OPERATING INSTRUCTIONS

GA05141_0702

MAG LINE digital

Turbomolecular Pumps
with Magnetic Bearing

MAG.DRIVE*digital*

Electronic Frequency Converter

Leybold vacuum

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General safety information

Warning Indicates procedures that must be strictly observed to prevent hazards to persons.

Caution Indicates procedures that must be strictly observed to prevent damage to, or destruction of the MAG.

The Leybold MAG*digital* vacuum pump system is designed for safe and efficient operation when used properly and in accordance with this manual. It is the responsibility of the user to carefully read and strictly observe all safety precautions described in this section and throughout the manual. The turbomolecular pump **must only be operated in the proper condition and under the conditions described in the Operating Instructions**. It must be operated and maintained by trained personnel only. Consult local, state, and national agencies regarding specific requirements and regulations. Address any further safety, operation and/or maintenance que-stions to your nearest Leybold Vacuum office.

Warning

Never expose any parts of the body to the vacuum.

Warning

The standard version of the equipment is not suited for operation in explosion hazard areas. Contact us before planning to use the pump under such circumstances.

Warning

The pump must be securely attached. If the pump should suddenly seize, inadequate attachment could cause the pump to break away or allow internal pump parts to be discharged.

The rotor has to be changed after 40,000 hours of operation or after 5000 starts/ stops or cycles at the latest. See also Section “3.4 Operation at high gas throughput or high forevacuum pressure”.

Due to high-speed and temperature, the service life of the rotor is limited.

If the rotor is changed too late, it may be destroyed. Thus in the flange mounts high forces and torque conditions can occur.

The mounting screws for the pump may be torn off. When using clamped flange connections at the housing or with components above the housing, sudden twisting of the entire pump can be experienced.

Warning

Parts of the pump can become so hot during operation (> 70 °C, > 158 °F) that they represent a burn hazard:

Provide protection against contact with the hot components.

Warning

The converter has dangerous voltage levels.

Failure to strictly follow the instructions in this Manual can result in death, severe bodily injuries or significant material damage.

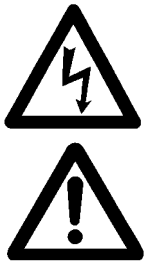
Unauthorizes opening of the frequency converter voids the warranty.

Before opening the converter, always disconnect it from the mains and the pump!

Before disconnecting any cables make sure that the converter is switched off and the pump has come to a standstill.

When applying external voltage in excess of 42 V to terminals of the device, observe local safety regulations!

Unauthorized device conversion and modifications are prohibited for safety reasons.



Only suitably qualified personnel are permitted to work on the pump or converter. Personnel must be completely knowledgeable of all warning information and measures which are specified in this Instruction manual for transporting, installing, and operating the unit.

Qualified personnel

Qualified electrical personnel in this instruction manual means a person who has received electrical engineering instruction or is an electrical expert in accordance with EN 60204, Part 1, 3.30 respectivly 3.55.

Warning

The device contains electrostatically sensitive devices (ESD)!

Caution

Ensure that no items like bolts, nuts, washers, pieces of wire, for example, enter into the inlet of the pump. Foreign objects which enter into the pump will generally cause severe damage. Damage caused by the intake of foreign objects is not covered by our warranty. For this reason always leave the supplied inlet screen in place.

Caution

The equipment must not be exposed to drip or spray water.

Figures

The references to diagrams, e. g. (1/2) consist of the Fig. No. and the Item No. in that order.

We reserve the right to alter the design or any data given in these Operating Instructions. The illustrations are not binding.

Retain the Operating Instructions for further use.

The Operating Instructions are included with the pump **and** the converter. If they have different editions, the version delivered with the pump describes the pump correctly and the version delivered with the converter describes the converter correctly. The version number is either the digit behind the "/" in the GA No. or the first two digits behind the "_". Example: GA 05.141/**6**.02 is the sixth edition and GA05141_**07**02 the seventh.

1 Description

1.1 System overview

The Leybold **MAG** pumping system consists of:

- The **MAG** turbo pump

  The MAG are turbomolecular pumps utilizing magnetic bearings.They are designed to evacuate vacuum chambers down to pressure values in the high-vacuum range and to pump high gas throughputs.

  The **versions without letter behind the number** are designed for clean applications only.

  MAG ... C ... CT

  The **C versions** have a coated rotor and are designed for clean or light corrosive applications.

  The **CT versions** are additionally equipped with a temperature management system (TMS) to control the pump temperature. They are prepared for use in medium to harsh corrosive applications.

  The pumps are available with 2 different rotors:

  MAG version: Turbo pump

  MAG W version: Turbo pump stages and an active drag stage.

See table “Pump configuration” for an overview on the available models.

- The **MAG.DRIVE***digital* frequency converter

  The electronic converter converts the single-phase line supply voltage into a three-phase DC voltage to drive the pump motor. It also evaluates measured signals and controls

  - the pump functions

  - the temperature management system (TMS) and

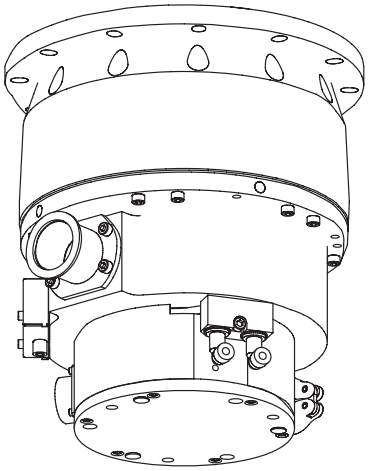
  - the active magnetic bearing system

  The MAG.DRIVE*digital* can be operated with the START and STOP keys, via a plug-in control, or via a network interface.

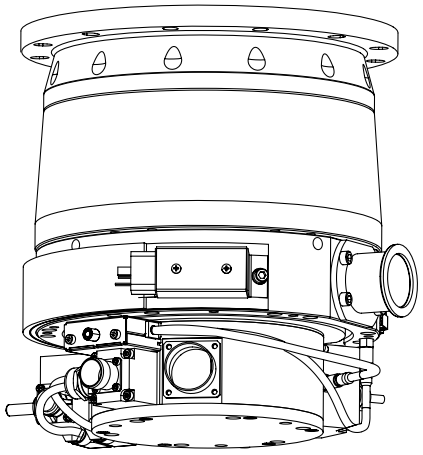
- A **cable set** consisting of:

  - DRIVE/BEARING cable

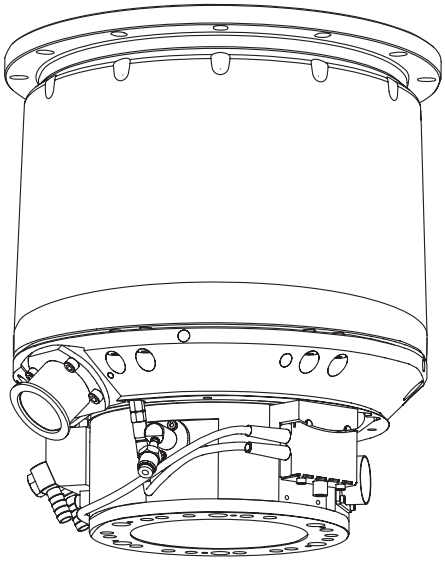
  - TMS or Purge/Vent cable if required



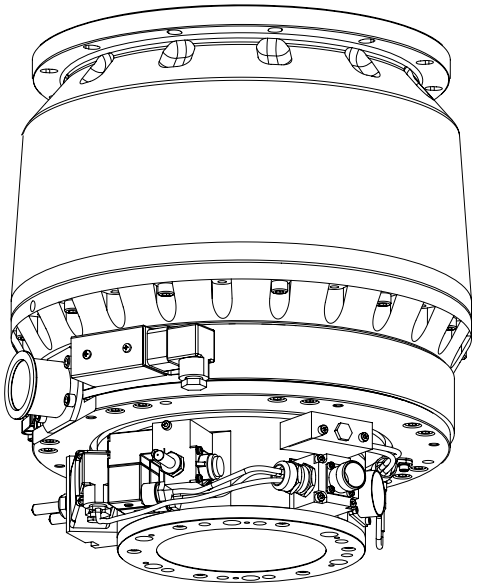
MAG W 830 C
MAG W 1300 C



MAG 1500 CT
MAG W 1500 CT



MAG W 2200 C



MAG W 2800 CT
MAG W 3200 CT

Fig. 1 MAG turbopumps

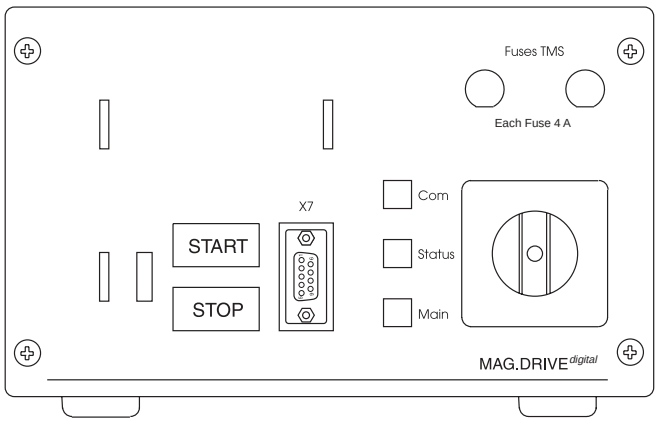


Fig. 2 MAG.DRIVE*digital* Front panel

1.2 Compatibility with pumped media

The MAG are specifically designed for the needs of the semiconductor industry.

Materials

All materials used inside the pump are compatible with typical gases used for semiconductor processes.

Caution

> Please consult Leybold for recommendations on pump models for specific processes and application requirements.

Corrosion protection

Purge gas

To protect the pump from corrosive gases it is mandatory to use dry Nitrogen purge during operation of the pump.The purge gas protects the bearing section and the motor from corrosive gases.

The rotor and the stator of the pump are KEPLA®-coated to prevent corrosive attack caused by the process gases. The corrosion protection of the pump is effective only when the pump is protected from moisture during standstill and storage. If the process gas contains moisture, contact Leybold for recommendations.

Sublimation

Some media (e.g. $AlCl_3$) can sublimate in the pump and form deposits. Thick coatings can infringe on the required operating clearence and ultimately cause the pump to seize. These deposits can also react with moisture and generate corrosive gases (e.g. HCl).This can become very critical when the pump is exposed to air. Deposits can be avoided in many processes by heating the pump with TMS (Temperature Management System).

The TMS is integrated in all CT-versions. The purpose of the TMS is to keep the pump temperature in a constant range. To achieve the temperature the pump is equipped with a heaterband.

Layers

Some media (e.g. metall organic compounds) can decompose at the hot surface of the pump and build layers. Please direct any inqueries to the manufacturer.

Caution

> In order to handle gases or media (e.g. $AlCl_3$) which can form deposits inside the pump it is required to use the TMS (Temperature Management System). The temperature selected for such processes has to be set to the maximum value.

Ignition danger

During operation the pressure inside the MAG is so low that there is no danger of ignition (at pressures below about 100 mbar). A hazardous condition will be created if flammable mixtures enter the hot pump at pressures above 100 mbar. During operation the pump can reach temperatures as high as 120 °C (248 °F). If the pump is damaged, sparks could occur which could ignite explosive mixtures.

Also note the safety information provided by the gas supplier.

1.3 Design of the MAG

The MAG comprises basically the pump housing, the multistage rotor with the stator package, the drive, and a magnetic bearing.

Rotor

Ceramic layer

The rotor is made from a high strength aluminium alloy. The rotor and the lower stator plates are protected with a special ceramic layer (KEPLA-COAT®). The standard rotor is a multi-stage axial-flow turbine. In addition to the turbine stage the wide range rotor has a screw stage.

Both rotors are machined from one piece and the geometry of the the blades is optimized for high compression and pumping speed of the typical gases used in semiconductor manufacturing processes.

Bearings

Magnetic bearing

The MAG has a built-in precision 5-axes controlled magnetic bearing. The rotor is suspended by trouble-free magnets:

- along two orthogonal axes in each of two radial planes
- and completely in the axial direction

The bearing concept allows for low vibration operations and insures operation of the pump in any mounting position. Magnetic bearings also guarantee ultra-clean vacuum because no grease is used for lubrication of bearings.

Touch down bearings

Two touch down bearings are provided to stabilize the rotor mechanically if impacts occur during operation. They are only used in case of the breaking of the power supply or BEARING cable during operation, strong shocks, or faulty electronics.

Motor and control

A DC motor without commutator is used to power the rotor.

Drive voltage for the motor and the operating voltage for the magnetic bearing are supplied by the MAG.DRIVE*digital* frequency converter. It also handles the automatic monitoring of these systems.

Data storage

The pump is equipped with a data storage device which stores the important operating parameters during the complete operation time of the pump.

The converter monitors continously all important operating parameters and provides warning and alarm signals in case the operating conditions exceed the specification or the set threshold.

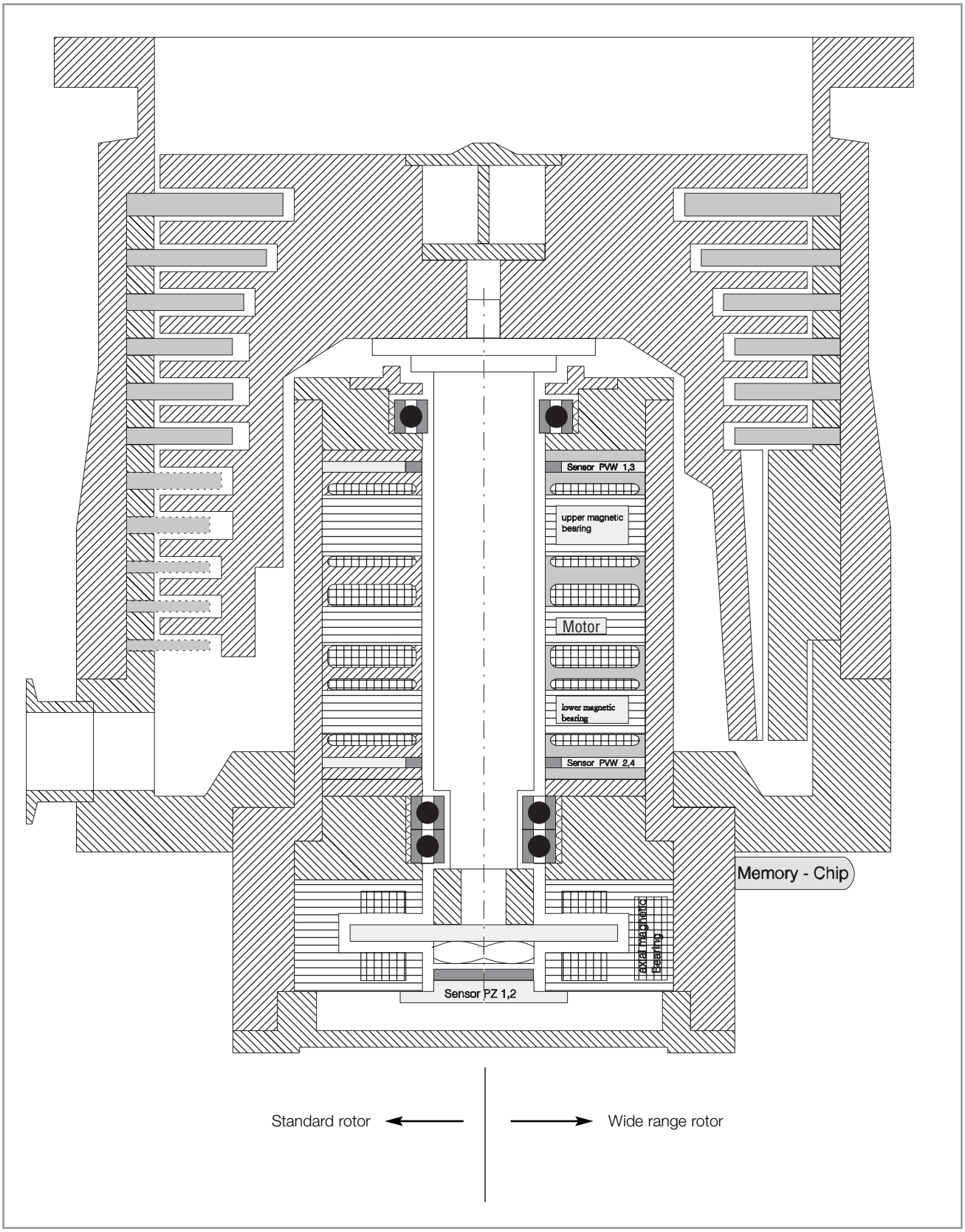


Fig. 3 Section of a MAG

1.4 Function and design of the MAG.DRIVE*digital*

The MAG.DRIVE*digital* electronic converter is used to drive the MAG pumps from MAG 830 to MAG 3200.

DC motor.

The electronic converter converts the single-phase line supply voltage into a three-phase DC voltage to control and monitor the electronically-commutated DC motor. It also evaluates measured signals and controls (open-loop and closed-loop) the pump functions.

TMS

The temperature management system (TMS) and the magnetic bearing control system are integrated into the converter. The TMS regulates the pump temperature by switching the heating on/off or cooling the pump. The digital magnetic bearing control system actively controls the pump rotor in five axes (closed-loop control).

All parameters required for pump operation and the listed faults and operating hours are stored in a non-volatile memory in the pump. When the converter is switched on, the data are loaded into the converter from the pump.

The outputs of the electronic converter are no-load and short-circuit proof.

For remote control via control connector X14 we recommend that either a relay or optocoupler is used to provide electrical decoupling.

Housing

The converter is supplied with a closed housing. It can be installed in a 19" cabinet; see Section 2.7.

Front panel

Main switch

9-pin connecting socket for the plug-in control or for connection of a serial interface

2 short-stroke keys

1 green/red STATUS LED

1 green COM LED (communications interface)

1 green MAIN LED (line supply voltage)

2 fuses TMS

Plug-in control

The optional plug-in control has 10 keys and 1 LCD with 2 lines, each 16 characters. The plug-in control displays operating statuses and failures and allows the configuration of the pumping system.

Rear panel

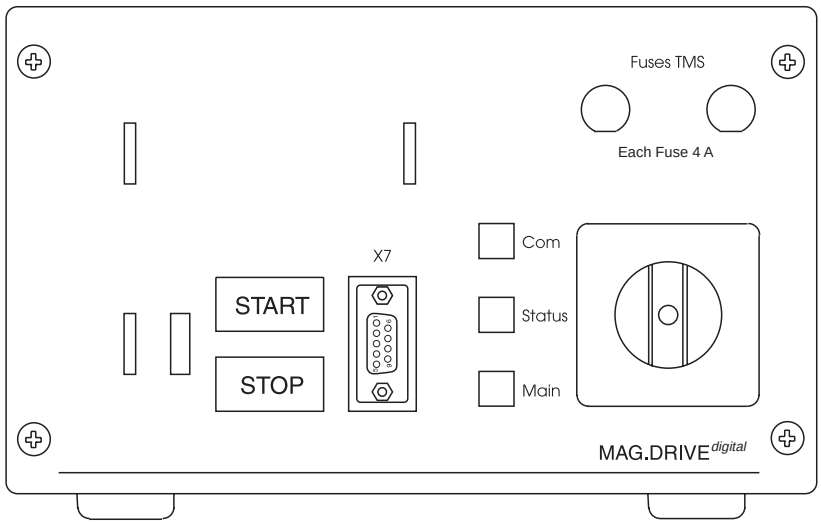
X14 50-pin D socket connector for remote monitoring and open-loop control

X19 3-pin Hirschmann connector for the connection to the mains supply

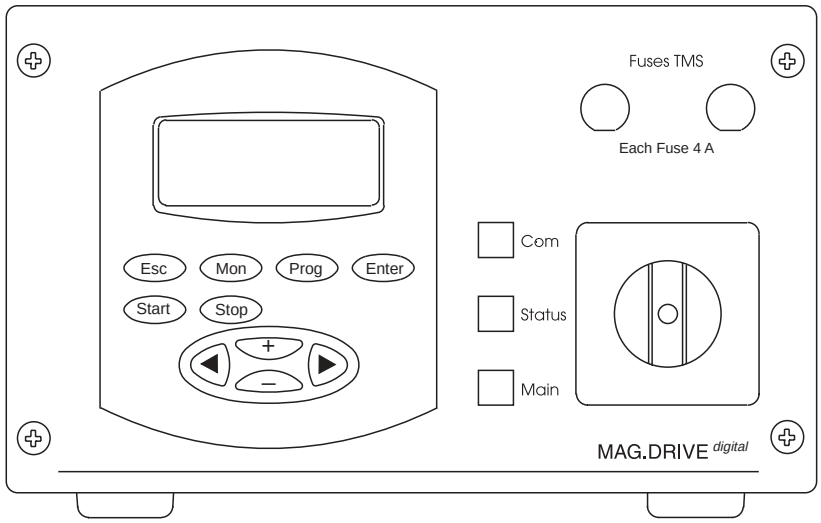
X20 MIL standard socket connector for internal sensors, magnetic bearing connection, motor drive, and communication to the memory chip

X21 MIL standard socket connector for the TMS and purge valve connection

Spare slot for optional network cards, e.g. Device Net



MAG.DRIVE*digital*



MAG.DRIVE*digital* with Plug-in control

Fig. 4 Front panel

X14 Connection control plug
X19 Mains connection
X20 Connection magnetic bearing / pump motor / memory chip
X21 Connection TMS / purge gas valve
X22 Network connection (optional)

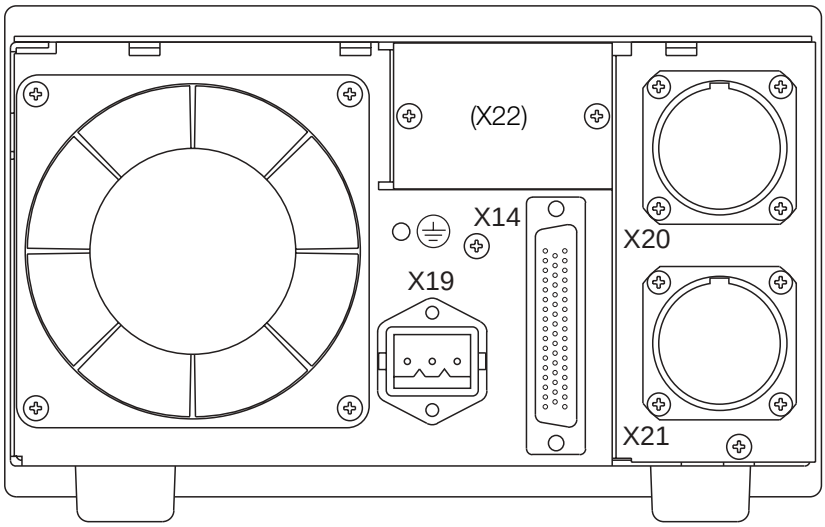


Fig.5 Rear panel with connections

1.5 Standard specification

MAG

The turbomolecular pumps are shipped complete, sealed in a PE bag containing a desiccant.

The maximum effective life time of the desiccant is one year.

The intake flange is sealed with a transport seal, the forevacuum flange with a plastic cap.

For the intake flange, a centering ring with FPM O-ring, outer ring, and a splinter guard are enclosed.

We also provide the bolts for attaching the pump to your tool. To avoid any safety risk we highly recommend using only the bolts provided with the pump. Refer also to Section 2.3 “Connecting the MAG ...”.

The electronic frequency converter MAG.DRIVE*digital*, the cables required for operation and a seal kit to seal the pump tightly if it is removed from the process must be **ordered seperately**.

MAG.DRIVE*digital*

- Converter
- Line supply cable with USA connector, approx. 3m
- Line supply cable with EURO connector, approx. 3 m
- 2 spare fuses for the TMS (miniature fuses 5 x 20 mm, F4A; according to IEC 127-2/1) and 2 fuse holders 6.3 x 30 mm
- Connector for control plug X14 (pins 47/48 bridged)

1.6 Technical data

MAG		W 830 C	W 1300 C	W 1300 C
High-vacuum flange	DN	160 ISO-F	200 ISO-F	250 ISO-F 250 ISO-K
Pumping speed (PNEUROP)				
for N_2	$l \cdot s^{-1}$	700	1100	1220
for Ar	$l \cdot s^{-1}$	650	1050	1180
for H_2	$l \cdot s^{-1}$	300	920	1020
Compression for N_2		$> 5 \cdot 10^7$	$> 10^8$	$> 10^8$
Ultimate pressure as to DIN 28 400	mbar	$< 10^{-8}$	$< 10^{-8}$	$< 10^{-8}$
Max. forevacuum pressure with N_2	mbar	2	2	2
Rotor speed	min^{-1}	24,000	36,000	36,000
Run-up time	min	< 4	< 6	< 6
Braking time with/without venting	min	1 / < 4	1 / < 6	1 / < 6
Cooling			water	
Cooling connection, threads	G		1/4“	
with Swagelok for tube OD	mm	6.4 (1/4“)	6.4 (1/4“)	6.4 (1/4“)
or with John Guest fitting for tube	mm	–	6	6
Cooling water temperature	°C		10 – 30	
	°F		50 – 86	
Weight	approx. kg		32	
Max. high-vacuum flange temperature				
short-time	°C		85	
	°F		185	
for continuous operation	°C		60	
	°F		140	
Vibration level at high-vacuum flange at max. speed	µm		< 0.01	
Forevacuum flange	DN	40 KF	40 KF	40 KF
	or	-	25 KF	-
Recommended backing pump				
Dry commpressing pump with pumping speed	m^3/h		100	
or rotary vane pump	TRIVAC		D 65 BCS	
Admissible ambient temperature	°C		5 – 40	
	°F		40 – 104	
Storage temperature	°C		-10 – +60	
	°F		14 – 140	
Max. relative air humidity			95% (non-condensing)	
Degree of protection (EN 60529)			IP 20	

Technical data (continued)

MAG		1500 CT	W 1500 CT	1500 CT	W 1500 CT
High-vacuum flange	DN	200 ISO-F	200 ISO-F 200 CF	250 ISO-F	250 ISO-F
Pumping speed (PNEUROP)					
for N_2	$l \cdot s^{-1}$	1100	1100	1220	1220
for Ar	$l \cdot s^{-1}$	1000	1050	1180	1180
for H_2	$l \cdot s^{-1}$	920	920	1020	1020
Compression for N_2		$>10^8$	$>10^8$	$>10^8$	$>10^8$
Ultimate pressure as to DIN 28 400	mbar	$< 10^{-8}$	$< 10^{-8}$	$< 10^{-8}$	$< 10^{-8}$
Max. forevacuum pressure with N_2	mbar	1.7	2.6	1.7	2.6
Rotor speed	min^{-1}	36,000			
Run-up time	min	< 6			
Braking time with/without venting	min	1 / < 6			
Cooling		water			
Cooling connection, threads	G	1/8“			
with Swagelok elbow for tube OD	mm	6,4 (1/4“)			
Cooling water temperature	°C	10 – 30			
	°F	50 – 86			
Base flange temperature	°C	20 – 90			
	°F	68 – 194			
Weight	approx. kg	32			
Max. high-vacuum flange temperature					
short-time	°C (°F)	85 (185)			
for continuous operation	°C (°F)	60 (140)			
for bake-out (CF flange only)	°C (°F)	–	120 (248)	–	–
Vibration level at high-vacuum flange at max. speed	µm	< 0.01			
Forevacuum flange	DN	40 KF			
Recommended backing pump					
Dry commpressing pump with pumping speed	m^3/h	100			
or rotary vane pump	TRIVAC	D 65 BCS			
Admissible ambient temperature	°C	5 – 40			
	°F	40 – 104			
Storage temperature	°C	-10 – +60			
	°F	14 – 140			
Max. relative air humidity		95% (non-condensing)			
Degree of protection (EN 60529)		IP 20			

Technical data (continued)

MAG		W 2200 C	W 2200 C	W 2800 CT	W 3200 CT
High-vacuum flange	DN	200 ISO-F	250 ISO-F	250 ISO-F	320 ISO-F
Pumping speed					
for N_2	$l \cdot s^{-1}$	1600	2000	2650	3200
for Ar	$l \cdot s^{-1}$	1450	1900	2450	3000
for H_2	$l \cdot s^{-1}$	1650	1800	2100	2250
Compression for N_2			$> 10^8$		
Ultimate pressure as to DIN 28 400	mbar		$< 10^{-8}$		
Max. forevacuum pressure	mbar		2,0		
Rotor speed	min^{-1}	29,400	29,400	28,800	28,800
Run-up time	min	< 8	< 8	< 10	< 10
Braking time with/without venting	min	1 / <7	1 / <7	2 / <9	2 / <9
Cooling			water		
Cooling connection, threads	G		1/8“		
with Swagelok elbow for tube OD	mm	–	–	6.4 (1/4“)	6.4 (1/4“)
with stainless steel hose nipples for tube ID		1/2“	1/2“	–	–
Cooling water temperature	°C		10 – 30		
	°F		50 – 86		
Base flange temperature	°C		20 – 80		
	°F		68 – 176		
Weight	kg	48	48	64	65
Max. high-vacuum flange temperature					
short-time	°C		85		
	°F		185		
for continuous operation	°C		60		
	°F		140		
Vibration level at high-vacuum flange at max. speed	µm		< 0.01		
Forevacuum flange	DN		40 KF		
Recommended backing pump					
Dry commpressing pump with pumping speed	m^3/h		100		
or rotary vane pump	TRIVAC		D 65 BCS		
Admissible ambient temperature	°C		5 – 40		
	°F		40 – 104		
Storage temperature	°C		-10 – +60		
	°F		14 – 140		
Max. relative air humidity			95% (non-condensing)		
Degree of protection (EN 60529)			IP 20		

Technical data (continued)

MAG		W 830	W 1300	W 2200	W 2800
High-vacuum flange	DN	160 CF	200 CF	250 CF	250 CF
Pumping speed for N_2 measured without splinter guard (PNEUROP)	$l \cdot s^{-1}$	900	1170	1800	2400
Compression for N_2		$1.5 \cdot 10^8$	$1.5 \cdot 10^8$	$3.5 \cdot 10^5$	$1 \cdot 10^9$
Compression for H_2		$7.5 \cdot 10^2$	$7.5 \cdot 10^2$	$1 \cdot 10^4$	$1.6 \cdot 10^3$
Ultimate pressure as to DIN 28 400	mbar	$< 1 \cdot 10^{-10}$			
Max. forevacuum pressure with N_2					
water cooled	mbar	2	2	1	3
air cooled	mbar	0.2	0.2	0.1	0.3
Rotor speed	min^{-1}	36,000	36,000	29,400	28,800
Run-up time	min	< 8	< 8	< 10	< 10
Weight	kg	30	30	60	75
Max. high-vacuum flange temperature					
short-time	°C (°F)	85 (185)			
for continuous operation	°C (°F)	60 (140)			
for bake-out (CF flange only)	°C (°F)	120 (248)			
Forevacuum flange	DN	40 KF			
Admissible ambient temperature	°C	5 – 40			
	°F	40 – 104			
Storage temperature	°C	-10 – +60			
	°F	14 – 140			
Max. relative air humidity		95% (non-condensing)			
Degree of protection (EN 60529)		IP 20			

Technical data (continued)

Purge gas

see Section 2.6

MAG.DRIVE*digital*

Voltage range	200 - 240 V +10% -15%
Line supply frequency	50 / 60 Hz
Load	
Stand-by	approx. 100 W
Maximum heated pumps	1800 W
Maximum non-heated pumps	1100 W
Max. voltage motor	60 V
Maximum pump current	15 A rms
Internal main fuse	16 A
Rated braking capacity	200 kA
System fuse	L or G characteristic
Maximum frequency	600 Hz
Load capability, relay output	42 V, 1 A
Temperature during operation	0-45 °C
Storage temperature	- 10 °C to + 60 °C
Relative air humidity	95% (non condensing)
Overvoltage category	II
Contamination level in accordance with EN 61010	2
Weight	10 kg
Degree of protection (EN 60529)	IP20

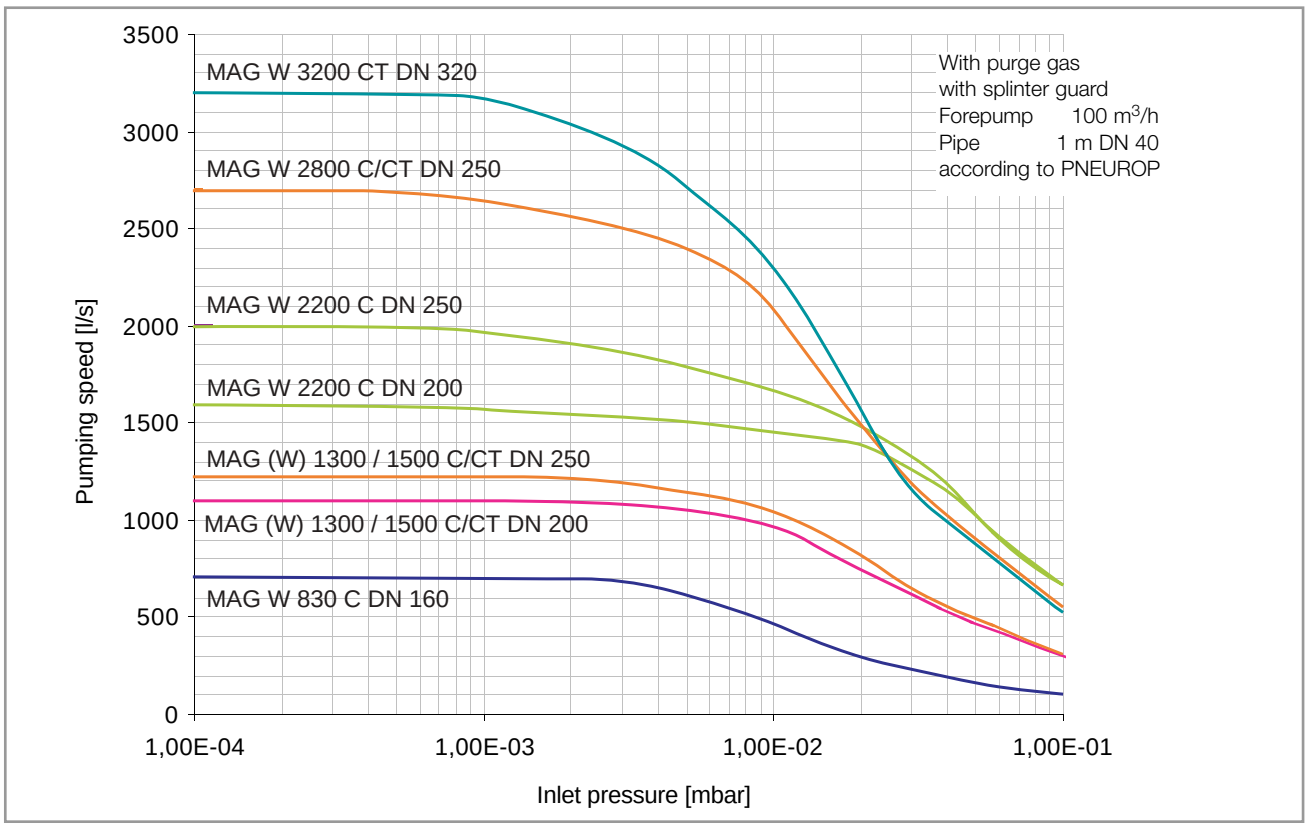


Fig. 6 Pumping speed curves for Nitrogen

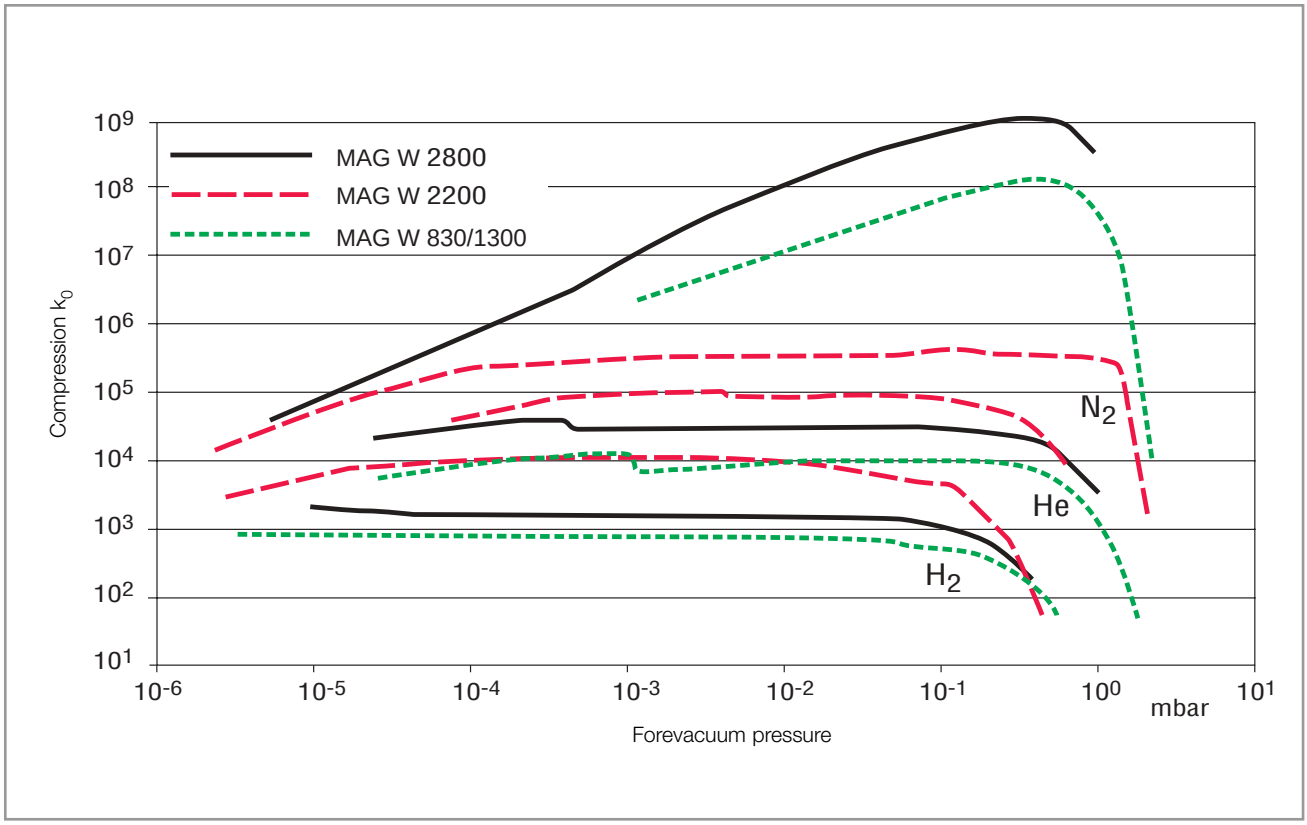


Fig. 7 k_0 curves

1.7 Ordering data

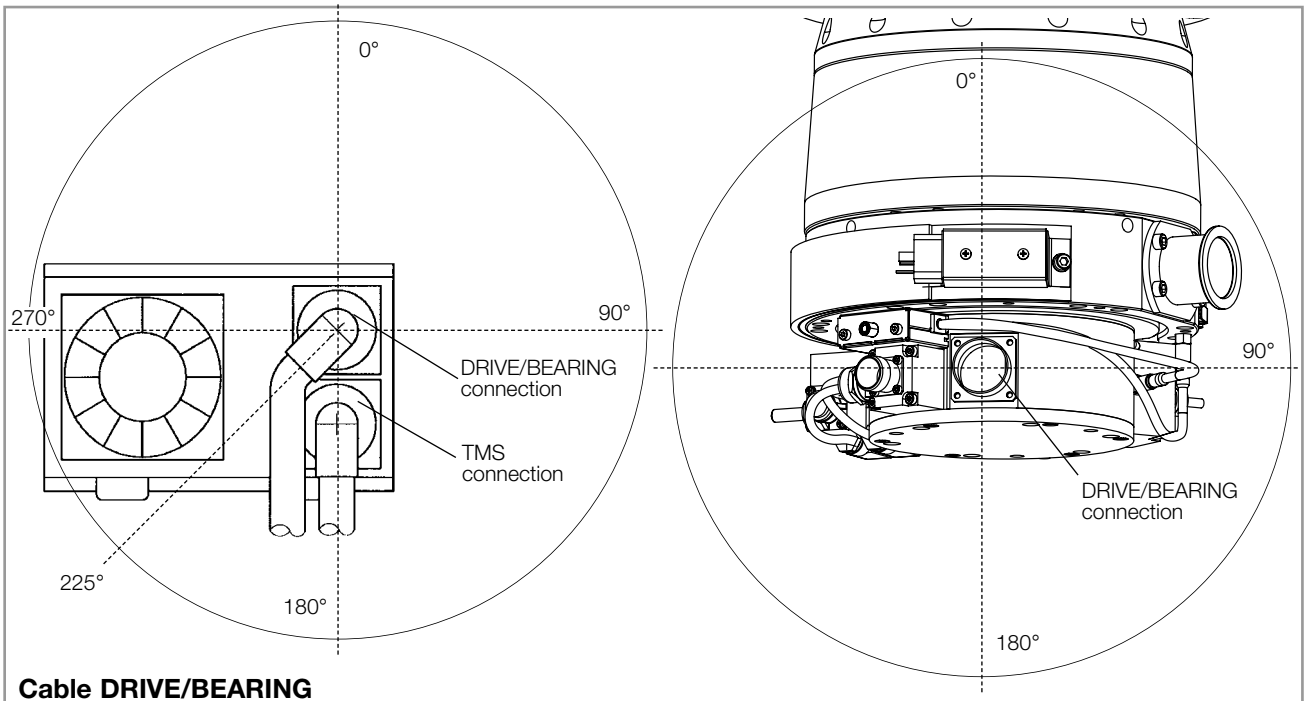
	Part No.
Pumps	see Table “pumps”
Seal Kit DN 250 metal	200 07 901
Seal Kit metal for other flanges	on request
MAG.DRIVE*digital* converter	400035V0011
Plug-in control	121 36
Connecting cables, converter — pump	see Fig. 8
19“ installation frame	161 00
Blind plate 1/4 19“ 3 HE	161 02
Connector for hardware interface from 25 pins to 50 pins	on request
Purge vent valve	121 33
Purge vent Tee	400153V0002
Screws M 10 x 50 Screw quality 12.9 according to EN ISO 898-1 with coating 0,2 % yield strength > 1080 N/mm2	200 15 752
Washers	200 07 833
Nuts	211 28 117
Collar flange with snap ring DN 250	267 72

Pump configuration

Pump	Inlet flange DN	Forevacuum flange DN	Purge gas connection	Purge valve mounted to pump	Rotor coated	Cooling water connection	Temperature sensor for cooling water	TMS**	Part No.
MAG W 830 C	160 ISO-F	40 KF	DN 10/16	no*	yes	Swagelock 1/4“ tube connector	no	no	400100V0005
MAG W 1300 C	200 ISO-F	40 KF	DN 10/16	no*	yes	John-Guest fitting 6 mm Rohr	no	no	400110V0011
MAG W 1300 C	200 ISO-F	25 KF	VCR	no*	yes	Swagelock 1/4“ tube (bended)	no	no	400110V0017
MAG W 1300 C	250 ISO-F	40 KF	DN 10/16	no*	yes	John Guest fitting 6 mm tube	no	no	400110V0021
MAG W 1300 C	250 ISO-F	40 KF	DN 10/16	no*	yes	Swagelock 1/4“ tube connector	no	no	400110V0023
MAG W 1300 C	250 ISO-K	40 KF	DN 10/16	no*	yes	Swagelock 1/4“ tube connector	no	no	400110V0121
MAG 1500 CT	200 ISO-F	40 KF	VCR Nut 1/4“	yes	yes	Swagelock 1/4“ tube	yes	yes	400020V0002
MAG 1500 CT	250 ISO-F	40 KF	VCR Nut 1/4“	yes	yes	Swagelock 1/4“ tube	yes	yes	400021V0002
MAG W 1500 CT	200 ISO-F	40 KF	VCR Nut 1/4“	yes	yes	Swagelock 1/4“ tube	yes	yes	400026V0002
MAG W 1500 CT	250 ISO-F	40 KF	VCR Nut 1/4“	yes	yes	Swagelock 1/4“ tube	yes	yes	400027V0002
MAG W 1500 CT	200 CF	40 KF	VCR Nut 1/4“	yes	yes	Swagelock 1/4“ tube	yes	yes	400030V0002
MAG W 2200 C	200 ISO-F	40 KF	VCR Nut 1/4“	no	yes	Stainless steel hose nipples 1/2“	yes	no	400081V0011
MAG W 2200 C	250 ISO-F	40 KF	VCR Nut 1/4“	no	yes	Stainless steel hose nipples 1/2“	yes	no	400081V0021
MAG W 2200 C	250 ISO-F	40 KF	Thread 1/4“	yes	yes	Thread 1/8“	no	no	400081V0020
MAG W 2800 C	250 ISO-F	40 KF	VCR Nut 1/4“	yes	yes	Swagelock 1/4“ tube	yes	no	400000V0001
MAG W 2800 CT	250 ISO-F	40 KF	VCR Nut 1/4“	yes	yes	Swagelock 1/4“ tube	yes	yes	400000V0002
MAG W 3200 CT	320 ISO-F	40 KF	VCR Nut 1/4“	yes	yes	Swagelock 1/4“ tube	yes	yes	400003V0002
MAG W 830	160 CF	40 KF	DN 10/16	no*	no	Swagelock 1/4“ tube	no	no	400100V0041
MAG W 1300	200 CF	40 KF	DN 10/16	no*	no	Swagelock 1/4“ tube	no	no	400110V0051
MAG W 2200	250 CF	40 KF	DN 10/16	no*	no	Swagelock 1/4“ tube	no	no	400081V0061
MAG W 2800	250 CF	40 KF	DN 10/16	no*	no	Swagelock 1/4“ tube	no	no	400006V0071

* Purge vent valve Part No. 121 36 or purge vent Tee can be mounted

** Heater band and temperature sensor for pump control



Cable DRIVE/BEARING

Cable length	Converter cable outlet DRIVE/BEARING X20	Pump cable outlet DRIVE/BEARING X23	PK X24	Part No.
1.5 m	bended 225°	straight	straight	400036V0001
1.5 m	straight	straight	straight	400036V0007
3 m	straight	bended 180°	straight	400036V0006
3 m	bended 225°	straight	straight	400036V0008
3 m	straight	bended 270°	straight	400036V0009
5 m	bended 225°	straight	straight	400036V0004
5 m	straight	straight	straight	400036V0010
8 m	bended 225°	straight	straight	400036V0005
10 m	bended 225°	straight	straight	400036V0002
20 m	bended 225°	straight	straight	400036V0003
23 m	bended 225°	straight	straight	400036V0012
30 m	bended 225°	straight	straight	400036V0011

Cable TMS (for CT versions only)

Cable length	Converter cable outlet TMS X21	Pump cable outlet TMS X30	Heater X31	Part No.
1.5 m	bended 225°	straight	bended 180°	400037V0001
1.5 m	straight	straight	bended 180°	400037V0007
3 m	bended 225°	straight	bended 180°	400037V0008
5 m	bended 225°	straight	bended 180°	400037V0004
8 m	bended 225°	straight	bended 180°	400037V0005
10 m	bended 225°	straight	bended 180°	400037V0002
20 m	bended 225°	straight	bended 180°	400037V0003

Cable Purge/Vent (for optional purge vent valve Part No. 121 33 only)

Cable length	Converter cable outlet TMS X21	Pump cable outlet Purge	Vent	Part No.
1.5 m	straight	bended	bended	400038V0007
3 m	bended 225°	bended	bended	400038V0006
10 m	bended 225°	bended	bended	400038V0002
20 m	straight	bended	bended	400038V0009

Fig. 8 Overview and ordering data for connecting cables

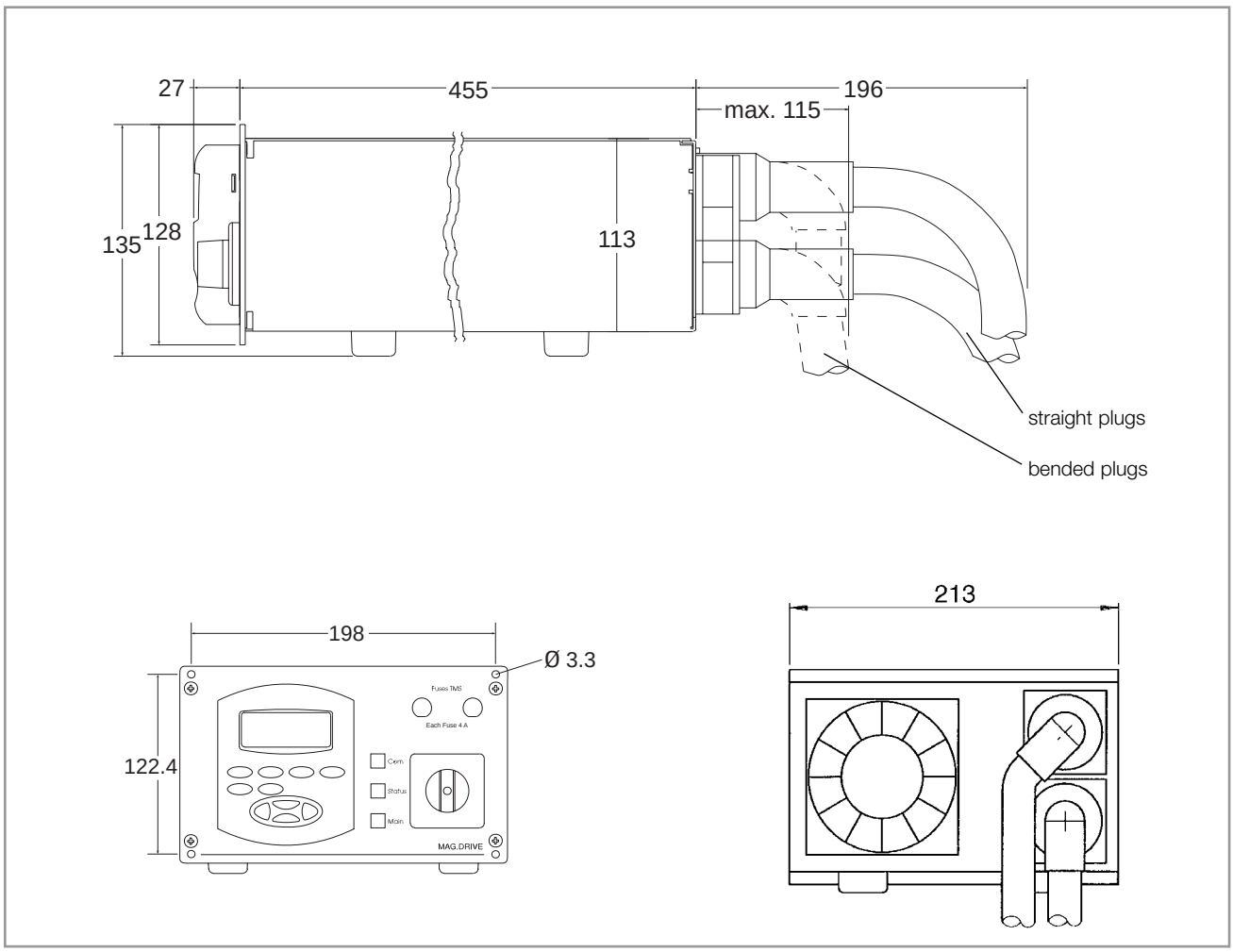


Fig. 9 Dimensional drawing of the MAG.DRIVE*digital*; dimensions in mm

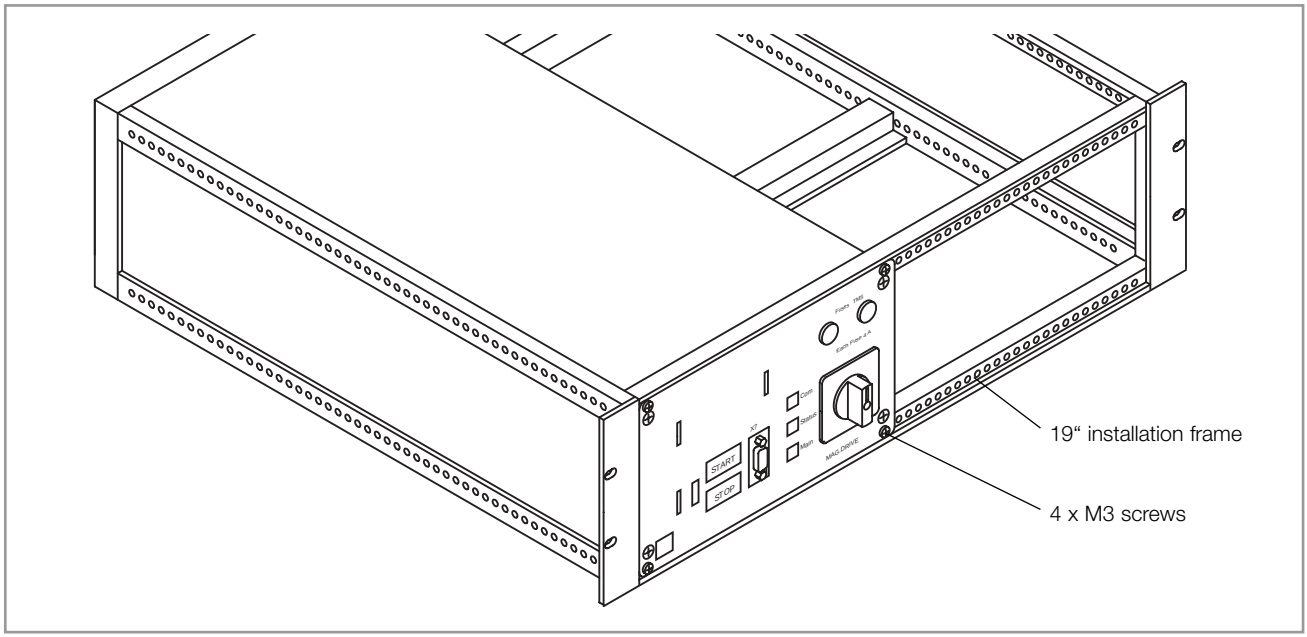


Fig. 10 Standard fixing of the MAG.DRIVE*digital*

MAG W 830 C
MAG W 1300 C

	Inlet flange	A	B	C	D	E	F	G	Forevacuum connection
MAG W 830 C	**160 ISO-F**	225	200	151	353	15°	45°	8	DN 40 KF
MAG W 1300 C	**200 ISO-F**	285	260	213	306	15°	30°	12	DN 40 KF / DN 25 KF
MAG W 1300 C	**250 ISO-F**	335	310	261	306	15°	30°	12	DN 40 KF
MAG W 1300 C	**250 ISO-K**	290	–	261	306	–	–	–	DN 40 KF

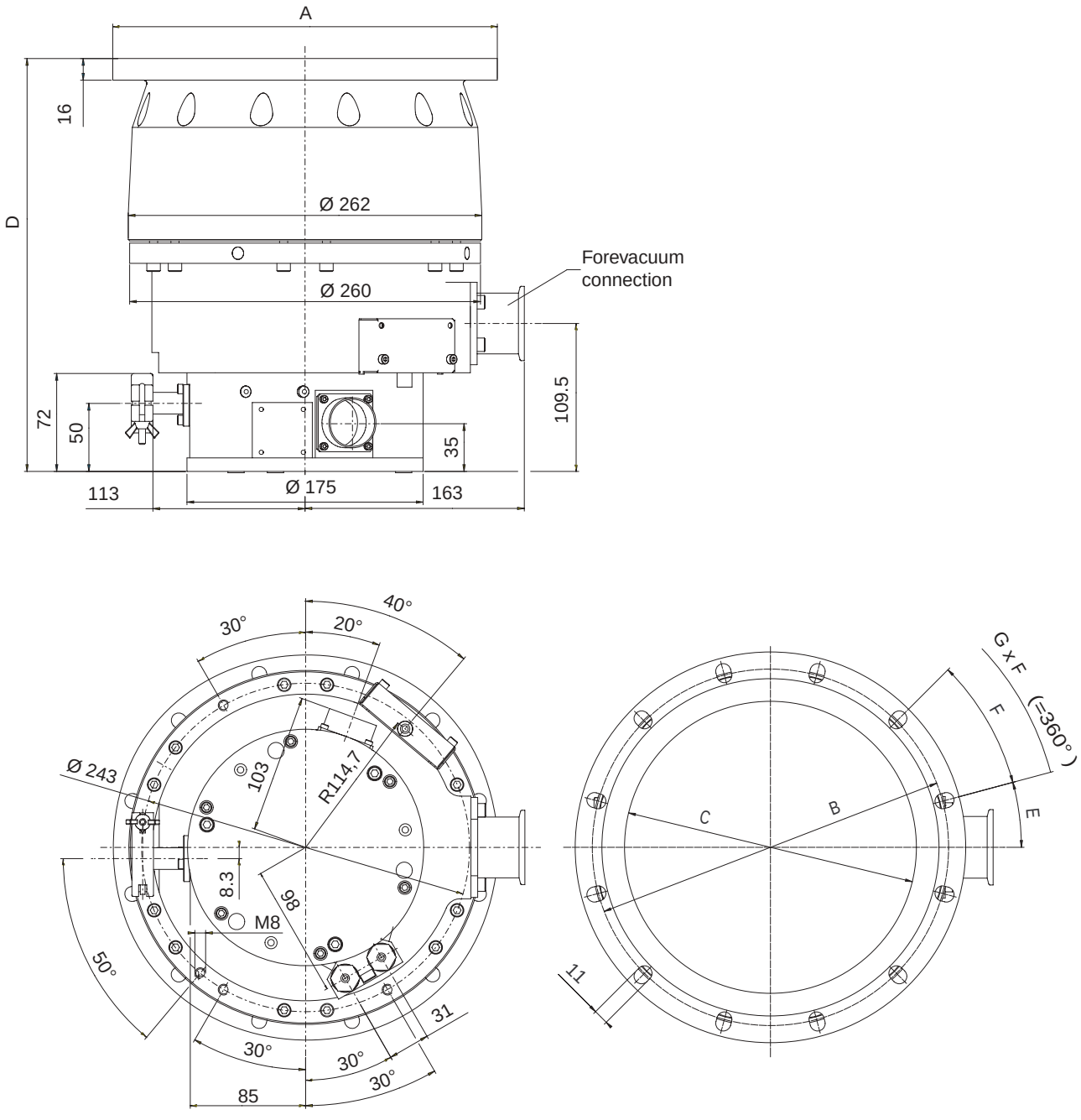
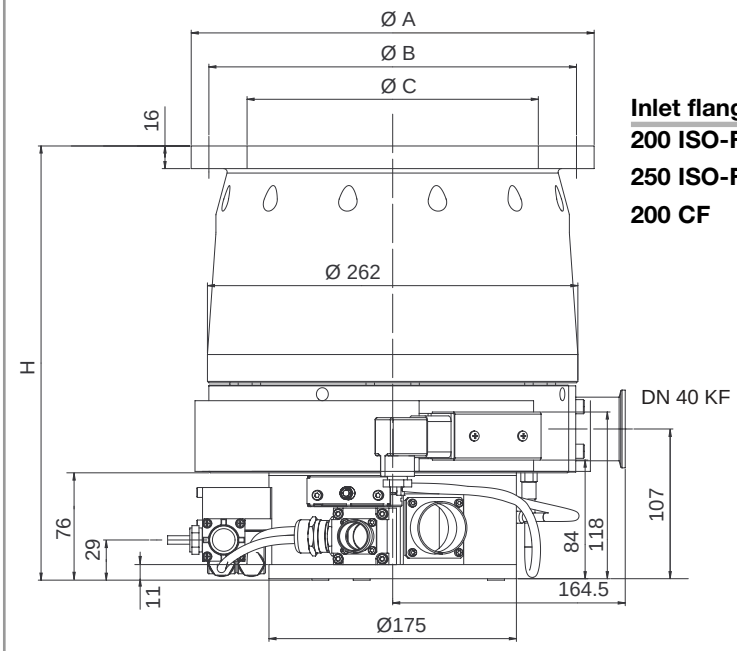


Fig. 11 MAG W 830 C and MAG W 1300 C, dimensions in mm

MAG (W) 1500 CT



Inlet flange	A	B	C	D	E	G	H
200 ISO-F	285	260	213	12	30°	15°	307
250 ISO-F	335	310	261	12	30°	15°	307
200 CF	253	231	200	24	15°	7.5°	327

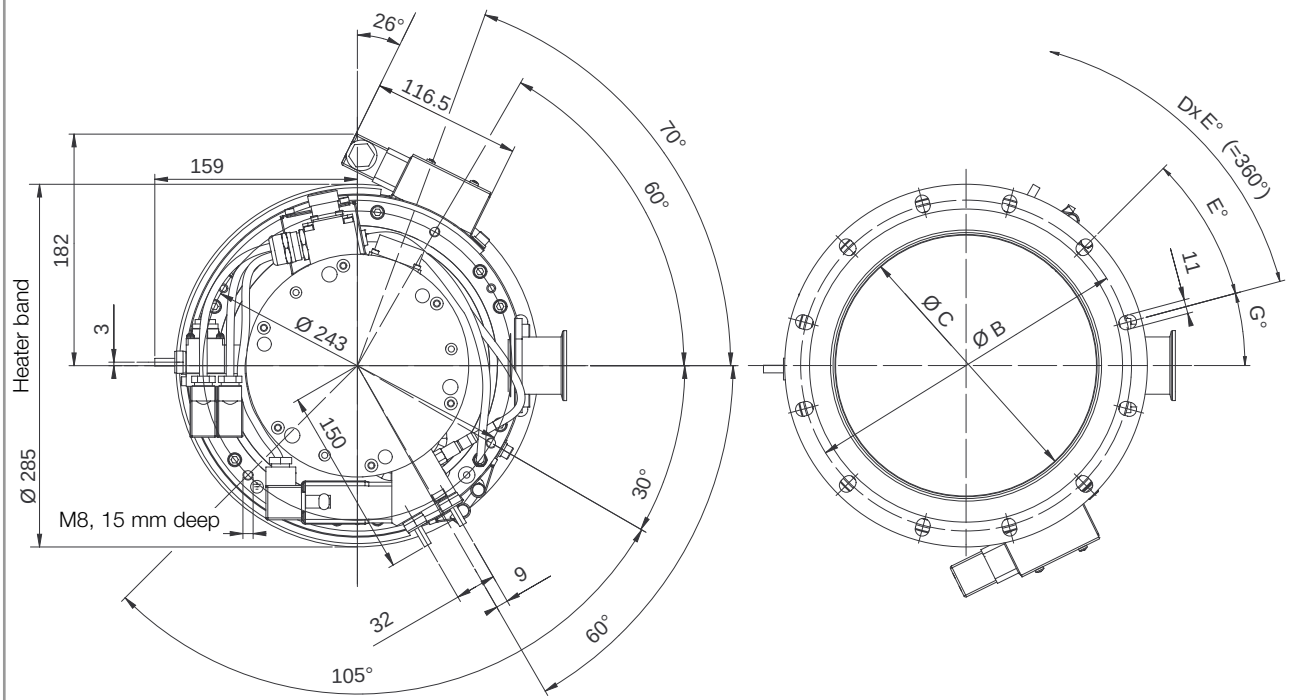


Fig. 12 MAG 1500 CT, dimensions in mm

Besprechungsexemplar - Nur zum intsrnen Gebrauch

MAG W 2200 C, Part No. 400081V0011
400081V0021

Inlet flange	A	B	C	D
200 ISO-F	285	396	213	260
250 ISO-F	335	371	261	310

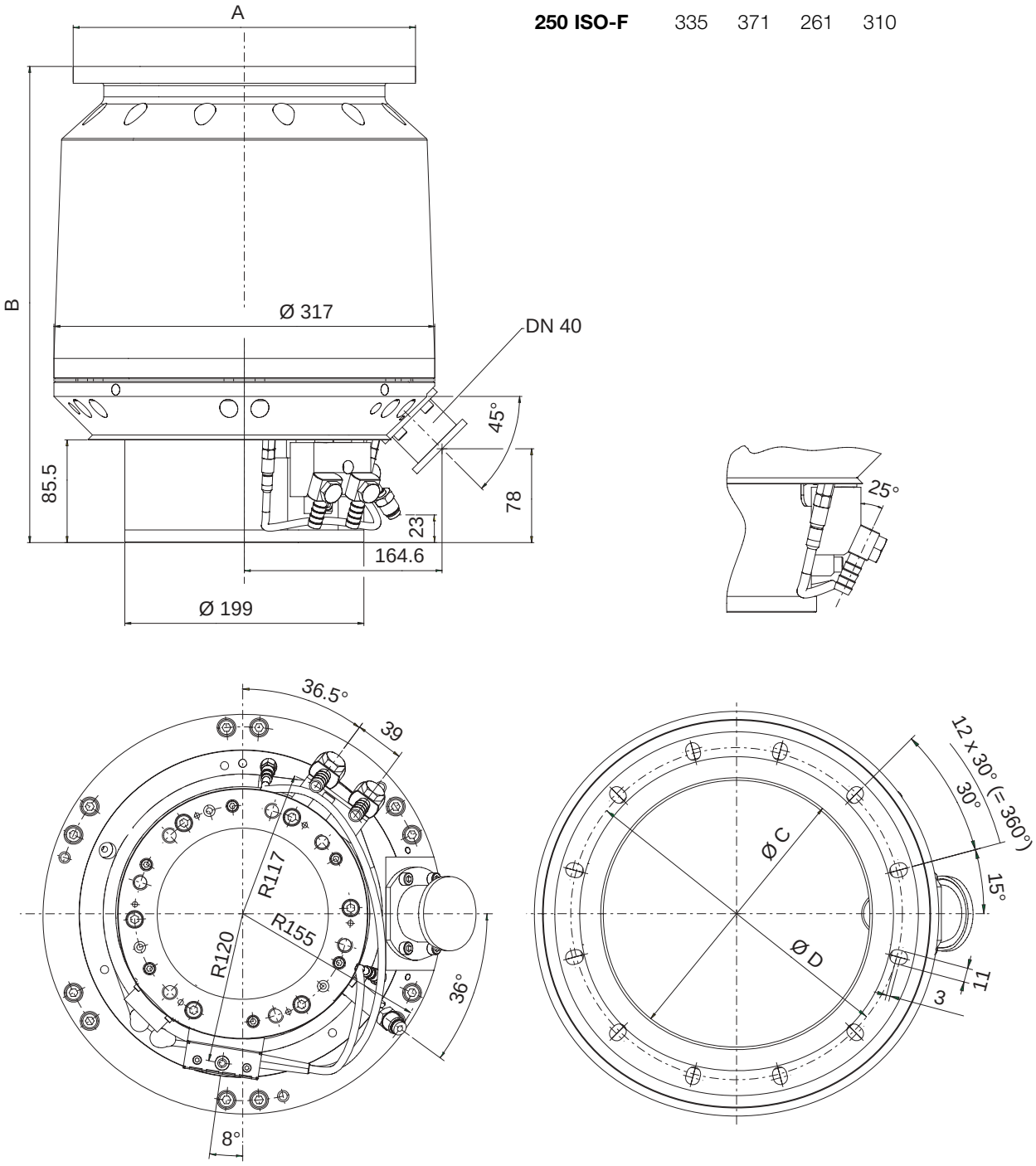


Fig. 13 MAG W 2200 C, dimensions in mm

MAG W 2200 C, Part No. 400081V0020

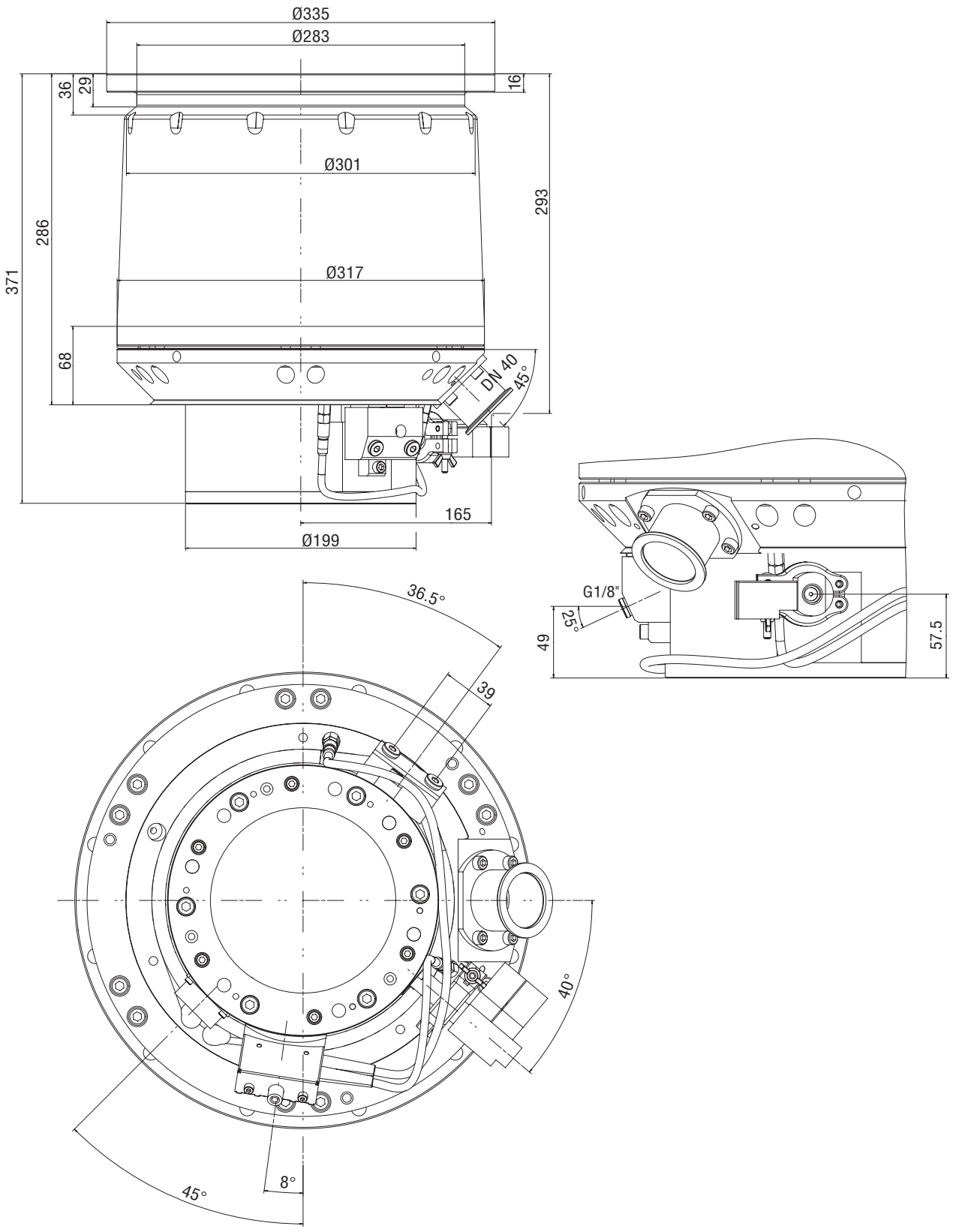


Fig. 14 MAG W 2200 C, dimensions in mm

MAG W 2800 CT,
MAG W 3200 CT

Inlet flange	A	B	C	D	E	F	G	H
250 ISO-F	335	310	261	11	3	293	361	408
320 ISO-F	425	395	318	13.5	0	248	316	363

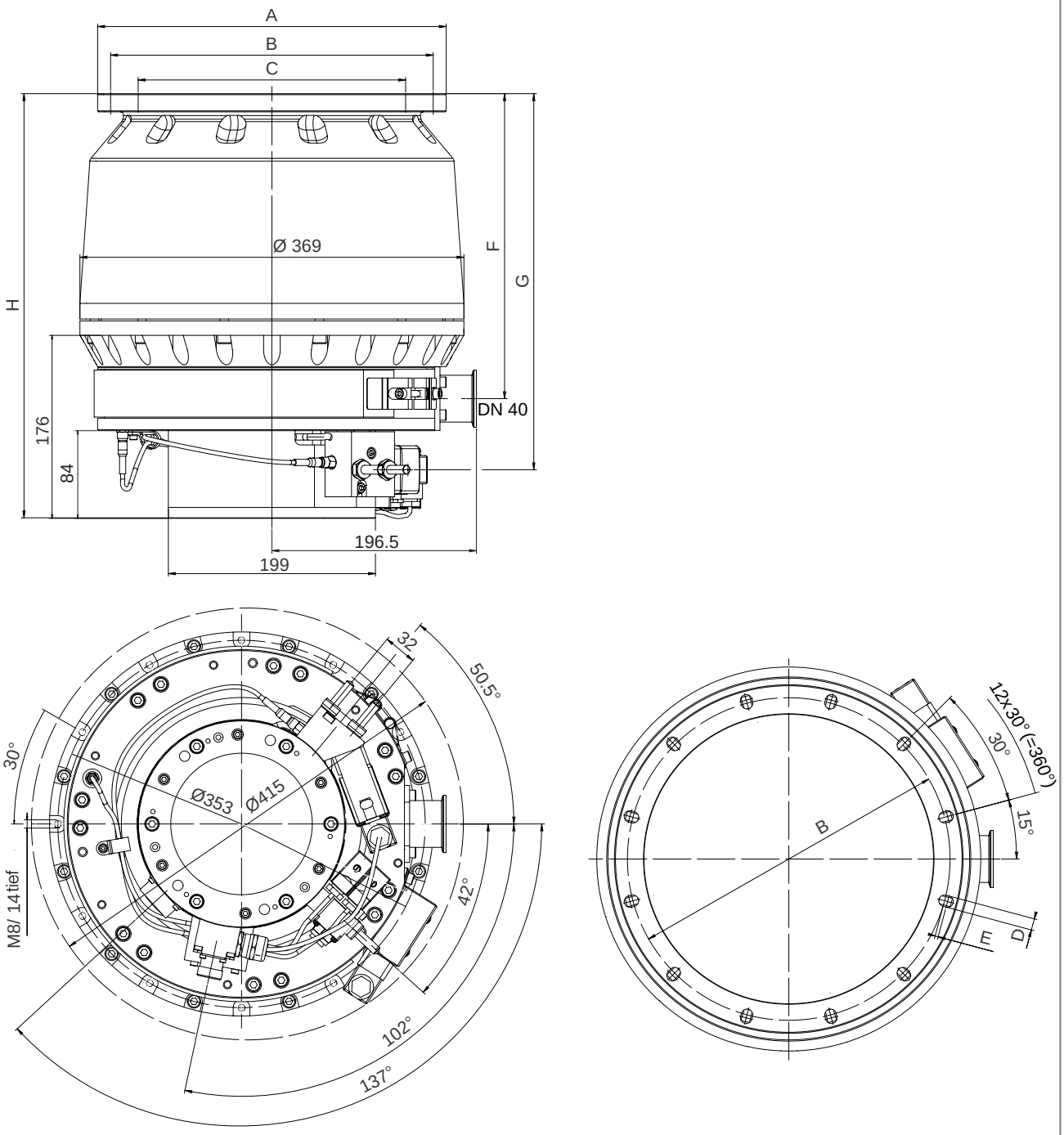


Fig. 15 MAG 2800 CT and MAG 3200 CT, dimensions in mm

MAG W 830

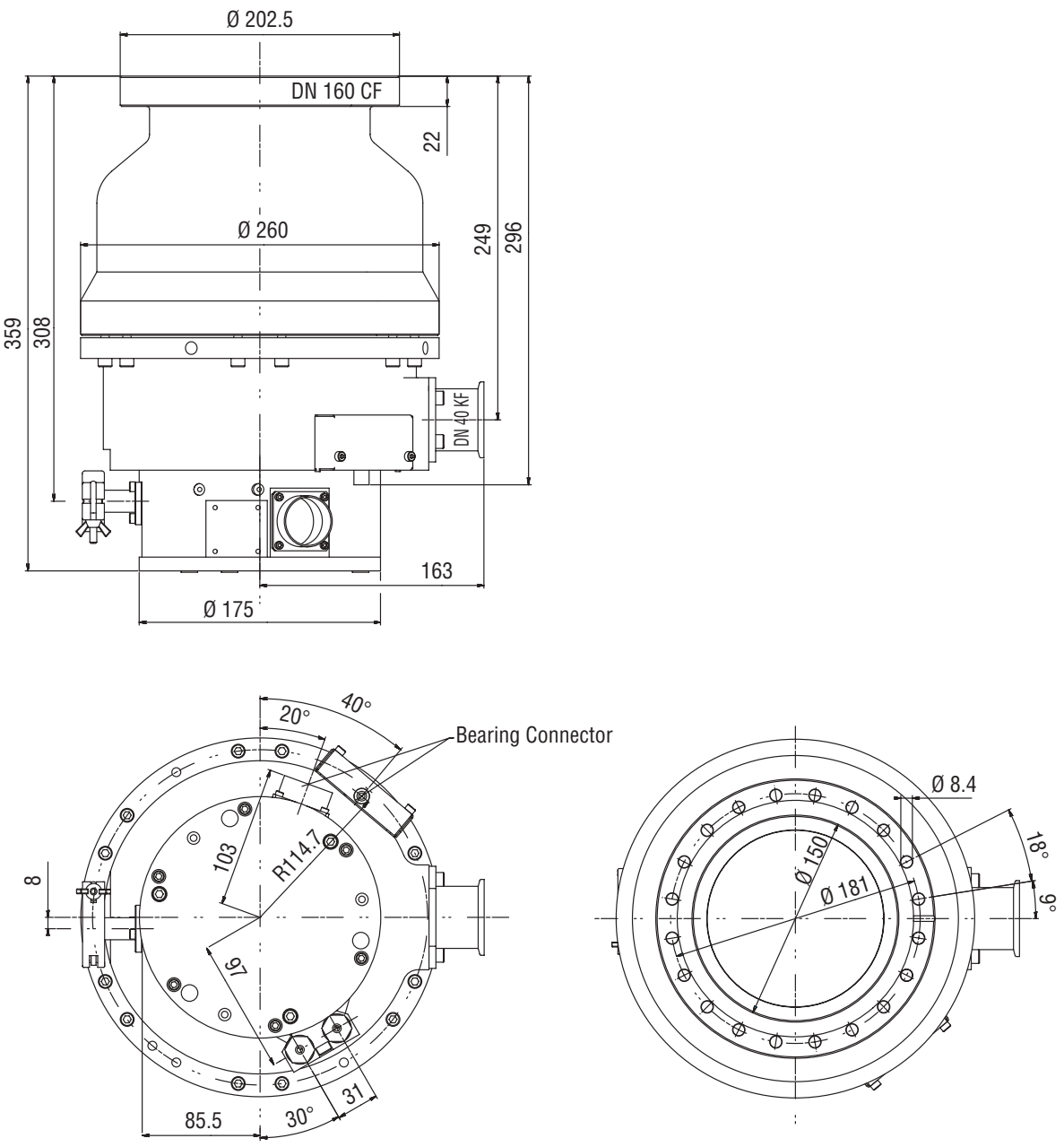


Fig. 16 MAG W 830, dimensions in mm

MAG W 1300

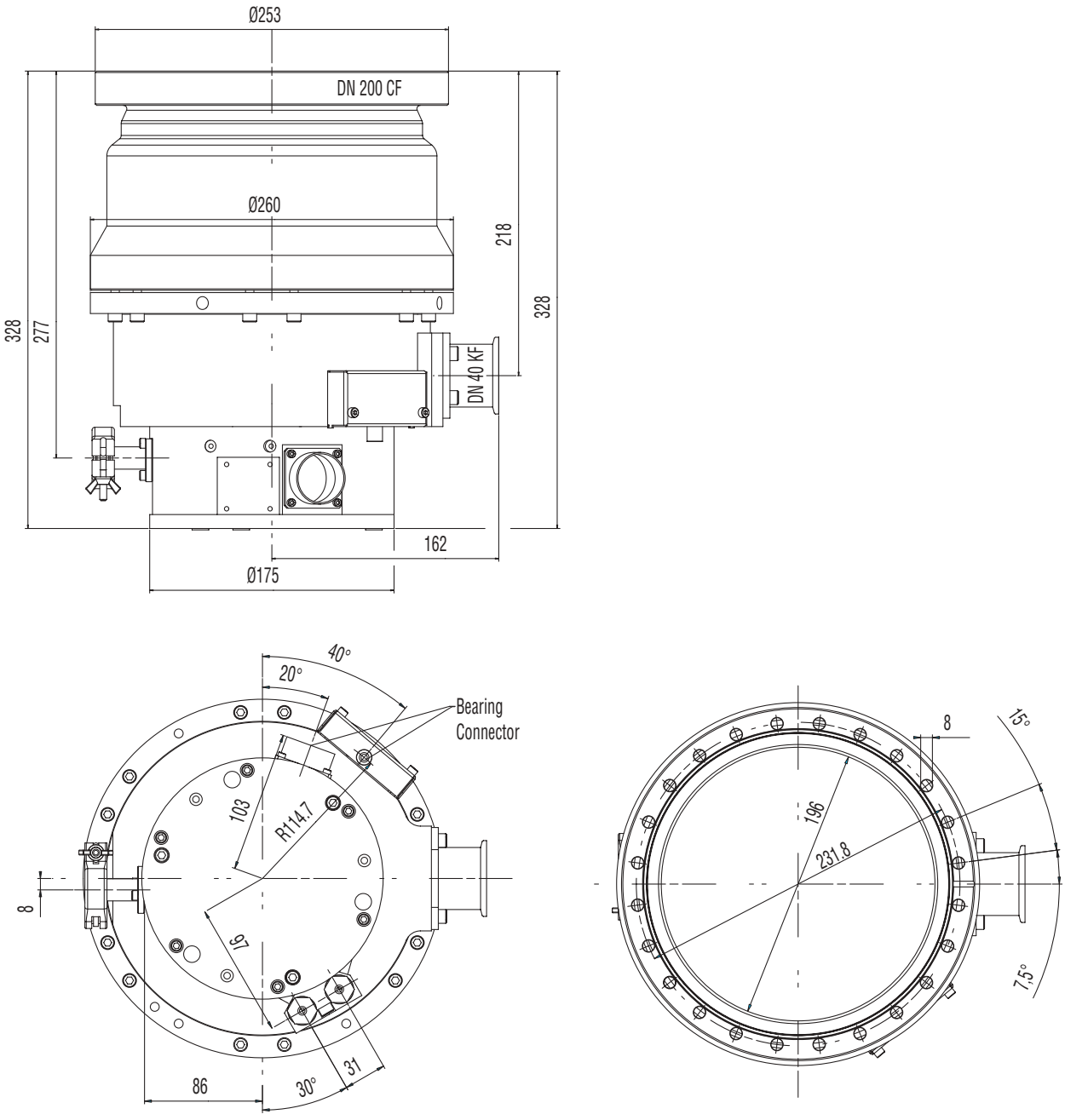


Fig. 17 MAG W 1300, dimensions in mm

MAG W 2200

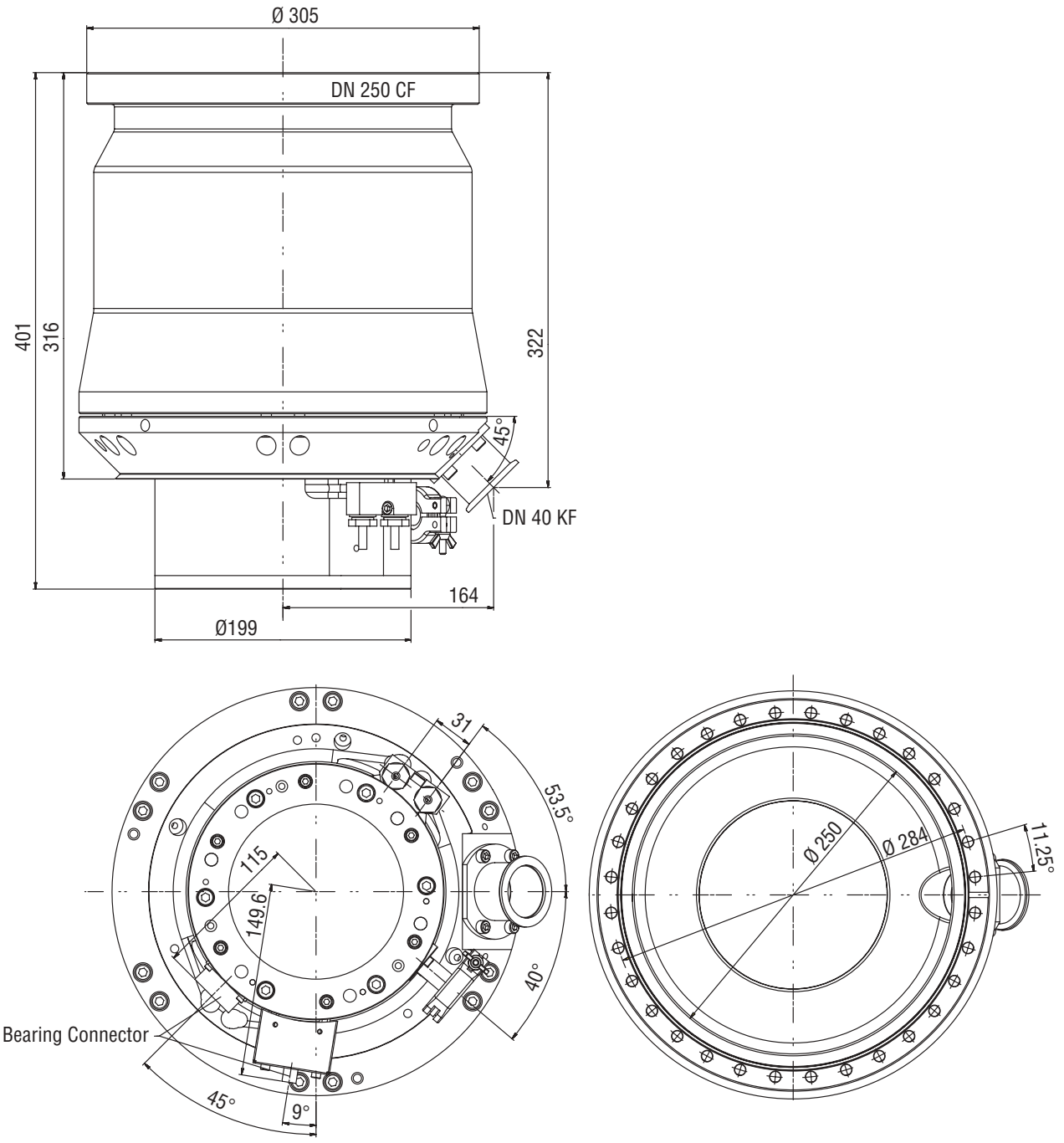


Fig. 18 MAG W 2200, dimensions in mm

MAG W 2800

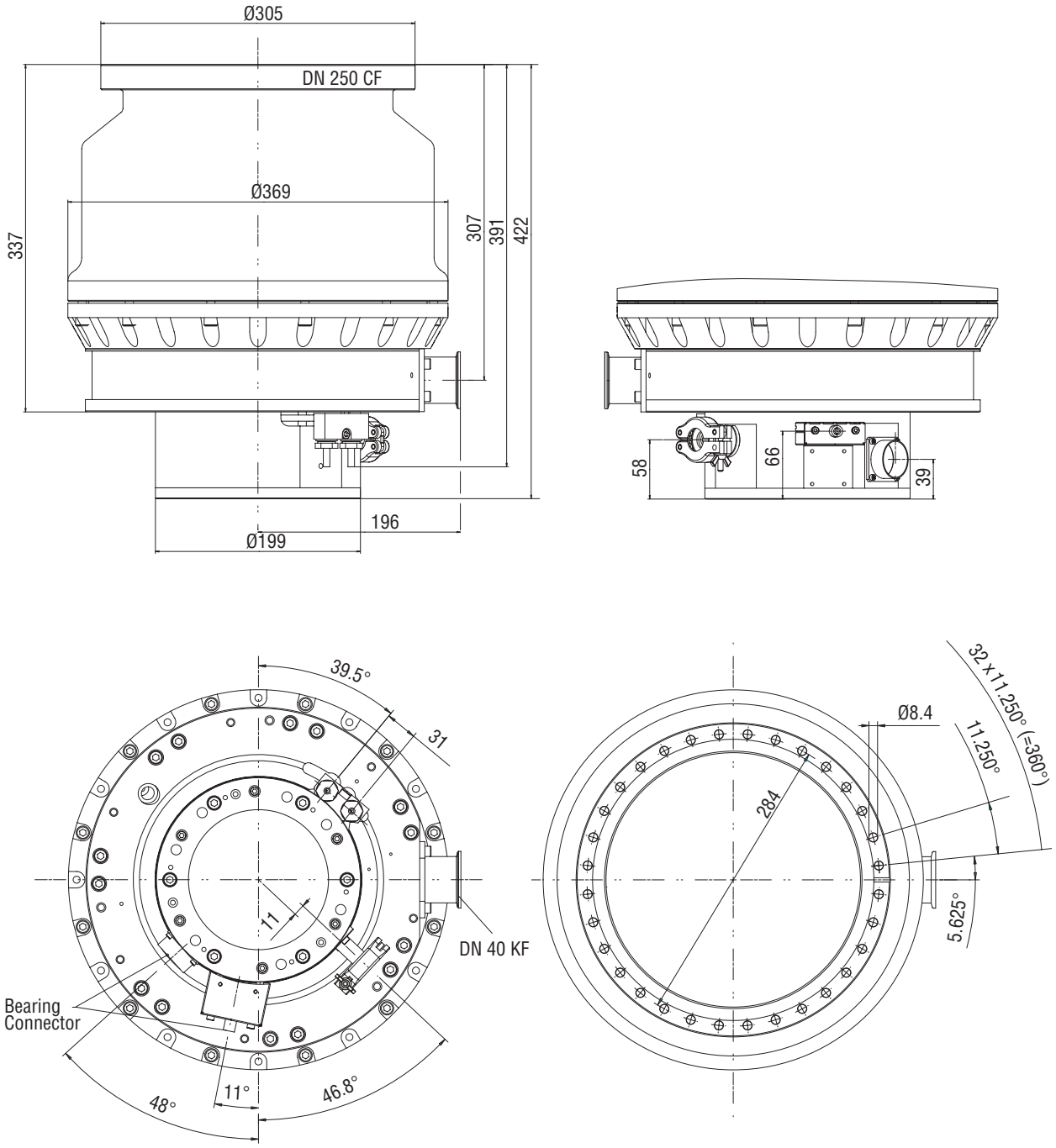
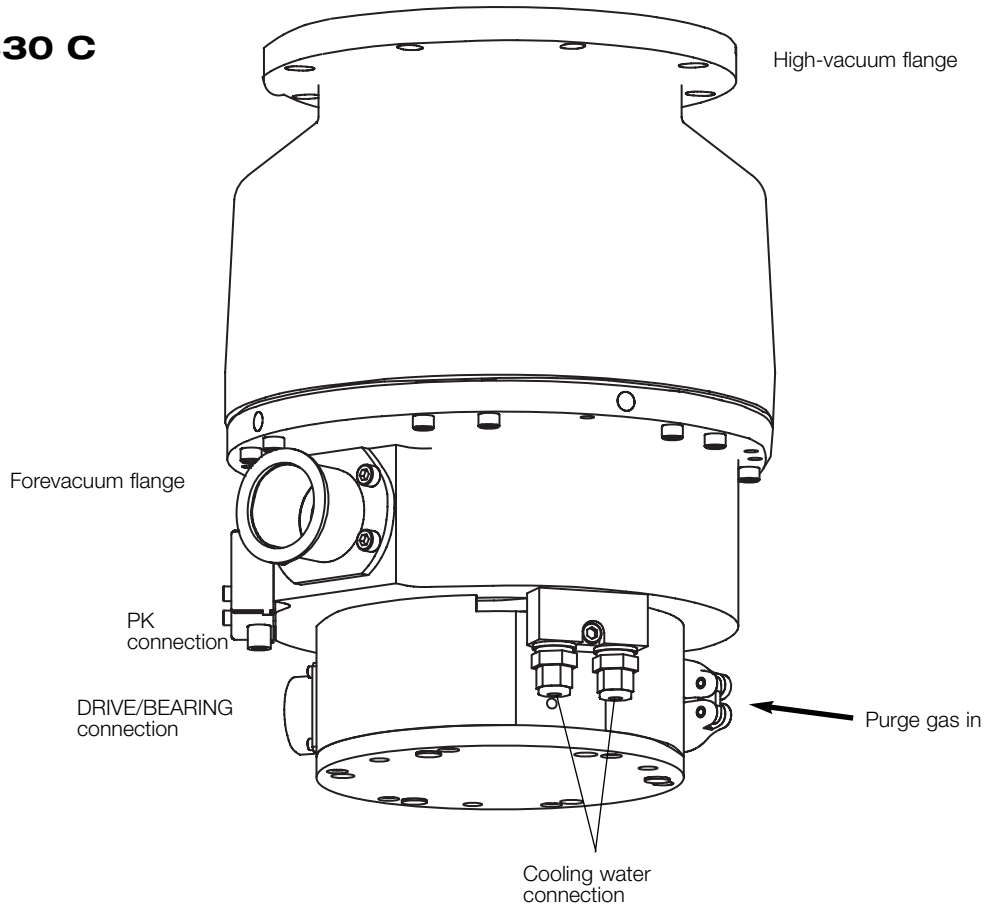
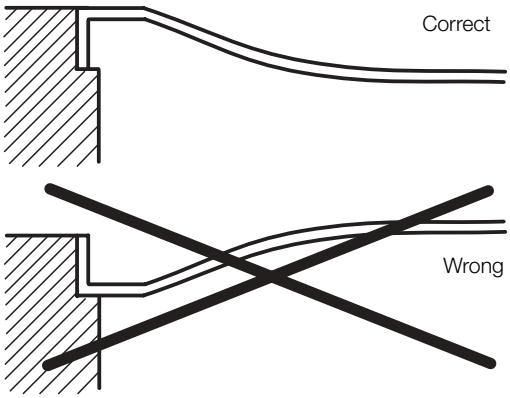


Fig. 19 MAG W 2800, dimensions in mm

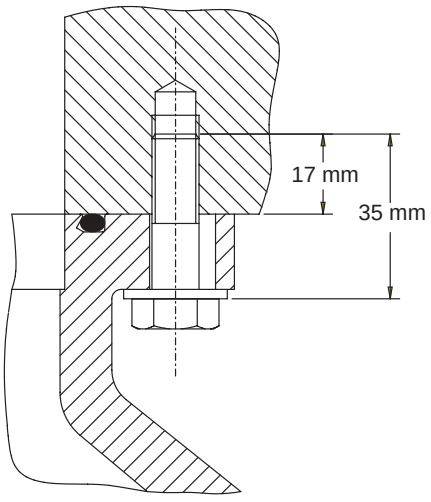
2 Installation

MAG W 830 C





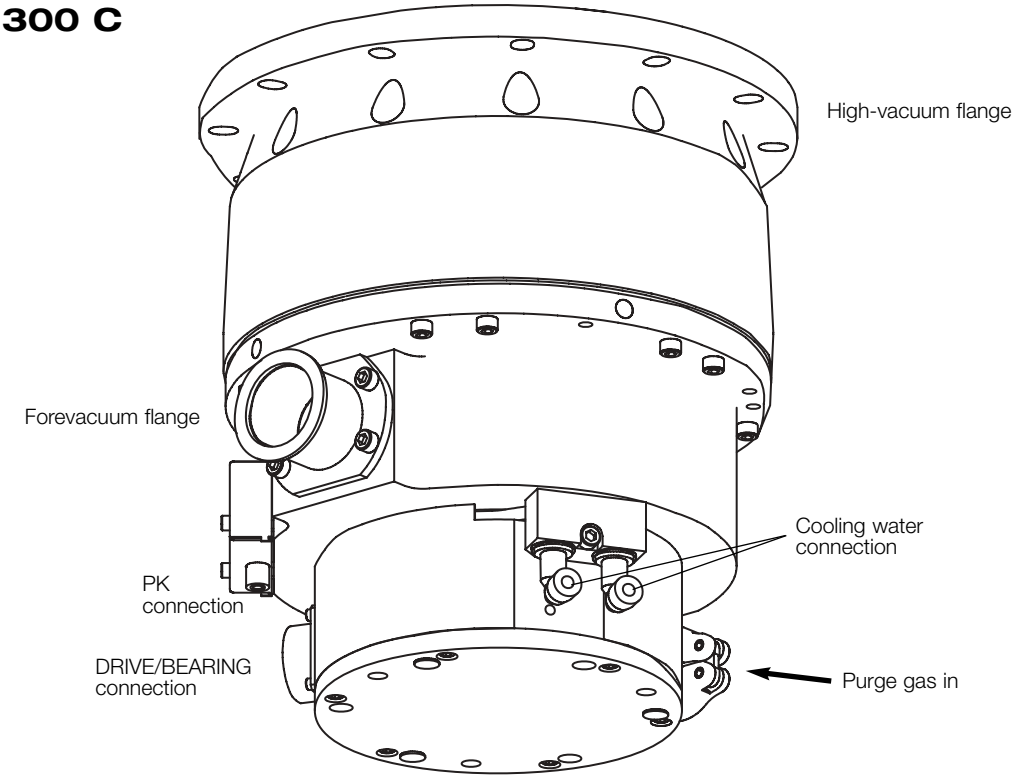
Caution
Install the splinter guard as shown. Installing the splinter guard upside down may lead to contact between splinter guard and rotor during fast venting of the pump.

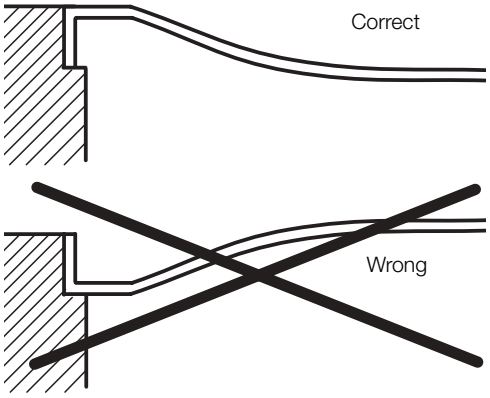


8 bolts M10 x 35
Installation torque per bolt 35^{+5} Nm
Bolt quality:12.9 according to EN ISO 898-1
with coating
0,2% yield strength > 1080 N/mm^2

Fig. 20 Connection elements, installing the splinter guard and fixing the intake flange for the MAG W 830 C

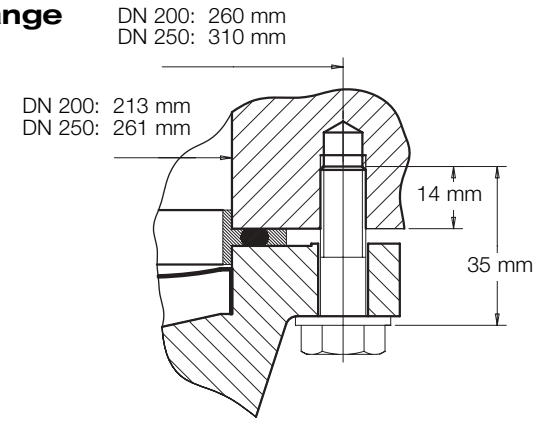
MAG W 1300 C



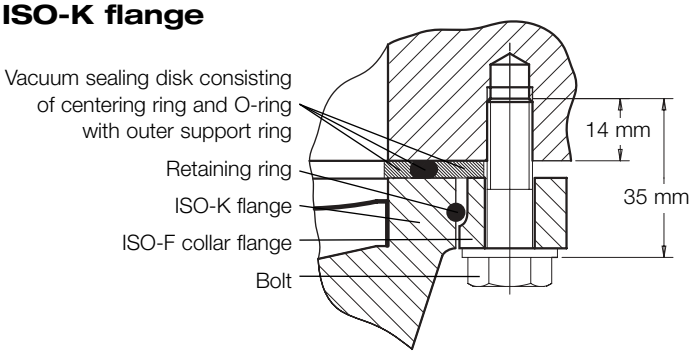


Caution
Install the splinter guard as shown. Installing the splinter guard upside down may lead to contact between splinter guard and rotor during fast venting of the pump.

ISO-F flange



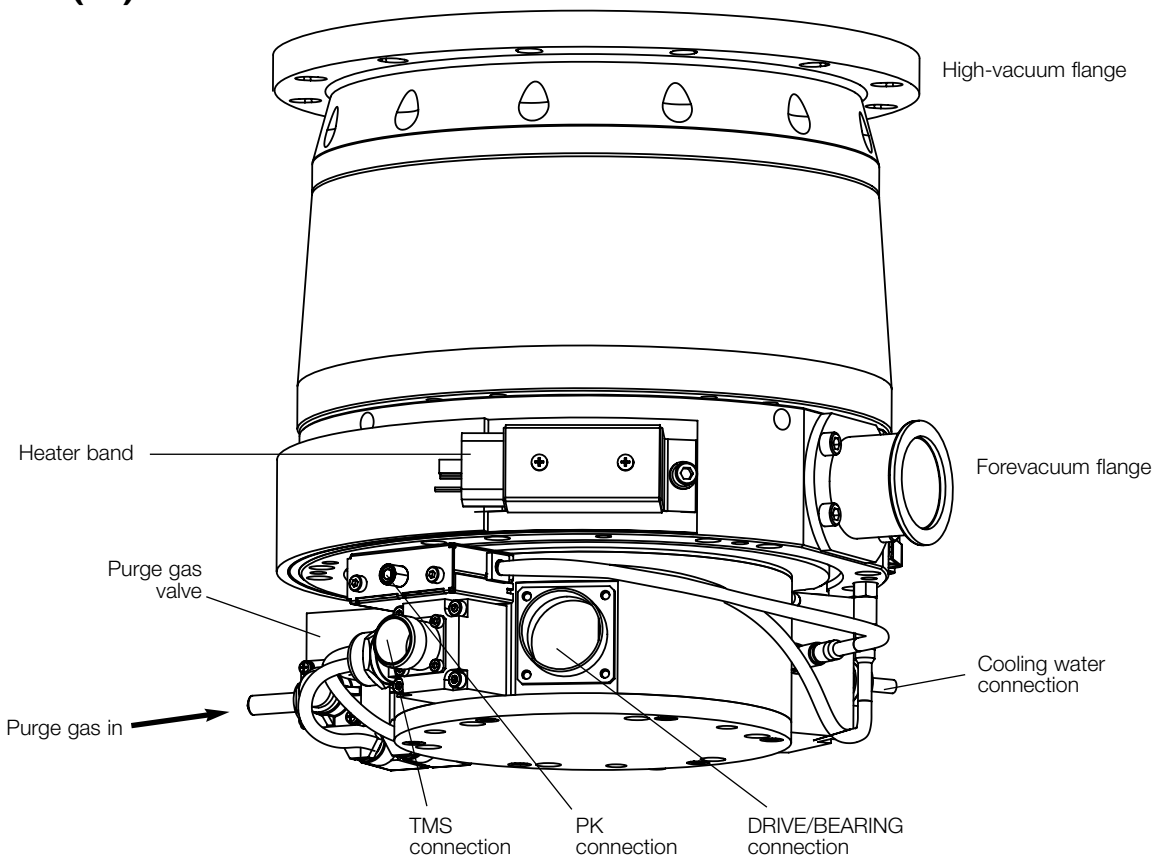
ISO-K flange

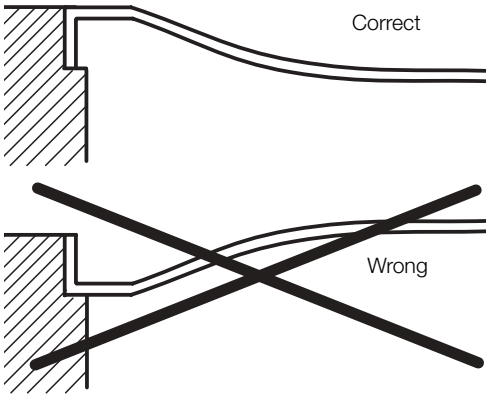


12 bolts M10 x 35
Installation torque per bolt 35^{+5} Nm
Bolt quality:12.9 according to EN ISO 898-1
with coating
0,2% yield strength > 1080 N/mm^2

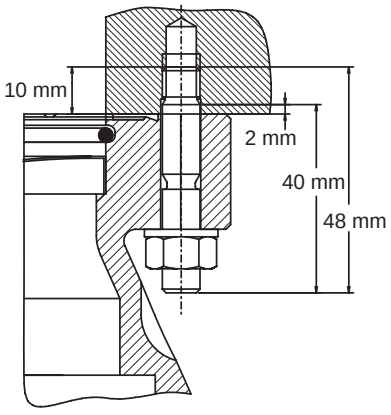
Fig. 21 Connection elements, installing the splinter guard and fixing the intake flange for the MAG W 1300 C

MAG (W) 1500 CT



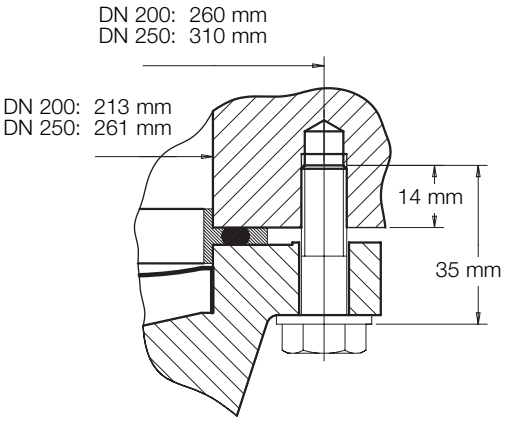


Caution
Install the splinter guard as shown. Installing the splinter guard upside down may lead to contact between splinter guard and rotor during fast venting of the pump.



DN 200 CF

24 bolts M8 x 40
Installation torque per bolt 25^{+5} Nm
Bolt quality: 10.9 according to EN ISO 898-1 with coating
0,2% yield strength > 900 N/mm^2

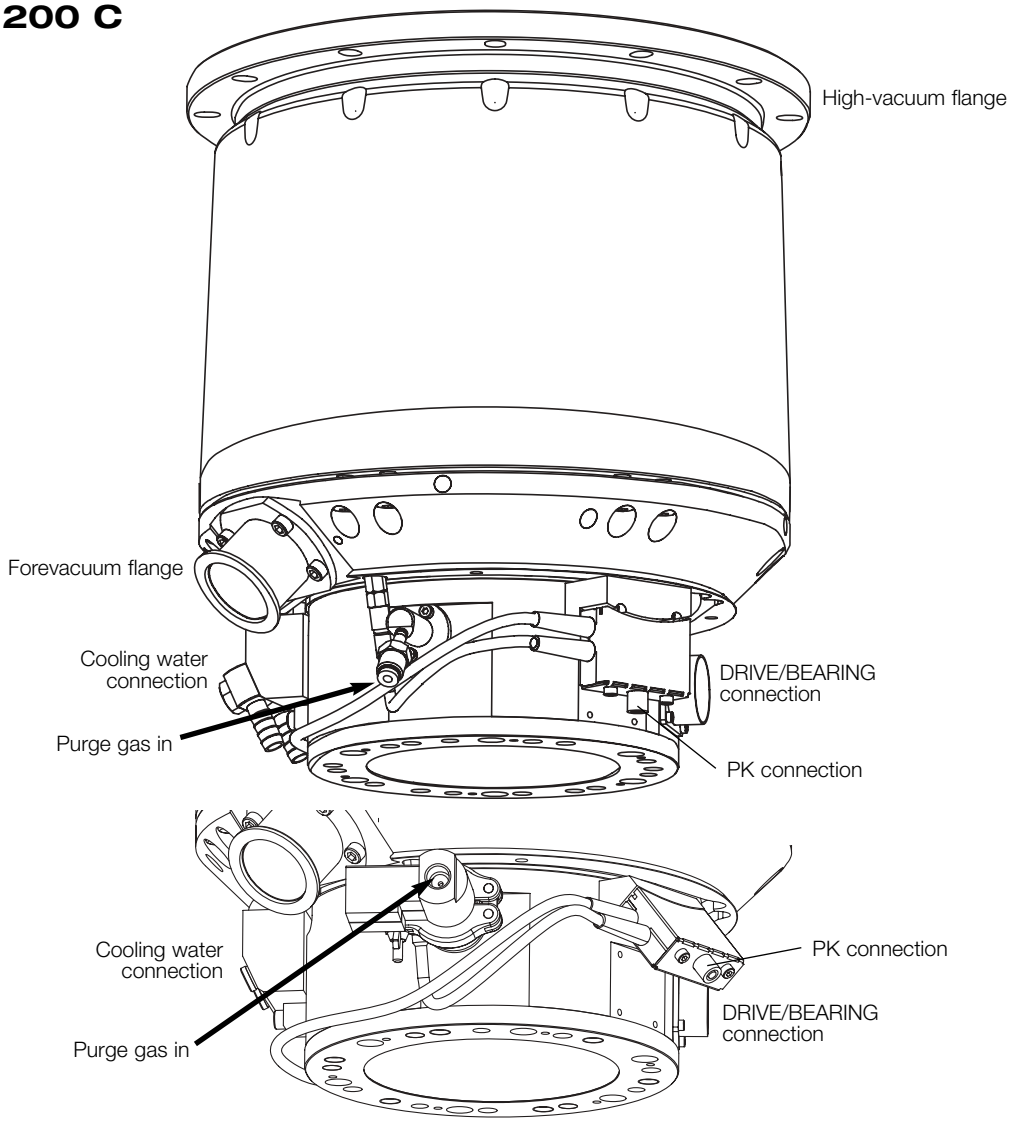


ISO-F flange

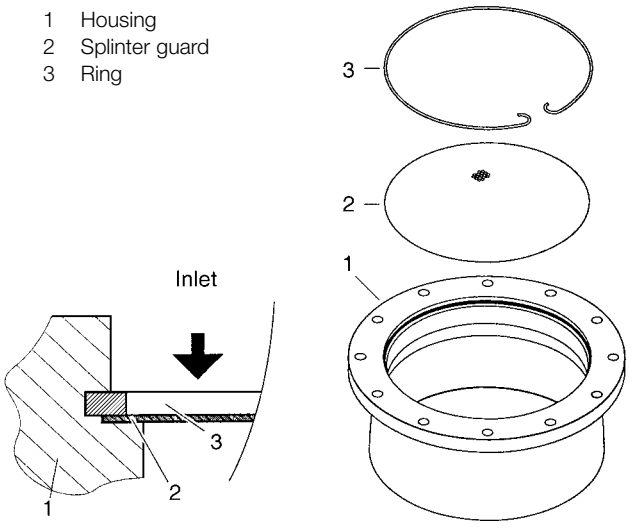
12 Schrauben M10 x 35
Installation torque per bolt 35^{+5} Nm
Bolt quality:12.9 according to EN ISO 898-1 with coating
0,2% yield strength > 1080 N/mm^2

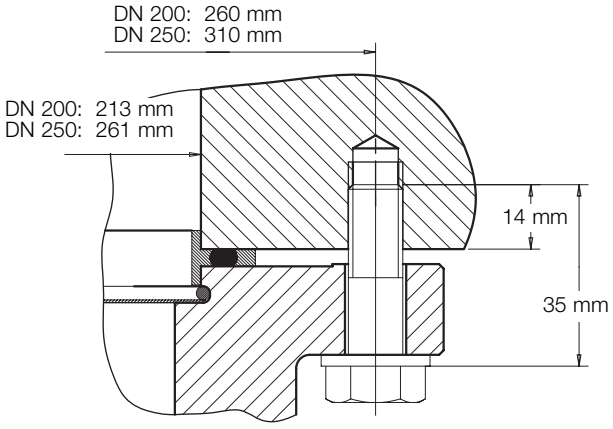
Fig. 22 Connection elements, installing the splinter guard and fixing the intake flange for the MAG (W) 1500 CT

MAG W 2200 C



1 Housing
2 Splinter guard
3 Ring

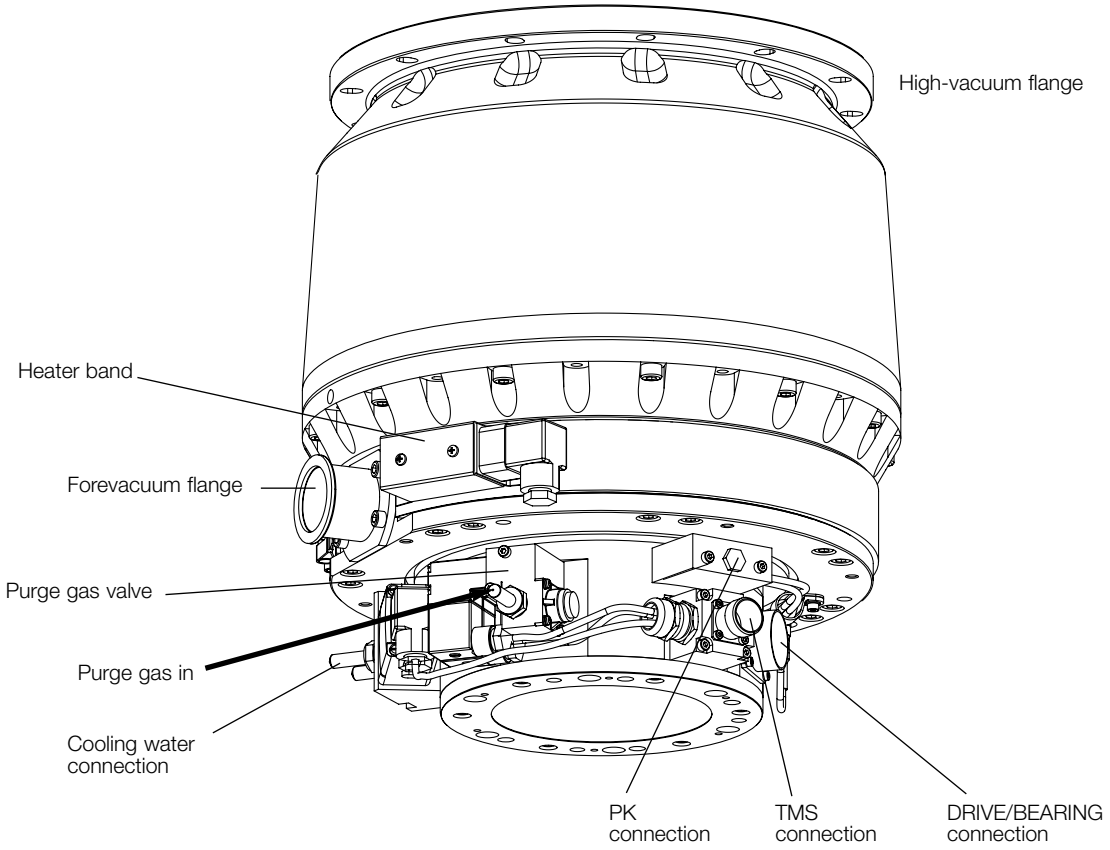




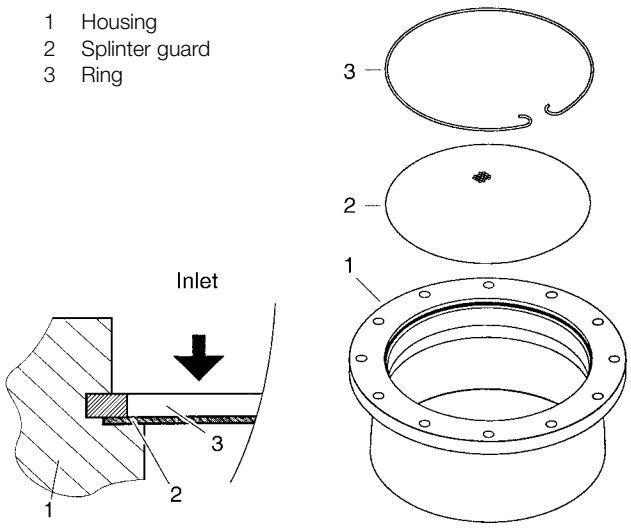
12 bolts M10 x 35
Installation torque per bolt 35^{+5} Nm
Bolt quality:12.9 according to EN ISO 898-1
with coating
0,2% yield strength > 1080 N/mm^2

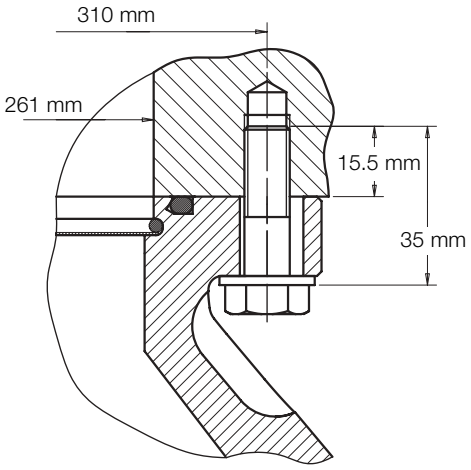
Fig. 23 Connection elements, installing the splinter guard and fixing the intake flange for the MAG W 2200 C

MAG W 2800 C, CT



1 Housing
2 Splinter guard
3 Ring

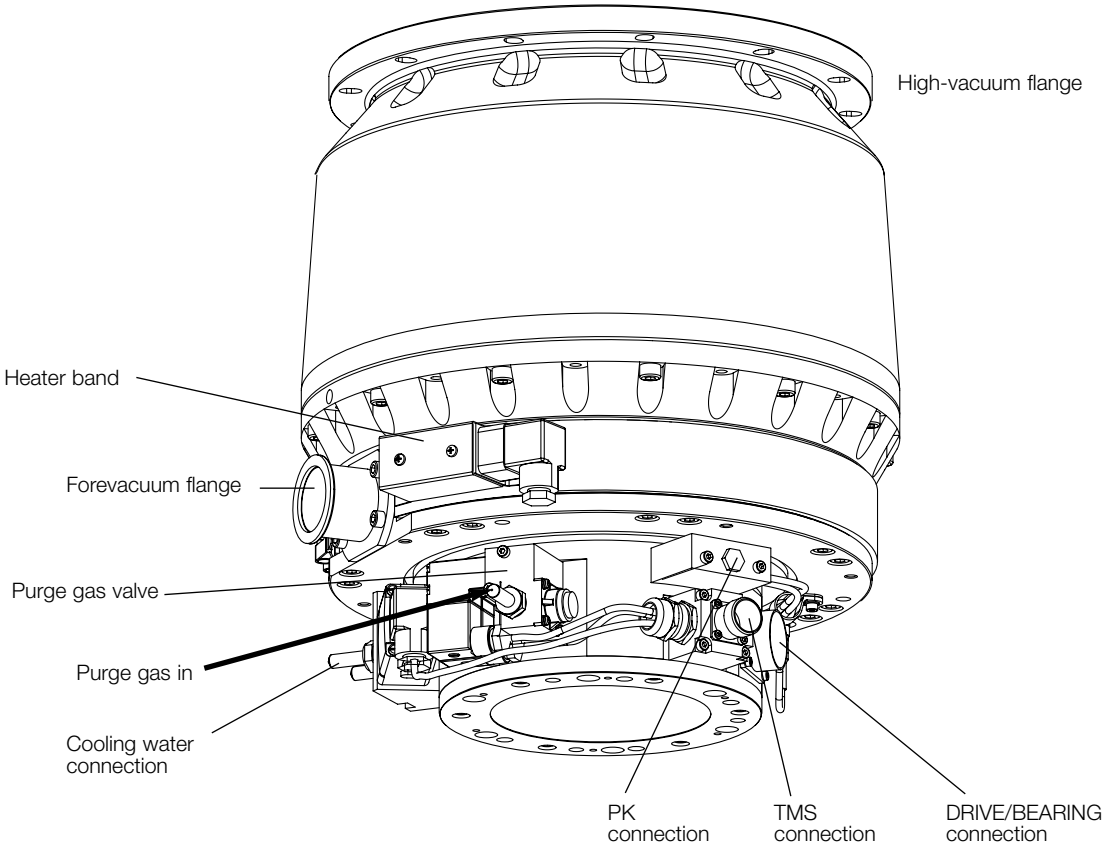




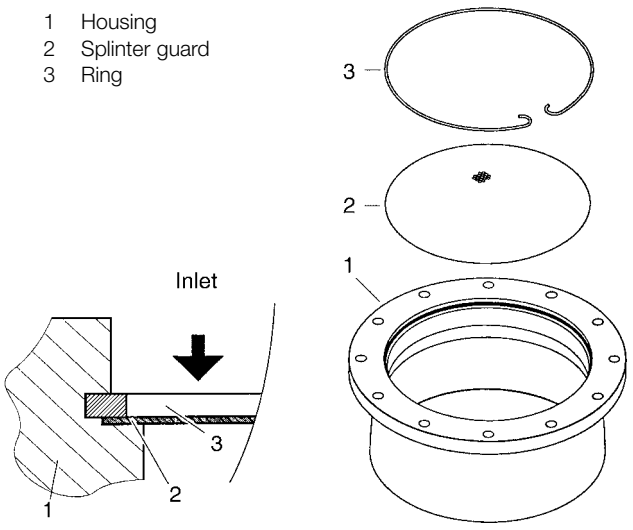
12 bolts M10 x 35
Installation torque per bolt 35^{+5} Nm
Bolt quality:12.9 according to EN ISO 898-1
with coating
0,2% yield strength > 1080 N/mm^2

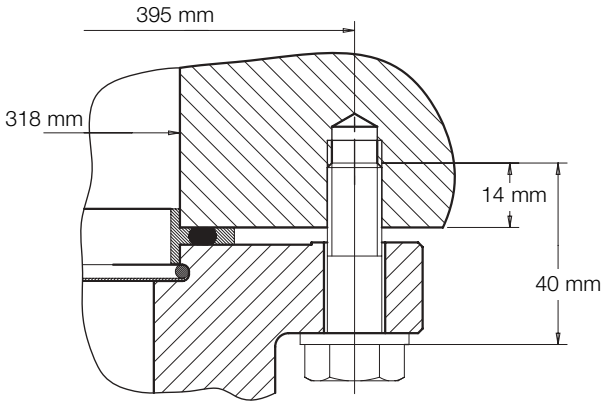
Fig. 24 Connection elements, installing the splinter guard and fixing the intake flange for the MAG W 2800 C, CT

MAG W 3200 CT



1 Housing
2 Splinter guard
3 Ring

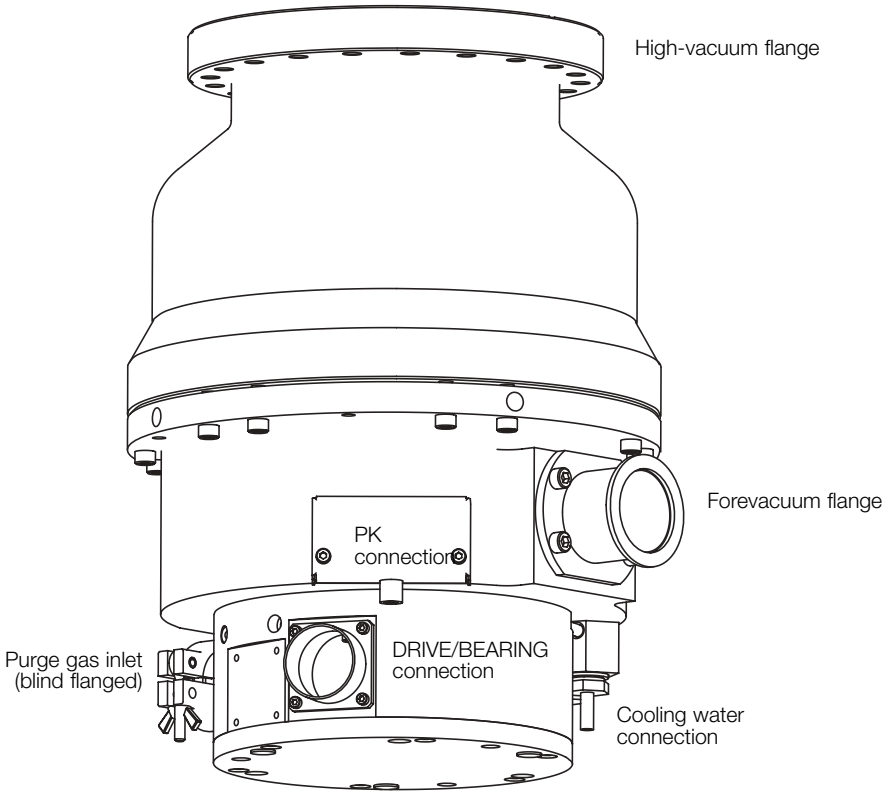


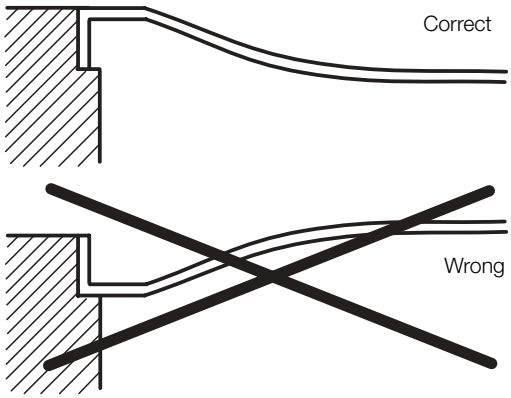


10 bolts M12 x 40
Installation torque per bolt 45^{+5} Nm
Bolt quality:12.9 according to EN ISO 898-1
with coating
0,2% yield strength > 1080 N/mm^2

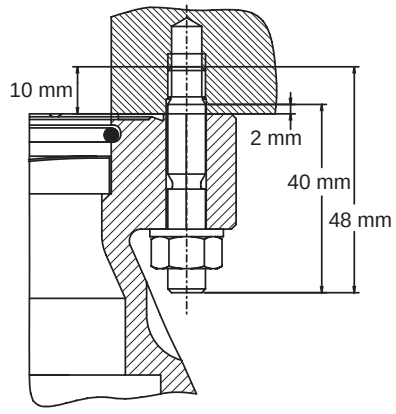
Fig. 25 Connection elements, installing the splinter guard and fixing the intake flange for the MAG W 3200 CT with DN 320 ISO-F flange

MAG W 830





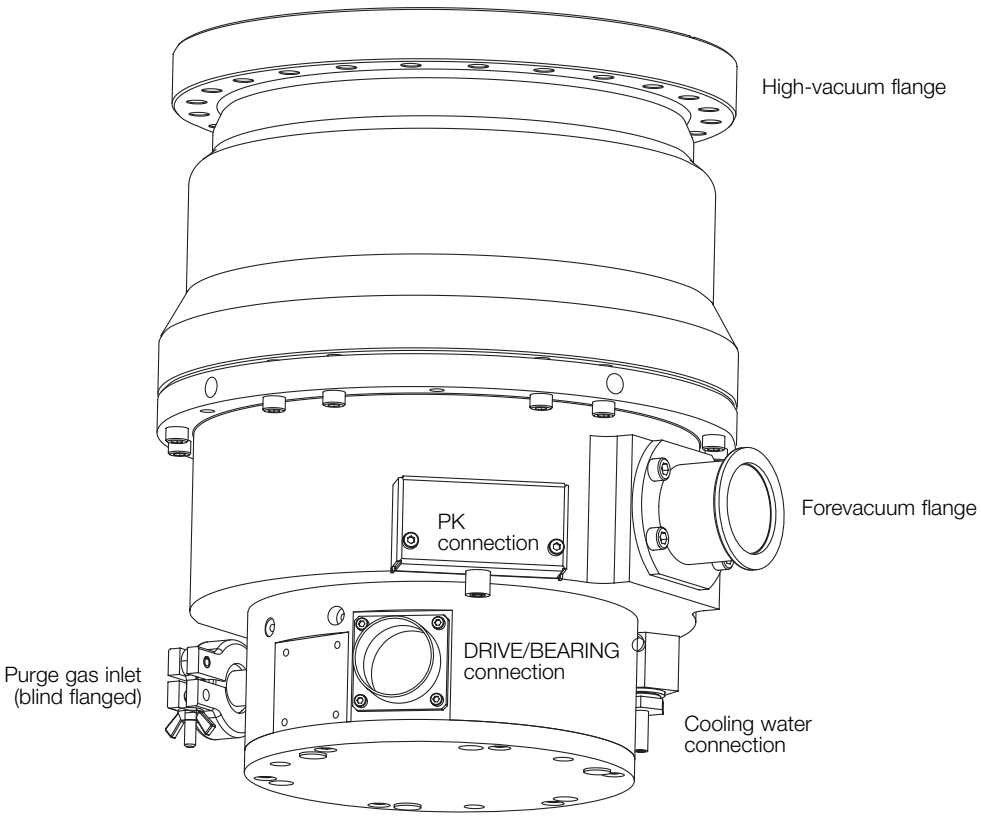
Caution
Install the splinter guard as shown. Installing the splinter guard upside down may lead to contact between splinter guard and rotor during fast venting of the pump

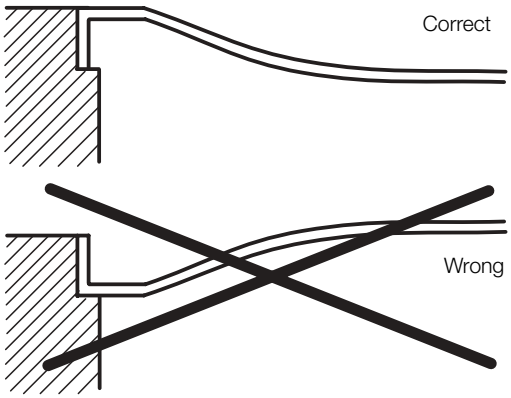


DN 160 CF: 20 bolts M8 x 40
Installation torque per bolt 25^{+5} Nm
Bolt quality: 10.9 according to
EN ISO 898-1 with coating
0,2% yield strength > 900 N/mm^2

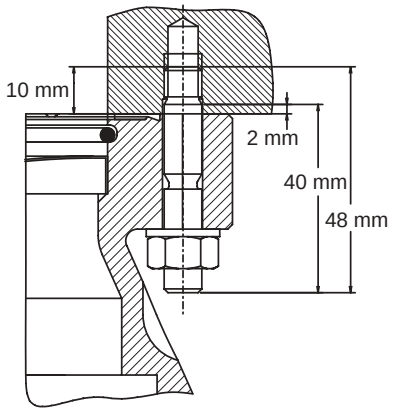
Fig. 26 Connection elements, installing the splinter guard and fixing the intake flange for the MAG W 830

MAG W 1300





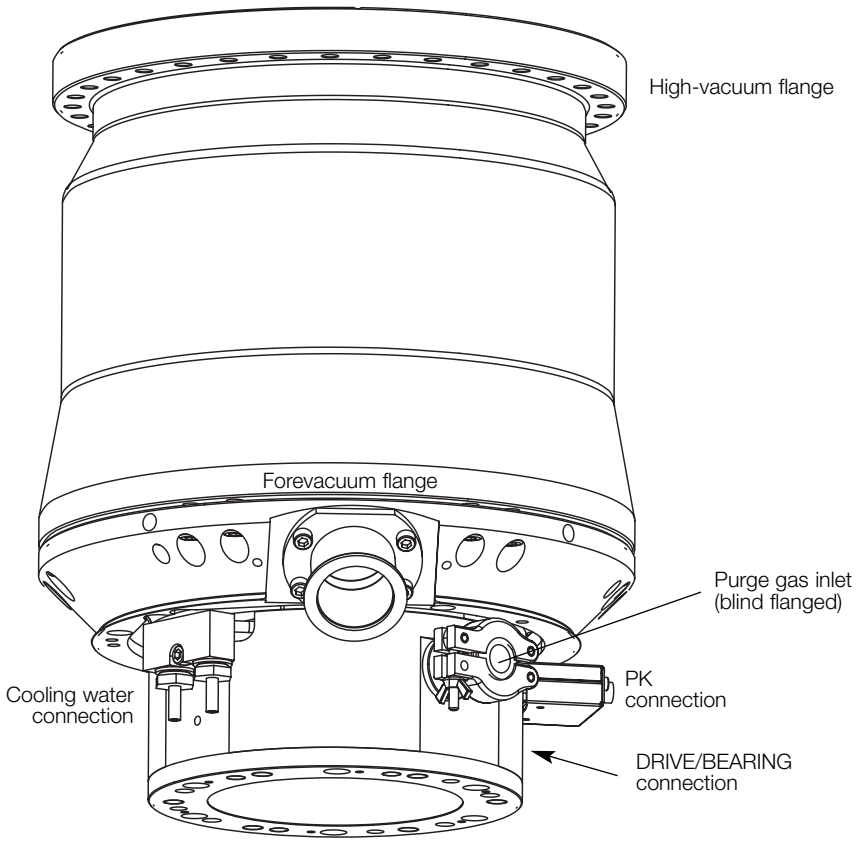
Caution
Install the splinter guard as shown. Installing the splinter guard upside down may lead to contact between splinter guard and rotor during fast venting of the pump.

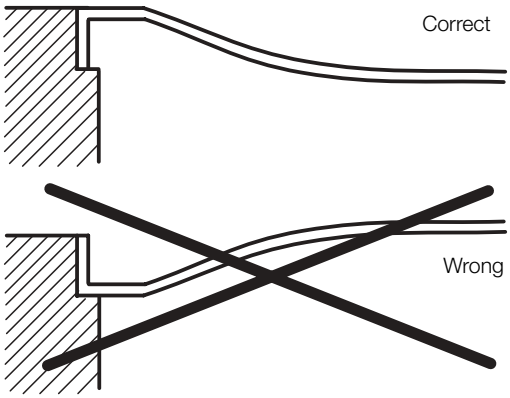


DN 200 CF: 24 bolts M8 x 40
Installation torque per bolt 25^{+5} Nm
Bolt quality: 10.9 according to
EN ISO 898-1 with coating
0,2% yield strength > 900 N/mm^2

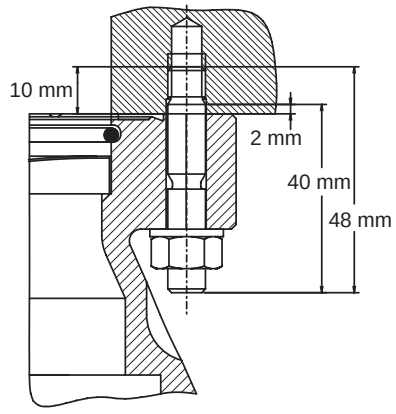
Fig. 27 Connection elements, installing the splinter guard and fixing the intake flange for the MAG W 1300

MAG W 2200





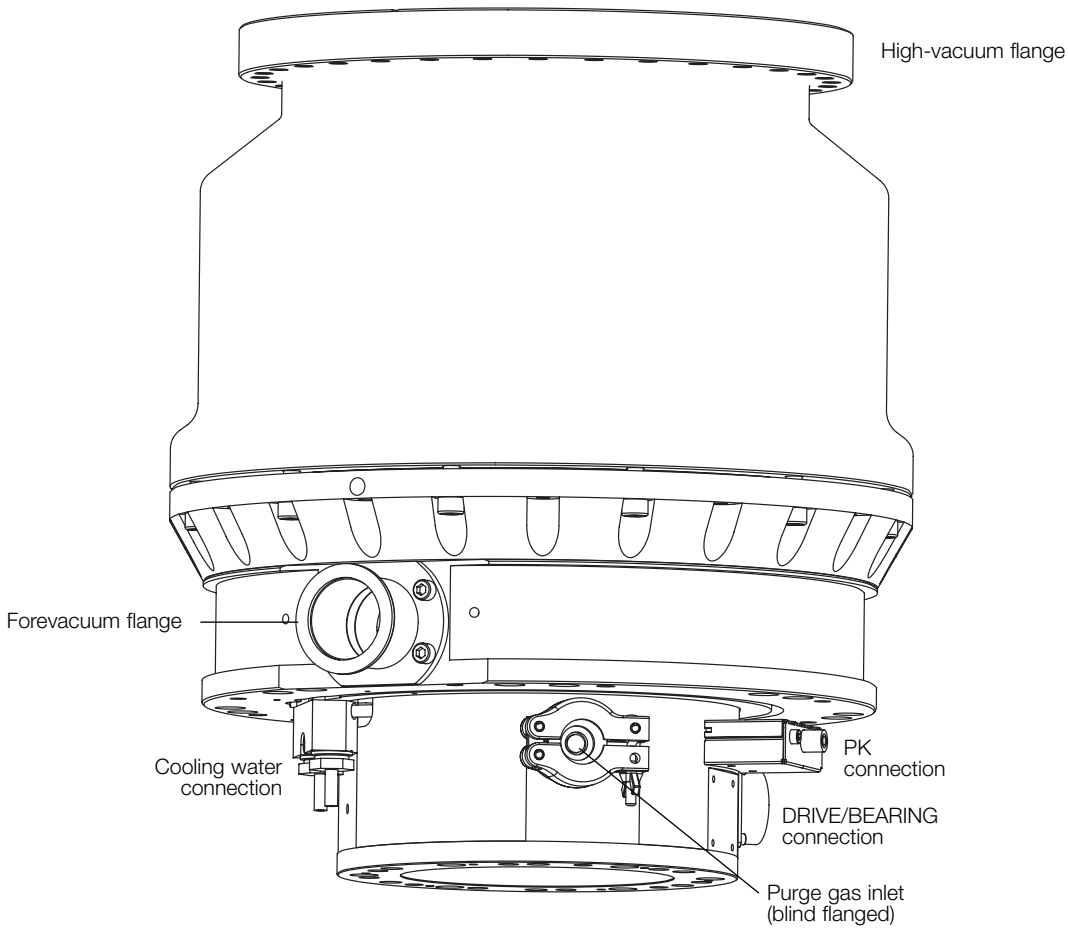
Caution
Install the splinter guard as shown. Installing the splinter guard upside down may lead to contact between splinter guard and rotor during fast venting of the pump.

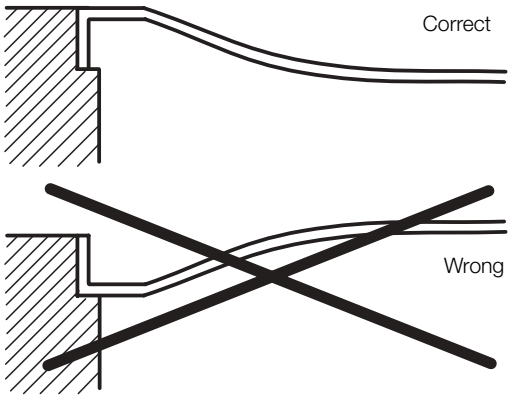


DN 250 CF: 32 bolts M8 x 40
Installation torque per bolt 25^{+5} Nm
Bolt quality: 10.9 according to
EN ISO 898-1 with coating
0,2% yield strength > 900 N/mm^2

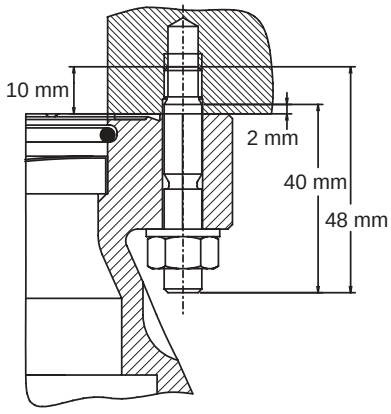
Fig. 28 Connection elements, installing the splinter guard and fixing the intake flange for the MAG W 2200

MAG W 2800





Caution
Install the splinter guard as shown. Installing the splinter guard upside down may lead to contact between splinter guard and rotor during fast venting of the pump.



DN 250 CF: 32 bolts M8 x 40
Installation torque per bolt 25^{+5} Nm
Bolt quality: 10.9 according to
EN ISO 898-1 with coating
0,2% yield strength > 900 N/mm^2

Fig. 29 Connection elements, installing the splinter guard and fixing the intake flange for the MAG W 2800

2.1 Unpacking - storing - transportation

Keep the packaging

Remove the equipment from the transportation box and keep the packaging. Make sure that the product has not been damaged during transportation. If this unit is damaged contact your carrier and inform Leybold if necessary. For storage of the product, use the packaging provided.

Lift the pump by the crane eyelets.

You can position the pump on the base plate for transport with a lift-truck. Protect the pump against slipping and tipping over.

Caution

Be careful not to damage the sockets and coolant connections during transportation.

Warning

Do not stand below the pump while connecting or removing the MAG.

The MAG is shipped in a sealed PE bag with desiccant. Do not open the sealed package until immediately before installing.

Do not remove the covers and blanking flanges until you are ready to make the connections, to ensure that the MAG is installed under the cleanest possible conditions.

2.2 Operating environment

Magnetic field

When using the MAG inside a magnetic field, the magnetic induction at the pump housing must not exceed 5 mT; (1 mT (milliTesla) = 10 G (Gauß))

Exceeding this limit can cause excessive rotor heating due to the eddy currents generated in this situation. It is therefore necessary to provide suitable shielding in such cases.

Radiation

The standard version of the MAG is resistant to radiation at levels up to 10^3 Gy. (1 Gy (Gray) = 100 rad)

The ambient temperature must not exceed 40 °C (104 °F).

The noise level when the pump is running is below 70 dB(A) (EN ISO 2151). No acoustic insulation is required.

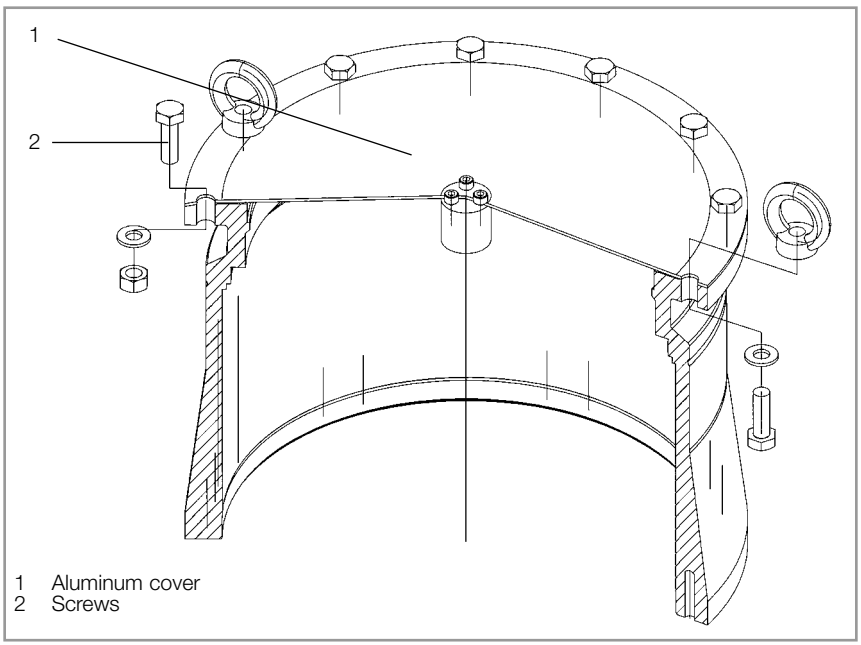


Fig. 30 Removing the transport seal

2.3 Connecting the MAG to the vacuum chamber

The MAG is shipped in a sealed PE bag with desiccant. Do not open the package until immediately before installing.

Do not remove the covers and blanking flanges until you are ready to make the connections, to ensure that the MAG is installed under the cleanest possible conditions.

Pay attention to maximum cleanliness when connecting.

Remove the transport seal from the intake flange. To do so unscrew the screws (30/2) and remove the aluminum cover. We recommend saving the transport seal for maintenance.

Splinter guard

Foreign objects entering the pump through the high-vacuum flange can cause serious damage to the rotor. That's why the splinter guard must always be installed.

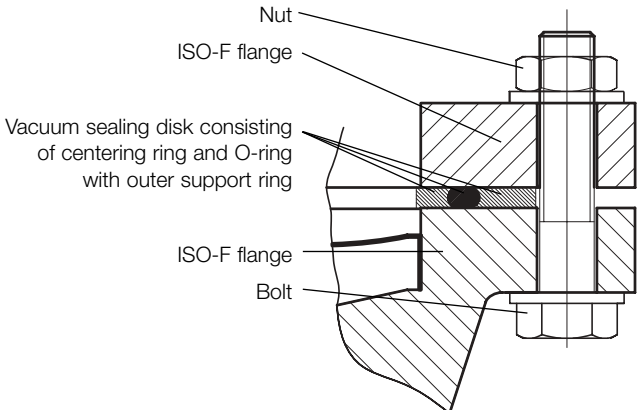
Damages caused during operation without the splinter guard are excluded from warranty.

Warning

The pump must be securely attached. If the pump should suddenly seize, inadequate attachment could cause the pump to break away or allow internal pump parts to be discharged. Never operate the pump (in bench tests, for instance) without its being connected at the vacuum chamber.

If the pump should suddenly seize, a high decceleration torque will have to be absorbed by the system. To accomplish this, use all bolts provided by Leybold for fastening the high-vacuum flange or use bolts of the prescribed quality; see also the Fig. 20 to 29 and 31 to 33.

Pumps with ISO-K flange must not be attached with clamps.



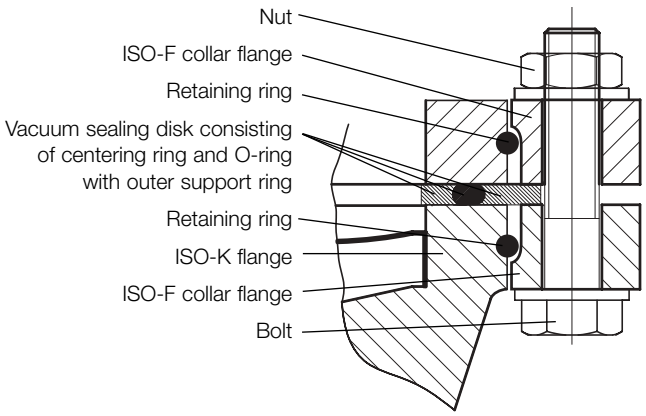
DN 160 ISO-F: 8 bolts M 10 x 50
Installation torque per bolt 35 +5 Nm

DN 200/250 ISO-F: 12 bolts M 10 x 50
Installation torque per bolt 35 +5 Nm

DN 320 ISO-F: 10 bolts M 12 x 50
Installation torque per bolt 45 +5 Nm

Bolt quality:12.9 according to
EN ISO 898-1 with coating
0,2% yield strength > 1080 N/mm^2

Fig. 31 **ISO-F connection with bolts and nuts**



DN 250 ISO-K: 12 bolts M 10 x 50
Installation torque per bolt: 35 +5 Nm
Bolt quality:12.9 according to
EN ISO 898-1 with coating
0,2% yield strength > 1080 N/mm^2

Fig. 32 For the MAG with ISO-K flange: **Clamped flange connection with collar flanges**

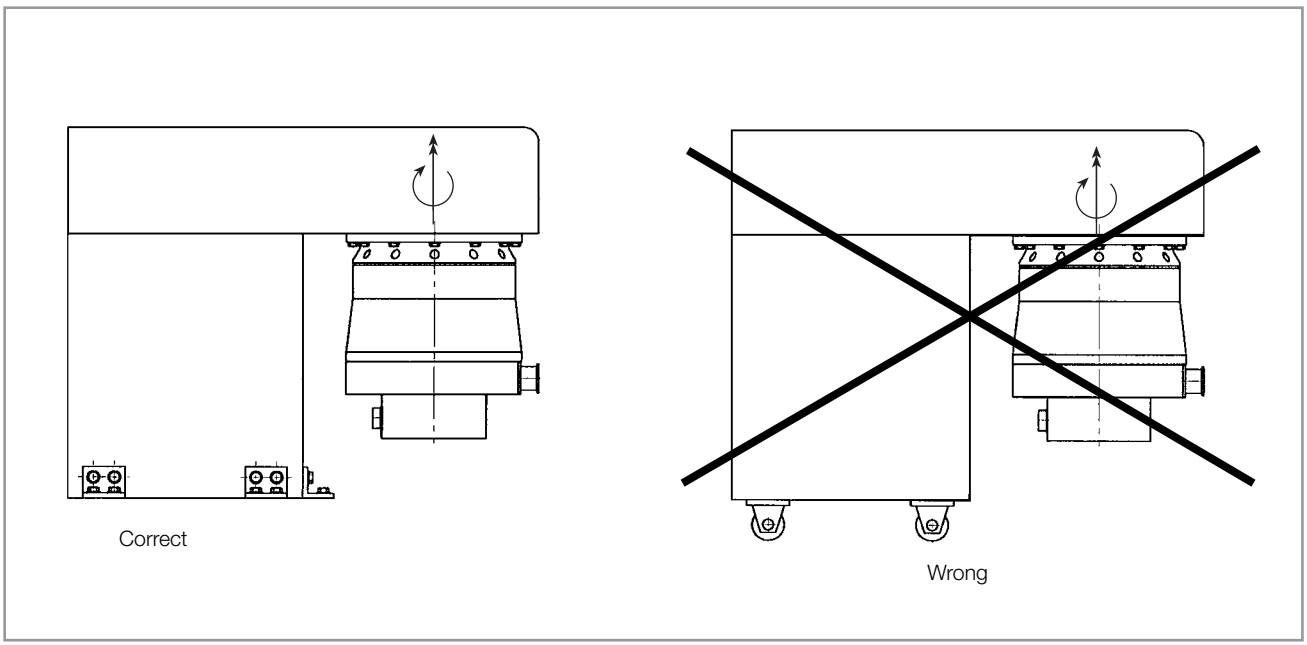


Fig. 33 Vacuum chamber fixed to the floor

Mount the MAG as close as possible to the vacuum chamber. If the MAG is permanently flanged to a vacuum chamber with a weight exceeding 500 kg, it will not be necessary to secure it in any other way.

The vacuum chamber must be securely attached to the floor or a solid wall.

In case of lighter vacuum vessels secure the pump additionally. The pump's bottom is equipped with tappered holes for fastening a support; see dimensional drawings.

Earthquake protection

For earthquake protection fix the pump as shown in Fig. 20 to 29. Depending on the chamber's weight and fixing use the boreholes in the pump's bottom in addition. The standard fixing for the converter is shown in Fig. 10.

Vibration influence

If several turbomolecular pumps are installed to the vacuum chamber of the same system, there is the risk of interference (vibration interference between the pumps). If such a risk exists please contact Leybold Vacuum Application Support.

Isolation valve

We recommend installing an isolation valve between the pump and the chamber. The valve should be closed during wet cleans of the chamber and in case of pump failures which will lead to a pump shut down. The valve should normally be closed with power off.

Warning

The basic flange heater can become so hot during operation (> 85 °C, > 185 °F) that it represents a burn hazard:

Provide protection against contact with the hot components.

1 Turbomolecular pump
2 Forevacuum gauge point
3 Backing pump
4 Anti-vibration bellows
5 Forevacuum valve
6 High vacuum valve
7 Purge gas connection
8 Valve in the roughing line
9 Electronic frequency converter

— — — — roughing line; recommended if shorter cycle times are to be achieved

— · — · — · — · DRIVE/BEARING and TMS cable

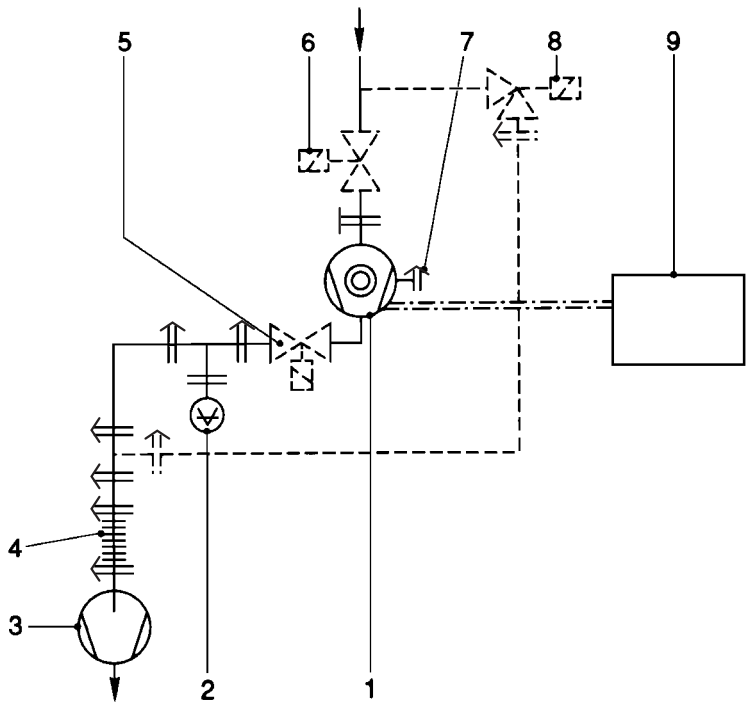


Fig. 34 Layout of a turbomolecular pump system

2.4 Connecting the backing pump

A two stage rotary vane pump or dry-compression backing pump is required to support operation of the MAG.

In case of high gas throughput, it may also be necessary to use a roots blower to achieve the backing pressure necessary for operating the MAG.

Fig. 34 shows schematically the design of a pump system incorporating a MAG with an additional foreline valve and an isolation valve between chamber and MAG.

Foreline valve

The foreline isolation valve is recommended to protect the MAG from shock venting in case of uncontrolled shut down of the backing pump. This valve must be able to close fast enough to avoid pressure increase in the MAG.

In case of an oil-sealed backing pump the foreline isolation valve protects the MAG from backstreaming oil vapor during standstill.

Connect the forevacuum flange of the MAG to the backing pump.

The torque on the forevacuum connection flange must not exceed the values shown in Fig. 35.

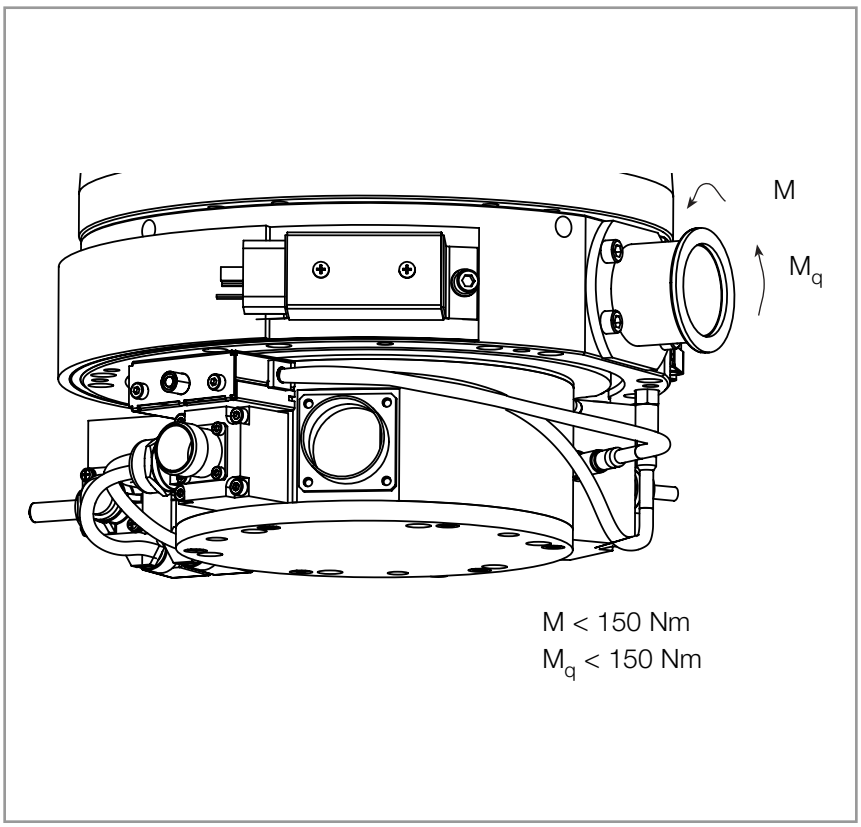


Fig. 35 Maximum torques for the forevacuum connection

The forevacuum line must be tight. Hazardous gases can escape at leaks or the gases being pumped can react with the air or humidity. We recommend a leak check.

Warning

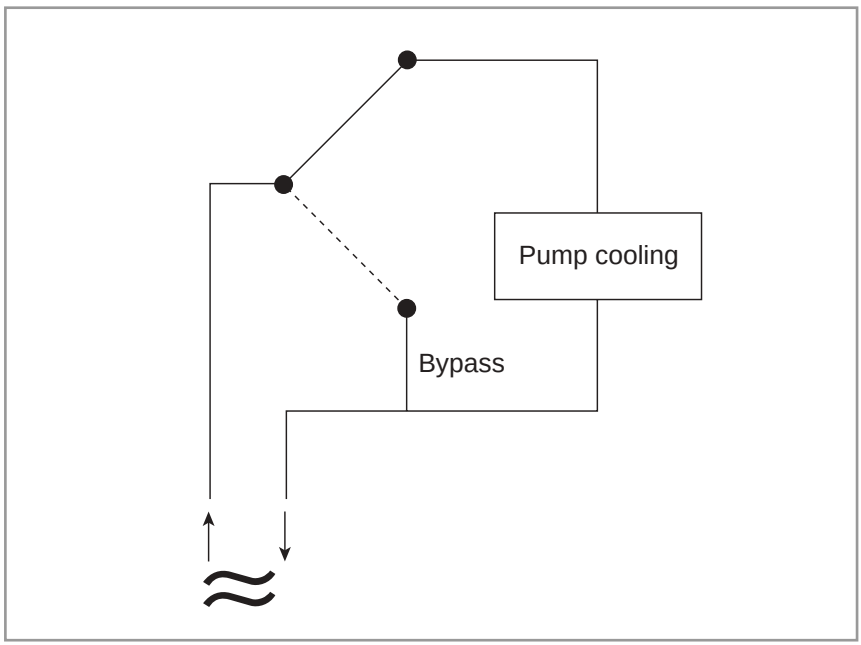


Fig. 36 Schematic of the cooling water flow for MAG (W) 1500, 2800, 3200 CT

2.5 Connecting the cooling water

Cooling water specifications

Inlet temperature	10 - 30 °C
Inlet pressure	2 to 7 bar absolute
Cooling water requirement	See Fig. 38
Appearance	Colorless, clear, free of oils and greases
Sediments	< 250 mg/l
Particle size	< 150 µm
Electrical conductivity	< 500 µS/cm
pH value	7 to 8.5
Overall hardness (total alkaline earths)	max. 20 ° German hardness scale (= 3.57 mmol/l)

Further information on request.

Connect the cooling water to the connectors; see Fig. 37.

Caution for CT versions

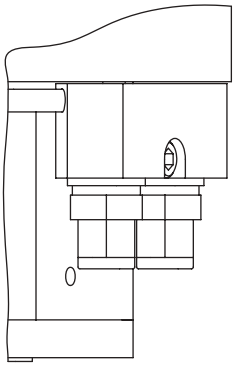
The CT versions have a cooling water bypass.

Make sure that you **do not mix up** the inlet and the outlet connection.

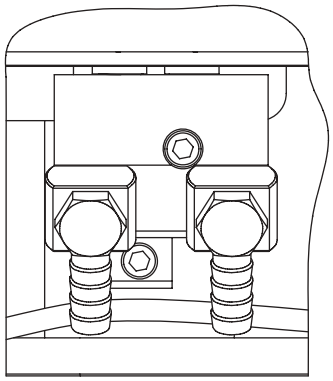
Turn off the cooling water supply when the pump is switched off in order to avoid condensate formation in the pump.

If you do not close the cooling water it may take longer to achieve ultimate pressure after start up of the system.

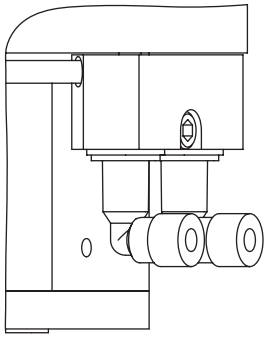
No cooling water is reqired when operating the pump at ultimate pressure. Cooling water is only reqired when baking out the pump.



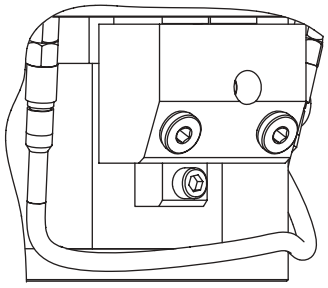
Swagelock tube fitting
for tube 1/4“



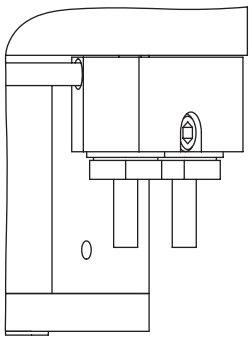
Stainless steel
hose nipples 1/2“



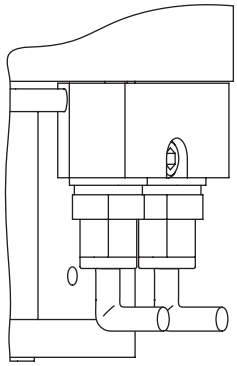
John Guest fitting
for hose
6 mm OD



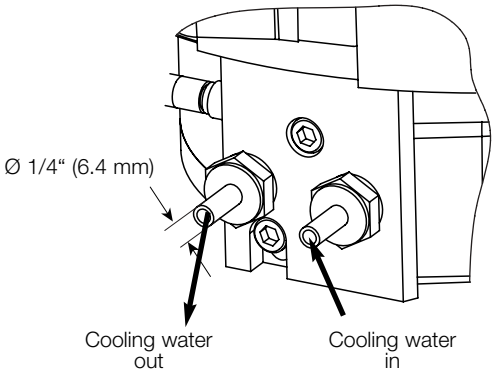
Thread G 1/8“



Swagelock tube 1/4“



Swagelock tube 1/4“
(bended)



Swagelock tube 1/4“

Do not mix up the inlet and the outlet!

Fig. 37 Connecting the cooling water

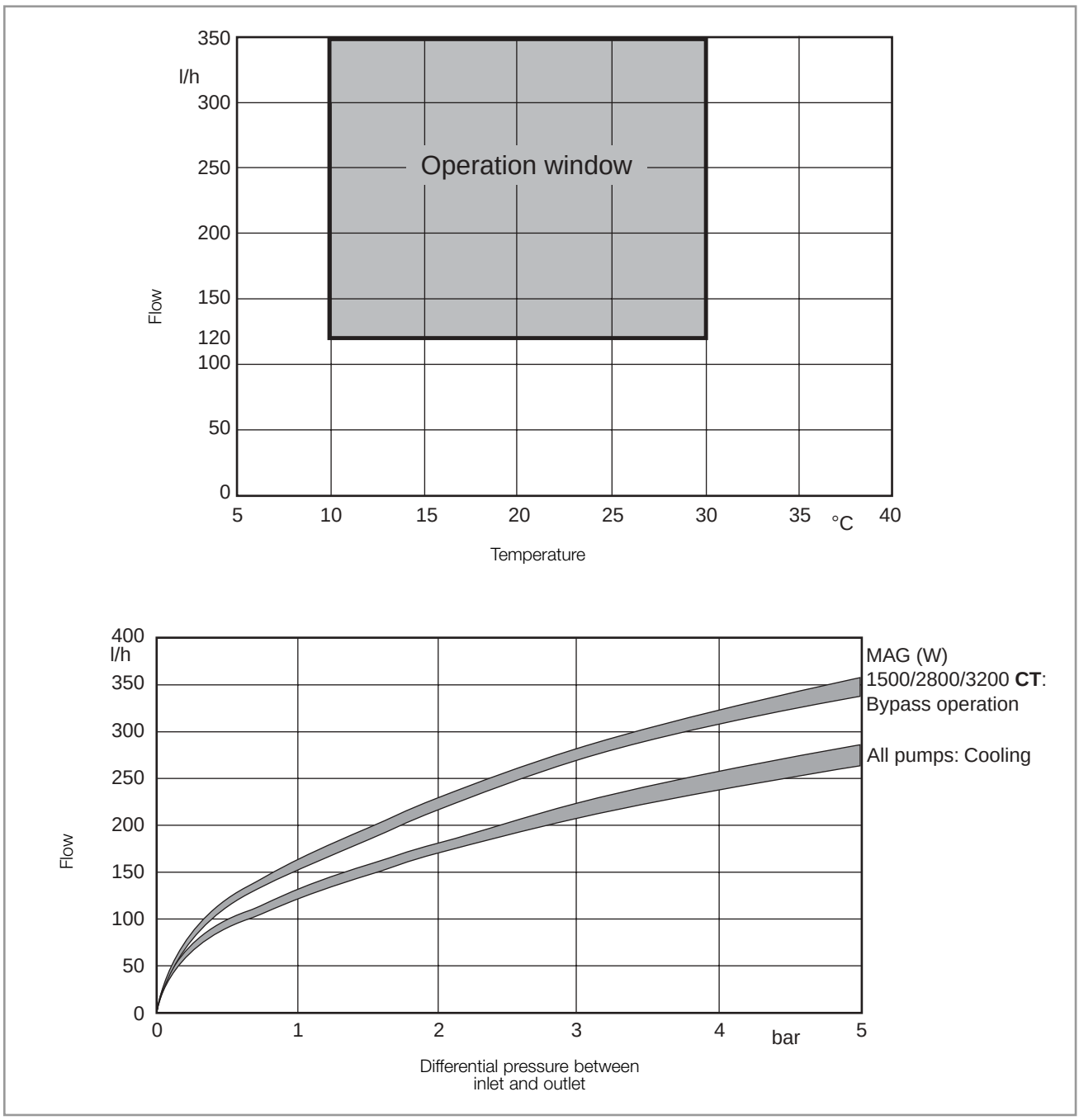


Fig. 38 Recommended cooling water flow

2.6 Connecting the purge gas

Please contact Leybold for assistance in making the decision as to which media can be pumped with or without purge gas.

In processes which require purge gas the pump will have to be vented, when it is switched off, through the purge gas port.

Suited are all gases,

- which will not cause corrosion or pitting in aluminium and steel and
- which in connection with process deposits in the pump will not cause corrosion or sticking.

For venting and as the purge gas we recommend inert gases like nitrogen or argon. The temperature of these gases should be between 5 °C and 80 °C , max. relative humidity should not exceed 10 ppm.

In individual cases and after consultation also dry, filtered, oil-free air or filtered ambient air may be used (filter mesh < 1µm). In this case connect a filter to the purge gas and venting valve; see Fig. 42

Change the filters after some time, at least annually.

Different venting methods are described in Chapter 3.1.

Monitor the purge gas supply continuously.

Insufficient purge gas flow can result in:

- Process gases entering the motor and bearing area of the MAG
- Process gases escaping from the purge gas inlet
- Humidity entering the pump.

Warning

Inadequate purge gas flow voids the warranty.

Pumps with purge gas valve (MAG (W) 1500 CT, W 2200 C, W 2800 C/CT, W 3200 CT)

The MAG is equipped with a purge gas and venting valve. It is controlled by the MAG.DRIVE*digital*.

The purge gas and vent valve

- regulates the flow of purge gas, at supply pressures of between 1.5 and 6.0 bar (absolute), to the pump, keeping pressure at a constant value and
- provides for safe pump venting.

The flow of purge gas into the pump keeps aggressive or corrosive media and dust from entering the motor and bearing area.

Refer to Figure 39 for details on the design and function of the purge gas and vent valve assembly.

Attach the purge gas hose to the nipple and secure with a hose clamp.

Set purge gas pressure for a value of 1.5 to 6.0 bar, absolute.

Use in the purge gas supply system only valves which can handle both the low purge gas flow and the much greater venting gas flow.

Caution Purge gas inlet pressure exceeding 10 bar can damage or destroy the purge gas and vent valve.

With no voltage applied the purge gas and vent valve is closed.

The purge gas and vent valve will be open when switching on the MAG.DRIVE*digital*. The red LED at the purge gas valve lights.

Technical data

Purge gas pressure, absolute	1.5 to 6.0 bar
Purge gas	Nitrogen or similar
Max. moisture content	10 ppm
Purge gas flow	36 sccm ± 5 sccm (36 sccm = 0.6 mbar·l/s)
Vent gas flow	$4800^{\pm 10\%}$ sccm
Leak rate	$< 10^{-7}$ mbar·l/s
Connection: VCR Nut	1/4“

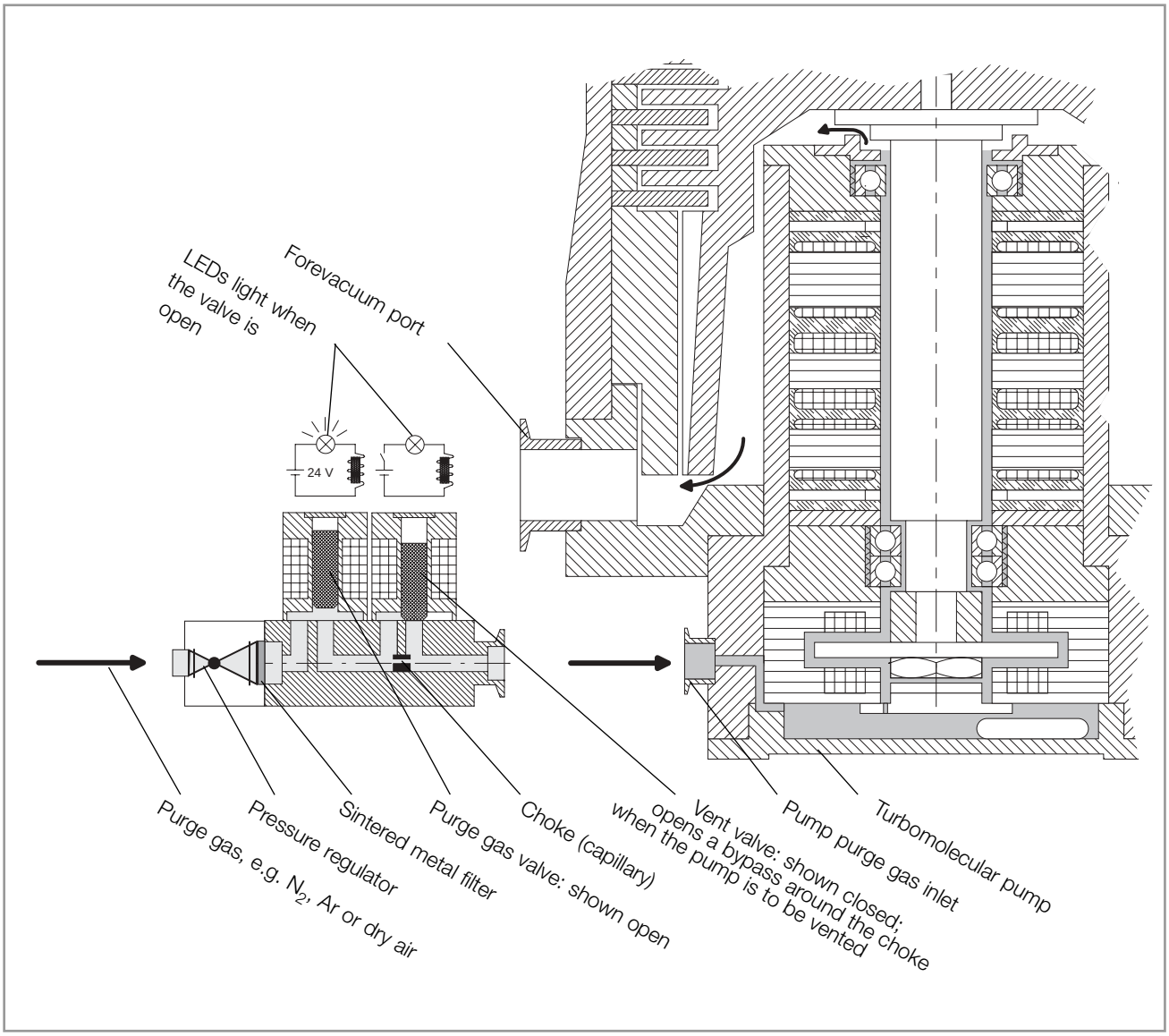


Fig. 39 Purge gas and vent valve assembly and turbomolecular pump (schematic)

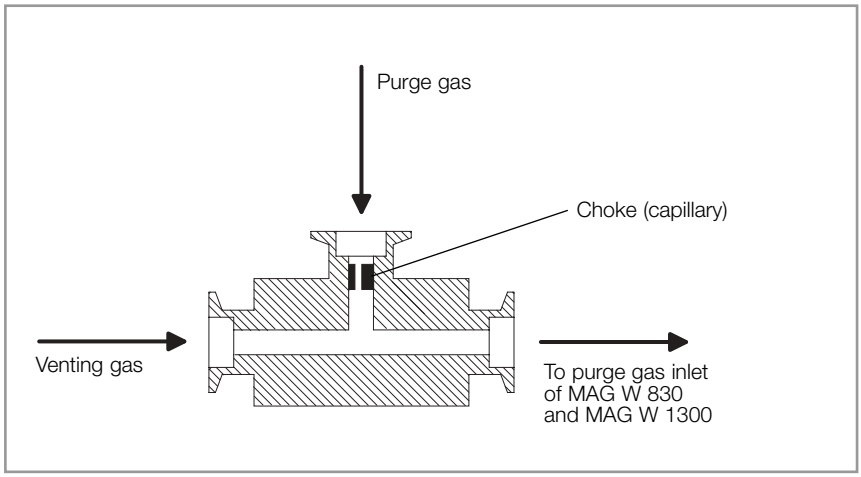


Fig. 40 Schematic drawing of the purge gas Tee

MAG W 1300 C,
Part No. 400110V0017:

Purge gas connection with capillary for flow reduction to 36 sccm at 1.5 bar abs.

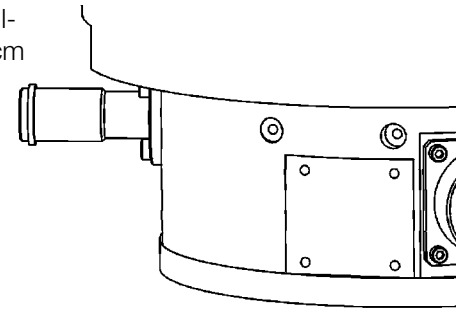


Fig. 41 Purge gas connection

Pumps without purge gas valve (MAG W 830 C, W 1300 C, W 2200 C, W 830, W 1300, W 2200, W 2800)

The MAG has a purge gas inlet VCR nut 1/4“ or DN 16 KF. The required purge gas flow is 36 sccm ± 5 sccm.

The pump needs an external purge gas control.

The optional purge gas Tee allows the throttled inlet of purge and venting gas. A purge gas pressure of 1.5 bar (abs.) will provide the required flow of 36 sccm ± 5 sccm.

The Tee and the the purge vent valve can be mounted to the MAG W 830 C, W 1300 C, W 830, W 1300, W 2200 and W 2800.

Caution The pumps without C in the name are not suitable for pumping corrosive and aggressive gases even when they are operated with purge gas.

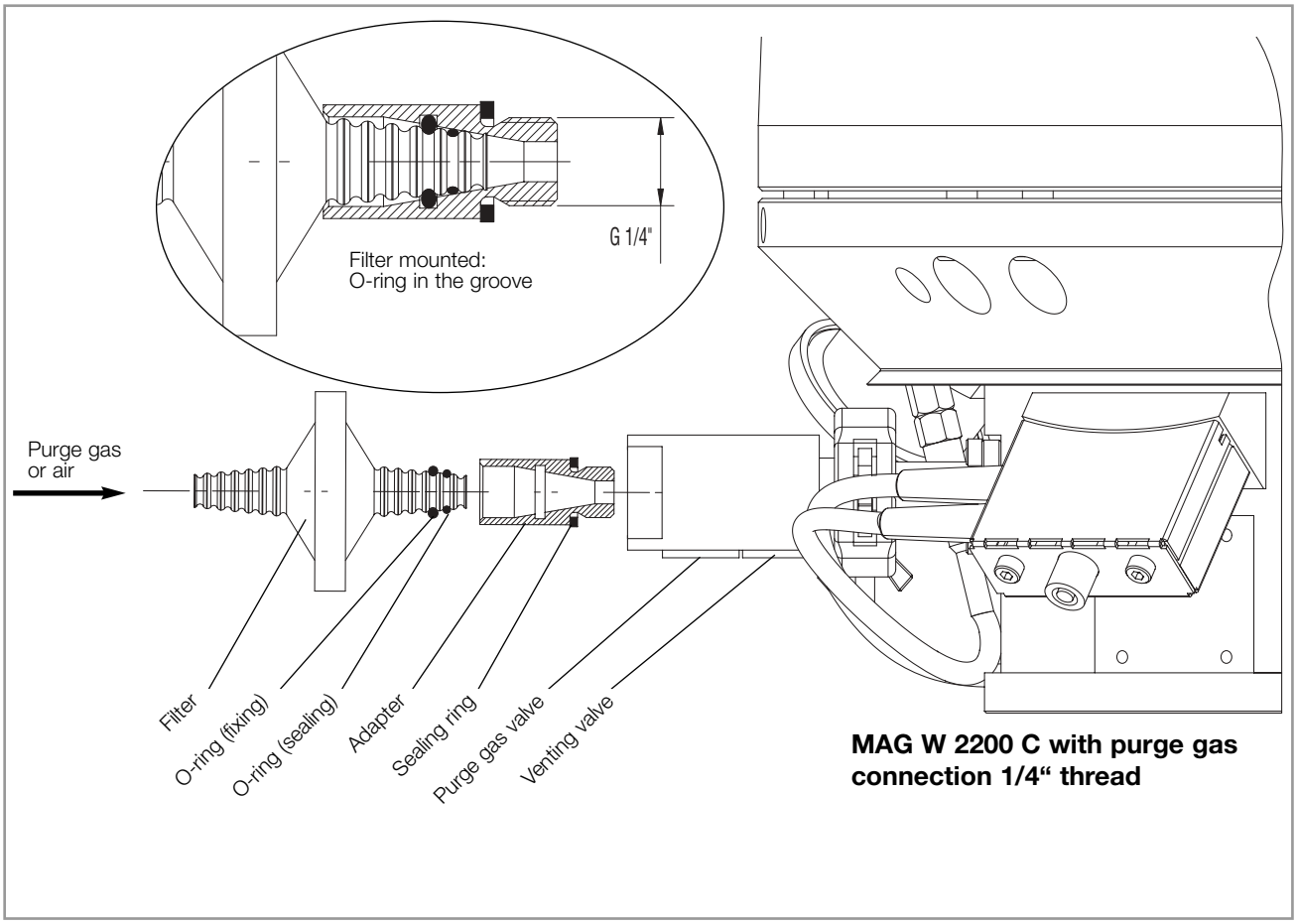


Fig. 42 Mounting the purge gas filter to the pump

2.7 Installing the MAG.DRIVE*digital*

The converter can be installed in a 19" cabinet. It is 1/2 of 19" wide and has 3 height units. For easier installation we offer an installation frame; see Section 1.7. If you use this installation frame, remove the converter's rubber feet when installing the converter.

Caution

In order to guarantee sufficient cooling, there must be a minimum clearance of 1 height unit (44.2 mm) at the bottom and 1 height unit at the top. During operation the temperature of the ambient air must not exceed 45 °C.

Warning

The pump may be operated only with a suitable frequency converter and a suitable connector cable.

Peak voltages of up to 130 V may be present at the connector line between the frequency converter and the pump; mains voltage is present at the heater.

Route all cables so as to protect them from damage.

The protection rating for the connectors is IP 30.

Do not expose the pump, the frequency converter or the connections to dripping water.

Install 16 A fuses for the converter.

When connecting the frequency converter to a polyphase network between two phases, provide additional external fuse protection for **both** phases (fuse amperage: 16 A). The external fuse must have a minimum rated braking capacity of 5 kA.

Warning

Only adequately trained electrical/electronic personnel may connect-up the equipment in accordance with valid IEC (international), EN (European) and/or national guidelines, or under their management and supervision.

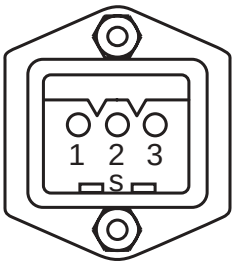
The connecting cables between the converter and pump may only be inserted or removed when the pump is switched off **and** stands still after the run-down procedure **and** the converter is isolated from the line supply.

Do not switch on frequency converter **until all cables** have been connected properly.

Unauthorized opening of the converter voids the warranty.

Hazardous voltages are present inside the converter. Death or severe injury can occur if you come into contact with these hazardous voltages. Before opening the converter, isolate the converter from the line supply, and lock the switch so that it cannot be accidentally switched on again.

In addition the pump has to stand still because it works as generator as long as it rotates, **and** the pump cables have to be disconnected.



1 = Phase L
2 = Not assigned
3 = Neutral N

Fig. 43 Connector assignment X19, supply connection

Installation instructions to maintain EMC

The MAG.DRIVE*digital* complies with the Electromagnetic Compatibility (EMC) Directives of the EC. In order to maintain this the following installation instructions must be observed:

- To connect the pump to the converter the prescribed Leybold cables must be used.
- The connection cables to the analog interface (control plug X14) and to the serial interface (connector X7) must be shielded. The shields must be connected to the metal housings of the SUB-D-connector and SUB-D-socket.

2.7.1 Power supply connection X19

The converter is ready to be connected to line supply voltages between 200-240 V 50/60 Hz. The connection is established using the power cable supplied, which is inserted at connector X19 at the rear of the converter.

Caution

The converter will be damaged if it is operated with the incorrect supply voltage.

2.7.2 Pump connection

Warning

To avoid contact with hazardous voltages in case of malfunction the pump must be connected to PE.

Connect the converter (X20) to the motor and magnetic bearing connection of the pump (X23) and the PK communication connection (X24) using the DRIVE/ BEARING cable.

Connect the converter (X21) to the TMS connection (X30) using the TMS cable.

Also refer to Fig. 46.

Make sure that you have fixed all cables properly.

2.7.3 Control plug X14

Emergency off

Make sure that pins 47 and 48 are connected via a jumper if you don't connect an emergency off switch.

A plug for the control plug X14 with a jumper connected between pins 47 and 48 is included in the standard specification.

Description of the Emergency Off connection

Pins 47 and 48 of control plug X14 make it possible to disable the output stage of the frequency converter via the hardware. The power flow to the motor is then interrupted.

The two pins must be connected to each other to ensure proper operation.

If the two pins are to be monitored by the system control, a floating (dry) contact must be available on the system side; load carrying capacity: 42 VDC, 100 mA.

The contact used and the connecting cable **must** be protected against line supply voltage through double or reinforced insulation such that no hazardous contact line supply voltage can be applied to pins 47 and 48 in the event of a fault.

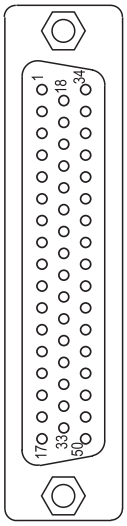
Relay outputs

The MAG.DRIVE*digital* converter has 9 relay outputs. They have changeover contact. Five relay outputs are permanently assigned a signal.

- Failure
- Normal operation
- Warning
- Acceleration
- Deceleration

The option relays can output one of the following signals:

- Threshold bearing temperature reached
- Threshold motor current reached
- Threshold frequency reached
- No cooling water
- No purge gas
- TMS temperature OK
- Vent
- Start command applied
- Power supply O.K.
- Pump standstill
- Stand-by



X14 50 pole Sub-D I/O

PIN	SIGNAL	
1	Relay 1 n.o.	FAILURE
2	Relay 2 n.o.	NORMAL OPERATION
3	Relay 3 n.o.	WARNING
4	Relay 4 n.o.	ACCELERATION
5	Relay 5 n.o.	DECELERATION
6	Relay 6 n.o.	OPTION
7	Relay 7 n.o.	OPTION
8	Relay 8 n.o.	OPTION
9	Relay 9 n.o.	OPTION
10	GND	
11	Dig. input	REMOTE/LOCAL
12	Dig. input	START/STOP
13	Dig. input	TMS OFF
14	Dig. input	PURGE GAS OFF
15		
16	Analog input	1
17	Analog input	2
18	Relay 1 com.	FAILURE
19	Relay 2 com.	NORMAL OPERATION
20	Relay 3 com.	WARNING
21	Relay 4 com.	ACCELERATION
22	Relay 5 com.	DECELERATION
23	Relay 6 com.	OPTION
24	Relay 7 com.	OPTION
25	Relay 8 com.	OPTION
26	Relay 9 com.	OPTION
27	GND	
28	+15V	
29	+15V	
30	GND	
31	GND	
32	Analog_GND	
33	Analog_GND	
34	Relay 1 n.c.	FAILURE
35	Relay 2 n.c.	NORMAL OPERATION
36	Relay 3 n.c.	WARNING
37	Relay 4 n.c.	ACCELERATION
38	Relay 5 n.c.	DECELERATION
39	Relay 6 n.c.	OPTION
40	Relay 7 n.c.	OPTION
41	Relay 8 n.c.	OPTION
42	Relay 9 n.c.	OPTION
43	GND	
44	Dig. input	VENTING ON
45	Dig. input	Option 1
46	Dig. input	Option 2
47	Dig. input	EMERGENCY OFF
48	Dig. input	EMERGENCY OFF
49		
50	Analog output	

n.o. = normally open
com. = common
n.c. = normally closed

Fig. 44 Assignment control plug X14

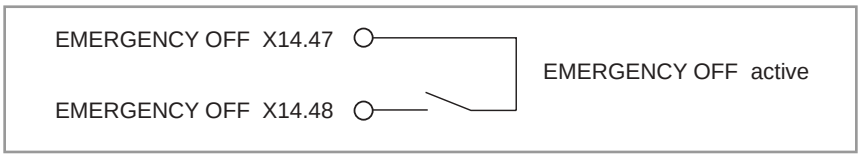


Fig. 45 Control plug X14: Emergency off

The selection of signals for the option relay and the adjustment of their thresholds can be achieved via the operator control menu; see Section 3.10.4.

Analog output

The converter has an analog output which provides an analog signal (0..10 V) with a 10-bit resolution. The analog output function can be alternatively used to output

motor current

actual frequency

motor temperature

rotor displacement signals (PW24, PV13, PZ12)

The output value can be increased or reduced by a scale factor; see Section 3.10.4 Set Converter.

Analog inputs

The converter has two analog inputs with a 10-bit resolution.

Input signal: 0...10V

A supplementary function can be set for analog input 2 via the operator control menu; see Section 3.10.4:

No function: The input signal can be output via the serial interface.

Frequency setpoint: In addition to the function described above, the drive frequency setpoint is entered via analog input 2.

Digital inputs

The converter has 5 digital inputs with the following functions:

TMS OFF

Purge gas OFF

Vent ON

Option 1 / 2

The functions are active if a High signal (15 V; e.g. Pins 28 or 29) is connected at the digital input.

The functions for Option 1 / 2 are set in the operating menu; see Section 3.10.4 Set Converter.

Remote

Start (if Remote is active)

The functions Start and Remote are active if a Low signal (GND; e.g. Pins 27 or 43) is connected at the digital input.

2.7.4 Interface connector

A 9-pin sub-D socket is provided at the front panel. The connector X7 is assigned the serial interface RS 232. It is only to be used by the Leybold Service.

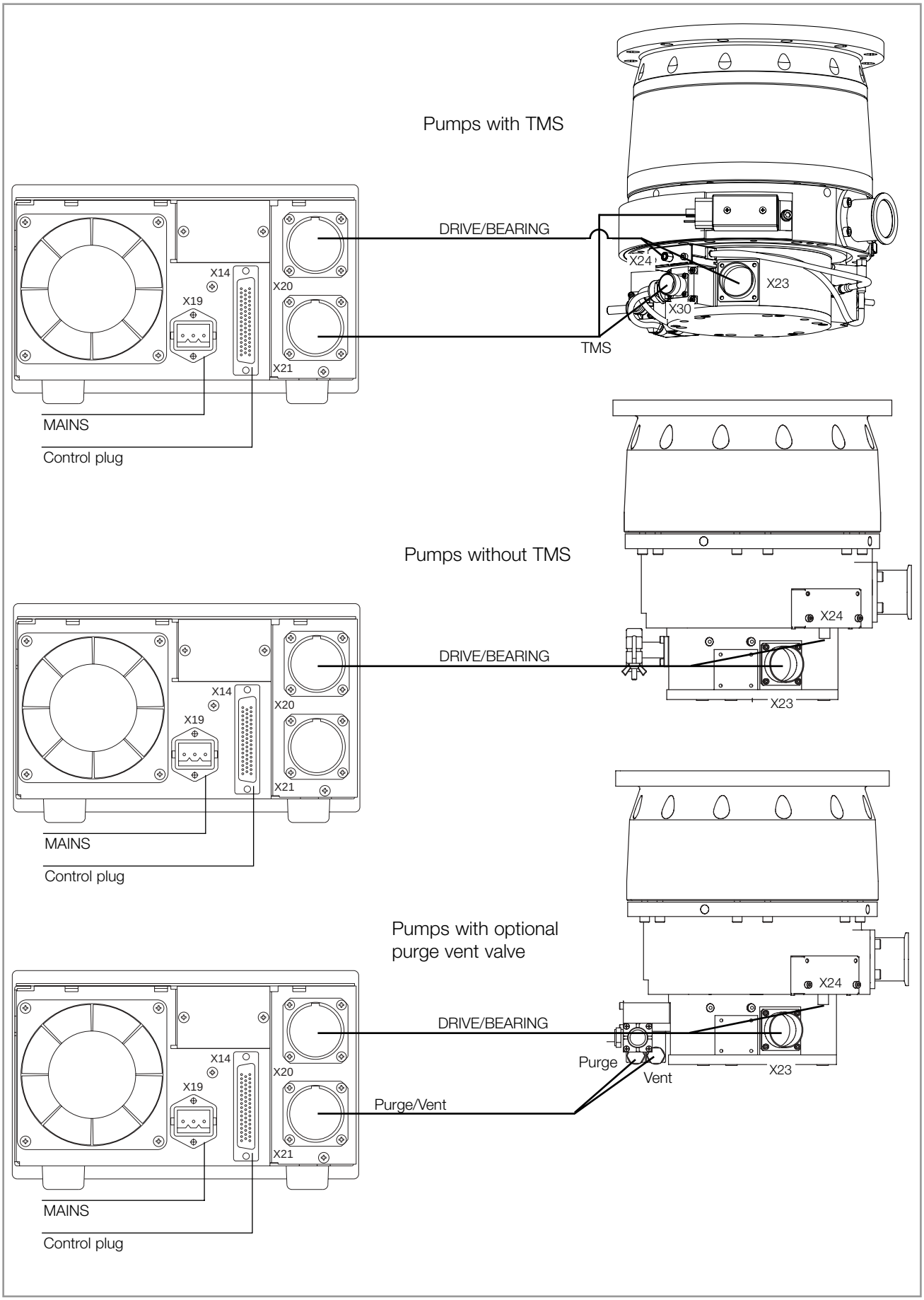


Fig. 46 Block wiring diagram

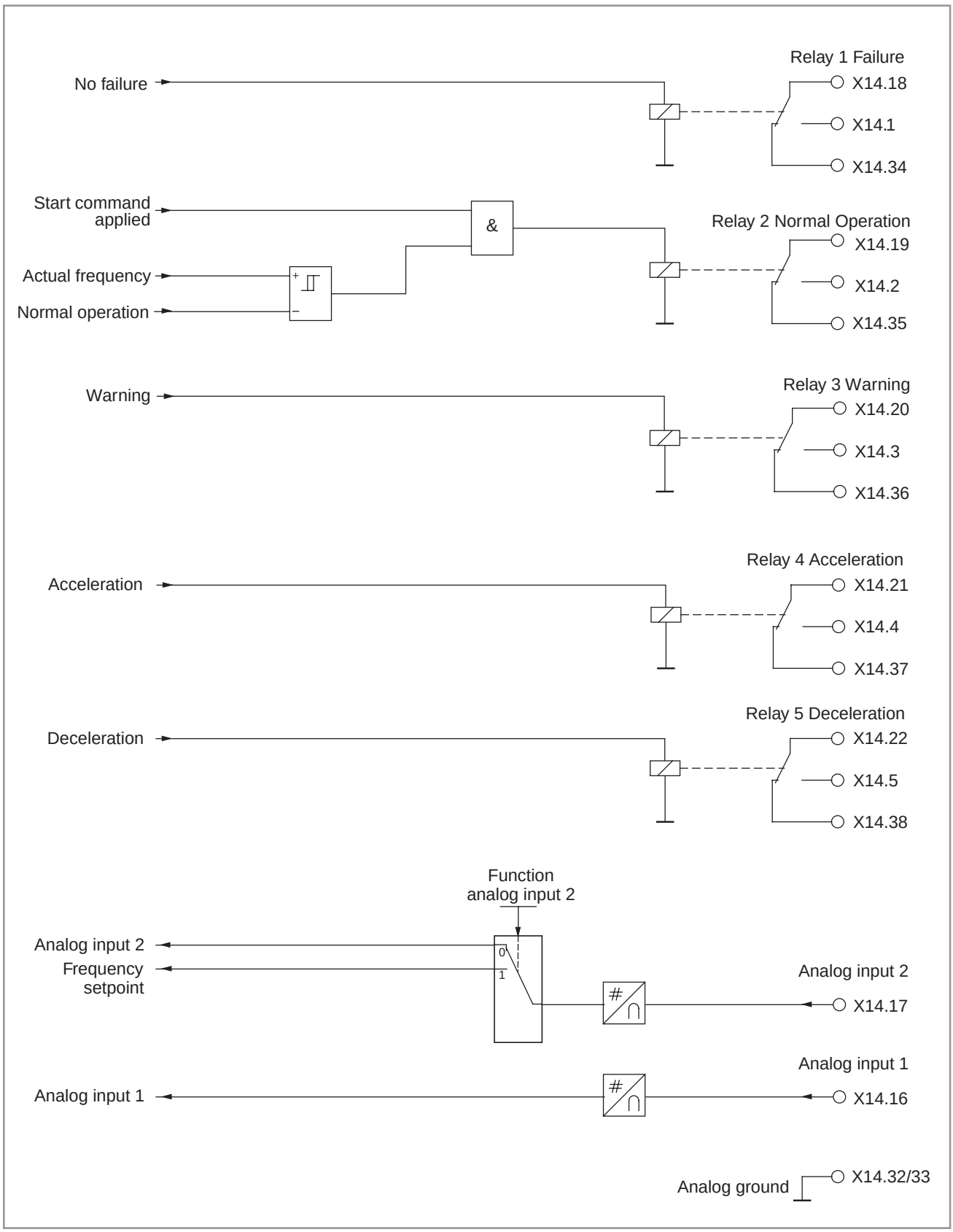


Fig. 47 Function diagram outputs, Part 1 & inputs

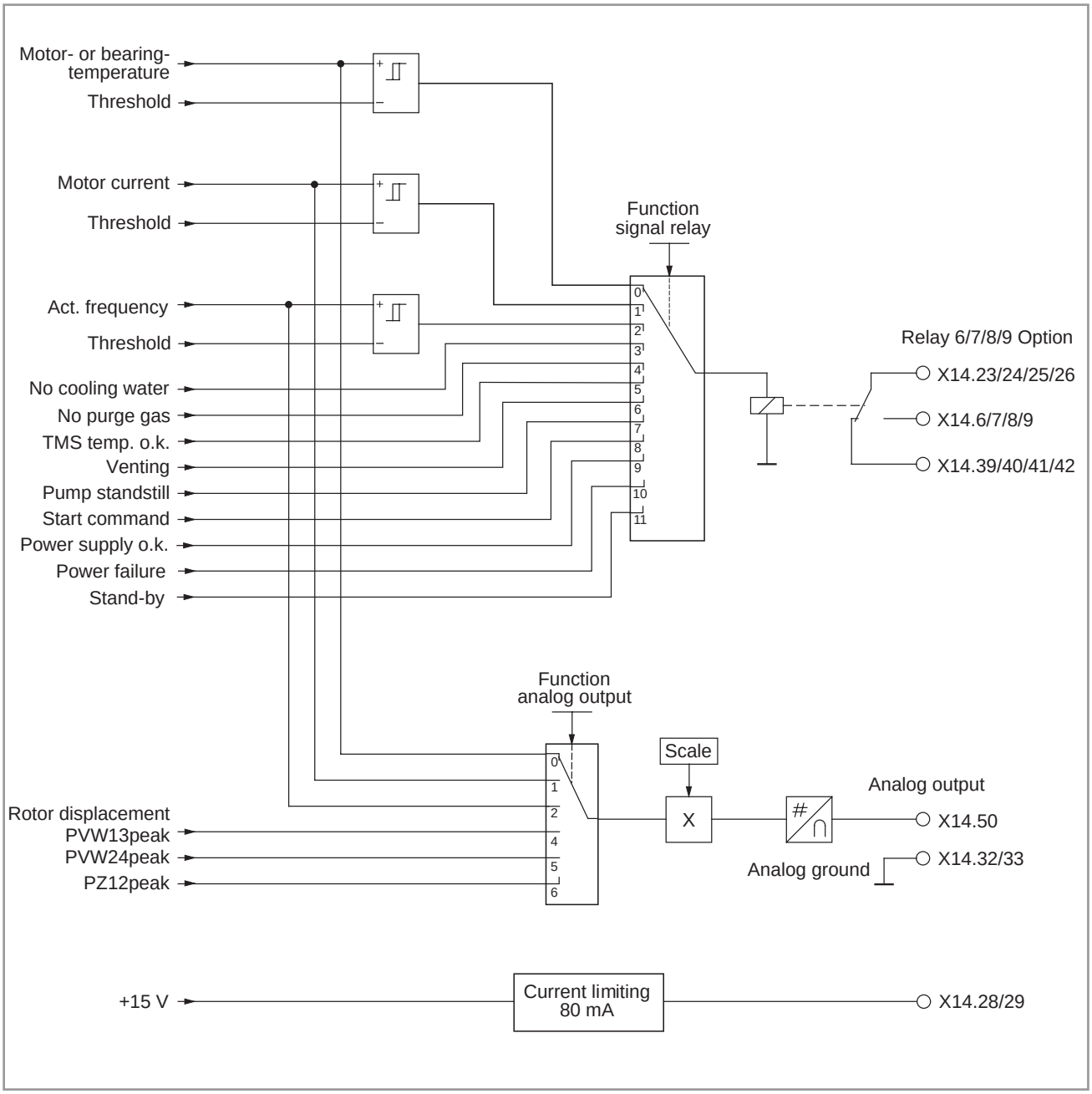
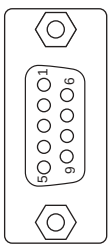


Fig. 48 Function diagram outputs, Part 2



1 +5V Power supply for plug-in control
2 TXD
3 RXD
4 n.c.
5 GND
6 -5V Power supply for plug-in control
7 Reset out for plug-in control
8 select plug-in control input
9 Boot input

Fig. 49 Connector assignment, interface X7 (front side)

3 Operation

3.1 General operation rules

Protecting the touch-down bearings

The magnetic bearing in the MAG are immune to wear. In addition to the magnetic bearings, the MAG is equipped with touch-down bearings which protect the rotor against mechanical contact with the stator if the pump is subjected to external shock loading or when the pump is switched off. These touch-down bearings have a limited service life. Please observe the following in order to obtain maximum service life.

- Avoid shock and vibrations (e.g. from other pumps) when the pump is running. Shocks perpendicular to the rotation axis are particularly harmful. If the pump appears to be running in the mechanical bearings continuously it is switched off.
- Do not suddenly expose the MAG to an already evacuated vacuum chamber. The pressure surge may cause the rotor to make contact with the touch-down bearings. This will cause increased wear.
- Do not disconnect the MAG and MAG.DRIVE while they are operating. If MAG and MAG.DRIVE have been disconnected accidently re-connect them.
- Do not stop the MAG with the mains. Use the STOP key or a stop command. Switching off the mains while the pump is running will wear out the touch down bearings.

The pump may make noise during the run-up and run-down phases. This has neither an influence on the pump nor on the process.

Warning

Monitor the purge gas continuously.

Insufficient purge gas flow can result in:

- Process gases entering the motor and bearing area of the MAG
- Process gases escaping from the purge gas valve
- Humidity entering the pump.

Refer to Section 2.6.

Warning

The pump can become so hot during operation that it represents a burn hazard:

Frequent acceleration and deceleration of the pump or operating cycles between stand-by and normal operation put pressure on the rotor. Therefore it has to be changed after 5000 start or stand-by cycles.

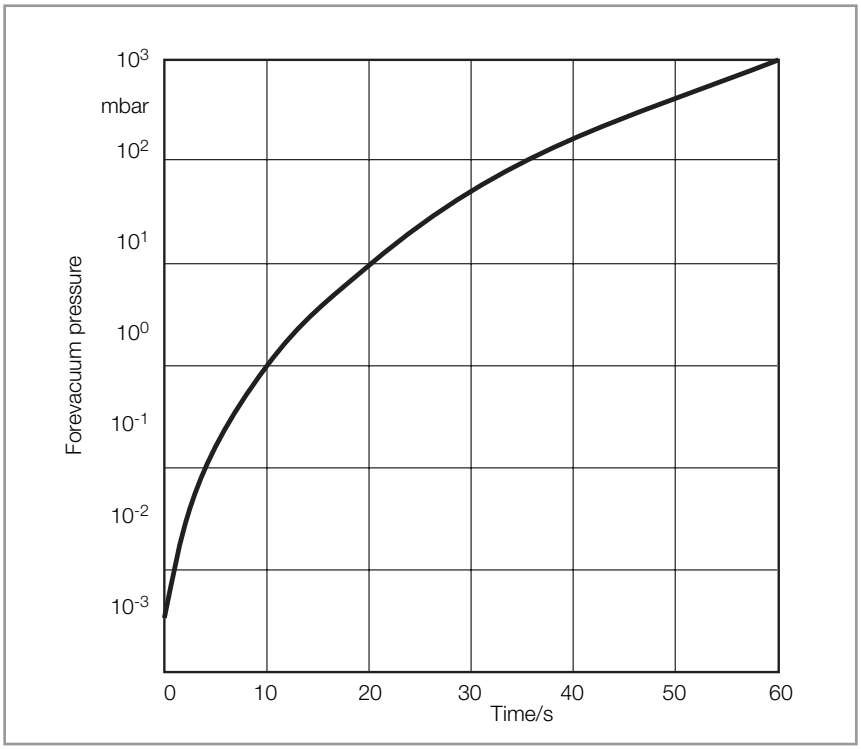


Fig. 50 Curve for safe venting of the MAG; pressure rise as a function of venting time

Venting

As to suitable gases, see Section 2.6.

Venting Method

The pump must be vented via the **purge gas and venting valve** or the **vent port** when shutting the pump down.

When additionally venting the vacuum chamber, the venting function of the purge gas and venting valve must be opened before opening the chamber valve. This will ensure the presence of a higher pressure in the magnetic bearings compared to the remaining vacuum area. This will prevent particles, dust or aggressive gases from being forced into the not yet vented motor chamber of the pump.

Speed of the pressure rise

All turbomolecular pumps may be vented at full speed. However, the pressure must not increase faster than specified through the pressure rise curve.

The pump must be vented significantly slower when there is the risk of particles entering into the pump from the process. During venting, the flow must be of the laminar type in both the vacuum chamber and the turbomolecular pump.

The pump must not be vented to pressures above atmospheric pressure.

3.2 Temperature Management System

Function description

only for MAG ... CT

The TMS is only in function, when a MAG C**T** version is connected. The heater will be activated when the mains is switched on. The TMS controls the heating and water cooling to maintain the pump at the specified setpoint temperature.

In order to maintain an almost homogeneous temperature distribution in the pump the system is equipped with several temperature sensors. The measured values of these sensors are used to determine two temperatures for the TMS: T_{TMS} and T_A. Both temperatures are used to switch on and off the heater and the cooling water valve.

Switching points

Heater OFF → ON	$T_{TMS} < T_{set} - 1$ K
Heater ON → OFF	$T_{TMS} > T_{set} + 1$ K
Cooling OFF → ON	$T_A > T_{set} + 2$ K
Cooling ON → OFF	$T_A < T_{set} + 1$ K
TMS ok	$T_{set} - 5$ K ≤ T_{TMS} ≤ $T_{set} + 5$ K
Warning TMS	$T_{TMS} > T_{set} + 5$ K

Settings

The temperature (TMS) setpoint can be programmed via the front panel keys at every time.

Principally the factory presetting will be used. The setting is saved in the pump's memory chip. Before changing any setpoint value request Leybold!

For the setting refer to 3.10.6 Operating menu, Set TMS.

Heat up

The setpoint temperature will be reached within 30 to 60 minutes depending on cooling and environmental conditions. For temperature sensitive applications observe the cooling water specifications (refer to Section 1.6 and 2.5).

Caution

In order to guarantee correct temperature setting of the pump it is required to provide the cooling water within the envelope described in Section 2.5.

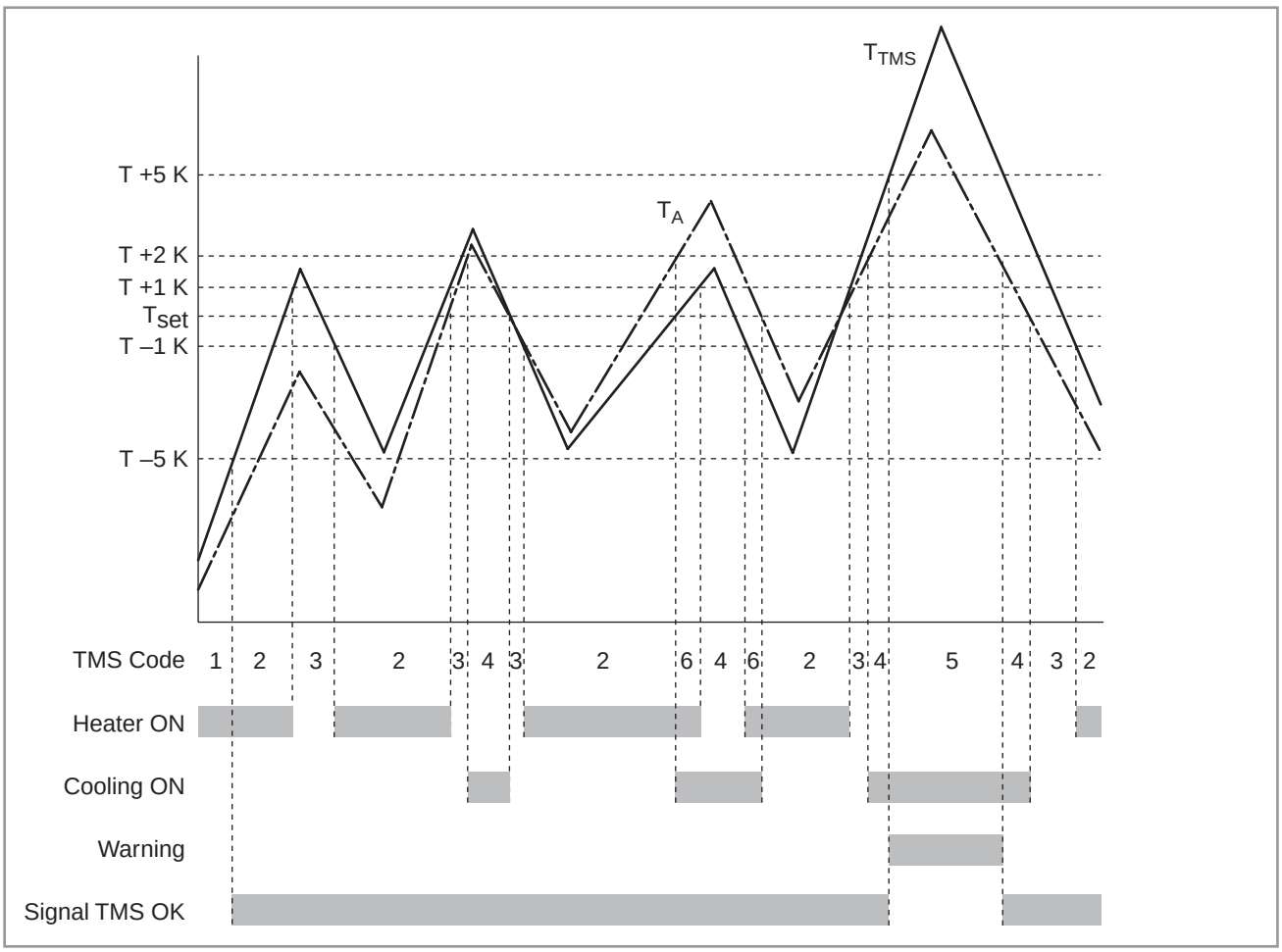


Fig. 51 Typical function diagram TMS for the MAG.DRIVE*digital*

TMS status code

The TMS status code is displayed on the operation display.

No.	Code	Description
1	H	Heating pump
2	H O K	Temp. TMS ok, heater ON
3	O K	Temp. TMS ok
4	C O K	Temp. TMS ok, cooling ON
5	W	Temp. TMS > TMS_{Set} +5K
	O F F	TMS cancelled via control plug X14
6	H C O K	Temp. TMS ok, cooling ON, heater ON
7	N O K	Temp. TMS not ok, cooling OFF, heater OFF
8	H C	Temp. TMS not ok, cooling ON, heater ON
9	C	Temp. TMS not ok, cooling ON

Actual temperature

The actual temperature is displayed on the operating display (refer to 3.10.1 Operating menu, Basic menu)

Signal TMS OK

If the actual TMS temperature lies in the range ±5K from the setpoint temperature, the TMS OK signal can be output via the option relay. The option relay must be programmed for this function (refer to Section 2.8.3 Control plug X14, Relay outputs)

3.3 Power control system (PCS)

(only for MAG (W) 1500, 2200, 2800, 3200)

For safety reasons, motor power is limited depending on the temperatures within the pump. Motor power will be highest when the pump is cold.

3.4 Operation at high gas throughput or high forevacuum pressure

In the operating software, the alarm triggers for the service life of the rotor have been defined. After this service life period has elapsed the rotor needs to be replaced. The alarm thresholds have been derived from the applications known to date.

Warning

Continuous operation at a high motor current will reduce the service life of the rotor. In such cases additional safety measures need to be introduced which must be co-ordinated with Leybold.

Also warming up of the rotor due to other influences will reduce its service life, for example, pumping of hot process gases.

Turbomolecular pumps contain a large amount of kinetic energy due to the high rotational speed in combination with the mass of their rotors. In case of a malfunction of the system for example rotor/stator contact or even a rotor crash the rotational energy may be released.

In most applications the motor current will remain during continuous operation below the permitted maximum value. The alarm thresholds have been selected in consideration of this maximum value. Depending on the operation conditions the maximum service life of the rotor is 40,000 h. The operation conditions depend on type of the gas, throughput and pressure. With high gas load, especially when pumping Ar and SF_6, the maximum service life of the rotor may be shorter. In this case we must ask you to consult us.

Also ensure that the high vacuum flange cannot warm up above the permissible temperature level.

3.5 Bakeout

Only for pumps with CF flange

If pressures in the range of 10^{-8} mbar or below are to be developed, the vacuum chamber and the components installed therein will have to be baked out.

Protect the rotor against intensive, direct heat radiation. When baking out at the forevacuum side – at a sorption trap, for example – ensure that the components attached direct are not heated to more than 80 °C.

The forevacuum pump must be in operation so as to eliminate the vapors liberated at the sorption trap.

The maximum bakeout temperature of the pump is 120 °C.

3.6 Operation with the START and STOP keys

Switching on

■ Switch on the MAG.DRIVE*digital*.

The MAIN LED lights green. Wait for approximately 20 to 30 seconds until the MAG.DRIVE has been initiated.

If the pump has the optional TMS (including e.g. the red heater band) the heater will be activated. The setpoint temperature will be reached within 30 - 60 minutes depending on cooling water temperature and flow.

In case of corresponding connection the backing pump will be activated when switching on the MAG.DRIVE*digital*.

■ Open the purge gas supply. With a converter with default settings the pump's purge gas valve is open.

■ Open the cooling water supply.

■ Press the START key.

The pump runs-up. The STATUS LED is slowly flashing green. When the STATUS LED is lit permanently green the pump is in normal operation.

Switching off

■ Press the STOP key.

The STATUS LED is fast flashing green. When the STATUS LED is off the pump has come to a standstill.

■ Close the cooling water supply when the pump is switched off in order to avoid condensate formation in the pump.

The backing pump may be switched off once the MAG has stopped.

Purge with dry nitrogen

If the MAG has been used for pumping corrosive gases it should be purged with dry nitrogen for one hour before switching off. During down times of the system take care that neither ambient air nor cleaning agents enter the pump.

After a failure has occured and has been removed, acknowledge the failure message by pressing the STOP key.

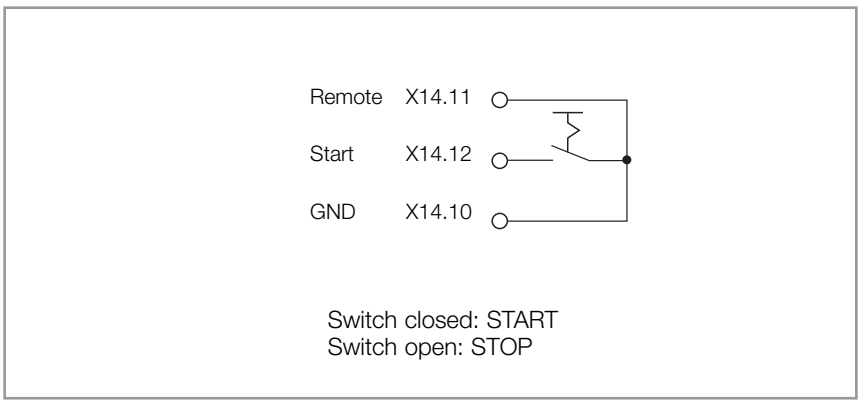


Fig. 52 Connecting-up example remote control

Significance of the lamps

COM (green)

Is lit if communication has been established via the interface.

STATUS (green/red)

Red, steady light	=	Failure
Red, flashing	=	Warning
Green, flashing (slow)	=	Start delay, Acceleration
Green, flashing (fast)	=	Deceleration, Kinetic buffering
Green, steady light	=	Normal operation / Stand-by

MAIN (green)

This lamp is lit if the power is switched-on, and all of the supply voltages for operation are available.

Flashes when the power fails as long as the power supply voltages in the converter are maintained by the kinetic buffering.

3.7 Remote control

The pump can be switched-on or off using the START/ STOP keys or via control connector X14.

- X14.11 not connected = Start/Stop via the operator control panel
- Jumper X14.11-X14.10 = Start/Stop via control input X14.12

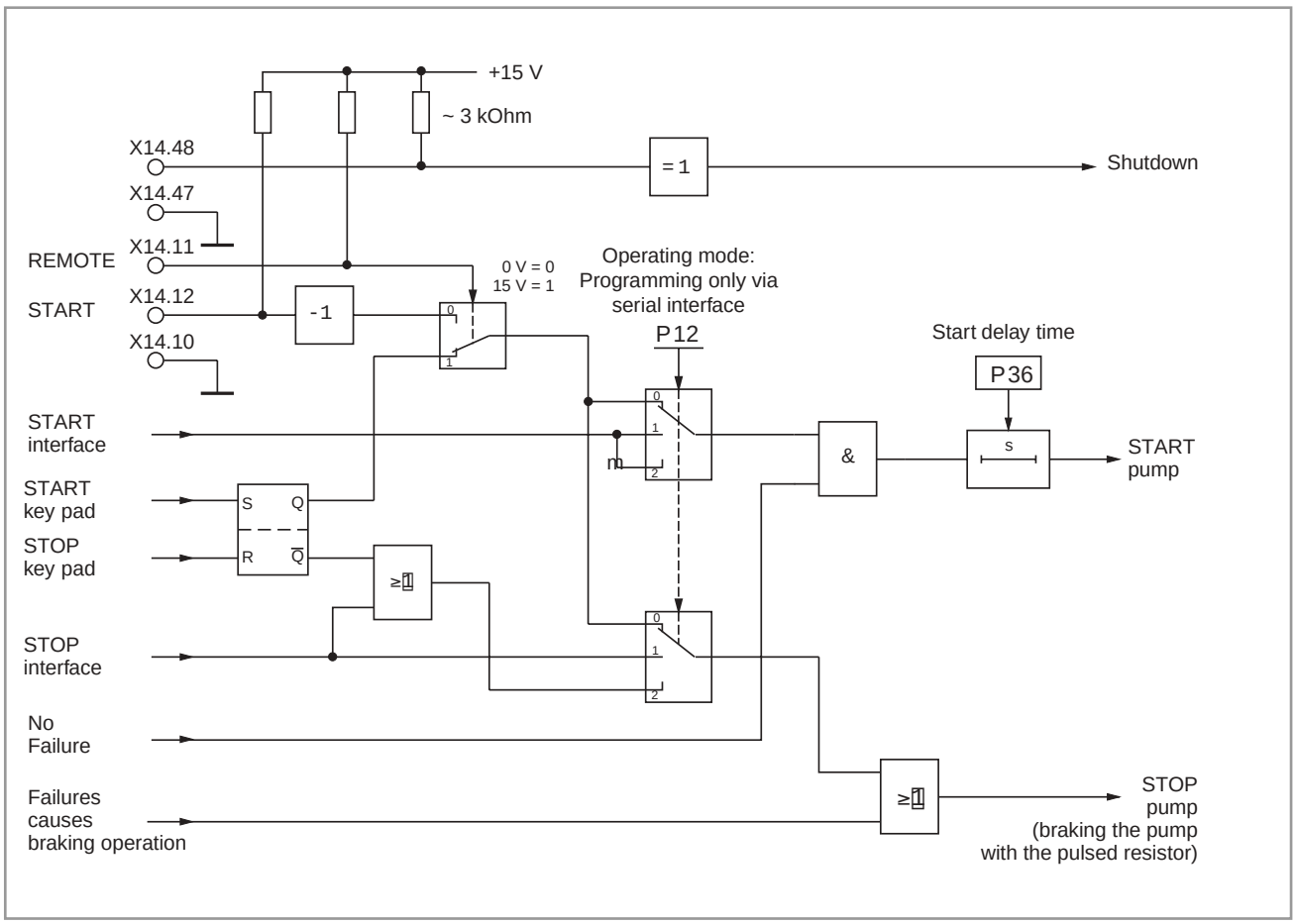


Fig. 53 Function diagram START/STOP

3.8 Operation with plug-in control

Observe the general operation rules given in Section 3.1 to 3.5.

Switching on

- Switch on the MAG.DRIVE*digital*. The display reads after approximately 20 to 30 seconds

Ready	
0.0 A	0 Hz

If the pump has the optional TMS (including e.g. the red heater band) the heater will be activated. The setpoint temperature will be reached within 30 - 60 minutes depending on cooling water temperature and flow.

In case of corresponding connection the backing pump will be activated when switching on the MAG.DRIVE*digital*.

- Open the purge gas supply.
- Open the cooling water supply.
- Press the START key.

The pump runs-up.

Acceleration	
15.0 A	250 Hz

is diplayed until the frequency setpoint has been reached. Then

Normal Operation	
1.0 A	600 Hz

is displayed.

Switching off

The MAG.DRIVE*digital* controls the venting automatically provided purge gas is connected to the MAG and the MAG.DRIVE*digital* is programmed correspondingly ("Vent on").

■ Press the STOP key.

Deceleration	
15.0 A	400 Hz

will be displayed. When the display reads

Ready	
0.0 A	0 Hz

the pump has come to a standstill.

■ Close the cooling water supply when the pump is switched off in order to avoid condensate formation in the pump.

The backing pump may be switched off once the MAG has stopped.

Purge with dry nitrogen

If the MAG has been used for pumping corrosive gases it should be purged with dry nitrogen for one hour before switching off. During down times of the system take care that neither ambient air nor cleaning agents enter the pump.

3.9 Operating statuses

Switch-On Guard

The converter goes into the "Switch On Guard" operating status after the power is switched on and after initialization. If there is no warning or failure, it changes over into the "Ready" condition.

After a failure has been acknowledged, the converter goes into the "Switch On Guard" operating status. The failure must be acknowledged a second time, so that it then goes into the "Ready" condition.

Ready

The converter is ready and waits for the START command. All parameters can be interrogated or changed via the operator control panel.

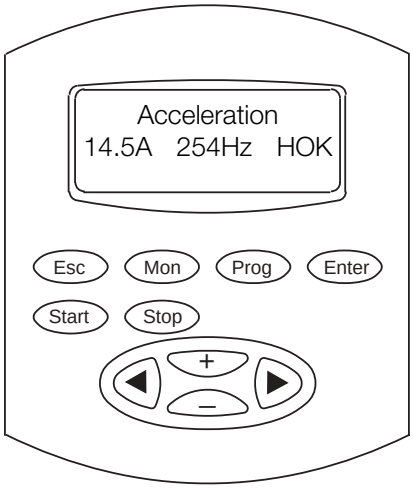
The basic menu parameters (refer to 3.10, Operating menu) can be scanned via the operator control panel.

Acceleration

The pump continuously accelerates with the maximum current. The acceleration time is monitored to ensure that it lies within a programmed value (refer to the menu "settings pump/Accel. Time"). If the converter hasn't reached the normal operating mode during the monitoring time, then it is shutdown with the failure message "Accel. Time".

Normal operation

After a programmable frequency threshold has been reached (refer to the menu "settings pump/Normal Operation"), the converter goes into the normal operation mode but the pump continues to accelerate up to the frequency setpoint.



Key	Function
Esc	■ Returns to the operating display from the storage procedure without storage. ■ Returns to the operating display from any point of the basic menu.
Mon	■ No function
Prog	■ Selects the programming menu from the operating display. ■ Confirms to store changed parameters to the EEPROM
Enter	■ Switches forward to the next submenu
Start	■ Starts the pump (only possible if there is no fault). The start key is only active if the user is in the basic menu or in the operating display.
Stop	■ Stops the pump ■ Returns to the operating display from the programming menu. ■ Acknowledges a failure after the cause of the failure has been removed. (only possible if the user is in the operating display)
+	■ Increases a parameter value or proceeds to the next option.
–	■ Lowers a parameter value or returns to the previous option.
◀	■ Selects the programming menu from the operating display. ■ Switches back to the last main menu.
▶	■ Selects the programming menu from the operating display. ■ Switches forward to the next main menu.

Fig. 54 Functions of the front panel keys

Operating display

Acceleration
14.5A 254Hz HOK

Operating status

Motor current / Actual frequency / TMS status code

If a critical operating status occurs this warning is displayed alternating with the operating display.

Failure
Accel. Time

Failure message

Failure cause

TMS status code*

No.	Code	Description
1	H	Heating pump
2	H O K	Temp. TMS ok, heater ON
3	O K	Temp. TMS ok
4	C O K	Temp. TMS ok, cooling ON
5	W	Temp. TMS > TMS_{Set} +5K
	O F F	TMS cancelled via control plug X14
6	H C O K	Temp. TMS ok, cooling ON, heater ON
7	N O K	Temp. TMS not ok, cooling OFF, heater OFF
8	H C	Temp. TMS not ok, cooling ON, heater ON
9	C	Temp. TMS not ok, cooling ON

see also Section 3.2. “TMS”

* only for pumps with TMS

Fig. 55 Display

Stand-by operation

The pumping system can be operated in a stand-by mode with reduced speed. The speed can be set in the operating menu “pump”. The function stand-by can be activated with the digital inputs option 1 or 2.

Do not use at the same time the stand-by function and the speed control via the analog input.

Overload

The speed is continuously monitored and controlled. If the speed, even at maximum current, cannot be held at the setpoint, as a result of external influences, e.g. excessive gas intake, the speed reduces until the converter goes into the “Overload” operating condition when the programmable frequency threshold is fallen below (refer to the menu “settings pump/Normal Operation”). The acceleration time is restarted. If the converter hasn’t gone into the normal operating mode after the monitoring time, it is shutdown with the failure message “Failure Overload Time”.

Mains Down

If the power fails while the pump is running the pump generates the power necessary to operate the MAG.DRIVE*digital* up to a minimum frequency of 110 Hz. When the power returns, the pump is again accelerated up to the frequency setpoint.

The acceleration time is now restarted. If the converter hasn’t gone into the normal operating mode after the monitoring time, it is shutdown with the failure message “Accel. Time”.

If the system is running in the normal operation mode, then in the case of an occurring mains failure the corresponding relay contact "Normal operation” will be disabled with a delay. Brief mains voltage interruptions of less than five seconds will not have an influence on the relay output provided the speed of the pump does not drop within this time span below the speed limit set up through the normal operation factor or if a stop process was initiated.

Deceleration

After a stop command, the pump is braked down to a speed < 5 Hz as quickly as possible. A brake resistor is integrated into the converter which converts the regenerative energy into heat.

Failure

The converter was shutdown with a failure message and waits for a failure acknowledgement after the failure has been removed. The failure type can be read from the display. The failure message can be acknowledged by depressing the STOP key or via the digital input “option”, when the pump stands still (f < 5 Hz).

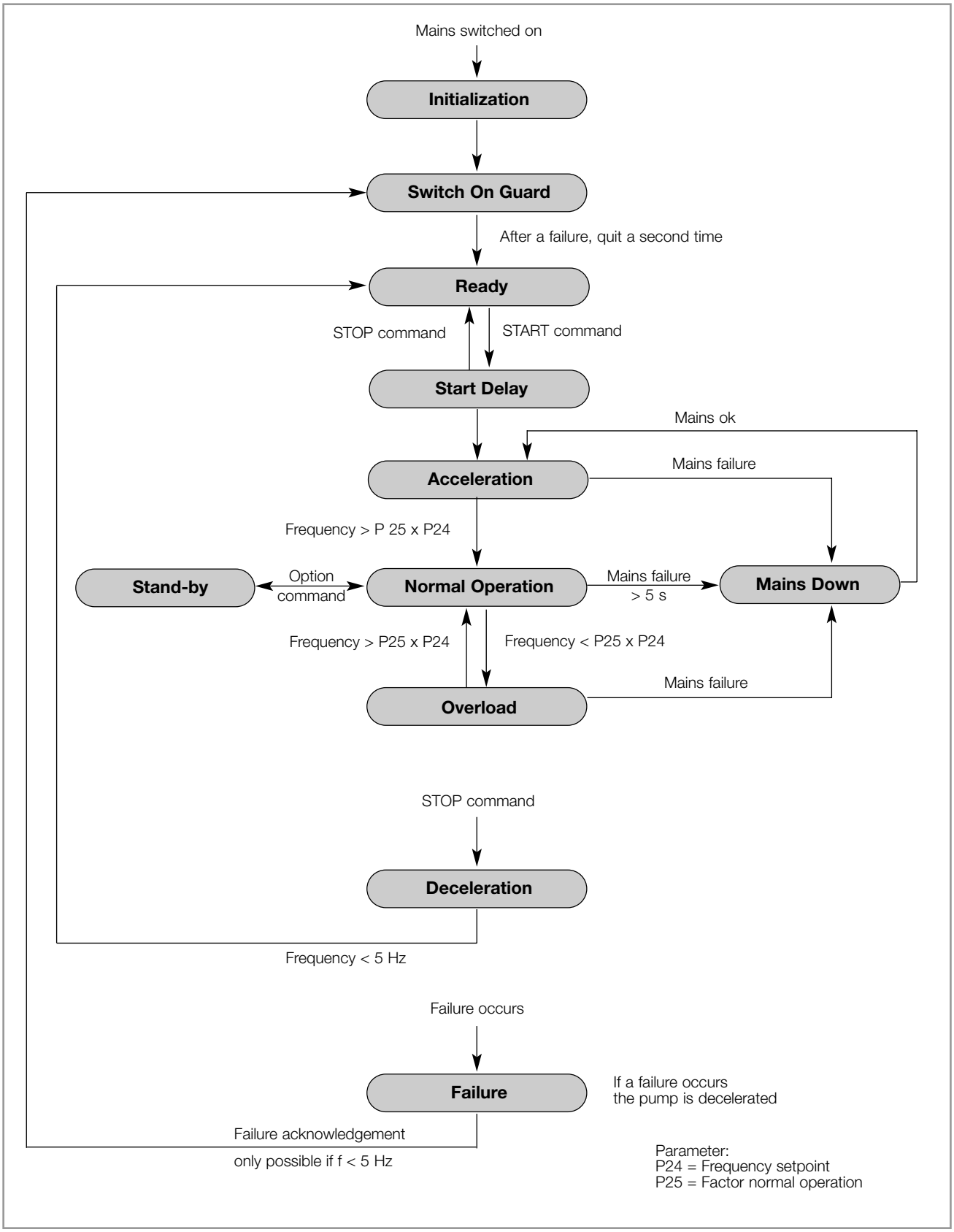
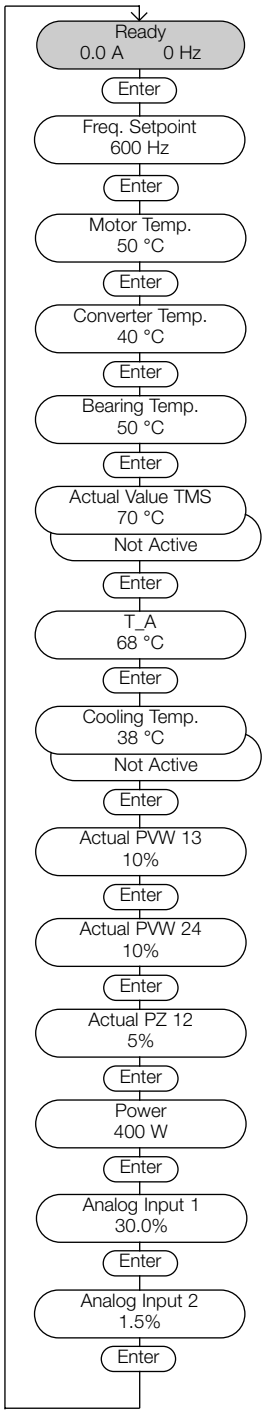


Fig. 56 Diagram: Operation status

3.10 Operating menu

3.10.1 Basic Menu



Menu item	Description	Adjustable value / option				Access
		min. value	max. value	standard	Unit	
Ready	Operating display	-	-	-	-	-
Freq. Setpoint	Sets the speed for operation !! Every change is directly written into the pump's data storage and is valid immediately!!	150	*	*	Hz	r/w on
Motor Temp.	Motor temperature		actual value		°C	r
Converter Temp.	Temperature of the power electronic		actual value		°C	r
Bearing Temp.	Temperature of the magnetic bearing		actual value		°C	r
Actual Value TMS	Temperature of the Temperature Management System		actual value		°C	r
T_A	Value for Cooling Temp. Control		actual value		°C	r
Cooling Temp.	Cooling water temperature		actual value		°C	r
Actual PVW 13	Rotor displacement in the magnetic bearing plane VW13		actual value		%	r
Actual PVW 24	Rotor displacement in the magnetic bearing plane VW24		actual value		%	r
Actual PZ 12	Rotor displacement in the magnetic bearing axis Z12		actual value		%	r
Power	Power consumption of the drive		actual value		W	r
Analog Input 1	Analog Input Channel 1 (0...100.0%) Input range 0...10 V Displ. 0.00...100.0%		actual value		%	r
Analog Input 2	Analog Input Channel 2 (0...100.0%) Input range 0...10 V Displ. 0.00...100.0%		actual value		%	r

* 400 Hz = 24,000 min^{-1} for MAG W 830 C
600 Hz = 36,000 min^{-1} for MAG W 830, W 1300 (C) & (W) 1500 CT
490 Hz = 29,400 min^{-1} for MAG W 2200 (C)
480 Hz = 28,800 min^{-1} for MAG W 2800 & 3200 (C/CT)

r (read) = value can **only** be read
r /w (read/write) = value can be read and written
on (online) = value can be changed always
off (offline) = value can only be changed when the pump stands still

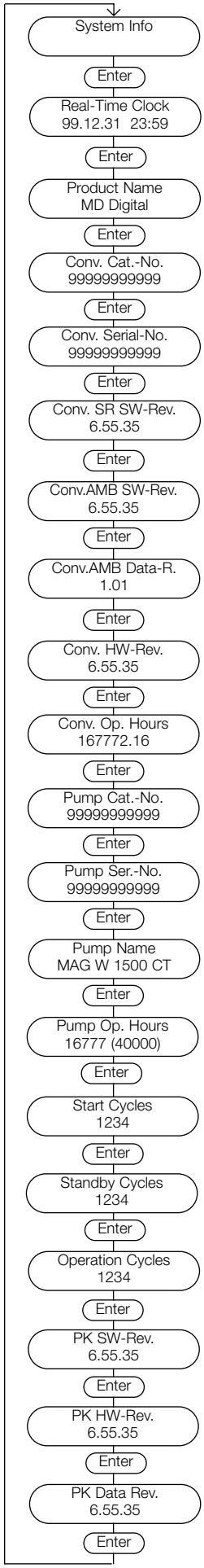
3.10.2 Menü System Info

Menu item	Description	Adjustable value / option				Access
		min. value	max. value	default	Unit	
Real-Time Clock 99.12.31 23:59	Real-Time Clock Format: YY.MM.DD HH:MM Greenwich-Mean-Time (GMT) Reference-Time for false memory			actual value	-	r
Product Name MD Digital	Actual product name of the converter			actual value	-	r
Conv. Cat.-No. 99999999999	Cat.-No. of the converter			actual value	-	r
Conv. Serial-No. 99999999999	Serial-No. of the converter			actual value	-	r
Conv. SR SW-Rev. 6.55.35	SW-Revision of the Drive-Controller			actual value	-	r
Conv.AMB SW-Rev. 6.55.35	SW-Revision. of the Magn. Bearing-Controller			actual value	-	r
Conv.AMB Data-R. 1.01	Data-Revision of the Magn. Bearing Data Setting			actual value	-	r
Conv. HW-Rev. 6.55.35	Hardware-Revision of the Converter			actual value	-	r
Conv. Op. Hours 167772.16	Operation hours of the Converter			actual value	h	r
Pump Cat.-No. 99999999999	Cat.-No. of the pump			actual value	-	r
Pump Ser.-No. 99999999999	Serial-No. of the pump			actual value	-	r
Pump Name MAG W 1500 CT	Pump name & type			actual value	-	r
Pump Op. Hours 16777 (40000)	Operation hours of the pump** (Permitted operating hours)			actual value	h	r
Start Cycles 1234				actual value	-	r
Standby Cycles 1234				actual value	-	r
Operation Cycles** 1234				actual value	-	r
PK SW-Rev. 6.55.35	SW-Revision of the pump-memory chip (PK)			actual value	-	r
PK HW-Rev. 6.55.35	HW-Revision of the pump-memory chip (PK)			actual value	-	r
PK Data Rev. 6.55.35	Revision of the pump-memory chip data-settings (PK)			actual value	-	r

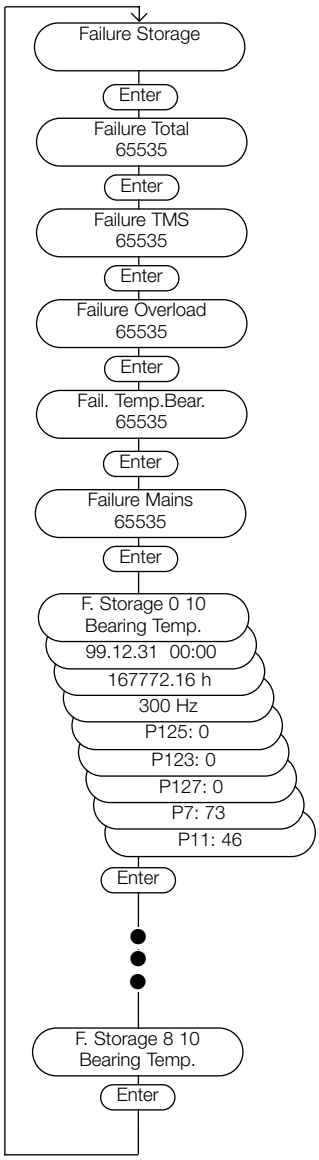
** For the permissible number of operating hours/operating cycles the system provides two thresholds. Exceeding these thresholds will result in a warning message (default) or an alarm message. The corresponding menu entry for setting up the required response can be found in the section "Programming the frequency converter".

Threshold for system start — If before starting the system the threshold is already exceeded, starting the system will no longer be possible.

Threshold during operation — The permissible threshold during operation is higher compared to the threshold which is permissible during system start. The permissible number of this value is indicated through the display (YYY).



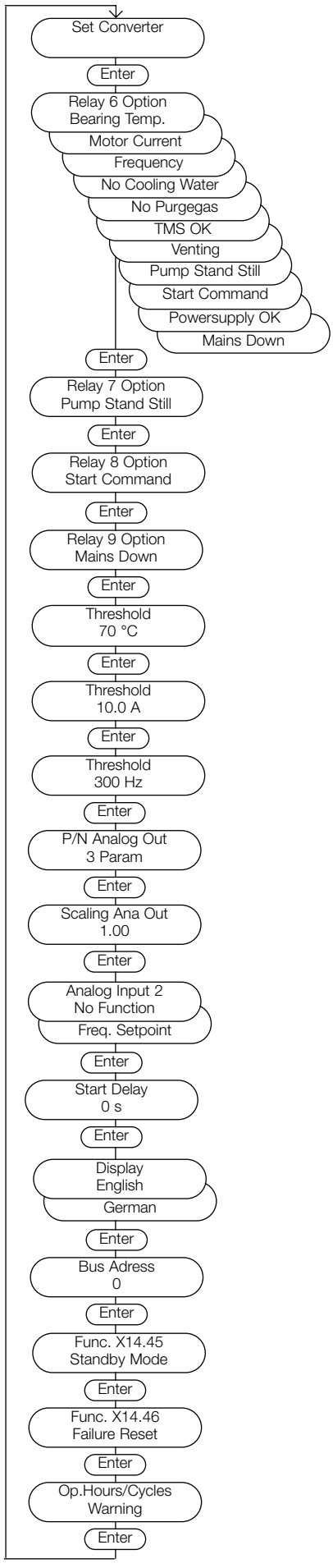
3.10.3 Menu Failure Storage



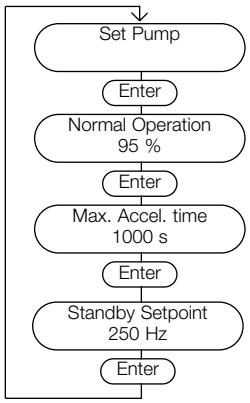
Menu item	Description	Adjustable value / option				Access
		min. value	max. value	default	Unit	
Failure Total 65535	No. of total failures since manufacturing date		actual value		-	r
Failure TMS 65535	No. of TMS-Failures since manufacturing date Refer to Failure TMS 1...4 (Section 6 “Troubleshooting”)		actual value		-	r
Failure Overload 65535	No. of Overload-Failures since manufacturing date Refer to Failure Overload (Section 6 “Troubleshooting”)		actual value		-	r
Failure Temp.Bear. 65535	No. of bearing temperature failures since manufacturing date Refer to Failure Bearing Temp. (Section 6 “Troubleshooting”)		actual value		-	r
Failure Mains 65535	No. of mains failures since manufacturing date Refer to Warning Mains Down (Section 6 “Troubleshooting”)		actual value		-	r
F. Storage 0 10 Bearing Temp.	In the event of a failure, the characteristic operating parameters (failure information 0...8) will be saved in the memory chip using a ring arrangement capable of saving 20 failure events (0...19) in chronological order. Index 0 represents the most recent, and index 19 the oldest failure event. Operating the Up/Down keys lets you step through the index range 0...19. Operating the Enter key lets you step through the failure information (0...8) indicating the following: Failure information 0: Failure message (in plain text) Failure information 1: Date and time of the failure which has occured Failure information 2: Number of operating hours for the pump Failure information 3: Actual frequency during operation Failure information 4...8: Extended parameter numbers. The 1st number represents the parameter number, the 2nd number represents the parameter value. For more information about parameter numbers see Table B “Parameters for the analog output”		actual value		-	r

3.10.4 Menu Set Converter

Menu item	Description	Adjustable value / option				Access
		min. value	max. value	standard	Unit	
Relay 6 Option	Relay with change-over contact; the operator can select one of the functions described in Table A “Option relays” on next page See also Relay outputs (section 2.8.3)	0	10	0	-	r/w on
Relay 7 Option	The settings of the relays 7 to 9 can be changed similar to relay 6.	0	10	7	-	r/w on
Relay 8 Option	After each power off the relays 7 to 9 are in the default state.	0	10	8	-	r/w on
Relay 9 Option	See also Relay outputs (section 2.8.3)	0	10	10	-	r/w on
Threshold	Threshold bearing temp. for option relay	0	200	70	°C	r/w on
Threshold	Threshold motor current for option relay	0	150	100	0.1 A	r/w on
Threshold	Threshold frequency for option relay	0	600	300	Hz	r/w on
P/N Analog Out	Signal choice Analog Out 0...10 V Setting of the selected parameters for the analog output Definition: $U_{Ana_out} = Para_{Current}/Para_{Max\ Value}$ *Scale factor* 10 V For more information about parameter numbers see Table B “Parameters for the analog output” on next page	0	1023	125	-	r/w on
Scaling Ana Out	Scale factor for the analog output	0.00	100.0	1.00	-	r/w on
Analog Input 2	Analog input 0...10 V; optionally frequency setpoint via analog input 2 (10 V = max. frequency setpoint)	no function / Function frequency setpoint				r/w off
Start Delay	Waiting time between start command and acceleration	0	3600	0	s	r/w off
Display	Display language	English / German				r/w on
Bus Address	Bus adress for the converter by operation via serial interface RS 232/485	0	31	0	-	r/w on
Func. X14.45	Function of the digital input option 1 (idle (no function) / Stand-by mode / Failure reset)	0	2	1	-	r/w off
Func. X14.46	Function of the digital input option 2 (idle (no function) / Stand-by mode / Failure reset)	0	2	2	-	r/w off
Op.Hours/Cycles	In the case of "Warning”, a warning will be displayed as soon as the number of permissible operating hours or cycles is exceeded; in the case of "Alarm” the system is shut down or a restart is prevented.	Warning (Default) / Alarm			-	r/w off

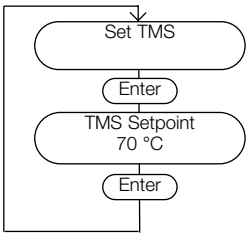


3.10.5 Menu Set Pump



Menu item	Description	Adjustable value / option				Access
		min. value	max. value	default	Unit	
Normal Operation	Threshold for normal operation corresponding to the frequency setpoint	Standby Setpoint	99	95	%	r/w off
Max. Accel. Time	Monitor time for acceleration and overload	600	3600	1000	s	r/w off
Standby Setpoint	Speed for Stand-by mode	200 = Min. Freq.	Normal Operation Thresh.	250	Hz	r/w on

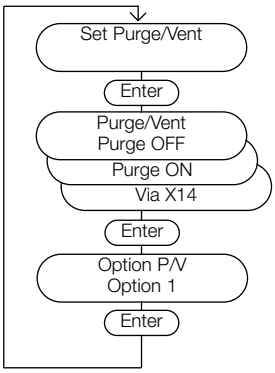
3.10.6 Menu Set TMS



Menu item	Description	Adjustable value / option				Access
		min. value	max. value	default	Unit	
TMS Setpoint	Setpoint of the Temperature-Management System	20	80/90*	70	°C	r/w on

* MAG (W) 1500 CT: 90 °C, MAG W 2800, 3200 CT: 80 °C

3.10.7 Menu Set Purge / Vent



Menu item	Description	Adjustable value / option				Access
		min. value	max. value	default	Unit	
Purge / Vent	The operator can select one of the beside standing options for purge and vent	purge OFF			-	r/w on
		purge ON			-	
		Controlling purge / vent via control plug X14			-	
Option P / V	Displays the factory installed option for purge and vent	Installed option			-	r

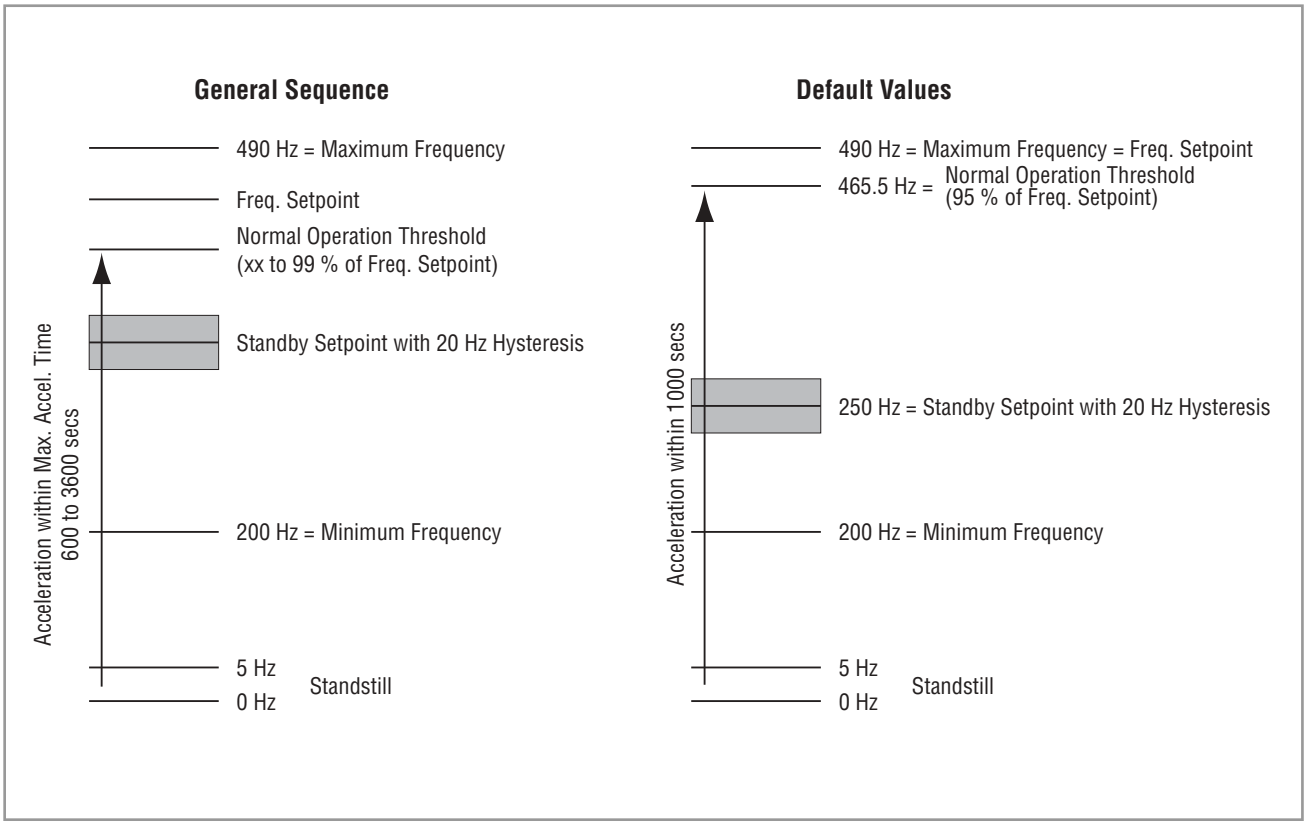


Fig. 57 Schematic of frequencies

3.10.8 Frequency settings

The operating frequency, the normal operation threshold and the stand-by frequency can be set.

The values for normal operation threshold and stand-by frequency including its hysteresis must not overlap.

The software does not accept values which could cause conflicts.

Table A “Option relays”

Function of the option relays

Refer to Set Converter/Relay option (section 3.10.4).
There are 4 option relays (relay 6...9) with change-over contact; the operator can select one of the functions described in the following table.
If the condition of the selected functions is performed, the selected relay switches over.

Bit	Setting	Condition
0	Bearing Temp.	Bearing Temp. (P125) > Treshold bearing temperature
1	Motor Current	Motor Current (P5) > Treshold motor current
2	Frequency	Frequency (P3) > Treshold frequency
3	No Cooling Water	Cooling Temp. (P127) > Shut down temperature
4	No Purge gas	Pumptype = C, CT and function purge/vent = off
5	TMS temp. OK	((TMS on) and (TMS Setpoint -5 < TMS temp. (P123) < TMS Setpoint +5))
6	Venting	Pumptype = C, CT and venting
7	Pump standstill	Frequency (P3) < 2 Hz
8	Start Command	Start command is applied
9	Power supply OK	Power supply OK
10	Mains down	Power supply breakdown
11	Stand-by	Stand-by rotor speed reached

Table B “Parameters for the analog output”

Typical parameter numbers

Parameter	Description	min value	max value	unit
3	Frequency	0	1000	Hz
5	motor current	0	200	0.1 A
6	power	0	6553.5	0.1 W
7	motor temp.	0	150	°C
11	converter temp.	0	1000	°C
123	TMS temp.	0	140	°C
125	bearing temp.	0	140	°C
127	cooling temp.	0	140	°C
386	average temp. of the pump	0	140	°C
220	rotor displacement in the mag. bearing plane VW13	0.00	199.99	%
221	rotor displacement in the mag. bearing plane VW24	0.00	199.99	%
222	rotor displacement in the mag. bearing axis Z12	0.00	199.99	%
209	analog input #1	0.00	100.00	%
210	analog input #2	0.00	100.00	%

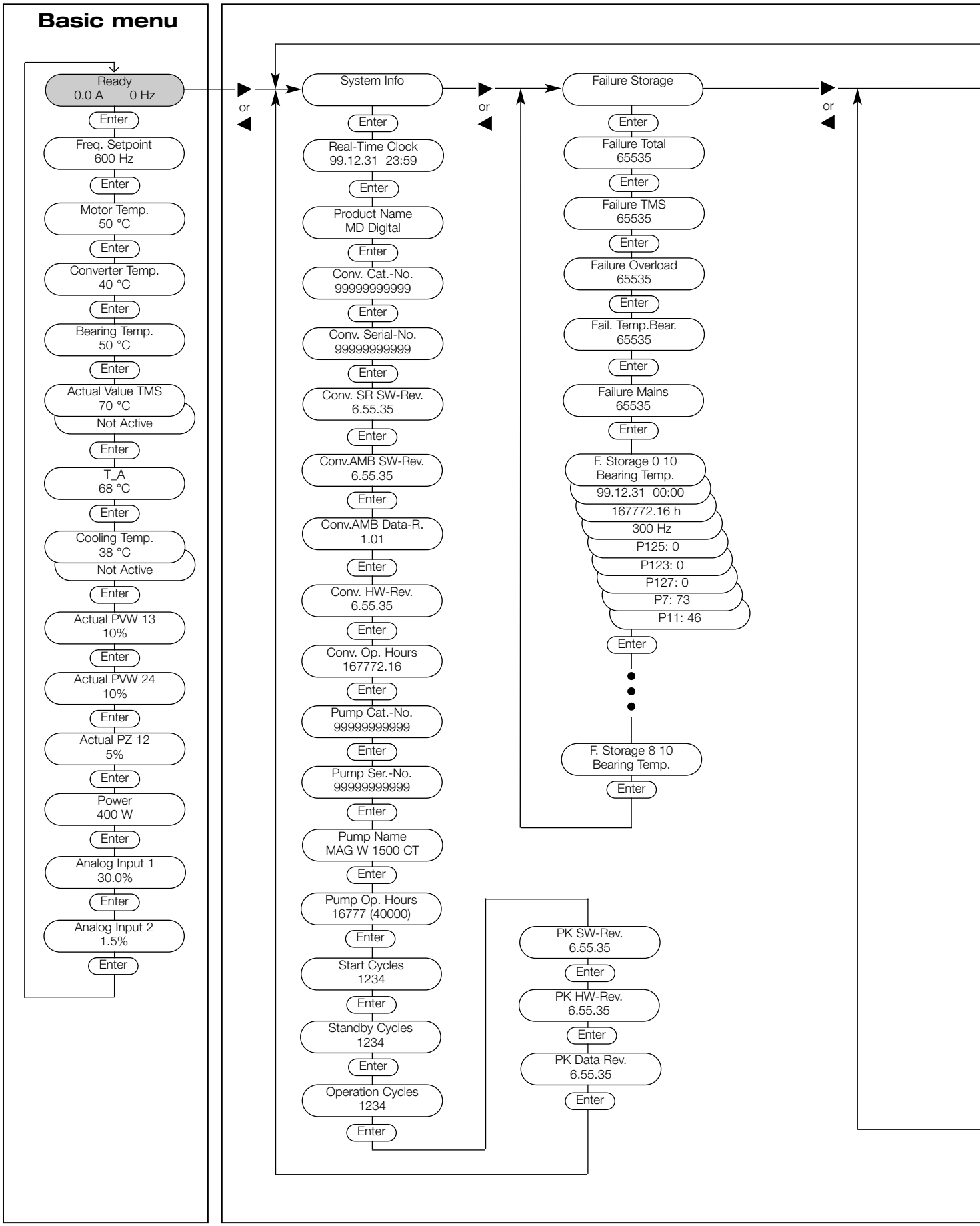
Example: P/N Analog Out (section 3.10.4) is set to parameter P125 (bearing temp.).

Definition: $\mathbf{U_{Ana_out}} = P125_{current} / P125_{max\ value} * \text{Scale factor} * 10\ V$

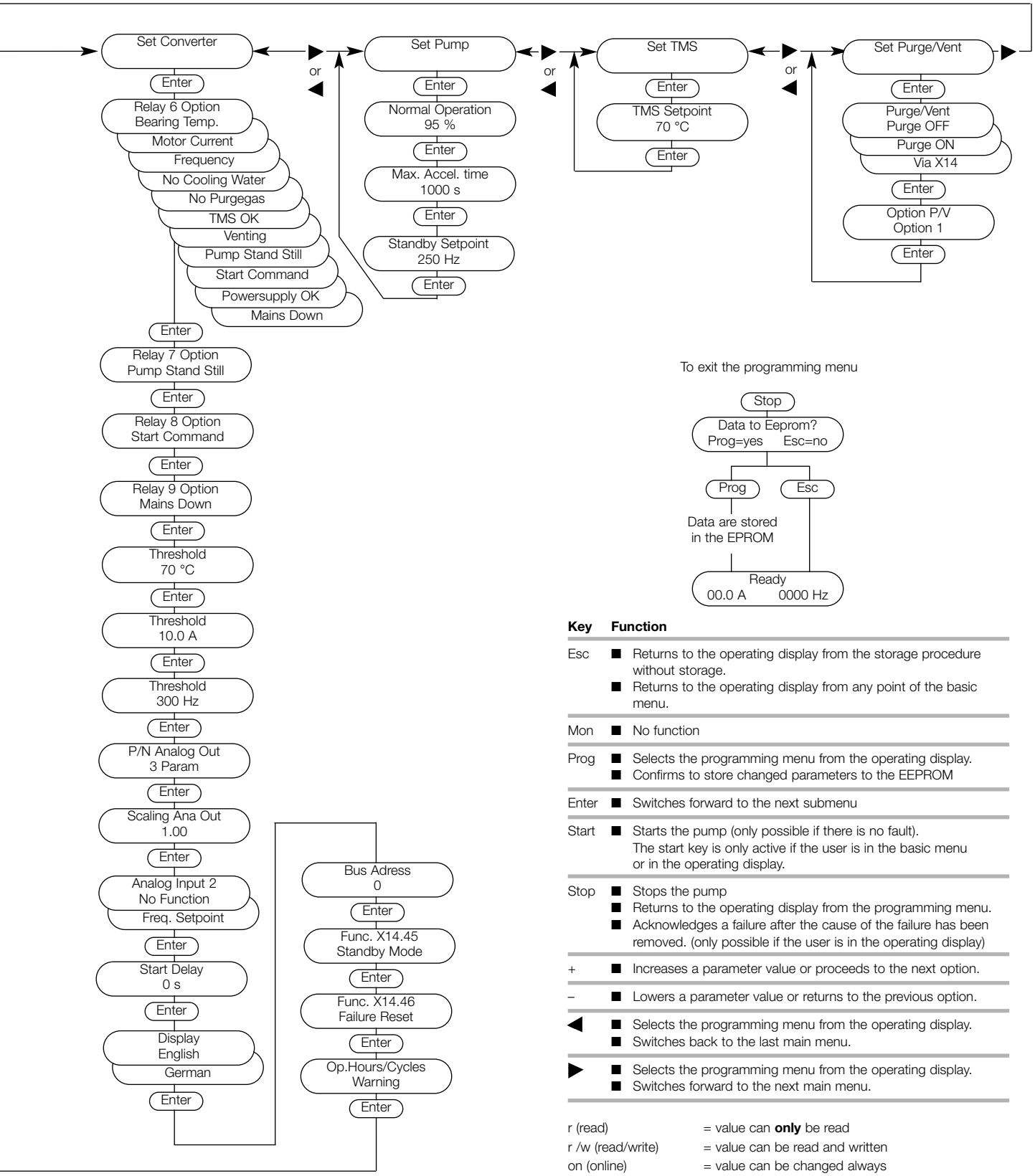
$\mathbf{P125_{current}} = U_{Ana_out} / P125_{max\ value} / \text{Scale factor} / 10\ V$

P125 (bearing temp.) / °C	Scale factor Analog out	$U_{Ana\ out}$ / V
20	1.00	1.43
40	2.50	7.14
75	1.87	10.00
100	1.00	7.14

3.10.9 Total view of the menu



Programming menu



To exit the programming menu

Key	Function
Esc	■ Returns to the operating display from the storage procedure without storage. ■ Returns to the operating display from any point of the basic menu.
Mon	■ No function
Prog	■ Selects the programming menu from the operating display. ■ Confirms to store changed parameters to the EEPROM
Enter	■ Switches forward to the next submenu
Start	■ Starts the pump (only possible if there is no fault). The start key is only active if the user is in the basic menu or in the operating display.
Stop	■ Stops the pump ■ Returns to the operating display from the programming menu. ■ Acknowledges a failure after the cause of the failure has been removed. (only possible if the user is in the operating display)
+	■ Increases a parameter value or proceeds to the next option.
–	■ Lowers a parameter value or returns to the previous option.
◀	■ Selects the programming menu from the operating display. ■ Switches back to the last main menu.
▶	■ Selects the programming menu from the operating display. ■ Switches forward to the next main menu.

r (read) = value can **only** be read
r /w (read/write) = value can be read and written
on (online) = value can be changed always
off (offline) = value can only be changed when the pump stands still

All menus can be invoked at all times for each operating mode;
in part they may be modified during operation.

4 Maintenance

4.1 Cleaning

If required clean the turbomolecular pump and the frequency converter of dust with a dry cloth.

4.2 Changing the rotor

The rotor has to be changed at the latest

- after 40,000 hours of operation or
- after 5000 starts/stops or cycles

Refer also to Section “3.4 Operation at high gas throughput or high forevacuum pressure”.

Warning

Due to high-speed and temperature, the service life of the rotor is limited.

If the rotor is changed too late, it may be destroyed. Thus in the flange mounts high forces and torque conditions can occur.

The mounting screws for the pump may be torn off. When using clamped flange connections at the housing or with components above the housing, sudden twisting of the entire pump can be experienced.

The pump’s operating hours are displayed at the frequency converter (see Sectiont 3.10.2).

A warning message appears after 37,000 hours of operation and after 3700 starts/stops or cycles.

Only the Leybold service can change the rotor.

4.3 Changing the touch-down bearings

Wear occurs at the touch-down bearings when hard shocks have to be supported.

Maintenance is also required after removing the bearing cable during operation of the pump. Under these conditions the rotor can not be controlled by the magnet bearing and the pump will have a full run down on the touch-down bearing.

Only the Leybold service can change the touch-down bearings.

4.4 Cleaning the frequency converter internally

Depending on the installation site the converter may collect grime (dust, moisture) on the inside. Such contamination may lead to malfunctions, overheating or short circuits. Therefore the converter must be cleaned after 5 years.

Only the Leybold service can clean the converter internally.

4.5 Removing the pump from the system

MAG which have been used in semiconductor processes are contaminated by semiconductor process gases. Most of these gases form acids when exposed to moist air which causes serious corrosion damage to the pump.

In order to prevent corrosion damage in the case of MAGs which have been removed, the pump needs to be packaged in a sealed package. For this the shipping package of the replacement pump may be used, for example.

Failure to seal a contaminated MAG voids the warranty.

Warning

For safety reasons we recommend to use a metal seal kit (see Fig. 58) for shipping of contaminated pumps.

Proceed as follows to seal the turbomolecular pump immediately after removing it from your process.

Purge the pump for two hours with the backing pump running. This helps to remove a large quantity of the process gases from the pump. We recommend purging the pump via the intake flange and the purge valve with approx. 200 sccm.

Press the STOP button at the MAG.DRIVE*digital* and wait until the pump has come to a standstill.

Afterwards turn the mains switch to the “0” position.

The cables between the MAG and MAG.DRIVE may be disconnected only after the MAG has come to a full stillstand **and** the mains is switched off.

Warning

When the pump has been pumping hazardous gases, ensure that proper safety precautions are taken before opening the intake or exhaust connections.

Use gloves or protective clothing to avoid skin contact with toxic or highly corrosive substances. Work under a fume hood if available.

Disconnect the cables from the pump.

Disconnect the cooling water lines. Remaining cooling water may flow out. Protect all parts below.

Remove all bolts but 2 which hold the intake flange. The 2 remaining bolts must be directly opposite.

Disconnect the forevacuum line.

Support the pump with a lift-truck at the base plate and remove the 2 remaining bolts.

Seal all ports

Clean the intake and forevacuum connection flange as necessary for good adhesion of tape.

Place the dry cartridge into the forevacuum port. Don't use loose crystals.

Firmly seal all ports with plastic adhesive film.

Cover the forevacuum connection port with its plastic cap.

Seal the high-vacuum connection flange with the cover and the screws.

Pack the pump so that it may not be damaged during transportation. Particularly protect the flanges, the cooling water connectors and the current feedthrough.

4.6 Service at Leybold's

Contamination

If you send a pump to Leybold indicate whether the pump is free of substances damaging to health or whether it is contaminated. If it is contaminated also indicate the nature of hazard. To do so, you must use a preprinted form which we shall send to you upon request.

Form

A copy of this form is printed at the end of the Operating Instructions: "Declaration of Contamination of Vacuum Equipment and Components". Another suitable form is available from the Leybold homepage:

http://www.leybold.com under the headline "customer service".

Either fasten this form at the pump or simply enclose it to the pump.

Don't pack the form with the pump into the PE bag.

This declaration of contamination is necessary to comply with legal requirements and to protect our staff.

Leybold must return any pump without a declaration of contamination to the sender's address.

4.7 Disposal

Contamination

The pump may be contaminated by the process or by environmental influences. In this case it must be decontaminated in accordance with the relevant regulations. Leybold offers this service for fixed prices. Further details are available on request.

Warning

Contaminated parts can be detrimental to health and environment. Before beginning to work, find out whether any parts are contaminated. Adhere to the relevant regulations and take the necessary precautions when handling contaminated parts.

Separate clean components according to their materials, and dispose of. Leybold offers this service free of charge. Further details are available on request.

If you send a pump to Leybold mind the regulations given in Section "4.6 Service at Leybold´s".

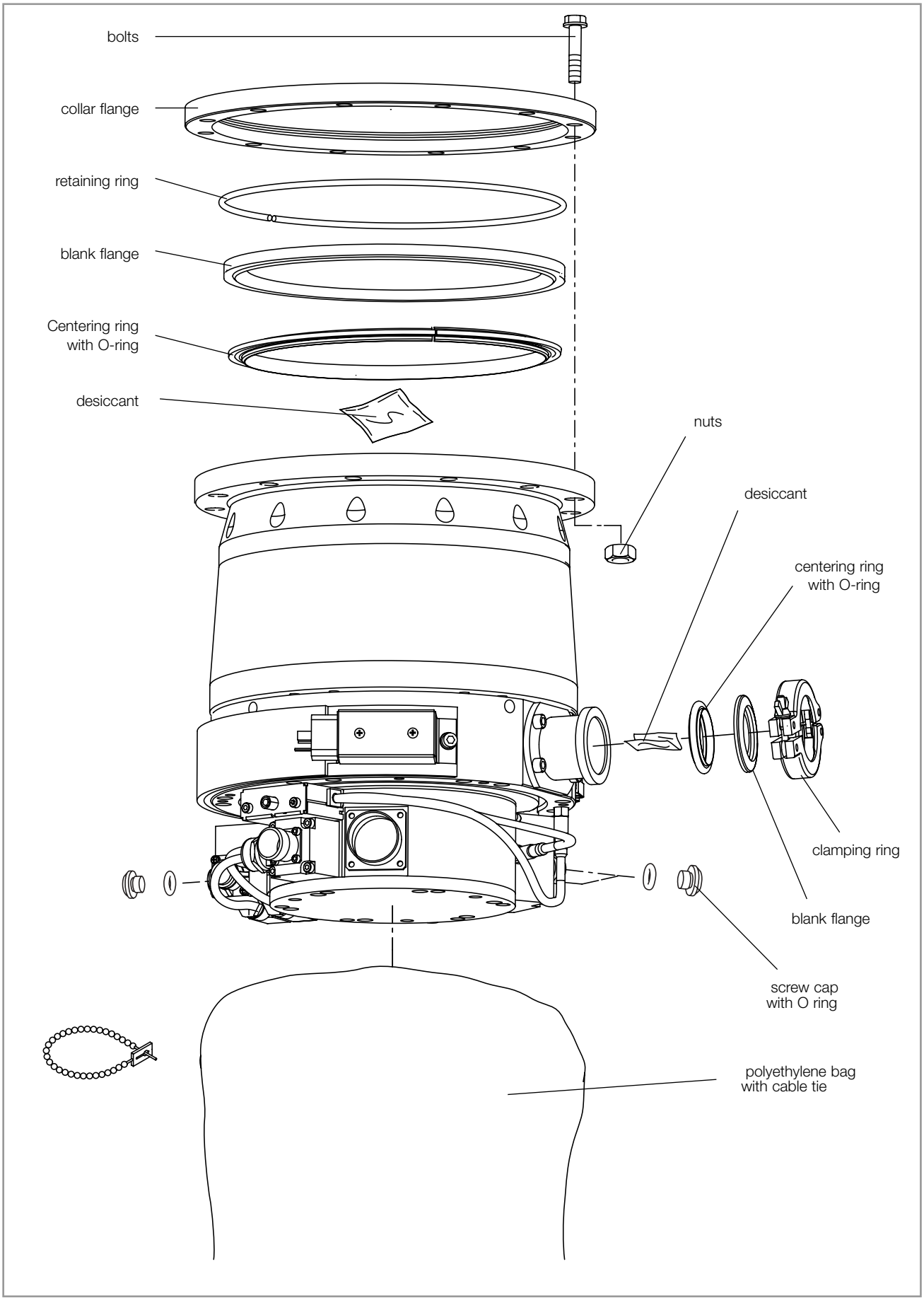


Fig. 58 Sealing the MAG tightly with the metal seal kit

5 Troubleshooting

In case of a malfunction, the MAG will be braked and the first line of the display shows

FAILURE

Malfunction messages can be cancelled once the pump has come to a stop and after the malfunction has been rectified; do so with the STOP function (button or remote control).

Warning

The MAG shall be stopped completely and the mains power cord detached before you open the MAG.DRIVE*digital*. Since dangerous voltages may nonetheless be encountered, the housing must be opened only by a qualified electrician.

5.1 Warning messages

Warning Message on Display	Possible Cause	Measures
Motor Temp. Temperature sensor inside the motor reads a higher temperature value than the warning threshold (130 °C).	Motor temperature exceeds the warning threshold e.g. due to a high gas load.	Take the actual motor temperature reading from the display; see Section 3.10.1. Reduce gas load. If the warning persists contact Leybold service.
	Drive failure or internal converter failure.	Contact Leybold service.
Bearing Temp. Temperature sensor inside the pump reads a higher temperature value than the warning threshold (98 °C).	Cooling water flow too low or cooling water temperature too high.	Apply cooling water according to specifications. Check cooling water tubes for deposits. See also Section 2.5.
	Frequent acceleration and deceleration of the pump.	Allow pump to cool down between the cycles.
Converter Temp. Temperature sensor inside of the converter reads a higher temperature value than the warning threshold (70 °C).	Frequent acceleration and deceleration of the pump.	Allow converter to cool down between the cycles.
	No sufficient air circulation.	Refer to Section 2.7 for the correct mounting of the converter in a rack; max. ambient temperature 45 °C.
Cooling Temp. Temperature sensor at cooling water block reads a higher temperature value than the warning threshold (50 °C).	Cooling water flow too low or cooling water temperature too high.	Apply cooling water according to specifications. Check cooling water tubes for deposits. See also Section 2.5.
Operation Cycles The registered number of start and standby cycles exceeds the permissible number (normal warning threshold). So as not to constantly mask this warning by others, it is only displayed during run-up (up to approximately 150 Hz) and during standby operation.	Intensive utilisation of the standby mode or a high number of starting processes.	Make a service date.
The registered number of start and standby cycles exceeds the permissible number (warning threshold 2 and 3). The warning is now displayed constantly.	This section will only be active provided the menu item "Operating Hours/Cycles" remains set to "Warning".	
Pump. Op. Hours	The operating time of the pump attains the pre-set warning threshold.	Make a service date.

Warning Message on Display	Possible Cause	Measures
Unbalanc. PVW13 **Unbalanc. PVW24** **Unbalanc. PZ12** A rotor displacement exceeding the warning threshold occured. The code designates the affected axis.	Mechanical shocks, perhaps due to tool maintenance. Shock venting. Converter failure.	If warning message persists contact Leybold service. Check the chamber pressure during operation. Contact Leybold service.
Overload The rotational speed dropped below normal operation frequency.	Backing pressure too high during operation. Parameters “Normal Operation” are not set correctly.	Reduce backing pressure. Additionally, check process gas flow. Set parameter “Normal Operation” to default 95%. Refer also to Section 3.10.5.
Mains down The converter is in the generator mode.	Mains interrupted or converter switched off during operation of the pump.	Reconnect converter to the mains. Switch on the converter.
Op. Without Purge The warning indicates that a C/CT type of pump is operated while the purge gas valve is closed.	Purge gas function disabled.	Set purge gas function to Purge ON. (Key panel or control connector X14).
Protection The pump drive is blocked.	Emergency off active.	Deactivate “Emergency off” via control plug X14.
PK Communication Converter does not communicate with the memory chip of the pump.	BEARING cable damaged or not connected. Memory chip malfunctioning.	Check BEARING connector and cable for damages or bent pins. Contact Leybold service if the cable is damaged. Contact Leybold service.
Overspeed Actual frequency exceeds the setpoint more then 10 Hz. The motor current drops to "0A”; the frequency decreases to the actual frequency setpoint.	The frequency setpoint has been set during operation with serial interface e.g. RS232.	Provide for right setting.
SPI Com.-Fail Communication problem between main controller and magnetic bearing controller	Converter failure	Contact Leybold service if the warning occurs frequently.
Rotor Not Lifted	Converter failure	Contact Leybold service
ABS Not Active	Converter failure	Contact Leybold service
ABS Active	Converter failure	Contact Leybold service

5.2 Failure messages

Failure Message on Display	Possible Cause	Measures
Motor Temp. Temperature sensor inside the motor reads a higher temperature value than the failure threshold (140 °C).	Motor temperature exceeds the failure threshold e.g. due to a high gas load.	Acknowledge failure message. Take the actual motor temperature reading from the display; see Section 3.10.1. Reduce gas load. If the warning persists contact Leybold service.
	Motor temperature sensor defective.	**Step 1: Check pump (temperature sensor)** Check pump connector X23. In particular measure resistance between pins X23/CC and X23/BB. The resistance is typically 2kΩ ± 1 %. In case of abnormal values (> 3.4 kΩ) are measured contact Leybold service.
	BEARING cable or connector damaged.	**Step 2: Check BEARING cable** If step 1 was successful do the following: Check BEARING cable for bent pins Measure the resistance between pins X20/CC and X20/BB with the cable connected to the pump. The resistance is typically 2kΩ ± 1 %. Replace the cable if it is damaged or in case the measurement of the resistance shows abnormal values (> 3.4 kΩ) now.
	Converter failure.	Contact Leybold service.
Cooling Temp. Temperature sensor at cooling water block reads a higher temperature value than the failure threshold (60 °C).	Cooling water flow too low or cooling water temperature too high.	Apply cooling water according to specifications. Check cooling water tubes for deposits. See also Section 2.5.
	Converter failure.	Contact Leybold service.
Bearing Temp. Temperature sensor inside the pump reads a higher temperature value than the failure threshold (100 °C).	Cooling water flow too low or cooling water temperature too high.	Apply cooling water according to specifications. Check cooling water tubes for deposits. See also Section 2.5.
	Frequent acceleration and deceleration of the pump.	Allow pump to cool down between the cycles.
	Pt 100 (temperature sensor bearing) damaged.	**Check pump (temperature sensor)** Check pump connector X23. In particular measure resistance between pins X23/q and X23/R. The resistance is typically between 110 Ω and 130 Ω (20 °C to 70 °C). In case abnormal values are measured contact Leybold service.
	Converter failure.	Contact Leybold service.
Converter Temp. Temperature sensor inside of the converter reads a higher temperature value than the failure threshold (90 °C).	Frequent acceleration and deceleration of the pump.	Allow converter to cool down between the cycles.
	No sufficient air circulation.	Refer to Section 2.7 for the correct mounting of the converter in a rack; max. ambient temperature 45 °C.
	Converter failure.	Contact Leybold service.

Failure Message on Display	Possible Cause	Measures
Overload PZ 12 **Overload PV 13** **Overload PW 24** An abnormal displacement of the rotor occured at frequencies between 0 and 5 Hz. The code designates the affected axis.	Mechanical shocks, possibly due to tool maintenance whwn the rotor stands still.	Acknowledge failure message and restart the pump. If failure message persists contact Leybold service.
	Pump is still protected with transport seal on power up.	Remove transport seal; see Section 2.4.
	BEARING cable or connector damaged.	Check BEARING connector and cable for bent pins. Contact Leybold service if the cable is damaged.
	Vibration influence of several pumps between each other.	Consult Leybold Application Support.
MB **MB, Purge ON** **MB, Purge OFF** An abnormal displacement ot the rotor occured at frequencies between 146 Hz and 600 Hz. The additional message gives information on the status of the purge gas valve the moment the failure occured. It can be used to estimate the run down time of the pump.	Mechanical shocks, possibly due to tool maintenance.	Acknowledge failure message and restart the pump. If failure message persists contact Leybold service.
	Shock venting.	Check the chamber pressure during the operation. Refer to Section 3.1 for correct venting of the pump.
	Converter failure.	Contact Leybold service.
	Vibration influence of several pumps between each other.	Consult Leybold Application Support.
Starting Time The frequency has not reached 40 Hz 2 minutes after the start command was applied.	Backing pressure too high during start-up.	Reduce backing pressure.
	Rotor blocked.	Check if the rotor rotates freely. Contact Leybold service if the rotor is damaged or blocked.
Accel. Time The pump does not reach the normal operation frequency after the set maximum acceleration time.	Backing pressure too high during start-up.	Reduce backing pressure.
	Parameter “Accel. Time” is not set correctly.	Set parameter “Accel. Time” to default 1000 s; see Section 3.10.5.
Overload Time The rotational speed has dropped below normal operation frequency and stays there for longer than the maximum “Accel. Time”.	Backing pressure too high during operation.	Reduce backing pressure. Additionally check process gas flow.
	Parameters “Accel. Time” or “Normal Operation” are not set correctly.	Set parameter “Normal Operation” to default 95 % and parameter “Accel. Time” to default 1000 s; see Section 3.10.5.
Shutdown Freq. Rotational speed dropped below the shutdown frequency threshold (140 Hz).	Backing pressure too high during operation.	Reduce backing pressure. Additionally check process gas flow.

Failure Message on Display	Possible Cause	Measures
Cooling Temp. SC The cooling water temperature sensor reads a temperature lower than 1 °C.	Temperature sensor Pt 100 short-circuited.	Measure the resistance between pins 1 and 3of the cooling water temperature sensor. Contact Leybold if the resistance of the sensor is under 100 Ω. See Figure on the next page for position of the sensor.
Operating Cycles The registered number of start and stand-by cycles exceeds the permissible alarm limit during system start. The system can no longer be started. The registered number of start and stand-by cycles has reached the pre-set alarm limit. The system is automatically shut down and can thereafter no longer be started.	Intensive utilisation of the standby mode or a high number of starting processes. The alarm is only active provided the menu item "Operating Hours/Cycles" was changed to "Alarm".	Have the pump serviced.
Operating Hours The number of operating hours of the pump has reached the pre-set alarm limit during system start. The system can no longer be started. The number of operating hours of the pump has reached the pre-set alarm limit. The system is automatically shut down and can thereafter no longer be started.	The number of operating hours of the system has reached the level necessary for servicing. The alarm is only active provided the menu item "Operating Hours/Cycles" was changed to Alarm.	Have the pump serviced.
! Firmware Update ! This failure message is displayed directly after switching on the mains. The system cannot be started.	A new converter software version is required for operation of the pump.	Have the converter software updated.

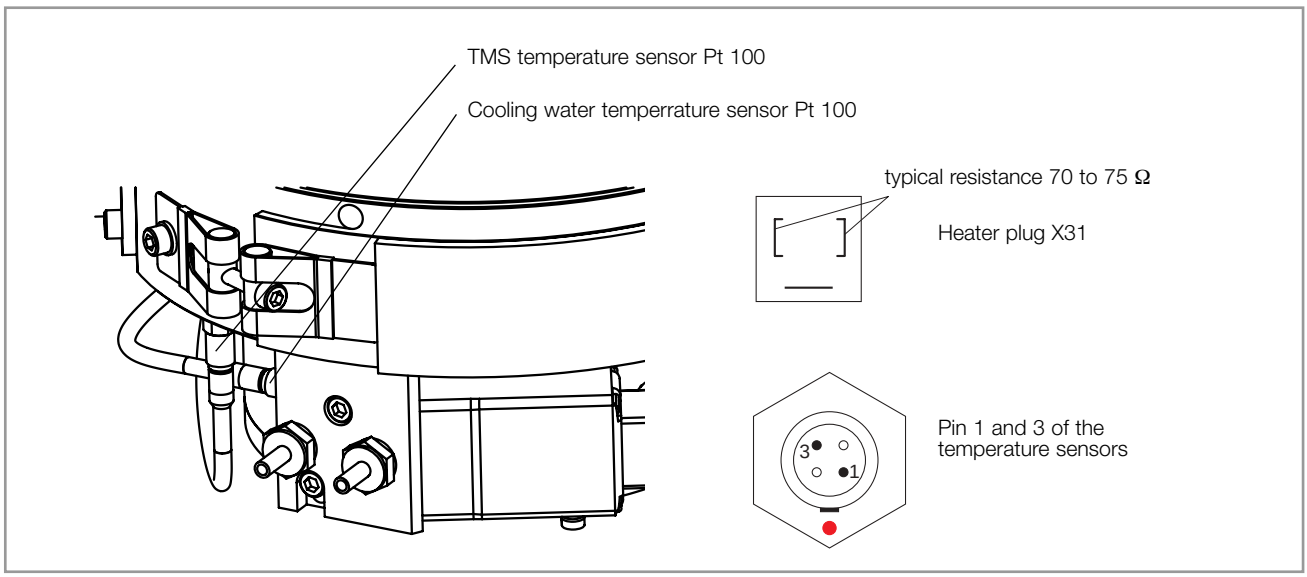


Fig. 59 Temperature sensors

Failure Message on Display	Possible Cause	Measures
Bearing Temp. SC The magnetic bearing temperature sensor reads a temperature lower than 1 °C.	Temperature sensor Pt 100 short-circuited.	Check pump connector X23. In particular measure the resistance between pins X23/q and X23/R. Contact Leybold if the resistance of the sensor is under 100 Ω.
Motor Temp. SC The motor temperature sensor reads a temperature lower than 1 °C.	Temperature sensor KTY short-circuited.	Repeat step 1 of “failure Motor Temp.”. Contact Leybold service if the resistance of the sensor is less than 1.62 kΩ.
	BEARING cable short-circuited.	Repeat step 2 of “failure Motor Temp.”. Contact Leybold service if the resistance of the sensor is less than 1.62 kΩ.
	Converter failure.	Contact Leybold service.
Frequency XX* Abnormal motor current or frequency *XX is a code no. between 43 and 55. It helps the Leybold service to find the cause of the failure.	The rotor frequency exceeds the nominal speed plus 5%.	Acknowledge failure message. If failure persists contact Leybold service.
	Converter failure.	Contact Leybold service.
No Motor Current	On START command: DRIVE cable not connected or connectors damaged.	Check cables and connectors, straighten pins if required.
	Resultant message after activating “Emergency off”.	Deactivate “Emergency off” via control plug X14 and acknowledge failure message.
	DRIVE cable interrupted during operation of the MAG.	Reconnect or replace DRIVE cable.

Failure Message on Display	Possible Cause	Measures
TMS 1 The converter measures a heating current of less than 300 mA when heater is on.	Fuse TMS blown.	**Step 1: Check fuse** Replace fuse TMS (F4A, 5x20 mm) if blown.
	Heating element or internal pump connection damaged.	**Step 2: Check pump (heating element X31)** Check if the connector of the heating element is connected. The resistance of the heating element X31 is typically between 70 Ω and 75 Ω. In case abnormal values are measured contact Leybold service.
	TMS/DRIVE cable or connectors damaged.	**Step 3: Check TMS cable** If step 2 was successful do the following: Check TMS cable for bent pins Measure resistance between pins X21/AA and X21/q with the cable connected to the pump. The resistance is typically between 70 Ω and 75 Ω. Replace the cable if it is damaged or in case the measurement of the resistance shows abnormal values now.
	Converter failure.	Contact Leybold service.
TMS 2 The converter measures a heating current of more than 4 A.	Overvoltage.	Check the line voltage (200-240 V +10% / -15%).
	Heating element defective.	Repeat step 2of failure TMS 1. In case the measured value is less than 60 Ω contact Leybold service.
	Converter failure.	Contact Leybold service.
TMS 3 TMS temperature sensor reads a temperature higher than 139 °C.	TMS sensor damaged.	**Check TMS sensor** Measure the resistance between pins 1 and 3 of the TMS temperature sensor. The resistance is typically between 110 Ω and 150 Ω (20 °C to 140 °C). Contact Leybold if the sensor is defective.
	Converter failure.	Contact Leybold service.
TMS 4 TMS temperature sensor reads a temperature lower than 1 °C.	TMS sensor short-circuited.	Measure the resistance between pins 1 and 3 of the TMS temperature sensor. Contact Leybold if the resistance of the sensor is under 100 Ω.
	Converter failure.	Contact Leybold service.

Failure Message on Display	Possible Cause	Measures
Bearing Temp. open Sensor loop is interrupted	Pt 100 (temperature sensor bearing) damaged.	Check pump (temperature sensor). For measures see failure **Bearing Temp.**
Cooling Temp. open Sensor loop is interrupted	Pt 100 (temperature sensor cooling) is not connected. Pt 100 damaged.	**Check cable conections.** Check if the Pt 100 is connected to the corresponding sensor cable. The sensor cables are marked with COOLING WATER or BASFLANGE (TMS-sensor). **Check cooling temperature sensor.** For Pin assignment see Fig. 44. Measure the resistance between pins 1 and 3 of the cooling temp. sensor.The resistance is typically between 110 and 150 Ohm (20°C to 140°C). Contact Leybold Service if the sensor is defective.
AMB Not Initial Converter can not identify the pump.	Drive / Bearing Cable is not connected with the pump, pumps memory chip "PK-.." or the controller. Drive / Bearing Cable or connector damaged Controller is not able to operate with the connected pump	Check cable connections. Check cable. Replace the cable if it is damaged Contact Leybold service. Principally controllers with SR-Software Revision 302.18 or higher can be updated for new pumps (see 3.10.2 for Conv. SR SW-Rev).
SPI Com.-Fail Communication problem between main controller and magnetic bearing controller	Converter failure	Contact Leybold service.
SPI-Timeout Communication problem between main controller and magnetic bearing controller	Converter failure	Contact Leybold service.
Bearing Overload Magnetic Bearing output current is overloaded	Converter failure	Contact Leybold service.
Internal Overload DC/DC Converter is overheated	Converter failure	Contact Leybold service.
Rotor Not Lifted	Converter failure	Contact Leybold service.
PK-Communication Converter does not communicate with the memory chip of the pump. The failure occurs when the frequency is lower than 5 Hz. In case of a frequency above 5 Hz a warning will occur.	Drive / Bearing Cable is not connected with the pump, pumps memory chip "PK-.." or the controller. Drive / Bearing Cable or connector damaged. PK. or converter failure	Check cable connections. Check cable. Replace cable if it is damaged. Contact Leybold service.

5.3 Malfunctions

Malfunction	Possible Cause	Measures
Converter dead, LED “mains” does not light up after switching on.	No power supply. Fuse F1 blown or converter failure.	Check the line voltage. Contact Leybold service.
Display malfunction, confusing messages. No reaction when pressing keys.	Converter failure.	Switch the converter off and on again. If the converter still malfunctions contact Leybold service.
Vacuum chamber pressure rises above normal backing pressure while the pump is stopped.	Purge gas and venting valve open or malfunctioning.	Open and close purge gas and/or venting valve via control plug X14. LED on the valve must light up and a clicking noise can be heard. Foreline pressure drops while the valve is closed.
No purge gas flow	Valve malfunctioning.	Set purge flow according to specification. Open and close purge gas and venting valve via control plug X14. LED on the valve must light up and a clicking noise can be heard. Foreline pressure drops while the valve is closed.
Base pressure not reached.	Degassing surfaces of rotor and stator. If the pump was stored in a humid environment or was exposed to humid ambient air all surfaces will be covered with condensation.	Leave the pump system run for 3 to 5 hours to reach a pressure below 10^{-5} mbar.
MAG CT does not heat up.	TMS failure.	See TMS failures.
Display blurred.	Ambient temperature too high or too low.	Operate the converter according to the specifications.
One or two high-frequency sounds every 4 to 7 minutes; display changes for a short time.	This is no malfunction but a routine check of the overspeed protection.	No measures required.
The values for frequency setpoint or normal operation are reset to standard values after the frequency converter has been changed.	The new frequency converter has a default value for stand-by operation that overlaps with the normal operation threshold.	Accept default values or set new values; see Sections 3.10 and 4.4.

EC Manufacturer's Declaration

in the spirit of Appendix IIb to the 98/37/EG Machinery Guidelines

We - LEYBOLD Vacuum GmbH - herewith declare that operation of the incomplete machine defined below, is not permissible until it has been determined that the machine into which this incomplete machine is to be installed, meets the regulations of the EEC Directive on Machinery.

When using the appropriate Leybold accessories, e.g. connector lines and when powering the pump with the specified Leybold frequency converters, the protection level prescribed in the EMC Guidelines will be attained.

Designation: Turbomolecular pump **MAG*digital* LINE**

Models:		**Part Nos.:**	
MAG W 830 C	MAG W 830	400000Vxxxx	400027Vxxxx
MAG W 1300 C	MAG W 1300	400003V0002	400030Vxxxx
MAG (W) 1500 CT	MAG W 2200	400006V0071	400081Vxxxx
MAG W 2200 C	MAG W 2800	400020Vxxxx	400100Vxxxx
MAG W 2800 C(T)		400021Vxxxx	400110Vxxxx
MAG W 3200 CT		400026Vxxxx	x = 0 to 9

Applied harmonized standards:

■ EN 1012 – 2 1996

Cologne, Sept. 14, 2004

Marcus Eisenhuth
Vice-President
Head of Product Development

Cologne, Sept. 14, 2004

Ralf Adamietz
Head of Design

Leybold Vacuum GmbH
Bonner Straße 498 (Bayenthal)
D-50968 Köln
Tel.: ++49 (0)221 347-0
Fax: ++49 (0)221 347-1250
documentation@leybold.com

www.leybold.com

EC Conformance Declaration

We, the Leybold Vacuum GmbH, declare herewith that the products listed below, in the embodiment which we have placed on the market, comply with the applicable EC guidelines.

This declaration becomes invalid if modifications are made to the product without consultation with us.

Maintaining the EMC guideline assumes an EMC adapted installation of component within the plant or machine.

Test were run using a typical construction in a test assembly that conforms with the standards.

Time of the CE label (year):	2004
Designation of the products:	Frequency converter / Plug-in control
Model:	**MAG.DRIVE*digital***
Part No.	400035V0011 / 121 36

The products comply to the following guidelines:

- EC Low-Voltage Equipment Guidelines (73/23/EWG and 93/68/EG
- EC Directive on Electromagnetic Compatibility 89/336/EWG, 91/263/EWG, 92/31/EWG and 93/68/EWG

Related, harmonized standards:

- EN 61010 - 1 2002
- EN 61000-6-4 2001
- EN 61000-6-2 2001

Cologne, Sept. 14, 2004

Marcus Eisenhuth
Vice-President
Head of Product Development

Cologne, Sept. 14, 2004

Manfred Kieffer
Development Design

Leybold Vacuum GmbH
Bonner Straße 498 (Bayenthal)
50968 Köln
Tel.: ++49 (0)221 347-0
Fax: ++49 (0)221 347-1250
documentation@leybold.com

www.leybold.com

Semiconductor Equipment and Materials International

NRTL LISTED

The system **MAG*digital* LINE**

- turbomolecular pump
- connecting cables
- frequency converter

has been tested by the TÜV Rheinland of North America according to the requirements of

- NRTL
  (used standards UL 61010A-1 and IEC 61010-1/A2) and
- SEMI S2

The components are in compliance to the tested standards.

Certificate No. US 2271305 01, 02 and 03

Leybold vacuum

Leybold vacuum

Declaration of Contamination of Compressors, Vacuum Pumps and Components

The repair and / or servicing of compressors, vacuum pumps and components will be carried out only if a correctly completed declaration has been submitted. **Non-completion will result in delay**. The manufacturer can refuse to accept any equipment without a declaration.

A separate declaration has to be copleted for every single component.

This declaration may be completed and signed only by authorised and qualified staff.

Customer/Dep./Institute: _____

_____

Address _____

_____

Person to contact: _____

Phone: _____ Fax: _____

Order number of customer: _____

Reason for returning ☒ applicable please mark

❑ repair ❑ chargeable ❑ warranty

❑ Austausch ❑ chargeable ❑ warranty

❑ DKD-calibration ❑ Factory calibration

restoring goods because of following reason:

❑ rent/loan ❑ for credit ❑ against exchange

❑ exchange already received/arranged

A. Description of the equipment (machine or component)

Ancillary equipment

Type: _____ _____

Part number: _____ _____

Serial number: _____ _____

Type of oil used: _____ _____

B. Condition of the equipment

	No	Yes	No
1. Has the equipment been used	❑	❑	
2. Drained (Product/service fluid)		❑	❑
3. All openings sealed airtight		❑	
4. Purged		❑	❑

If yes which cleaning agent: _____

and which method of cleaning: _____

Contamination:	No	Yes
toxic	❑	❑
corrosive	❑	❑
mmicrobiological	❑	❑
explosive	❑	❑
radioactive	❑	❑
other harmful substances	❑	❑

C. Description of processed substances (Please fill in absolutely)

1. What substances have come into contact with the equipment:

Trade name and / or chemical term of service fluids and substances processed, properties of the substances; According to safety data sheet (e.g. toxic, inflammable, corrosive, radioactive)

	Tradename:	Chemical name:	Residues:
a)	_____	_____	❑ Yes ❑ No
b)	_____	_____	❑ Yes ❑ No
c)	_____	_____	❑ Yes ❑ No
d)	_____	_____	❑ Yes ❑ No

	Yes	No
2. Are these substances harmful?	❑	❑
3. Dangerous decomposition products when thermally loaded	❑	❑

Which:

Components contaminated by microbiological, explosive or radioactive products will not be accepted without written evidence of decontamination.

D. Legally binding declaration

I / we hereby declare that the information supplied on this form is accurate and sufficient to judge any contamination level.

Name of authorised person (block letters): _____

date _____ signatur of authorised person _____

firm stamp

© Leybold Vacuum Köln

Fax to: Service LV
Fax#: (0049) 221 347 1945

Form TMP-1 ... Turbopump Field Failure Report

Field Service IR No.: RMA No. (if returning to factory):

Service Center:

Customer:

Turbopump Model: Turbopump Pump Part Number:

Turbopump Serial Number:

Complaint:

Process:

OEM Equipment Name and Model:

Process Gas:

Was the turbopump replaced? ❒ Yes; ❒ No.

If yes, replacement pump P/N: replacement pump S/N:

Date Installed: Date Removed:

Date Received:

Date Examined: Examined by:

Received Condition:

Findings:

Cause of Failure:

Recommendations:

Remarks/Questions:

Leybold vacuum

Operating Instructions for MAG*digital*-series

Operating Instructions		Valid for pumps	Valid for converters
GA 05.141/6.02 English (July 2003)	GA 05.141/6.01 German (July 2003)	MAG W 830 C MAG W 1300 C MAG 1500 CT MAG W 1500 C, CT MAG W 2200 C MAG W 2800 C, CT MAG W 3200 CT	MAG.DRIVE*digital* from software version 302.18
GA 05.152/2.02 English (July 2003)		MAG W 2200 C Part No. 400081V0020	MAG.DRIVE*digital* from software version 303.00
KA 05154_0302 Engl. (April 04) Suppl. for GA 05.141/6.02	KA 05154_0301 German (April 04) Suppl. for GA 05.141/6.01	MAG W 830 MAG W 1300 MAG W 2200 MAG W 2800 with CF flange	MAG.DRIVE*digital* from software version 302.18
KA 05157_0202 Engl. (July 04) Suppl. for GA 05.141/6.02	KA 05157_0201 German (July 04) Suppl. for GA 05.141/6.01	MAG W 1300 C with ISO-K flange	MAG.DRIVE*digital* from software version 302.18
GA 05141_0702 English (Sept. 2004)	GA 05141_0701 German (Sept. 2004)	MAG W 830 C MAG W 1300 C MAG 1500 CT MAG W 1500 CT MAG W 2200 C MAG W 2800 C, CT MAG W 3200 CT MAG W 830 MAG W 1300 MAG W 2200 MAG W 2800	MAG.DRIVE*digital* from software version 3.03.05

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Sales and Service Net Worldwide

EUROPE

Germany:
Leybold Vacuum
Bonner Strasse 498
(Bayenthal)
D-50968 Cologne
sales@leybold.com
Phone: +49-221-347 1234
Fax: +49-221-347 1245

Leybold Vacuum
Service Center
Emil-Hoffmann-Strasse 43
50996 Cologne-Suerth
service@leybold.com
Phone: +49-221-347 14 39
Fax: +49-221-347 19 45

Belgium:
Leybold Vacuum
Nederland B.V.
Belgisch bijkantoor
Leuvensesteenweg 542, 9A
1930 Zaventem
info@leybold.be
Sales:
Phone: +32-2-711 00 83
Fax: +32-2-720 83 38
Service:
Phone: +32-2-711 00 82
Fax: +32-2-720 83 38

France:
Leybold Vacuum
France S.A.
7, Avenue du Quebec
Z.A. de Courtaboeuf, B. P. 42
91942 Courtaboeuf Cedex
leybold-vacuum@leybold.fr
Sales and Service:
Phone: +33-1-69 82 48 00
Fax: +33-1-69 07 57 38

Great Britain:
Leybold Vacuum UK Ltd.
Waterside Way, Plough Lane
London SW17 0HB
Sales:
sales@leybold.co.uk
Phone: +44-20-8971 7000
Fax: +44-20-8971 7001
Service:
service@leybold.co.uk
Phone: +44-20-8971 7030
Fax: +44-20-8971 7003

Italy:
Leybold Vacuum
Italia S.p.A.
8, Via Trasimeno
20128 Milano
Sales:
sales@leybold.it
Phone: +39-02-27 22 31
Fax: +39-02-27 20 96 41
Service:
service@leybold.it
Phone: +39-02-27 22 31
Fax: +39-02-27 20 96 41

Netherlands:
Leybold Vacuum
Nederland B.V.
Computerweg 7
3542 DP Utrecht
e-mail: mail@leybold.nl
Sales and Service:
Phone: +31-346-58 39 99
Fax: +31-346-58 39 90

Spain:
Leybold Vacuum
España S.A.
C/. Huelva, 7
08940 Cornella de
Llobregat (Barcelona)
leybold@leyboldspain.com
Sales:
Phone: +34-93-666 46 16
Fax: +34-93-666 43 70
Service:
Phone: +34-93-666 49 51
Fax: +34-93-685 40 10

Sweden:
Leybold Vacuum
Scandinavia AB
Box 9084
40092 Göteborg
info@leybold.se
Sales and Service:
Phone: +46-31-68 84 70
Fax: +46-31-68 39 39

Switzerland:
Leybold Vacuum
Schweiz AG
Leutschenbachstrasse 55
8050 Zürich
sales@leybold.ch
Sales:
Phone: +41-1-308 40 50
Fax: +41-1-302 43 73
Service:
Phone: +41-1-308 40 62
Fax: +41-1-302 40 60

AMERICAS

USA:
Leybold Vacuum USA Inc.
5700 Mellon Road
Export, PA 15632
info@leyboldvacuum.com

Sales:
Eastern & Central time zones
Phone: +1-724-327-5700
Fax: +1-724-733-1217
Pacific, Mountain,
Alaskan & Hawaiian time zones
Phone: +1-480-752-9191
Fax: +1-480-752-9494

Service:
Phone: +1-724-327-5700
Fax: +1-724-733-3799

ASIA

P.R. China:
Leybold Vacuum
(Tianjin)
International Trade Co., Ltd.
Beichen Economic
Development Area
(BEDA), Tianjin,
300400, China.
Phone: +86-22-26970808
Fax: +86-22-26974061,
Fax: +86-22-26972017
leybold@leybold.com.cn

Leybold (Tianjin)
Vacuum Equipment
Manufacturing Co. Ltd
Beichen Economic
Development Area
(BEDA), Tianjin,
300400, China.
Phone: +86-22-26970808
Fax: +86-22-26974061
Fax: +86-22-26972017
leybold@leybold.com.cn

Leybold Vacuum
(Tianjin)
International Trade Co., Ltd.
Shanghai Branch:
Add: No.33, 76 Futedong
San Rd., Waigaoqiao
FTZ, Shanghai,
200131, China.
Phone: +86-21-5064-4666
Fax: +86-21-5064-4668
leybold_sh@leybold.com
.cn

Leybold (Tianjin)
Vacuum Equipment
Manufacturing Co.Ltd.
Guangzhou Branch:
Add: G/F,#301 Building,
110 Dongguangzhuang
Rd, Tianhe
District,Guangzhou
510610, China.
Phone: +86-20-8723-7873
Phone : +86-20-8723-7597
Fax: +86-20-87237875
leybold_gz@leybold.com
.cn

Japan:
Sales:
Leybold Vacuum
Japan Co., Ltd.
Head Office
Tobu A.K.Bldg.
4th Floor 23-3,
Shin-Yokohama 3-chome
Kohoku-ku, Yokohama-shi
Kanagawa-ken 222-0033
Phone: +81-45-4713330
Fax: +81-45-4713323

Sales:
Leybold Vacuum
Japan Co., Ltd.
Osaka Branch Office
MURATA Bldg.7F
2-7-53, Nihi-Miyahara,
Yodogawa-ku
Osaka-shi 532-0004
Phone: +81-6-6393-5211
Fax: +81-6-6393-5215

Service:
Leybold Vacuum
Japan Co., Ltd.
Tsukuba Technical S.C.
Tsukuba Minami Daiichi
Kogyo Danchi
21, Kasumi-no-Sato,
Ami-machi nashiki-gun
Ibaraki-ken, 300-0315
Tel.: +81-298-89-2841
Fax: +81-298-89-2838

Korea:
Leybold Vacuum
Korea Ltd.
#761-47, Yulkeum-ri,
SungHwan-eup, Chonan
Choongchung-Namdo,
330-807, Korea
Sales:
Tel.: +82-41-580-4431
Fax: +82-41-588-3737
Service Center:
Phone: +82-41-588-3765
Fax: +82-41-588-3769

Singapore:
Leybold Vacuum
Singapore Pte Ltd. No.1,
International Business Park,
B1-20B, The Synergy
Singapore 609917
Phone: +65-66652910
Fax: +65-65668202
vacuum@leyboldvac.com.sg

Taiwan:
Leybold Vacuum
Taiwan Ltd.
2F, No 416-1, Sec.3
Chung-Hsin Rd., Chu-Tung
Hsin-Chu, Taiwan, R.O.C.
Phone: +886-3-5833988
Fax: +886-3-5833999

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Leybold vacuum

Leybold Vacuum GmbH
Bonner Strasse 498 (Bayenthal)
D-50968 Cologne
Phone: ++49 (0)221 347-0
Fax: ++49 (0)221 347-1250
documentation@leybold.com

www.leybold.com