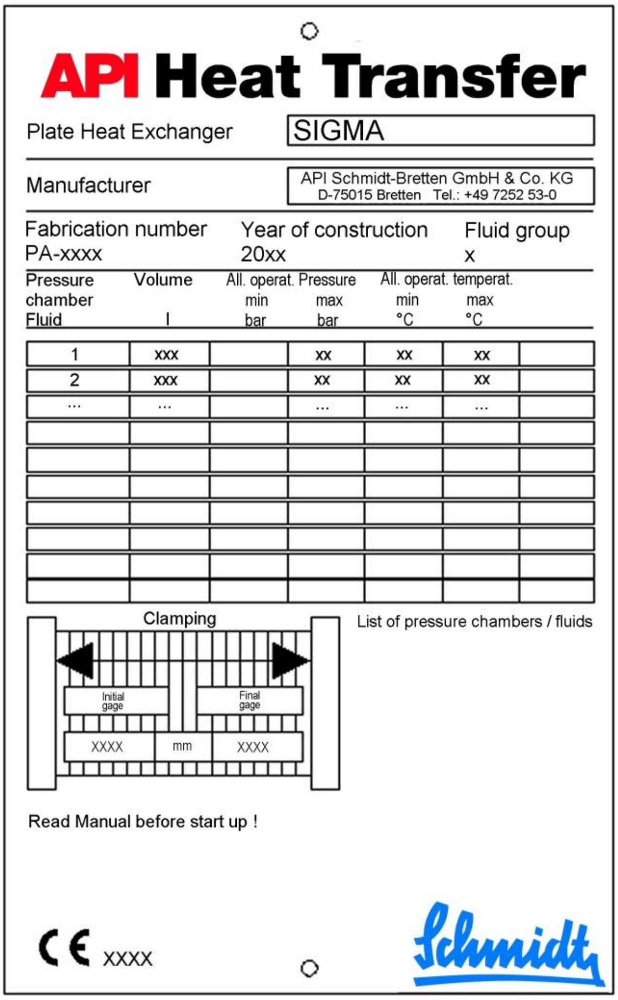
4. Start Up and Shutdown

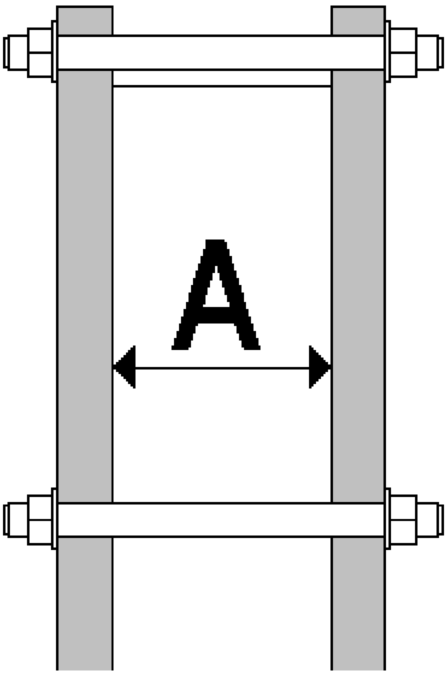
Before starting up a plate heat exchanger, make sure that the admissible pressures and temperatures indicated on the name plate are not exceeded. Safety measures in case of exceeding temperature and pressure are to be observed.

The compatibility of the media to be treated with the materials used for the construction of the plate heat exchanger is to be checked before the start up of the unit.

It may be possible that the tie rods become loose during transportation of the unit in a depressurized state, or after the first few days of operation, simple retighten the tie rods.

Before restarting the unit it should be checked that the measurements regarding size and uniformity of all tightening bolts correspond to the dimension A (see drawing).





To avoid pressure shocks during start-up and shutdown of a heat exchanger unit appropriate components should be built into the unit or the technical operation conditions should be adjusted so that a minimum of pressure shocks occurs.

After prolonged operating periods with on and off phases it is possible, especially when using compressed fiber gaskets, that leakage occurs when the heat exchange unit is cold. These leaks get smaller with ever increasing temperatures. They are a part of the natural setting phenomenon of the gaskets.

4.1 Starting up the Plate Heat Exchanger

To start-up the plate heat exchanger please follow the following instructions:

1. Position of the valves:
   - Close the valves in the feeding pipe (unless a volumetric pump is installed).
   - Open the valves in return pass (if applicable).
2. Open the vent valves (if applicable).
3. Check positioning of the valves, then switch on the pump.
4. Open the inlet slowly in order to avoid pressure shocks.
5. When all the air has been evacuated from the plate heat exchanger, close the vent valves.
6. Before opening the inlet completely, check if all the air has been evacuated from the heat exchange unit.

Which product side is to be started-up first depends on the type of system used, as well as from the thermodynamic process that is to take place. As far as it is possible, the following rules should be followed:

- It is recommended to start-up the product side, which will contain the medium with the lower process temperature and pressure.
- By cold pressure cycles, if the temperature of the cooling medium is below the freezing point, then the medium to be treated should be fed into the heat exchange unit first in order to avoid a freezing up of the unit.
- It is also important to note that the sequence of the product feed should be chosen so that when the product enters the plate heat exchanger no uncontrollable evaporation occurs.
- Generally: Volumetric pumps have to start up softly.

4.2 Shutdown of the Plate Heat Exchanger

When shutting down the plate heat exchanger, in order to avoid any pressure shocks, please follow these instructions:

1. Slowly close the valve of the product feed pipe.
2. Turn off the pump only after the valves of the feeding pipe are completely closed.
3. Steps 1 and 2 are to be repeated for the second product side.
4. Close the valves for the return pass.

4.3 Stop Periods

Before a long operation pause, clean the plate heat exchanger thoroughly so that the risk of corrosion damage is minimized.

It is recommended that the tension is released within the plate heat exchanger and only to retighten the unit before it is to be put back into operation.

5. Operation

Each plate heat exchanger is designed and built for specific thermodynamic operations with processing, cleaning, and sterilization cycles taken into account.

Before the heat exchanger unit can be used for the processing of any media other than originally planed, all parts of the unit which come into contact with the medium, such as gaskets, heat exchange plates and connections, have to be tested for compatibility with the new medium.

The plate heat exchanger may only be put into operation after it has been verified that the unit is capable of processing the new medium.

It is the responsibility of the units owner to ascertain that upon feeding a new product into the unit no chemical or thermal reactions will occur due to reaction with previously treated fluids which remained in the unit.

If the possibility of such a reaction exists then the heat exchange unit must be completely drained before a new fluid is pumped in.

If during a thermal process the operating temperature, operating pressure or the flow rate of the product feed has to be changed, the adjustment should be done slowly and over longer span of time.

In general, a continuing operation cycle is best suited for a heat exchange unit.

If however the continuing operation of the heat exchange unit is not possible due the required thermal treatment conditions, precautions have to be foreseen in order to avoid rough switch over to a different thermal process function.

Often occurring pressure variations even in small amplitudes may have a negative effect on the service life of the gaskets.

If possible it should be avoided that a plate heat exchanger constantly undergoes extreme temperature variations, from being hot to completely cold, since this process speeds up the aging of the gaskets.

To minimize the stress and to extend the service life on the gaskets additional spring joint packages can be built into the tie rods.

Not only, the variations in operation conditions can damage the heat exchanger unit, but processes, which take place within other parts of the system. On- or off-switching of other components may cause pressure shocks that are carried all the way through the system to the heat exchanger unit.

In this case, the demands for the heat exchanger units' rigidity should be compared with the actual parameters given for the original function of the unit.

With a plate heat exchanger the risk exists that a plate cracks occurs. This problem may be caused through the deposit of corrosive materials on the heat exchanger plates or due to pressure variations that occur over longer operation periods.

In case of a plate crack the mixing of the products may occur.

If one of the products must be kept clean, and may not be contaminated by the other medium taking part in the thermodynamic process, possible contamination in case of a plate crack can be avoided by pumping this medium through the unit at a much higher pressure than the other fluid.

6. Servicing and Repair

Due the great number of heat exchange applications, it is not possible to set a standard time interval at which the unit must be serviced.

According to need, the following repairs and tune-ups have to be carried out:

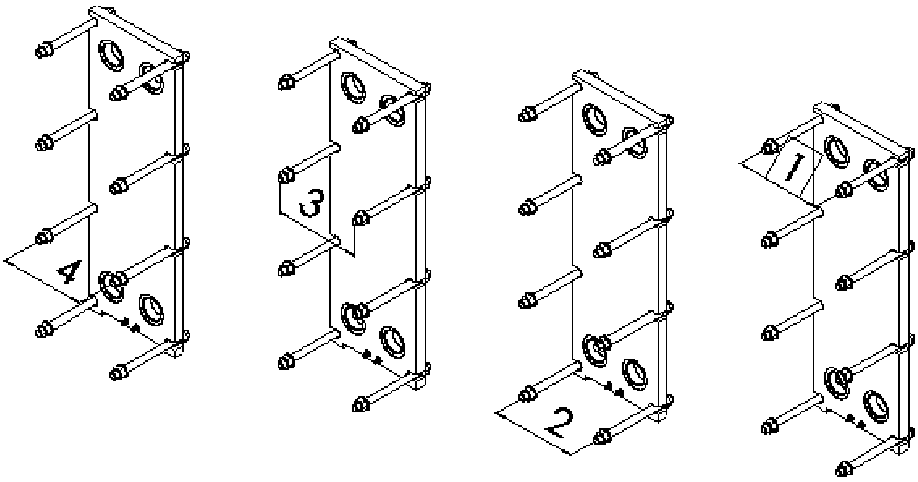
- In case of leakage, the unit has to be retightened.
- If leaks persist after the unit has been retightened, other causes have to be investigated.
- If leaks can not be stopped because the unit has been tightened up to the final platage (see name plate), then the gaskets have to be changed.
- For units that have been in use since a longer period, not only the gasket at the leakage spots should be changed, but also the whole gasket system should be replaced.
- The tie rods as well as the contact surfaces between the lock nuts and centering plates has to be greased before being retightened.
- By reduced heat capacity or increased pressure loss, the heat exchanger plates have to be cleaned.

6.1 Opening the Heat Exchanger Unit

As already explained above, before opening the heat exchange unit it must be shut down and completely drained of its content.

Fluids that represent a health hazard to humans, and a threat to the environment, have to be carefully stored in the appropriate containers.

Generally gloves or a similar protection should be worn during handling the equipment to avoid injuries by i.e. sharp plate edges.



Tubes connected to the movable cover or to intermediate frames have to be dismantled.

So that the unit can later be returned to its original dimensions, the actual degree of platage should be measured and noted before opening the unit.

Please note that the heat exchanger unit may only be opened once it has been depressurized and cooled to a temperature of less than 40°C.

The tie rods should always be loosened towards the inside (see diagram).

While loosening the tie rods, it is important to verify that the movable cover does not reach an inclination of more than 10mm, as long as there is still strain on the tie rods.

6.2 Cleaning of the Plates

Different options exist for the cleaning of the heat exchanger plates:

6.2.1 Cleaning in Place (CIP)

When cleaning the unit with the heat exchanger plates in place (CIP) a cleaning solution takes the place of the product. For the best cleaning results, the cleaning solution should be pumped through the unit in the opposite direction as the usual product flow.

A higher flow rate of the cleaning solution ensures an even better cleaning result.

In case that the pressure pumps are not strong enough to further augment the flow rate during the cleaning cycle another option remains. Through the addition of compressed air, the turbulence of the cleaning solution within the unit is increased and better cleaning results are obtained.

The compatibility of the cleaning substance with the plates, connections and gasket materials as well as gasket adhesives must be tested before the cleaning of the unit occurs.

The exact cleaning procedure, regarding cleaning substance, volume of cleaning solution, as well as duration of the process, depends on the type of construction materials used in the heat exchanger unit as well as the type of deposits to be removed. We recommend that you take up contact with a cleaning agent manufacturer.

We recommend the following DIN 11 483 certified cleaning and disinfecting agents:

Cleaning and disinfecting agent	Concentration [wg.-%]	Contact time [h]	Temperature [°C]	Gasket Material
Alkaline cleaning agent with NaOH-base	up to 5	no limit	up to 90	NBR EPDM
Combination cleaning agent NaOH + Na-Hypochlorite	up to 5	1	up to 70	NBR EPDM
Acidic cleaning agent with Phosphoric acid base	up to 5	1	up to 90	NBR EPDM
Acidic cleaning agent with nitric acid Base	up to 2	0,5	up to 50	NBR EPDM
Acidic cleaning agent with citric acid base	up to 4	1	up to 40	NBR EPDM
Disinfecting agent with peracetic acid and / or hydrogen peroxide base	up to 1	up to 2	20	NBR EPDM
Hot water	-	no limit	120	NBR EPDM

6.2.2 Cleaning of the Plates in Disassembled Form

In the dismantled state, the heat exchanger plates can be cleaned with a steam jet.

Stainless steel or plastic brushes may be used for the scrubbing of the heat exchanger plates.

A chemical cleaning of the heat exchanger plates, in an acidic or in an alkaline bath, is possible for plates with non-adhesive gaskets as long as the gaskets are removed before the plates are placed into the bath.

The chemical resistance of the plates to the chemical cleaning agent should be checked before the plates are submerged into the bath, in order to avoid any possible damage to the heat exchanger plates.

For plates with adhesive-gaskets, the same precautions apply. It should be verified that the gaskets and the adhesive are compatible with the cleaning solution, what the maximum contact time is, as well as the maximum temperature tolerance.

After the cleaning process, it is important to remove any cleaning solution residues in order to avoid any possible corrosion, which may be caused by the solution. The unit should be rinsed out with plenty of water.

6.3 Inspecting the Heat Exchanger Plates

The ware of the heat exchanger plates can be checked visually, damages of the plates such as scratches, deformities or corrosion can be seen with the naked eye.

In order to detect any plate cracks one of the following procedures is to be followed:

One of the circuit paths is to be filled with a medium while the other circuit path is to remain depressurized.

If the medium filled circuit path shows a significant drop in pressure, and there are no leaks to be seen from the outside, then it is certain that there is a plate crack within the unit. It is recommended that this test be performed in all the units circuit paths.

To detect plate cracks in a depressurized state a dye penetration method is used. One side of the plates is sprayed with a red color, while the other side is impregnated with a white color sensitive developing agent.

If there are any cracks or holes present, which have penetrated through the heat exchanger plates the red color, through diffusion, will appear as a spot on the white side of the plate.

6.4 Inspecting the Gaskets

Through a visual inspection, deformities of the gasket, improper fit into the gasket groove or damage of the gasket or of the adhesive, are easily detected.

To test the functioning of the gaskets, a single sided circuit pressure test can be performed.

It is certain that the gaskets are functional, under the condition that the leakage grooves are not deformed or blocked with dirt, when no leakage is detected on the outside of the unit when using the single circuit pressure test.

A very minute, drop like leak can be fixed by simply re-tightening the unit, as long as the unit has not been tightened to its final platage, and the gaskets have not suffered any thermal, mechanical or age related damage.

If the leak is not corrected after re-tightening of the unit, the problem might have had some other reasons. The gaskets have to be inspected because they may have shifting out of place or be damaged.

6.5 Changing the Gaskets

Adhesive-free gaskets can be changed by simply opening the heat exchanger unit and without having to remove the plates.

It is important to check that there is no dirt on or under the gasket, as well as in the plates' gasket groove.

For heat exchanger plates with adhesive fixed gaskets the following procedure applies: (EPDM gaskets are an exception, it is recommended that plates with EPDM gaskets are sent back to the manufacturer who will perform the gasket change).

- Dismantling of the plates.
- Removal of the gasket either through the light application of a flame to the back of the gasket groove (annealing colors through the applied heat should be avoided) or through the submergence of the plate in a nitrogen liquid bath.
- The gasket groove must be cleaned, and all adhesive as well as gasket residues must be removed.
- Roughen the gasket groove through sand blasting or sandpaper.
- Apply the adhesive into the gasket groove with a paintbrush.
  (only original API Schmidt-Bretten – adhesive is to be used)
- Clean the gaskets with a lint free cloth, which was drenched in acetone.
- Place the gaskets into the gasket grooves.
- Place about 20 plates in between a wooden frame, which is then compressed with a parallel screw clamp.
- Let the adhesive dry for approximately 12 hours at room temperature.
- Remove any excess adhesive on the gasket surface.
- Reinstall the plates according to the plate diagram.

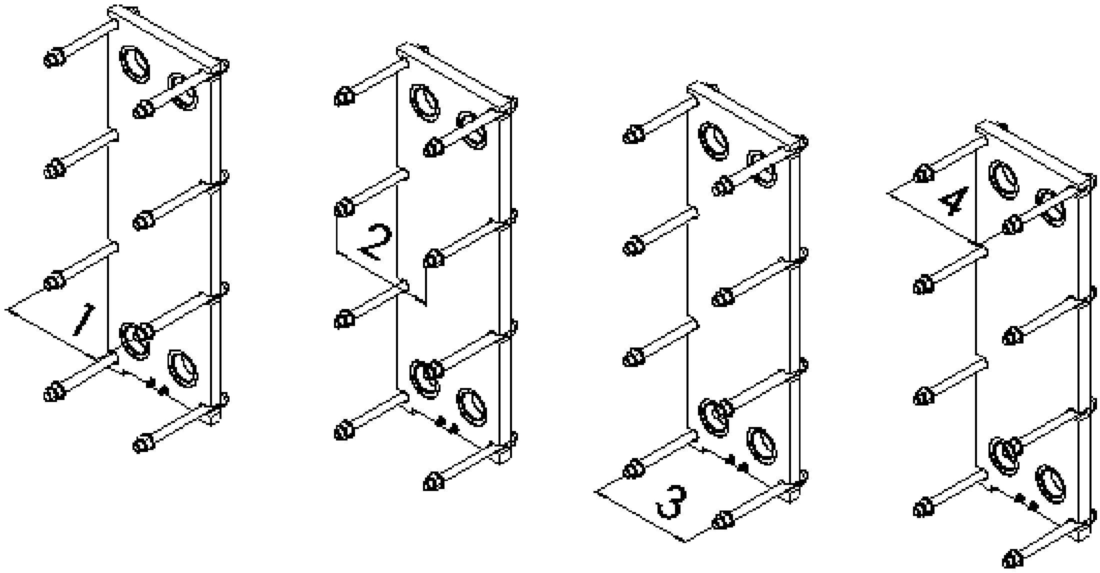
More detailed instructions are available from our head office upon request.

6.6 Assembly of the Heat Exchanger Unit

Plates have to be installed in the same layout as is shown in the instruction manual. It is important to check that each plates' corrugation pattern, connecting ports, orientation (every second plate is turned by 180°) and position within the plate pack is correct.

Only after all the plates have been properly installed can the heat exchanger unit be tightened.

The plate pack should be clamped evenly and the tie rods should be tightened crosswise in the opposite order as when un-tightening the unit.



Take care not to tilt the cover to one side or bend it at any stage (max. inclination 10 mm).

The plate heat exchanger should not be tightened more than necessary so that the service life of the gaskets is not reduced due to excessive pressure.

6.7 Modifications / Extensions / Repairing

One of the advantages of plate heat exchangers is that they can easily be modified to suit new production needs without greater proceedings.

However, ever time a plate heat exchanger is rebuilt its name plate has to be updated or exchanged, since the plate quantity and sequence, as well as the maximum clamping was altered.

If due to the reconditioning or enlarging of the unit the bottom carrying bar and/or the tie rods have to be exchanged, a special permission is to be obtained from the manufacturer since these parts are important pressure parts.

The same applies to welding work that needs to be performed on pressure parts. The welding work may only be performed through qualified specialists after having received the approval from the manufacturer.

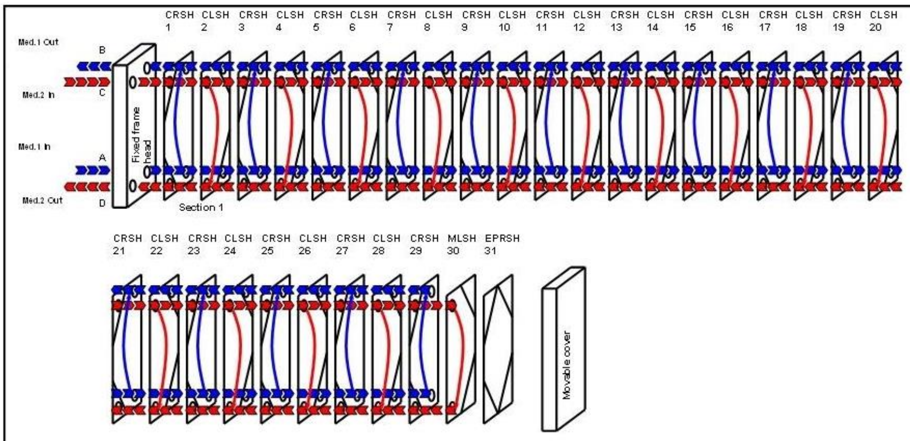
The laws and regulations of the country in which the plate heat exchanger is to operate apply to the start-up of the system.

6.8 Plate Diagram

The plate diagram is contained in a schematic drawing out of which the proper sequence of the heat exchange plates within the heat exchanger unit can be read.

The flow paths by which the medium is pumped through the heat exchange unit can be verified with the help of this drawing.

The identification of each individual plate can be seen in detail in a previous chapter. In this way, each plate can be identified on the basis of its perforations and its orientation.



Schmidt API Schmidt-Bretten	Plate-layout SIGMA M 13 NBL	Drawn up	SBG	20.10.2011	Fabrication number PA 000001	Sheet 1
	Customer name	Replacement for the plate-layout			Version number 001	from
	D-75015 Bretten	Replaced by plate-layout dated			Order number P 00 00001	2
		copyright by API Schmidt-Bretten GmbH & Co. KG				

Sect.	Function	Repre-sent.	Med.	Product	Material Plates	Material Gasket	Gasket fixing	Arrangement	Rem.	Plate-sum
1	Section 1	›››	1	Water 1	1.4301	EPDM	mechanical	1x15-SH	+ 1 FP	31
		›››	2	Water 2		EPDM	mechanical	1x15-SH		

Remarks:

6 / 7,8 bar, Type of plate (Sect. 1): M; Sheet metal thickn.: 0,6 mm; Clamping value: max. 118 / min: 105

Schmidt API Schmidt-Bretten	Plate-layout SIGMA M 13 NBL	Drawn up	SBG	20.10.2011	Fabrication number PA 000001	Sheet 2
	Kundenname	Replacement for the plate-layout			Version number 001	from
	D-75015 Bretten	Replaced by plate-layout dated			Order number P 00 00001	2
		copyright by API Schmidt-Bretten GmbH & Co. KG				

API Schmidt-Bretten GmbH & Co. KG Service Telefon: 07252/53-425/348 Telefax: 07252/53-200

7. Recognizing and Correcting Mistakes

During the operation of the heat exchanger unit it is possible that malfunctions occur. These malfunctions may be caused by outer influences or by the circumference of the heat exchanger unit.

Below you will find a list of questions you should try and answer before taking up contact with API Schmidt-Bretten so that we can help you more quickly. Included below you will also find registers which include possible malfunctions with their possible causes and solutions to these problems as well as suggestions how to avoid these problems.

7.1 List of Questions

- Is there a leakage problem?
- Where is the leakage (outer or inner leakage, on the plate pack, on the connections, between the plate pack and the frame)?
- How strong is the leak (drops or continuous stream)?
- When does the leakage occur (permanent, during operation, during on- or off-switching, during production or cleaning)?
- Is the heat exchanger unit in continuous operation?
- Do pressure variations or temperature variations occur?
- How many plates are presently contained in the plate pack?
- Is the unit functioning with the original number of heat exchanger plates?
- What is the present measure of clamping?
- How large is the theoretic final measure of clamping?
- Is the heat exchanger unit clamped without inclination?
- Are there any stresses between the pipelines connections to the frame, cover or intermediate frames?
- Are the gaskets still in place (even pattern along the plate pack)?
- How old are the plates and the gaskets?
- What is the composition of the products and cleaning agents used in the unit?
- Is there a problem with the heat capacity (flow rate or outlet temperature)?
- How long has the unit been functioned without problems?

7.2 Leakage Towards the Outside

Problem	Solution	Possible causes	How to avoid these problems in the future
Corrosion of the plates	Replacement of the plates	Chlorides	Change the material of the heat exchanger plates
Deformation of the plates	Replacement of the plates	Pressure shocks Over-pressing of the plates	Change the valves or the production process. Teaching of the maintenance stuff
Plate cracks	Replacement of the plates	Pressure changes, Chemical attacks on the plate material	Thicker plate material and reduction of the platage. More resistant plate material
Aging of the gaskets	Replacement of the gaskets	End of lifetime, Temperature- or pressure-changes	Change the gasket material
Leakage when cold	Replacement of the gaskets	Aging of the gaskets, especially compressed fiber gaskets	Installation of spring packages on the tie rods
Hardening of the gaskets	Replacement of the gaskets	Inadequate chemical resistance, Temperatures too high	Change the gasket material
Swelling of the gaskets	Replacement of the gaskets	Inadequate chemical resistance, Temperatures too high	Change the gasket material
Gasket cracks	Replacement of the gaskets	Mechanical stress	Arrangements to avoid mechanical stress

7.3 Product Mixture / Internal Leakage

Problem	Solution	Possible cause	How to avoid these problems in the future
Corrosion of the plates	Exchange of the plates	Chlorides	Change the material of the heat exchanger plates
Plate cracks	Exchange of the plates	Pressure changes, Chemical attacks on the plate material	Thicker plate material, Reduction of platage. More resistant plate material
Braking of the connections	Exchange of the connections	Stresses in the pipeline	Compensatory expansion joints or articulation elbows

7.4 Heat Exchange Performance Problems / Low Service Life

Problem	Solution	Possible cause	How to avoid these problems in the future
Fouling in the plate gaps	Cleaning of the plate heat exchanger	Particles, Fibers, Bacteria Composition of the product Hard deposit due to high temperature	Filters Changing of the plate arrangement Changing of the temperature difference between cold and hot side
Fouling in the connections	Cleaning of the plate heat exchanger	Particles, Fibers, Bacteria Composition of the product	Filters
Changing of the operating conditions	Switch back to old operating conditions, if possible	Entrance temperatures Change of flow rates Composition of the product	Changing of the plate arrangement or plate type

7.5 Pressure Loss- / Flow Rate Problems

Problem	Solution	Possible cause	How to avoid these problems in the future
Fouling in the plate gaps	Cleaning of the PHE	Particles, Fibers, Bacteria Consistency of the product Hard deposit due to high temperature	Filter Changing of the plate arrangement Changing of the temperature difference between cold and hot side
Fouling in the connections	Cleaning of the PHE	Particles, Fibers, Bacteria Composition of the product	Filter
Changes of operating conditions	Switch back to old operating conditions, if possible	Entrance temperatures Flow rates Composition of the product	Changing of the plate arrangement or plate type

8. Spare Parts

It is recommended to keep spare parts in stock at the production site, as far as the plate heat exchanger is a necessary and urgent component of your production process.

Depending on the possible off-time the following variants of spare parts vary:

- Spare gaskets
- Single spare plates
- Complete gasketed plate package
- A complete stand-by PHE

Normally it is no necessary to keep spare parts for the frames or intermediate frames in stock at the facility.

Keep the following conditions for the storage of the above mentioned spare parts:

- Gaskets and gasketed plates should not be stored for more than two years
- Don’t store the parts outside
- Storage is good at temperatures below room temperature
- If possible store the parts in a dark room and avoid neon light
- The atmosphere in the store has to be free of solvents or ozone

9. Tools

For best handling for mounting or maintenance work with the plate heat exchanger, several tools should be available.

- Spanner for smaller units
- Wretch-spanner for larger units
- Electric or hydraulic screwing machine for very large units
- Lifting gears as fork lifter or a crane should be on site, if frame parts have to be changed

10. Documentation

The standard documentation contains the following papers and pieces:

- Name Plate
- Dimensioned drawing of the unit
- Parts List
- Plate Diagram
- Technical Datasheet
- Operating Manual

Optional the documentation can be supplemented by:

- Manufacturer Certificate
- Declaration of conformity (where appropriate)
- Material certificate
- Approval drawings
- Documentation of inspection by an inspection company (for example TÜV, GL)

11. Addresses

Feel free to contact our staff in the main facility in Bretten or in one of the subsidiaries outside Germany, if you have any question or need any information about spare parts or other products of API Schmidt-Bretten.

API Schmidt-Bretten GmbH & Co. KG

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Germany
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Direct contact to our aftersales services:

Tel.: +49.7252.53.333

Fax: +49.7252.53.200

Email: service@apiheattransfer.de

Important Note !!!!

The plate heat exchanger is only allowed to operate under the specified operating conditions otherwise the guarantee and all other liabilities of the manufacturer will expire!

API Schmidt-Bretten GmbH & Co. KG

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