GA 05.141/6.02

MAG*digital* Series

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

Turbomolecular Pump with Magnetic Bearing

MAG.DRIVE*digital*

Electronic Frequency Converter

Operating Instructions

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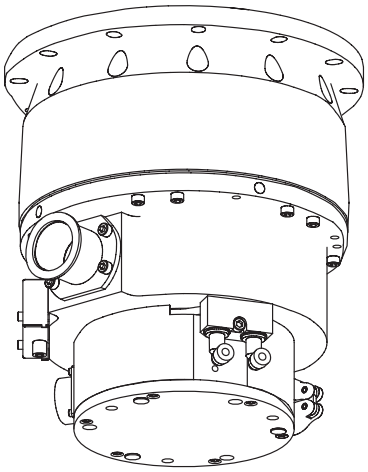
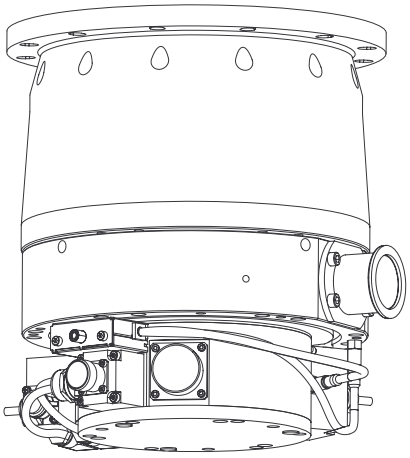
We reserve the right to alter the design or any data given in these Operating Instructions. The illustrations are not binding.

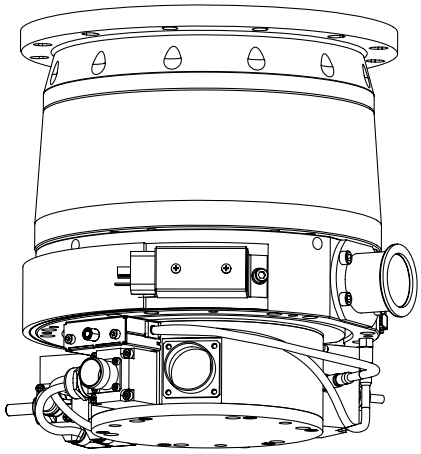
The Operating Instructions are included with the pump **and** the converter. If they have different editions, the version delivered with the pump describes the pump correctly and the version delivered with the converter describes the converter correctly. The version number is the digit behind the "/" in the GA No.. Example: GA 05.141/**5**.02 is the fifth edition. See also the last page.



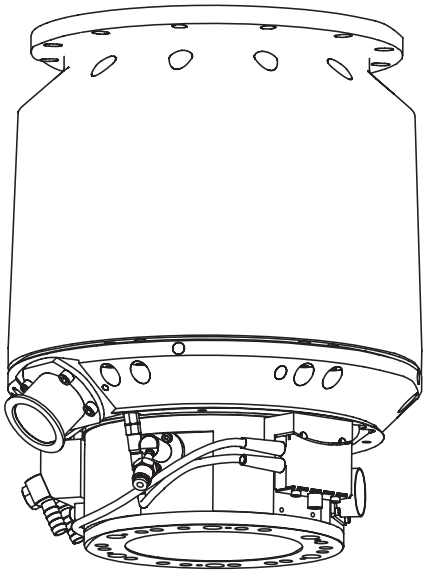
MAG W 830 C
MAG W 1300 C



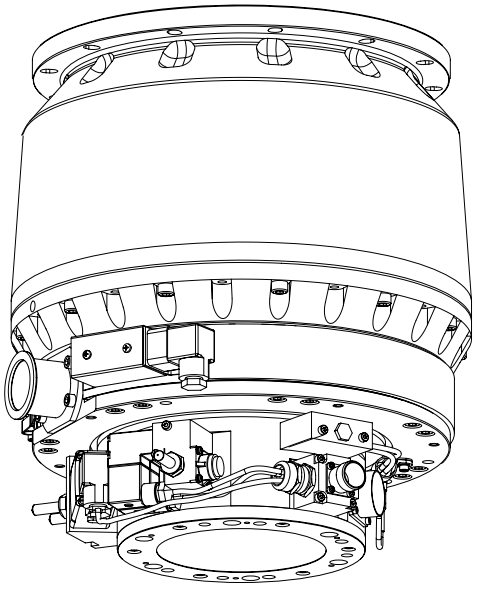
MAG W 1500 C



MAG 1500 CT
MAG W 1500 CT



MAG W 2200 C



MAG W 2800 CT
MAG W 3200 CT

Fig. 1 MAG turbopumps

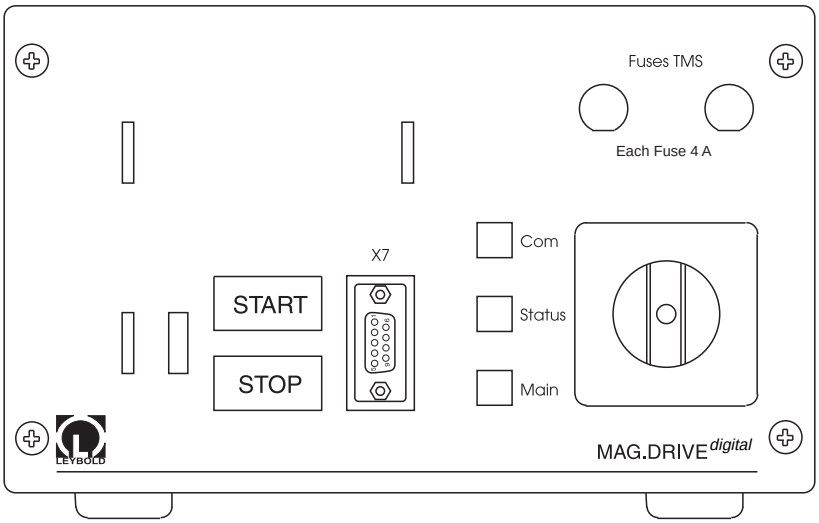


Fig. 2 MAG.DRIVE*digital* Front panel

1 Description

1.1 System overview

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

- The **MAG** turbopump; see Figure 1

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

  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 cable if required

1.2 Compatibility with pumped media

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

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

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.

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. $AlCl_3$, $WOCl_4$) 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.

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

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

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.

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.

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.

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.

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.

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 2.8.

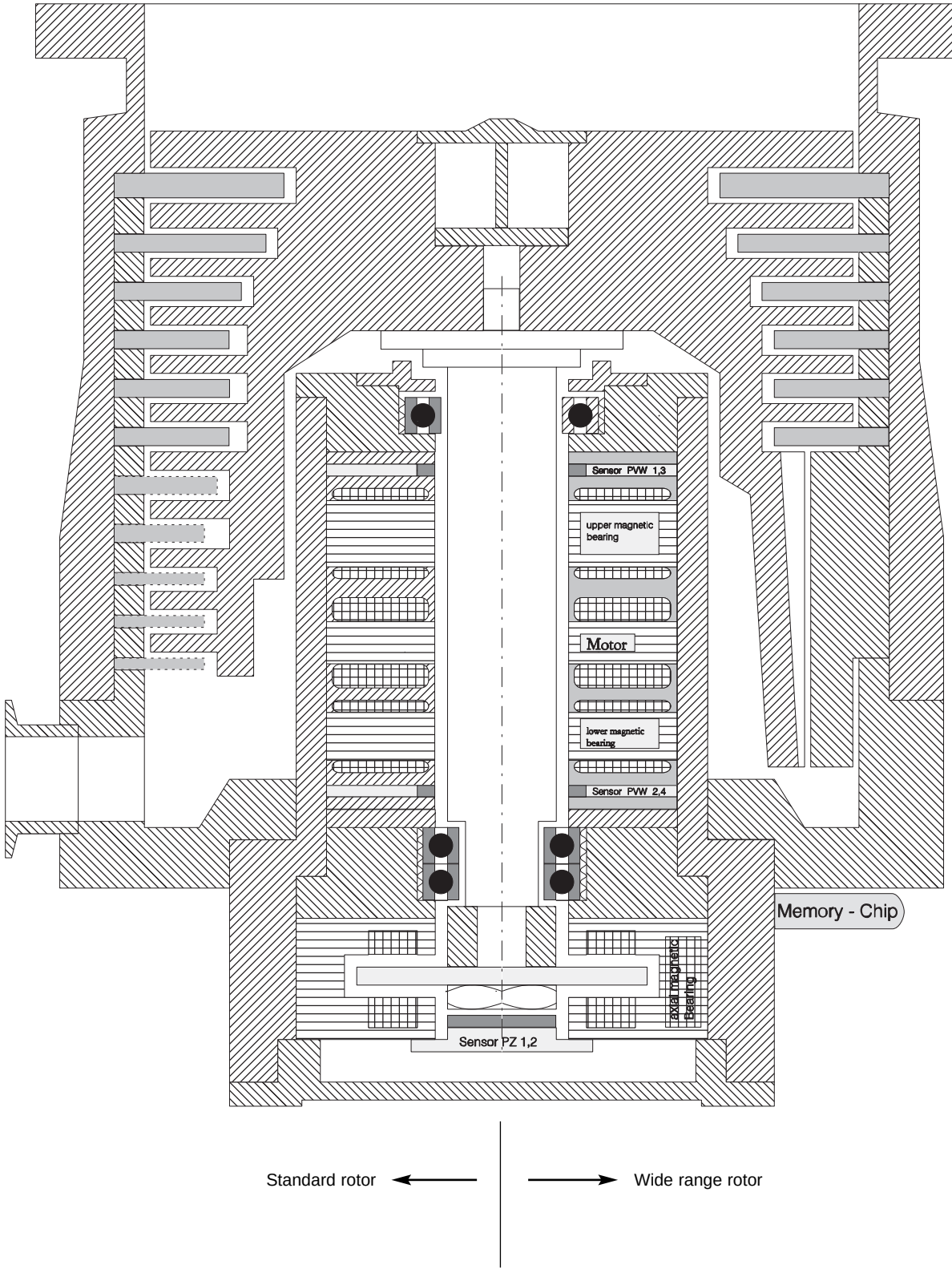


Fig. 3 Section of a MAG

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

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

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.

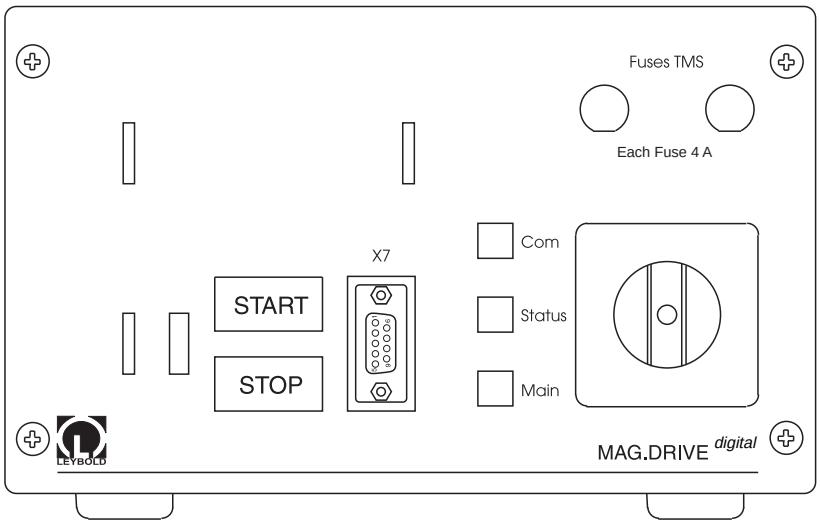
For the intake flange, a centering ring with FPM O-ring, outer ring, and a splinter guard are enclosed.

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 2.4 “Connecting the MAG ...”.

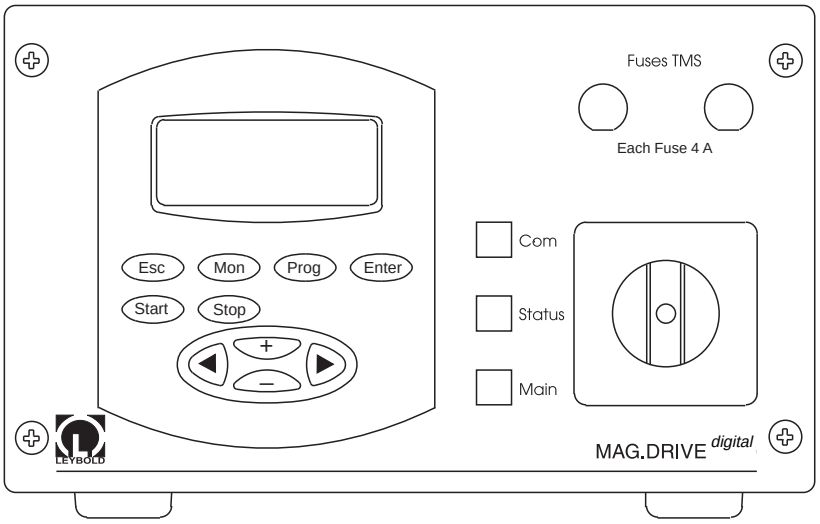
The electronic frequency converter MAG.DRIVE*digital*, the cables required for operation and a seal kit to seal the pump tightly if it is removed from the process must be **ordered seperately**.

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)



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)

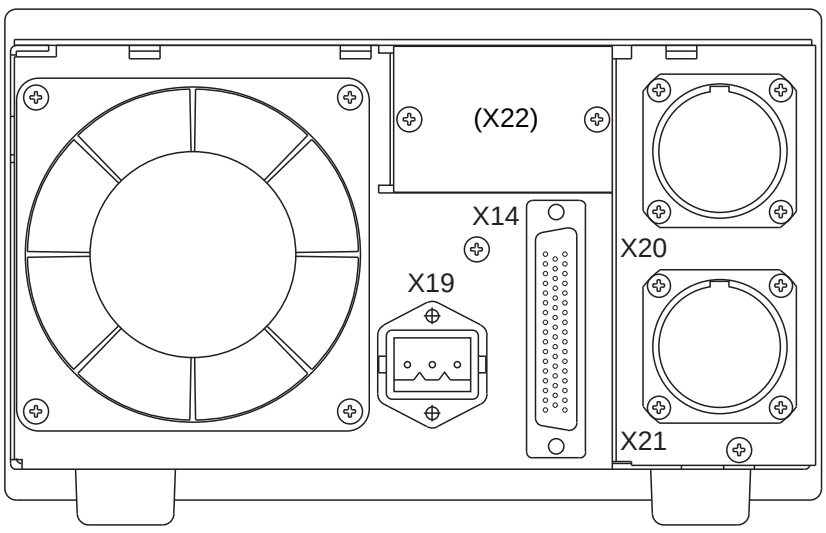


Fig.5 Rear panel with connections

1.6 Technical data

MAG		***W 830 C DN 160***	***W 1300 C DN 200***	***W 1300 C DN 250***
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“)	–
or with John Guest fitting for tube	mm	–	6	6
Cooling water temperature	°C		10 to 30	
	°F		50 to 86	
Weight	approx. kg		32	
High-vacuum connection flange	DN	160 ISO-F	200 ISO-F	250 ISO-F
Max. high-vacuum flange temperature for continuous operation	°C		85	
	°F		185	
Bake-out temperature at high-vacuum flange	°C		120	
	°F		248	
Vibration level at high-vacuum flange at max. speed	µm		< 0.01	
Forevacuum connection 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 to 40	
	°F		40 to 104	
Storage temperature	°C		-10 to +60	
	°F		14 to 140	
Max. relative air humidity			95% (non-condensing)	
Degree of protection (EN 60529)			IP 20	

Technical data (continued)

MAG		***1500 C/CT DN 200***	***W 1500 C/CT DN 200***	***1500 C/CT DN 250***	***W 1500 C/CT DN 250***
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 to 30			
	°F	50 to 86			
Base flange temperature	°C	20 to 90			
	°F	68 to 194			
Weight	approx. kg	32			
High-vacuum connection flange	DN	200 ISO-F	200 ISO-F 200 JIS 200 CF	250 ISO-F	250 ISO-F
Max. high-vacuum flange temperature for continuous operation	°C	85			
	°F	185			
Bake-out temperature at high-vacuum flange	°C	120			
	°F	248			
Vibration level at high-vacuum flange at max. speed	µm	< 0.01			
Forevacuum connection 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 to 40			
	°F	40 to 104			
Storage temperature	°C	-10 to +60			
	°F	14 to 140			
Max. relative air humidity		95% (non-condensing)			
Degree of protection (EN 60529)		IP 20			

Technical data (continued)

MAG		***W 2200 C DN 200***	***W 2200 C DN 250***	***W 2800 CT DN 250***	***W 3200 CT DN 320***	***W 3200 CT VG 350 JIS***
Pumping Speed						
for N_2	$l \cdot s^{-1}$	1600	2000	2650	3200	3200
for Ar	$l \cdot s^{-1}$	1450	1900	2450	3000	3000
for H_2	$l \cdot s^{-1}$	1650	1800	2100	2250	2250
Compression for N_2				$> 10^8$		
Ultimate pressure	mbar			$< 10^{-8}$		
Max forvacuum pressure	mbar			2.0		
Rotor speed	min^{-1}	29,400	29,400	28,800	28,800	28,800
Run-up time	min	< 8	< 8	< 10	< 10	< 10
Braking time with/without venting	min	1 / <7	1 / <7	2 / <9	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“)	6.4 (1/4“)
with stainless steel hose nipples for tube ID		1/2“	1/2“	–	–	–
Cooling water temperature	°C			10 to 30		
	°F			50 to 86		
Base flange temperature	°C			20 to 80		
	°F			68 to 176		
Weight	kg	48	48	64	65	66
High-vacuum connection flange	DN	200 ISO-F	250 ISO-F	250 ISO-F	320 ISO-F	VG 350 JIS
Max. high-vacuum flange temperature for continuous operation	°C			85		
	°F			185		
Bake-out temperature at high-vacuum flange	°C			120		
	°F			248		
Vibration level at high-vacuum flange at max. speed	µm			< 0.01		
Fore-vacuum connection 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 to 40		
	°F			40 to 104		
Storage temperature	°C			-10 to +60		
	°F			14 to 140		
Max. relative air humidity				95% (non-condensing)		
Degree of protection (EN 60529)				IP 20		

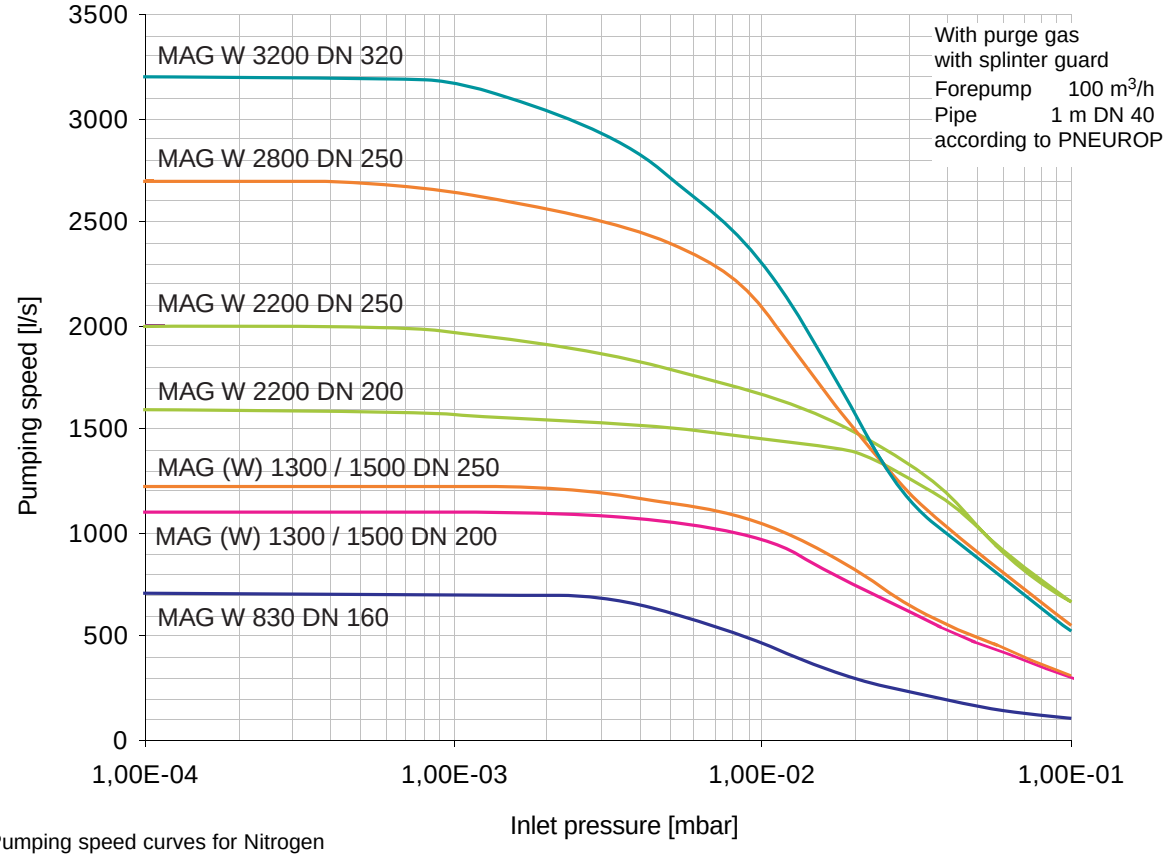


Fig. 6 Pumping speed curves for Nitrogen

Technical data *(continued)*

Purge Gas

see Section 2.7

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
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	Class F acc. to DIN 400 40
Overvoltage category	II
Contamination level in accordance with EN 61010	2
Weight	10 kg

The units have degree of protection IP20 in accordance with EN 60529

(protection against the ingress of solid foreign bodies > 12 mm diameter (finger). It is not protected against the ingress of water with damaging effects.)

An increased degree of protection, e.g. IP54 can only be implemented by mounting the converter in an additional housing.

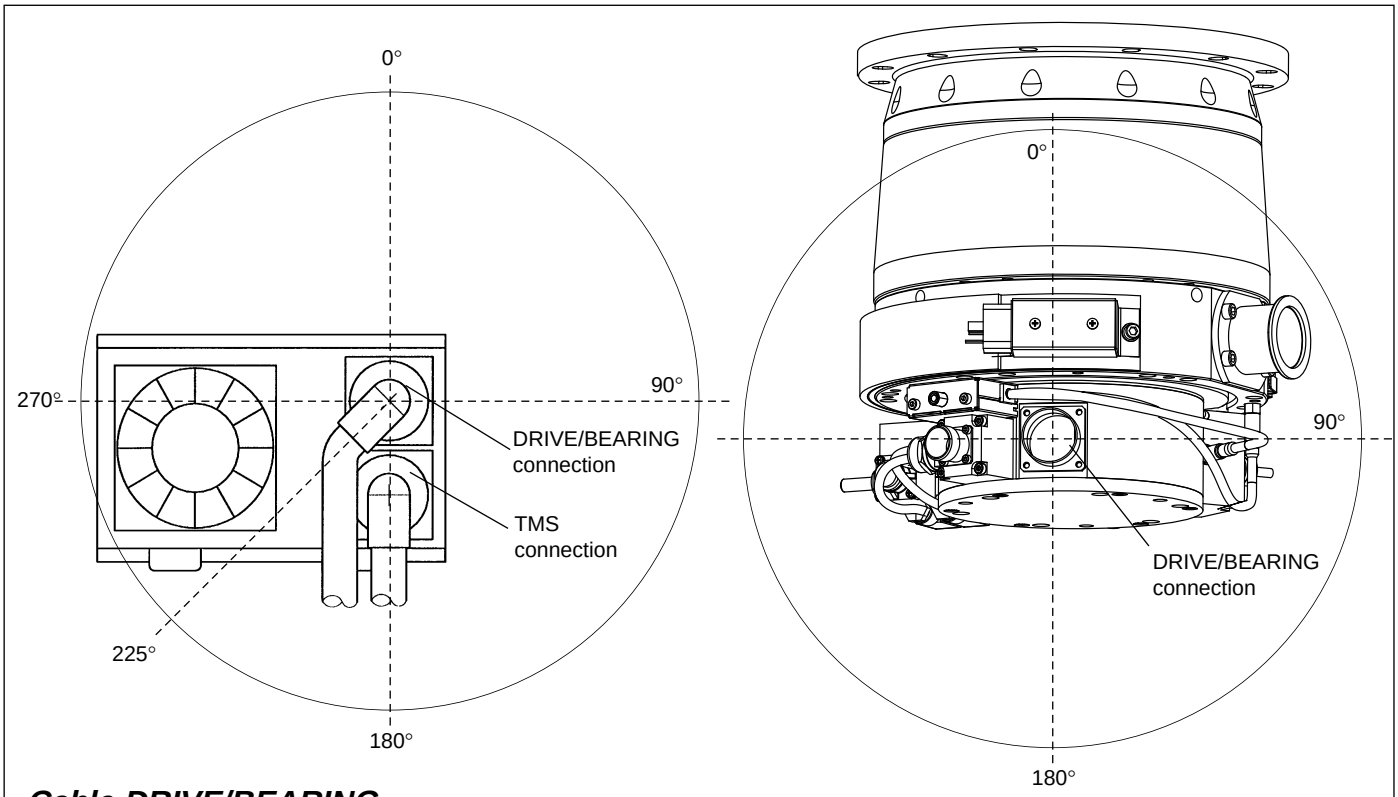
Pump configuration

Pump	Inlet flange DN	Fore-vacuum flange DN	Purge gas connection	Purge vent valve mounted to pump	Cooling water connection	Temperature sensor for cooling water	TMS: Heater and temperature sensor for pump control	Part No.
MAG W 830	160 ISO-F	40 KF	DN 10/16	no*	Swagelock 1/4“ tube fitting	no	no	400100V0005
MAG W 1300 C	200 ISO-F	40 KF	DN 10/16	no*	John Guest fitting 6 mm tube	no	no	400110V0011
MAG W 1300 C	200 ISO-F	25 KF	VCR	no*	Swagelock 1/4“ tube	no	no	400110V0015
MAG W 1300 C	250 ISO-F	40 KF	DN 10/16	no*	John Guest fitting 6 mm tube	no	no	400110V0021
MAG 1500 CT	200 ISO-F	40 KF	VCR nut 1/4“	yes	Swagelock 1/4“ tube	yes	yes	400020V0002
MAG 1500 CT	250 ISO-F	40 KF	VCR nut 1/4“	yes	Swagelock 1/4“ tube	yes	yes	400021V0002
MAG W 1500 C	200 ISO-F	40 KF	VCR nut 1/4“	yes	Swagelock 1/4“ tube	yes	no	400026V0001
MAG W 1500 CT	200 ISO-F	40 KF	VCR nut 1/4“	yes	Swagelock 1/4“ tube	yes	yes	400026V0002
MAG W 1500 CT	250 ISO-F	40 KF	VCR nut 1/4“	yes	Swagelock 1/4“ tube	yes	yes	400027V0002
MAG W 1500 CT	200 JIS	40 KF	VCR nut 1/4“	yes	Swagelock 1/4“ tube	yes	yes	400028V0002
MAG W 1500 CT	200 CF	40 KF	VCR nut 1/4“	yes	Swagelock 1/4“ tube	yes	yes	400030V0002
MAG W 2200 C	200 ISO-F	40 KF	VCR nut 1/4“	no	Stainless steel hose nipples 1/2“	yes	no	400081V0011
MAG W 2200 C	250 ISO-F	40 KF	VCR nut 1/4“	no	Stainless steel hose nipples 1/2“	yes	no	400081V0021
MAG W 2800 C	250 ISO-F	40 KF	VCR nut 1/4“	yes	Swagelock 1/4“ tube	yes	no	400000V0001
MAG W 2800 CT	250 ISO-F	40 KF	VCR nut 1/4“	yes	Swagelock 1/4“ tube	yes	yes	400000V0002
MAG W 3200 CT	320 ISO-F	40 KF	VCR nut 1/4“	yes	Swagelock 1/4“ tube	yes	yes	400003V0002
MAG W 3200 CT	350 JIS	40 KF	VCR nut 1/4“	yes	Swagelock 1/4“ tube	yes	yes	400004V0002

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

1.7 Ordering data

	Part No.
Pumps	see Table “Pump configuration”
Seal Kit DN 160/200/250 standard	on request
Seal Kit DN 250 metal	200 07 901
Seal Kit DN 320 standard	on request
Seal Kit DN 350 JIS standard	on request
MAG.DRIVE*digital* converter	400035V0001
Plug-in control	121 36
Connecting cables, converter — pump	see Fig. 7
19“ installation frame	161 00
Blind plate 1/4 19“ 3 HU	161 02
Connector for hardware interface from 25 pins to 50 pins	on request
Purge vent valve	121 33
Purge vent Tee	400153V0002



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 (only for CT versions)

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 (only for optional purge vent valve Part No. 121 33)

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

Fig. 7 Overview and ordering data for connecting cables

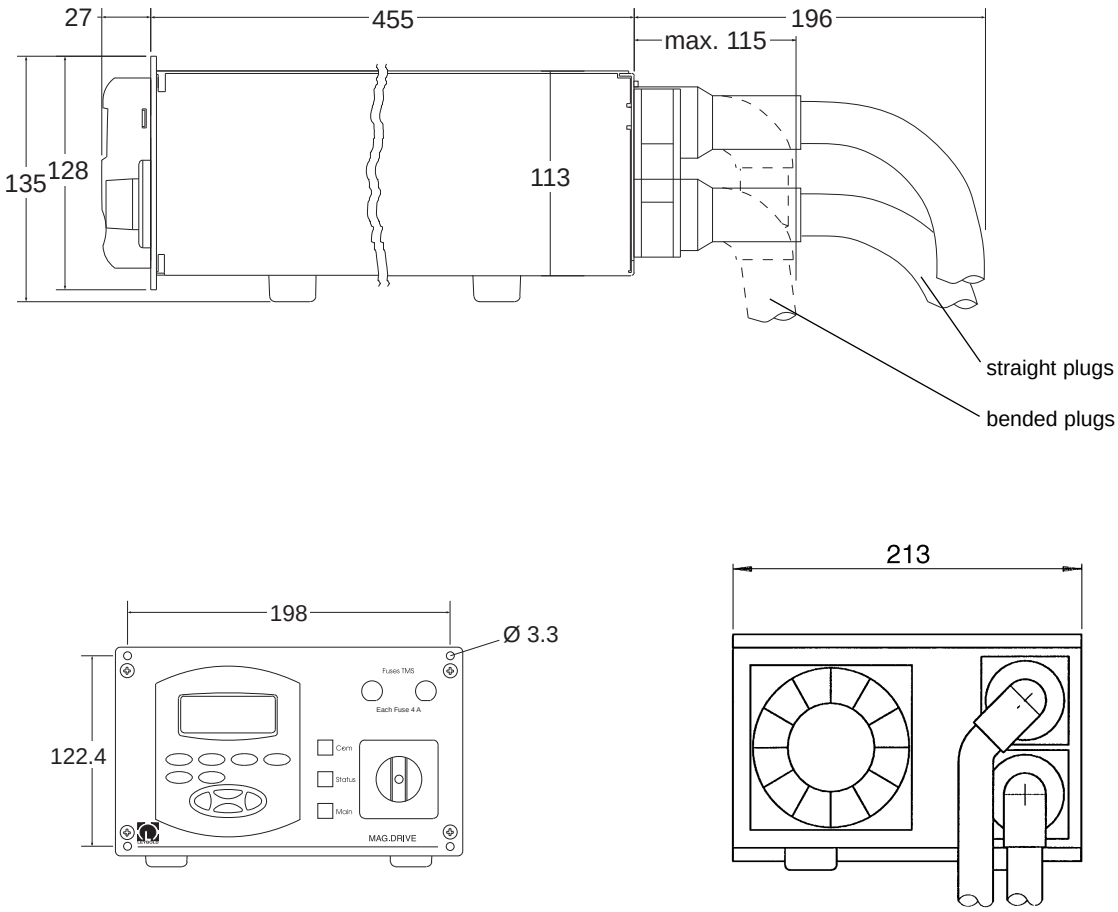


Fig. 8 Dimensional drawing of the MAG.DRIVE*digital*; dimensions in mm

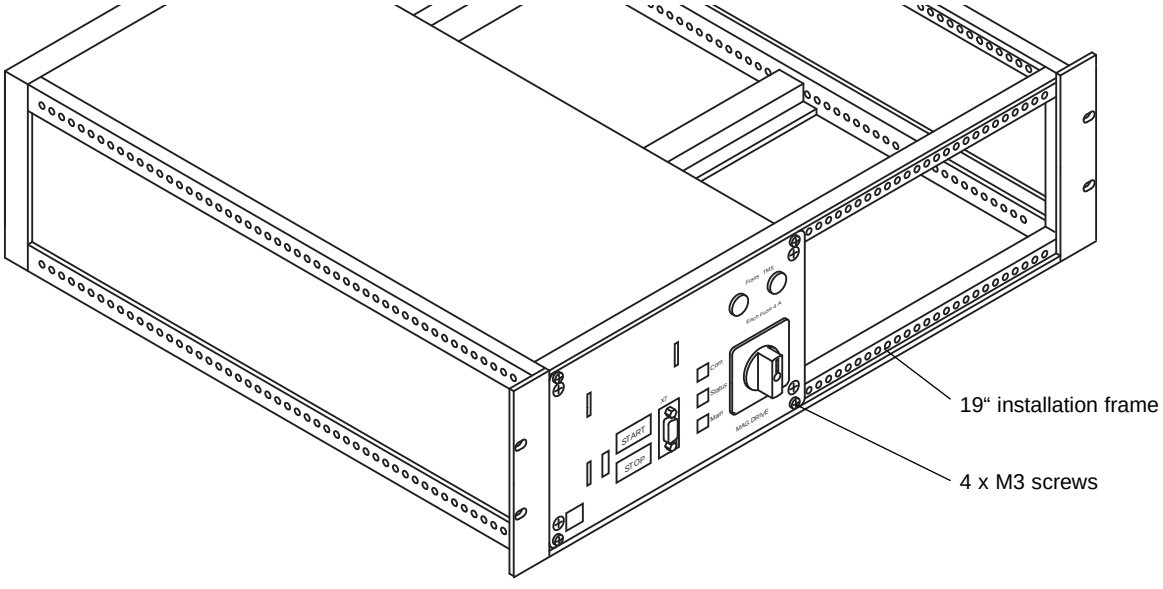


Fig. 9 Standard fixing of the MAG.DRIVE*digital*

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

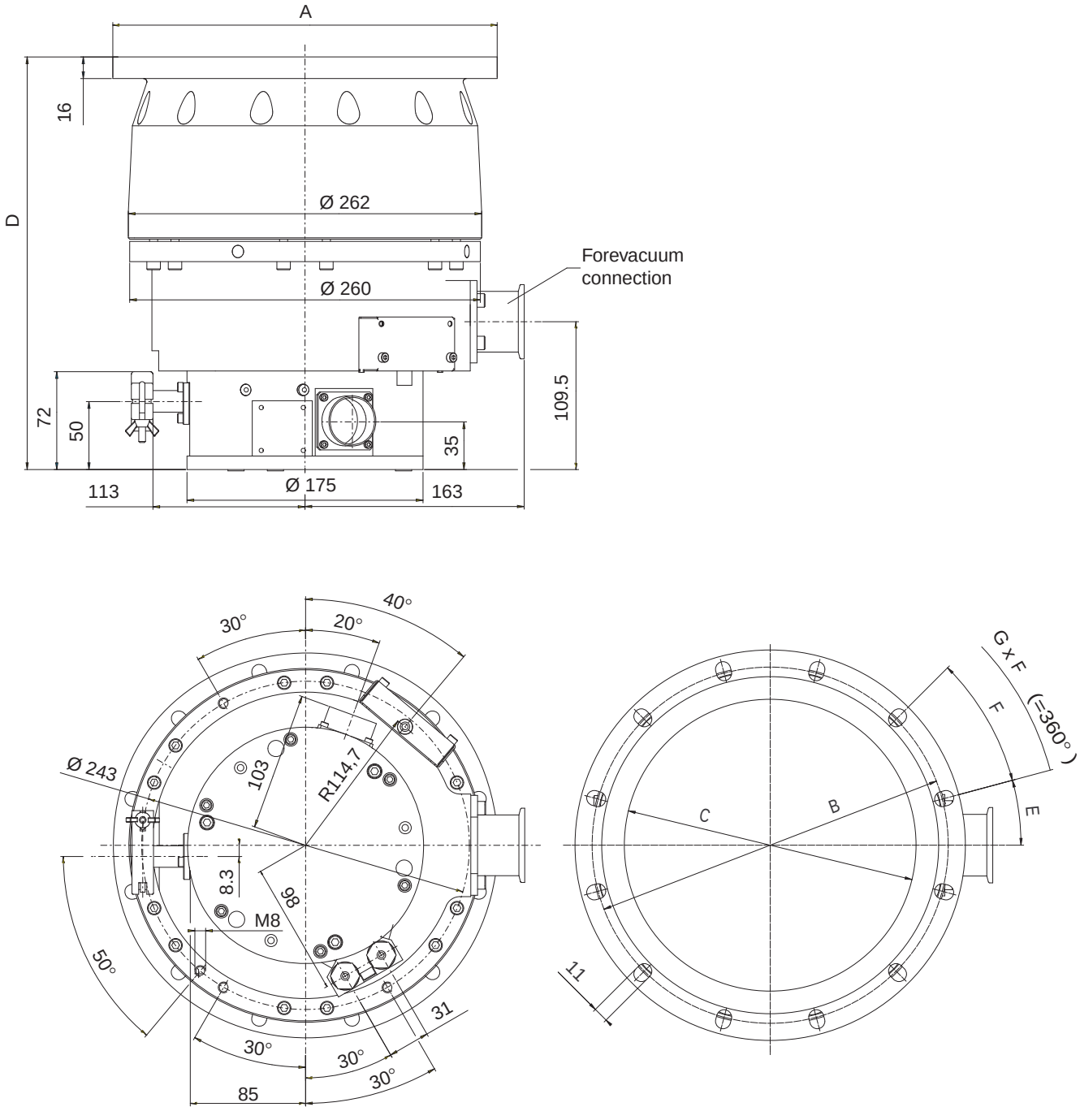


Fig. 10 MAG W 830 C and MAG W 1300 C, Dimensions in mm

MAG W 1500 C

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

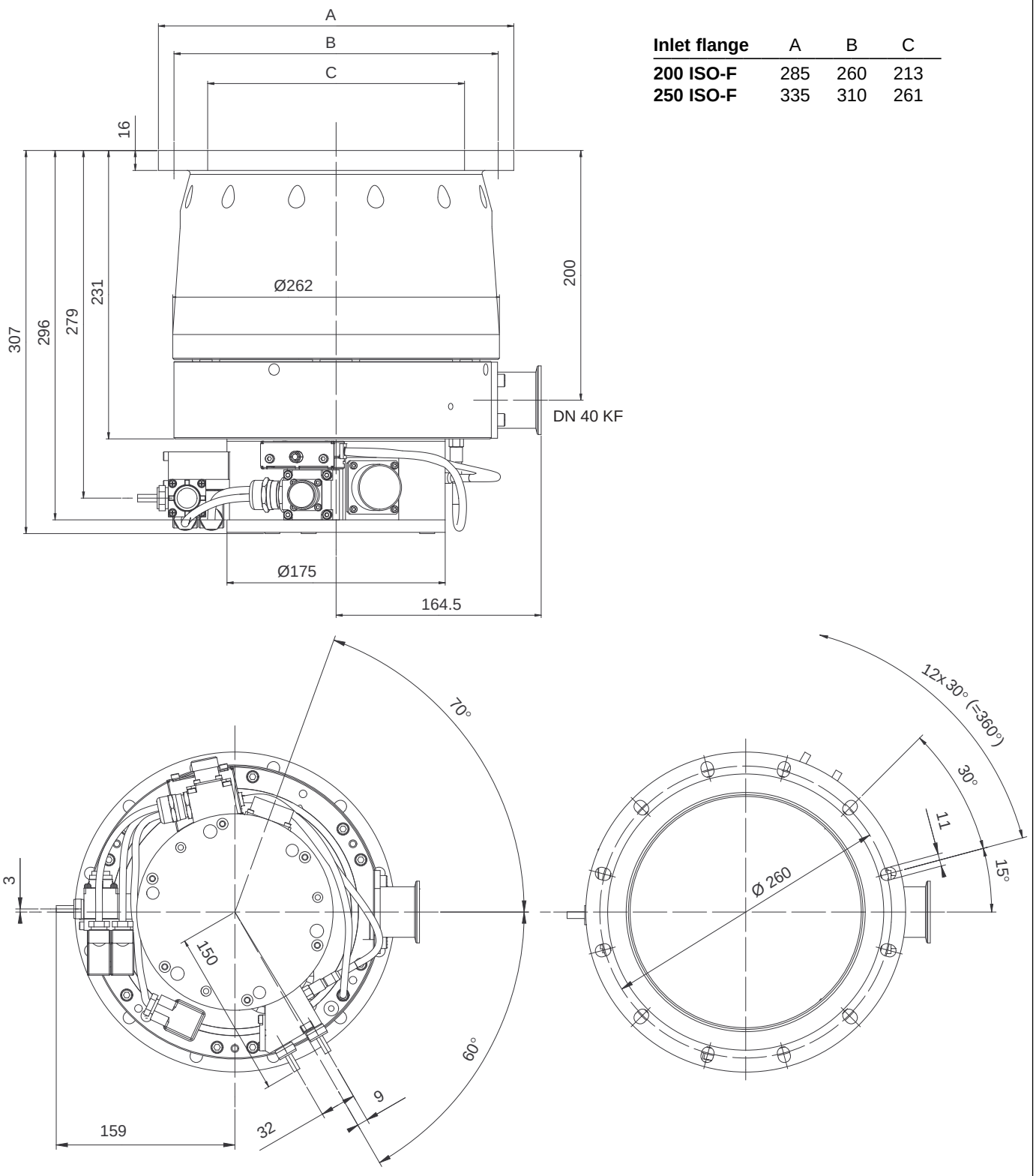
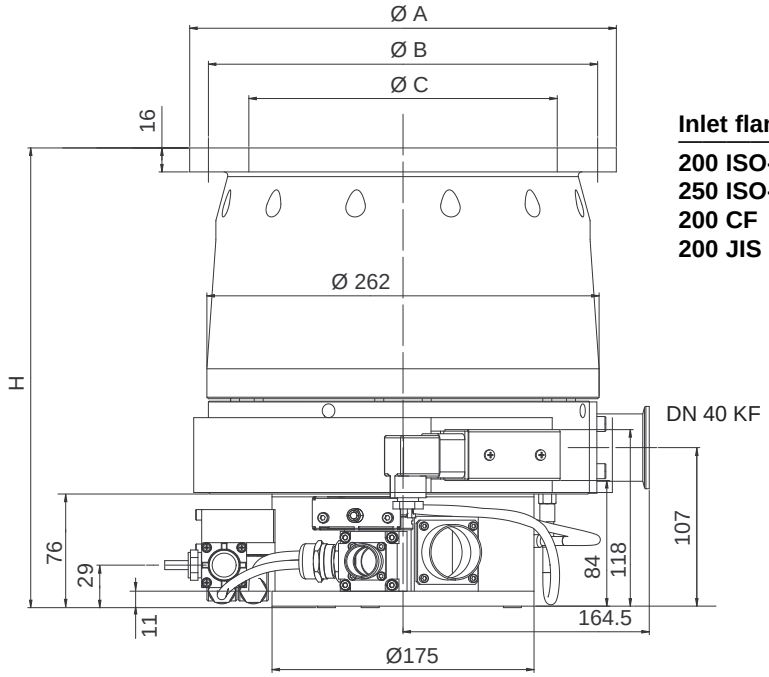


Fig. 11 MAG 1500 C, Dimensions in mm

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
200 JIS	300	270	213	8	45°	22.5	307

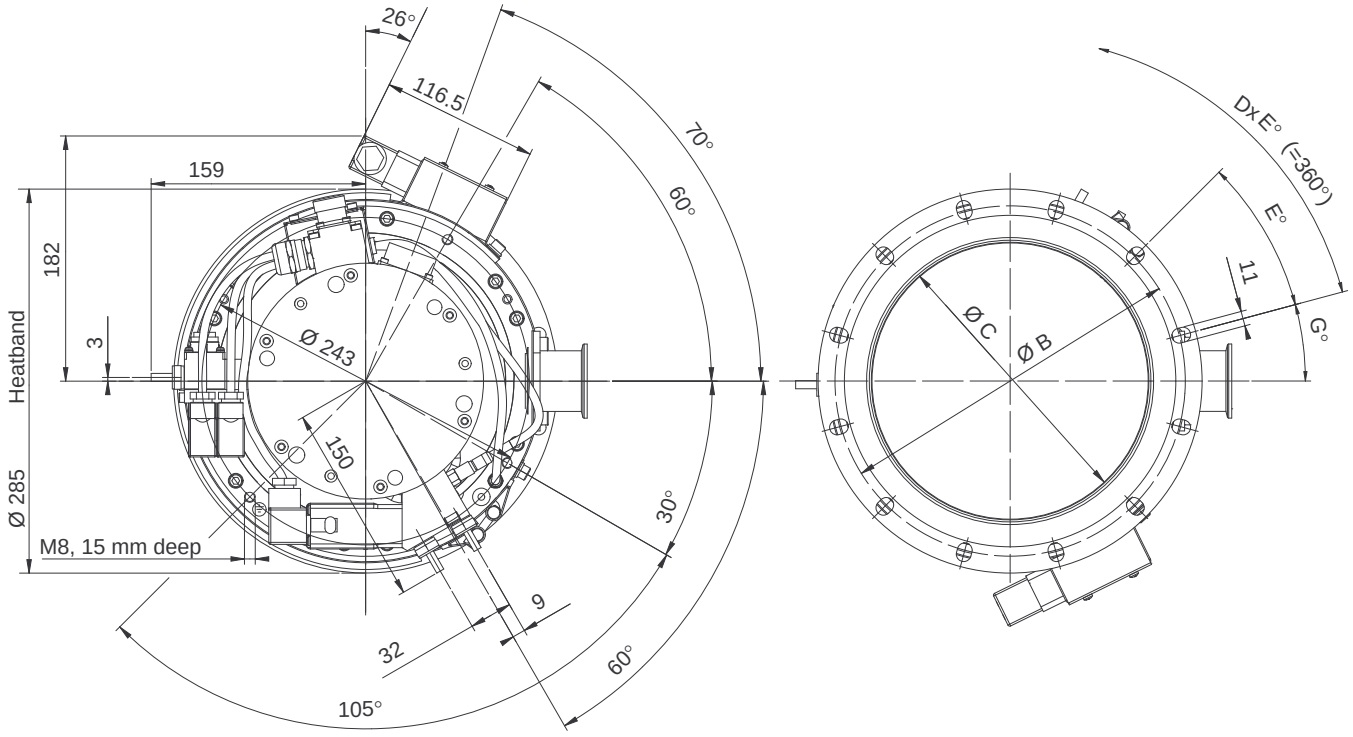


Fig. 12 MAG 1500 CT, Dimensions in mm

MAG W 2200 C

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

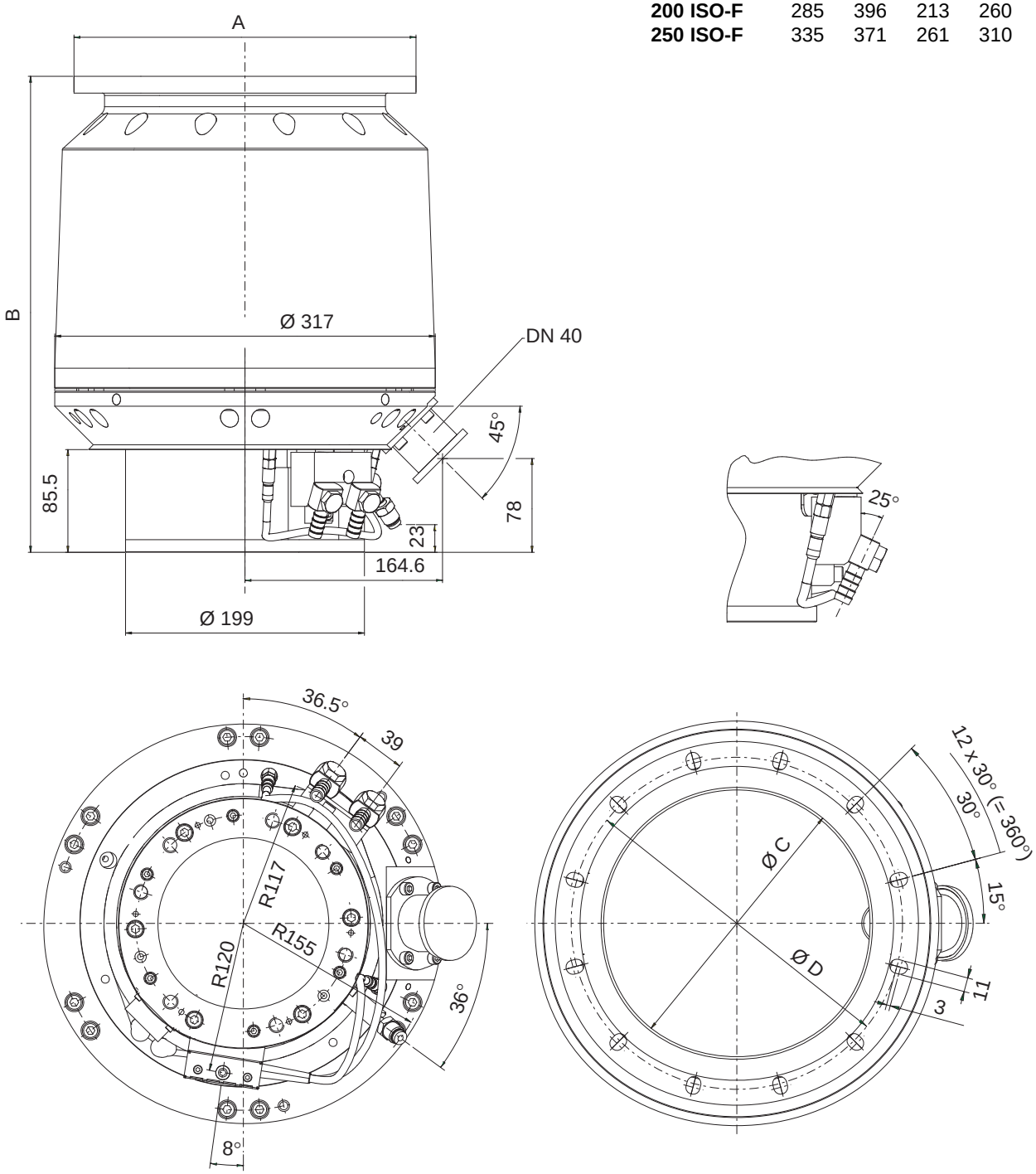


Fig. 13 MAG W 2200 C, Dimensions in mm

MAG W 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
350 JIS	450	420	318	15	0	248	316	363

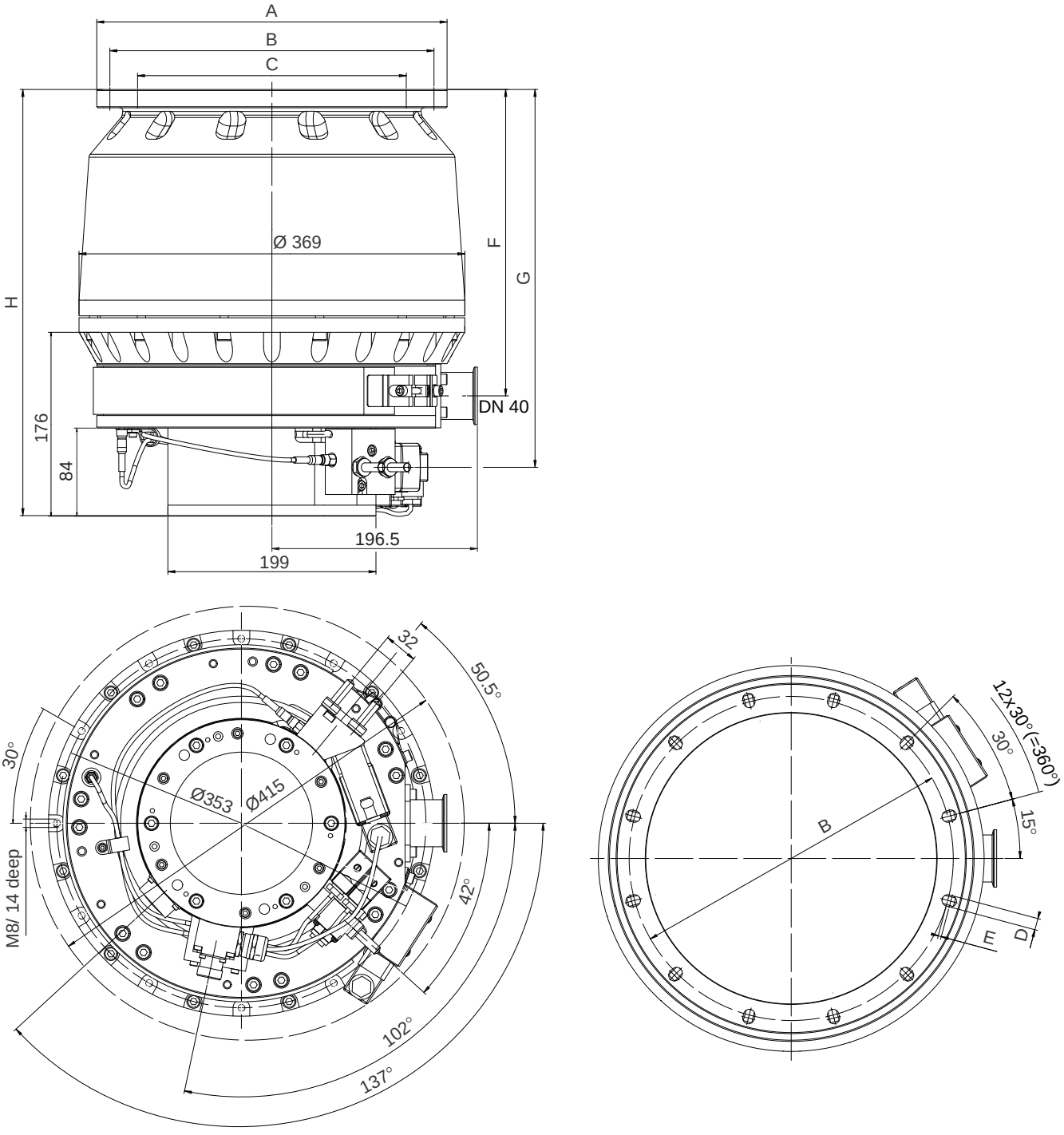


Fig. 14 MAG 2800 CT and MAG 3200 CT, Dimensions in mm

2 Installation

2.1 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.

Warning

Never expose any parts of the body to the vacuum.

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.

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)!

Warning

Unauthorized opening of the 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.

Warning

The rotor has to be changed after 40,000 hours of operation or after 5000 starts/ stops.

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

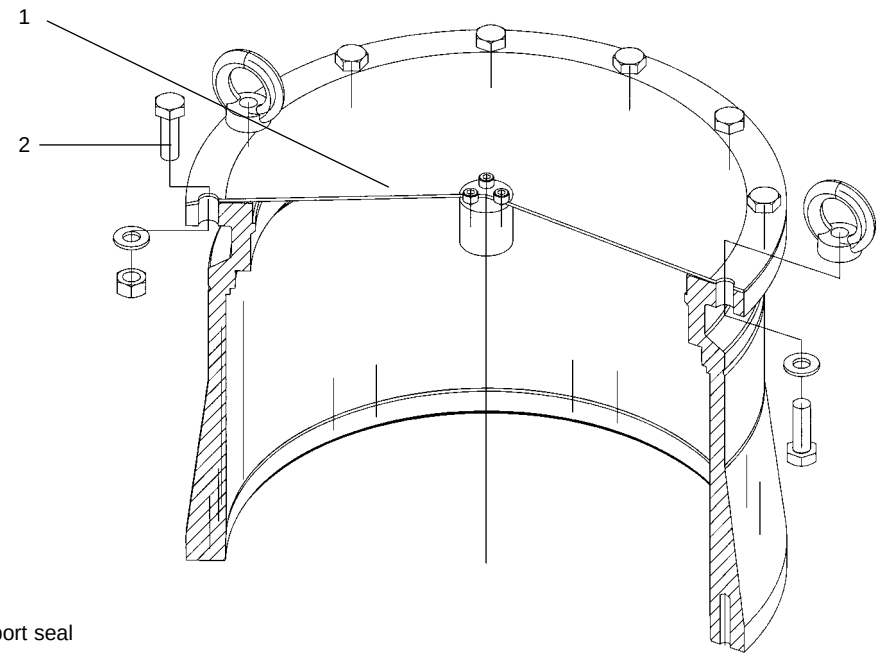
If the rotor is changed too late, it may be destroyed. Thus in the flange mounts high forces and torque conditions can occur.

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 4.3.2).

Only the Leybold service can change the rotor.

Please keep this Operating Instruction for future reference.



1 Aluminum cover
2 Screws

Fig. 15 Removing the transport seal

2.2 Unpacking - storing - transportation

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 or move it with at least two persons.

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.

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.

2.3 Operating environment

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))

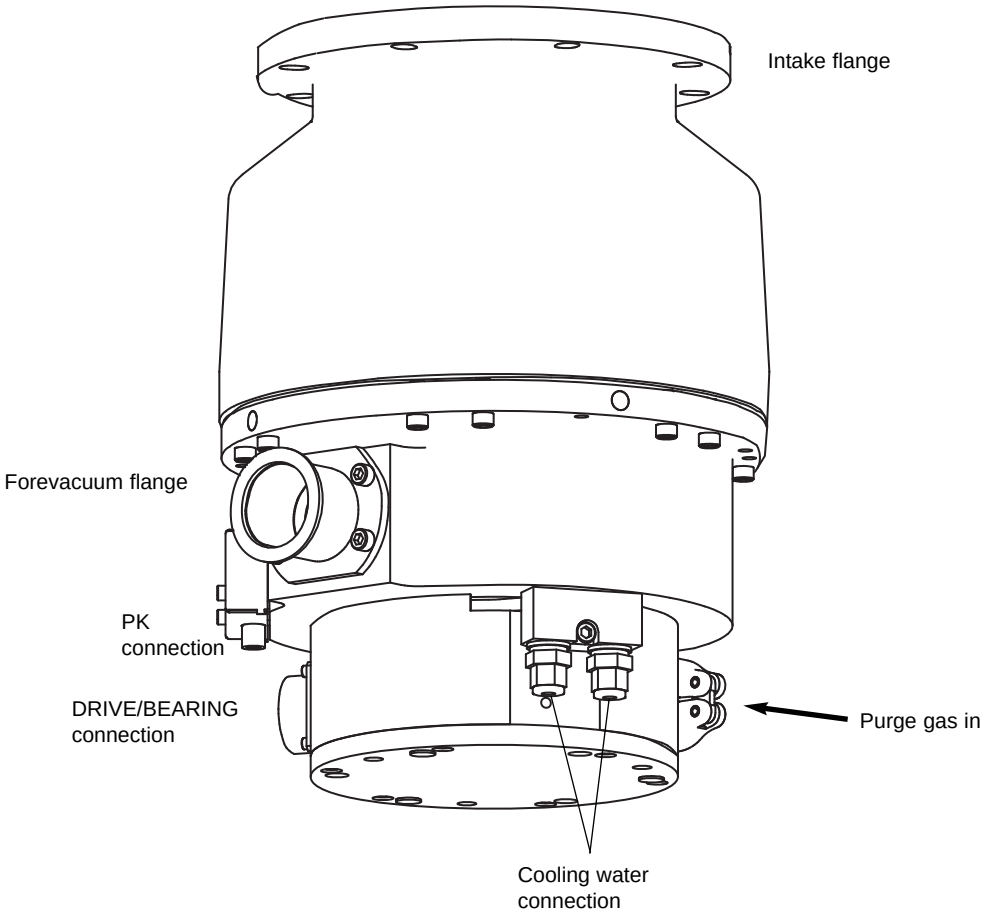
Exceeding this limit can cause excessive rotor heating due to the eddy currents generated in this situation. It is therefore necessary to provide suitable shielding in such cases.

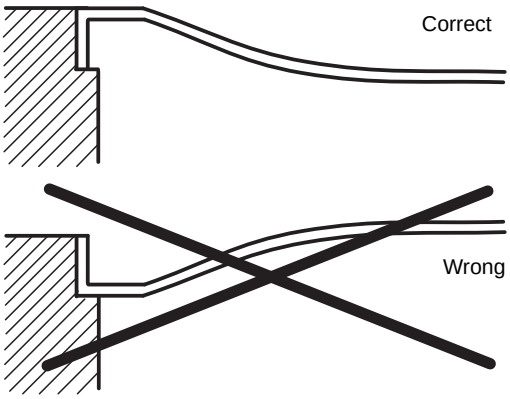
The standard version of the MAG is resistant to radiation at levels up to 10^3 Gy. (1 Gy (Gray) = 100 rad)

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

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

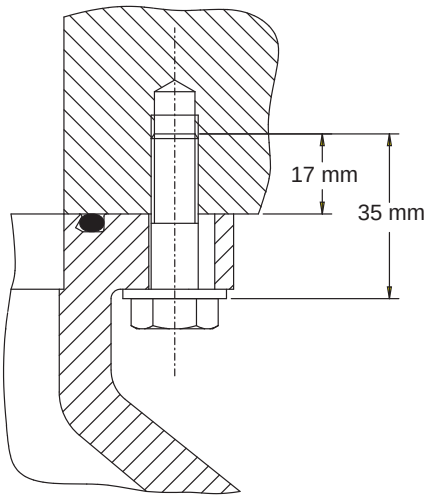
MAG W 830 C





Caution

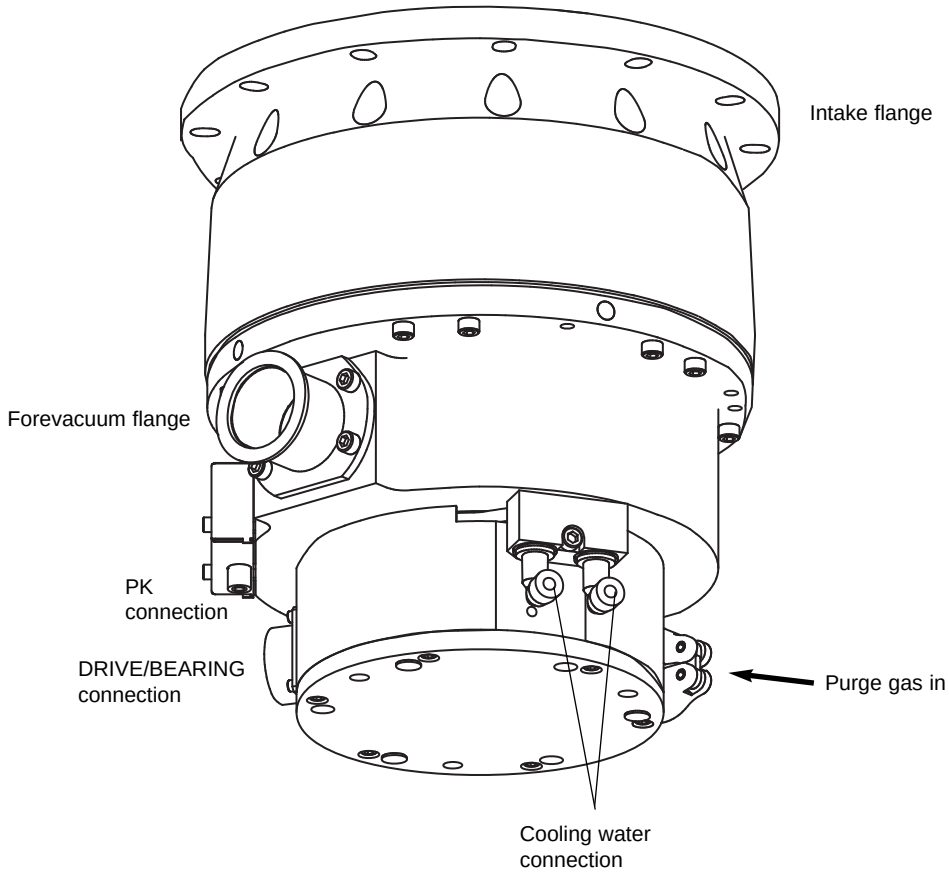
Install the splinter guard as shown. Installing the splinter guard upside down may lead to contact between splinter guard and rotor during fast venting of the pump.

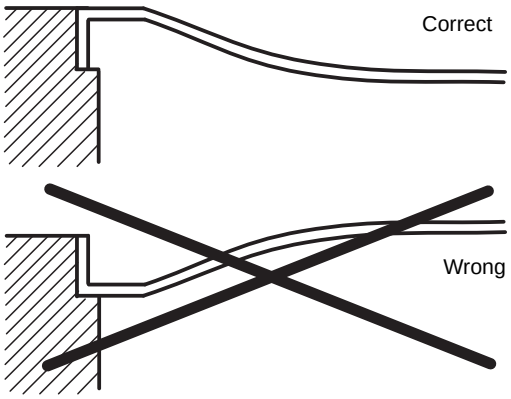


8 bolts M10 x 35
Installation torque per bolt: 35^{+5} Nm
Bolt quality:12.9 according to DIN 898 with coating
0,2% yield strength > 1080 N/mm^2
Max. pump torque 30 kNm

Fig. 16 Connection elements, installing the splinter guard and fixing the intake flange for the MAG W 830 C

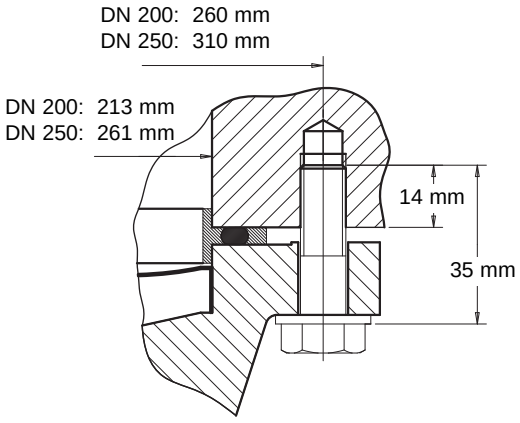
MAG W 1300 C





Caution

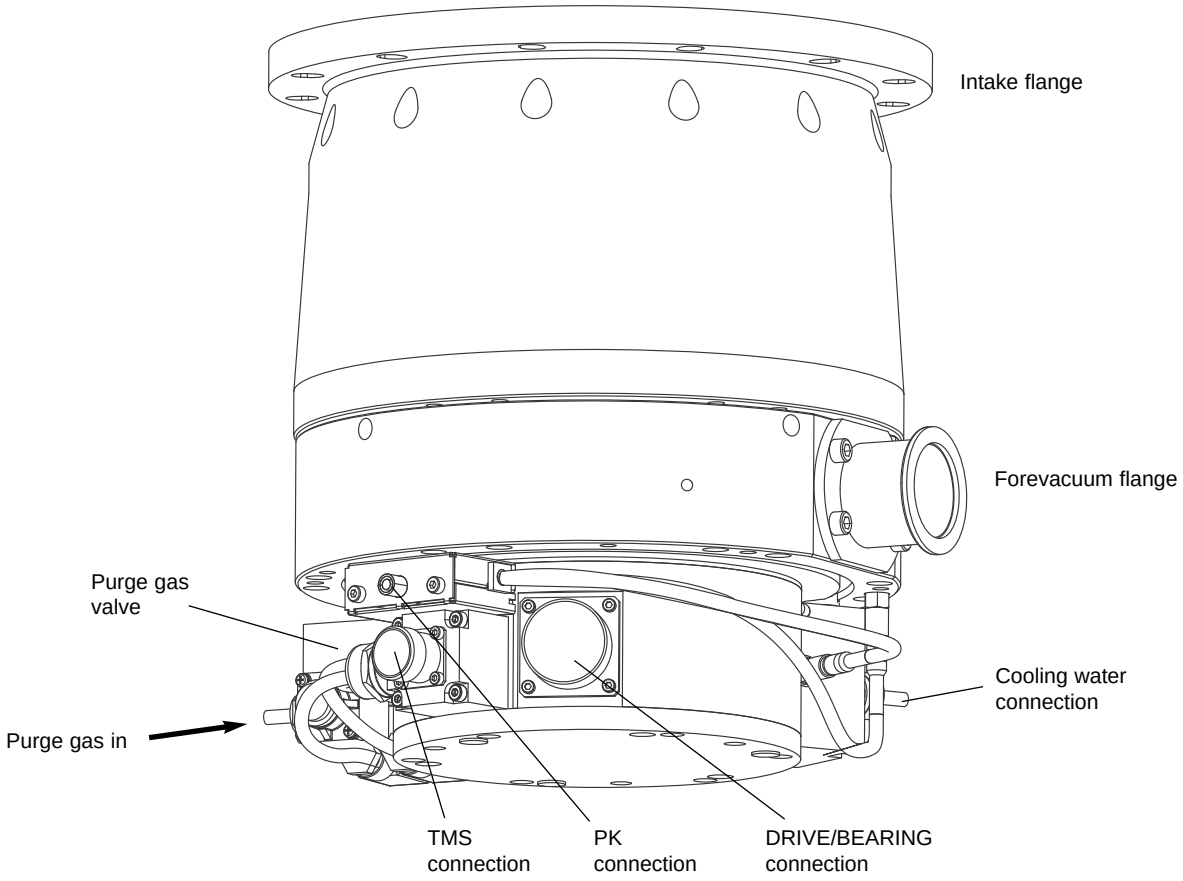
Install the splinter guard as shown. Installing the splinter guard upside down may lead to contact between splinter guard and rotor during fast venting of the pump.

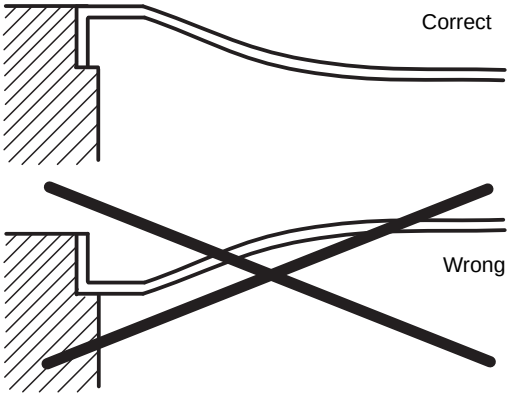


12 bolts M10 x 35
Installation torque per bolt: 35^{+5} Nm
Bolt quality:12.9 according to DIN 898 with coating
0,2% yield strength > 1080 N/mm^2
Max. pump torque 40 kNm

Fig. 17 Connection elements, installing the splinter guard and fixing the intake flange for the MAG W 1300 C

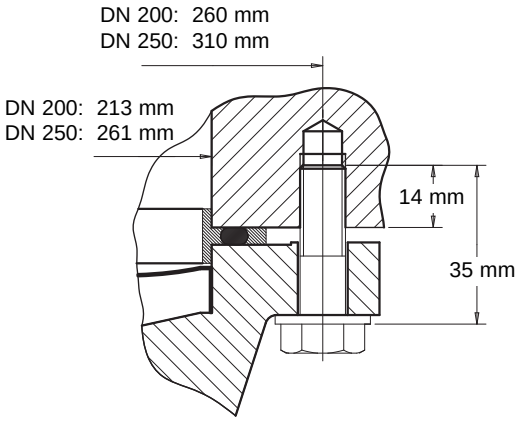
MAG W 1500 C





Caution

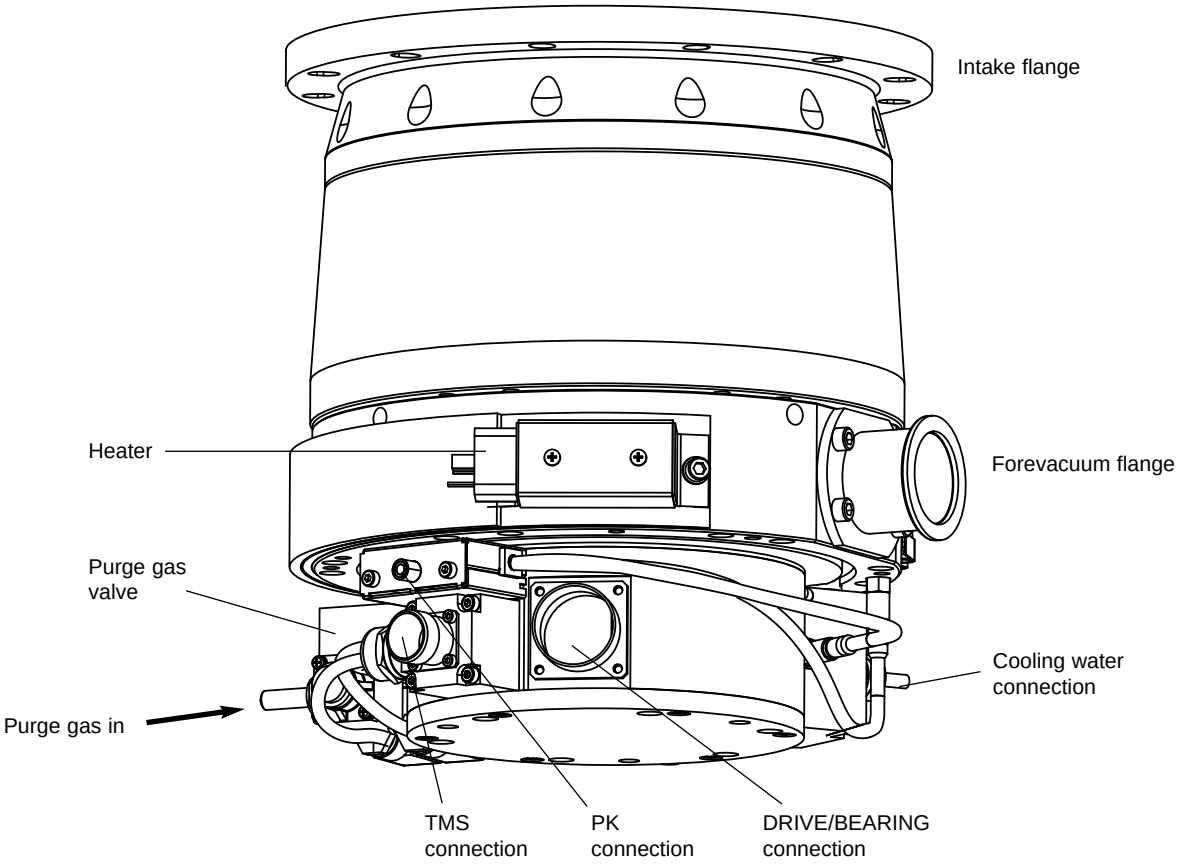
Install the splinter guard as shown. Installing the splinter guard upside down may lead to contact between splinter guard and rotor during fast venting of the pump.

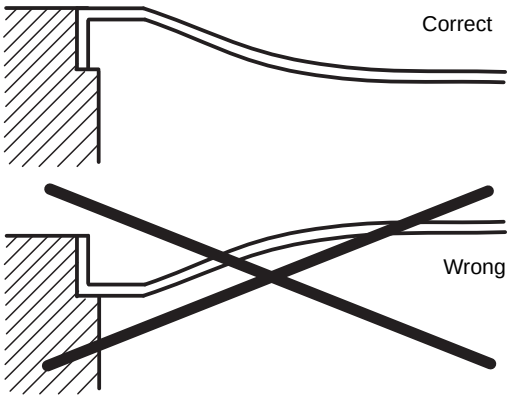


12 bolts M10 x 35
Installation torque per bolt: 35^{+5} Nm
Bolt quality:12.9 according to DIN 898 with coating
0,2% yield strength > 1080 N/mm^2
Max. pump torque 40 kNm

Fig. 18 Connection elements, installing the splinter guard and fixing the intake flange for the MAG W 1500 C

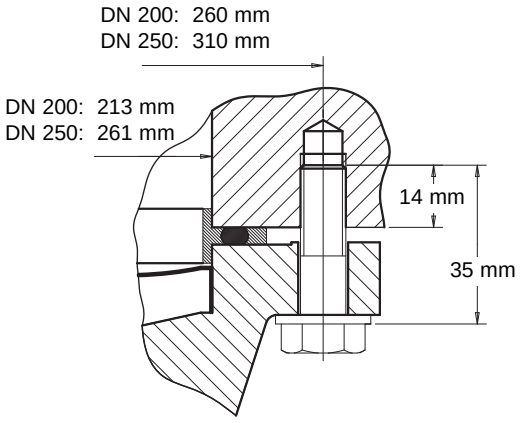
MAG (W) 1500 CT with DN 200/250 ISO-F





Caution

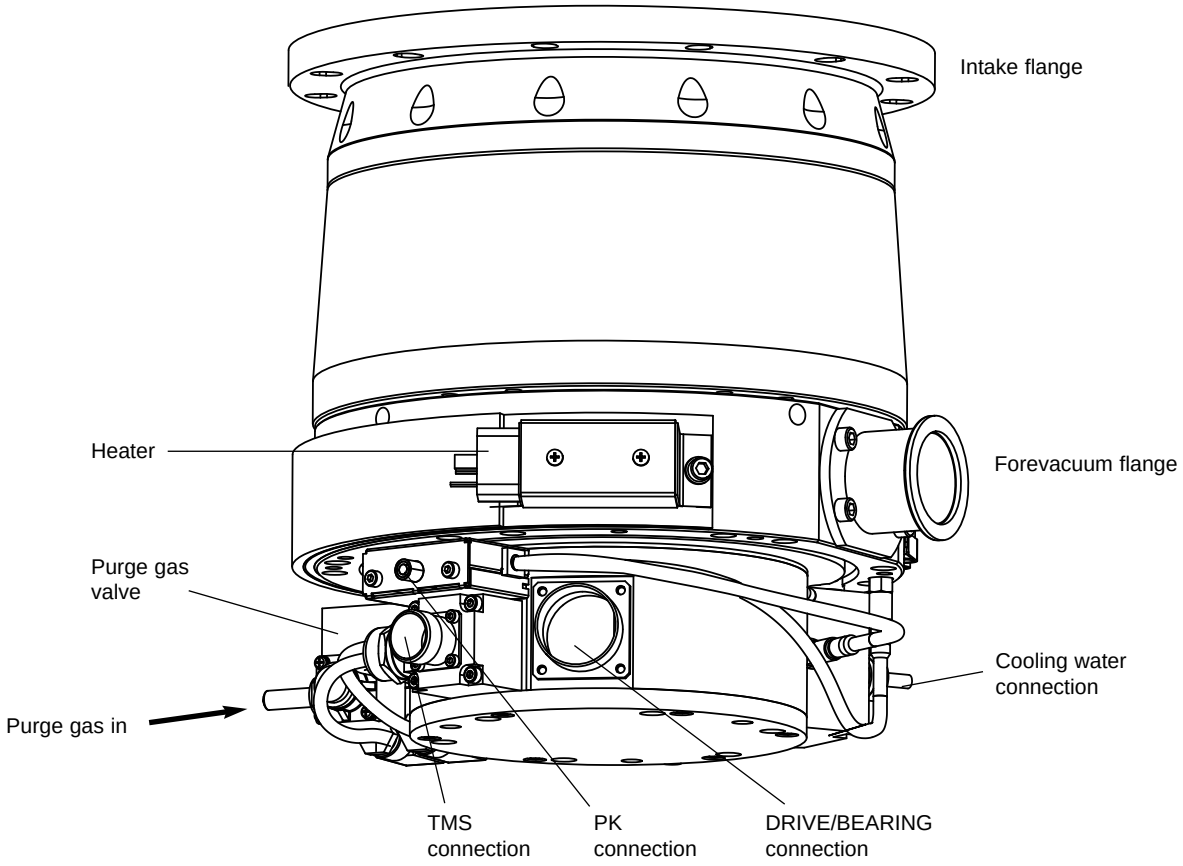
Install the splinter guard as shown. Installing the splinter guard upside down may lead to contact between splinter guard and rotor during fast venting of the pump.

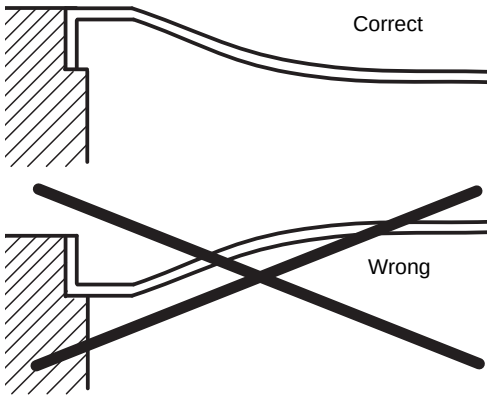


12 bolts M10 x 35
Installation torque per bolt: 35^{+5} Nm
Bolt quality:12.9 according to DIN 898 with coating
0,2% yield strength > 1080 N/mm^2
Max. pump torque 40 kNm

Fig. 19 Connection elements, installing the splinter guard and fixing the intake flange for the MAG (W) 1500 CT with ISO-F flange

MAG W 1500 CT with CF and JIS intake flange

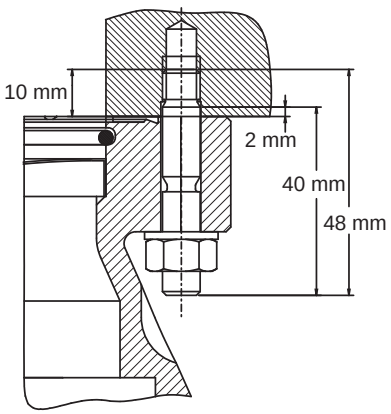




Caution

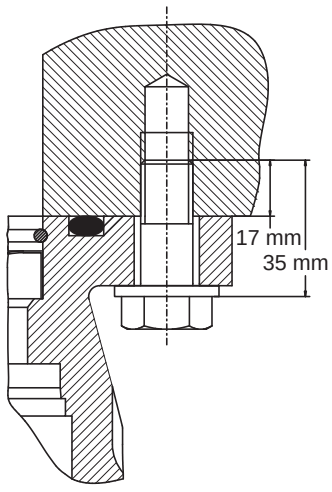
Install the splinter guard as shown. Installing the splinter guard upside down may lead to contact between splinter guard and rotor during fast venting of the pump.

DN 200 CF



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

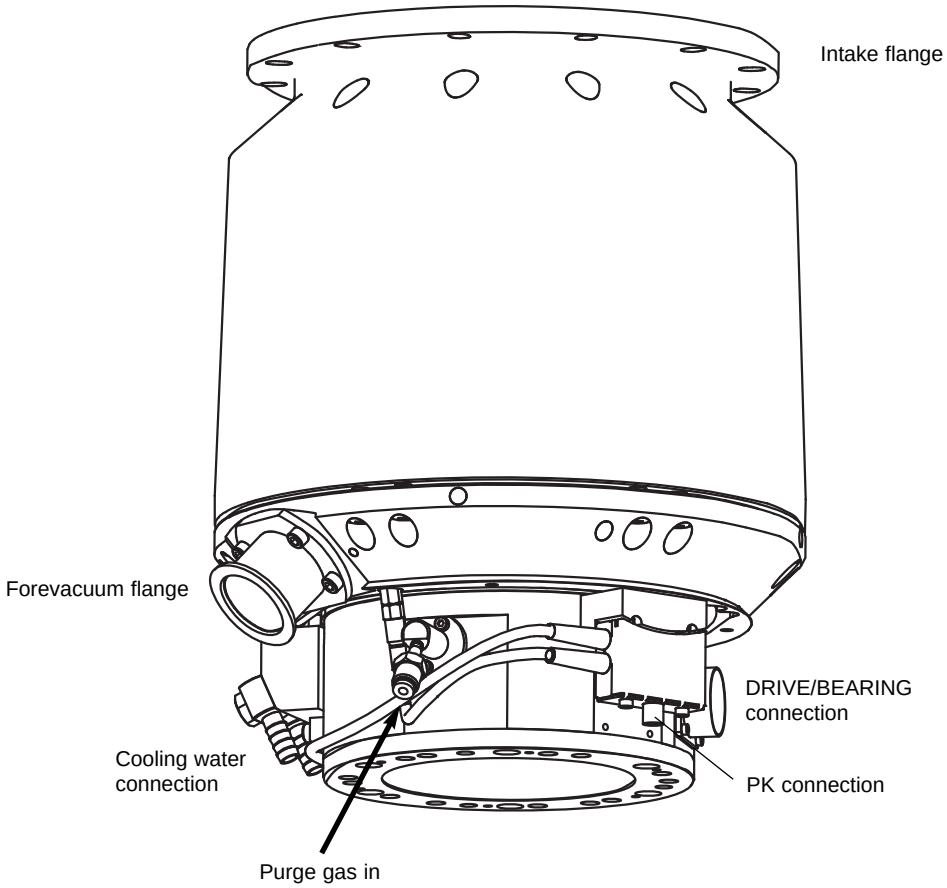
DN 200 JIS



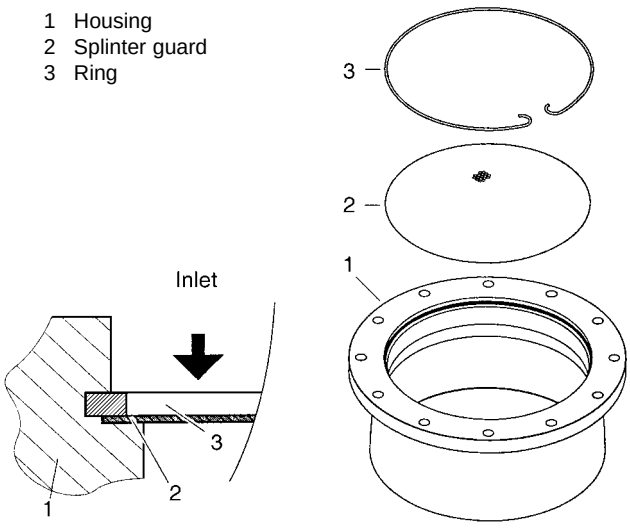
12 bolts M12 x 35
Installation torque per bolt: 35^{+5} Nm
Bolt quality:12.9 according to DIN 898 with coating
0,2% yield strength > 1080 N/mm^2
Max. pump torque 40 kNm

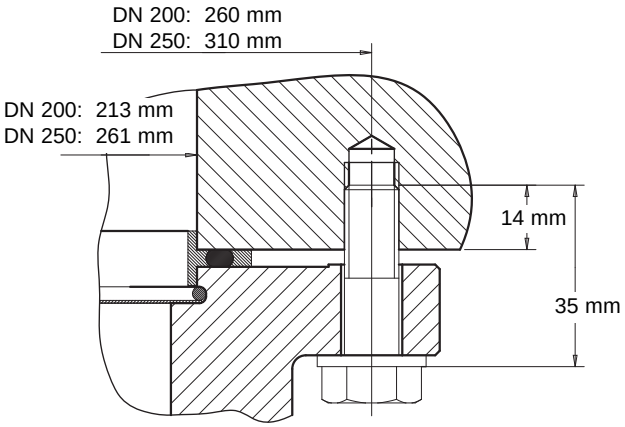
Fig. 20 Connection elements, installing the splinter guard and fixing the intake flange for the MAG W 1500 CT with CF and JIS flange

MAG W 2200 C



1 Housing
2 Splinter guard
3 Ring

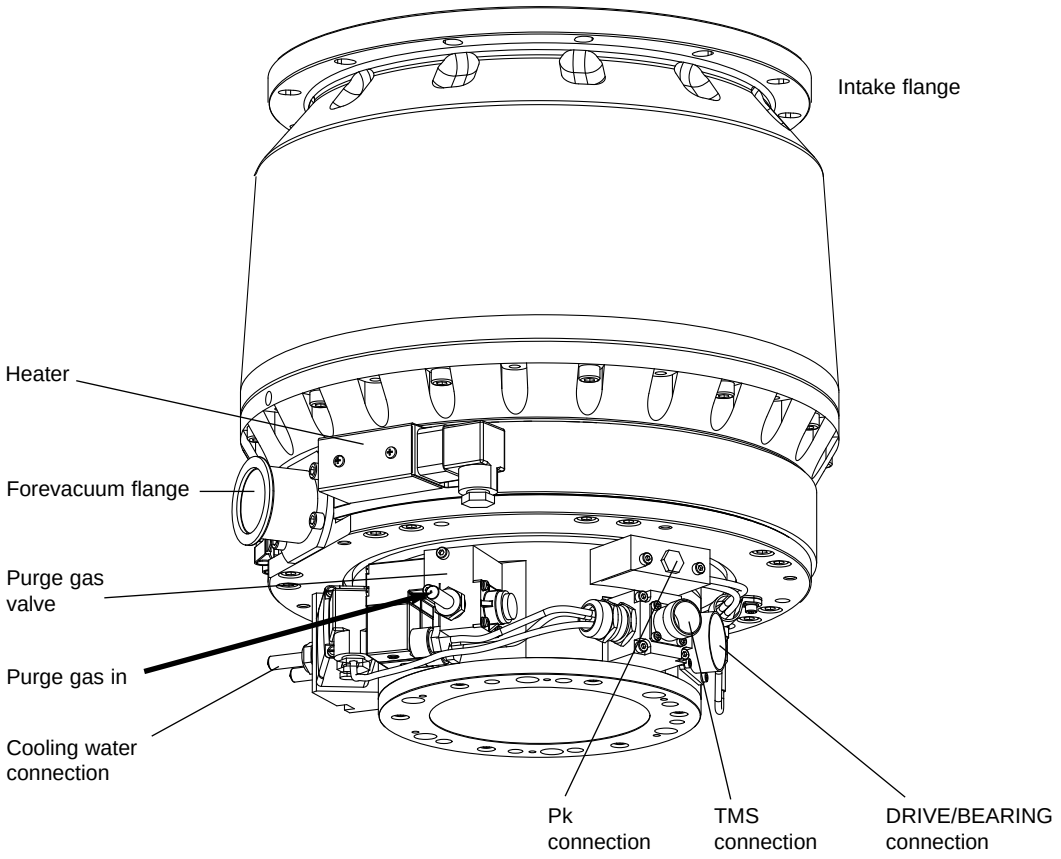




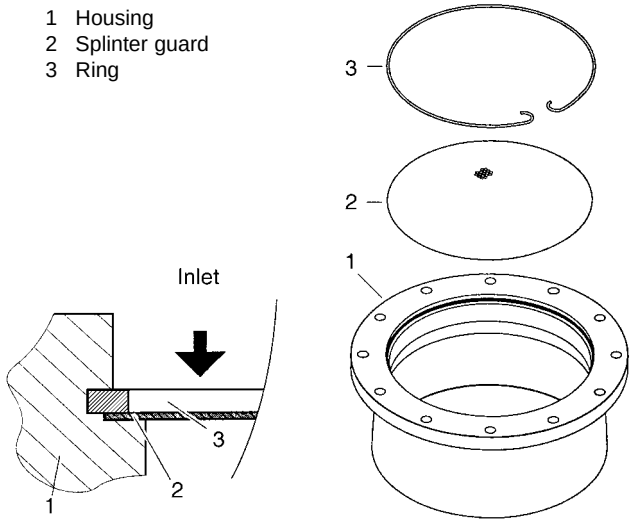
12 bolts M10 x 35
Installation torque per bolt: 35^{+5} Nm
Bolt quality:12.9 according to DIN 898 with coating
0,2% yield strength > 1080 N/mm^2
Max. pump torque 55 kNm

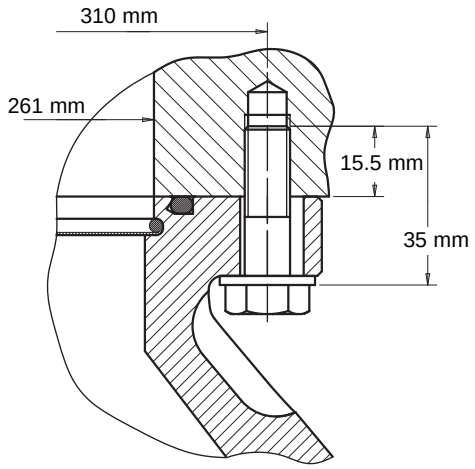
Fig. 21 Connection elements, installing the splinter guard and fixing the intake flange for the MAG W 2200 C

MAG W 2800 C, CT



1 Housing
2 Splinter guard
3 Ring

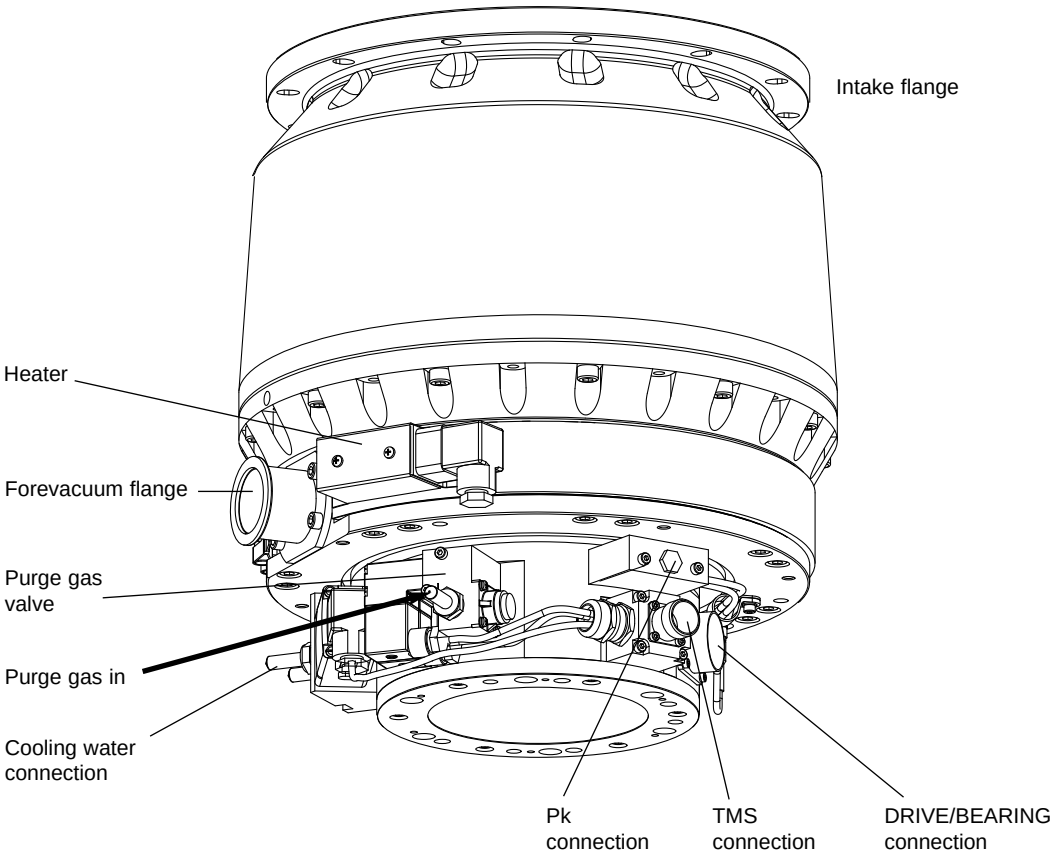




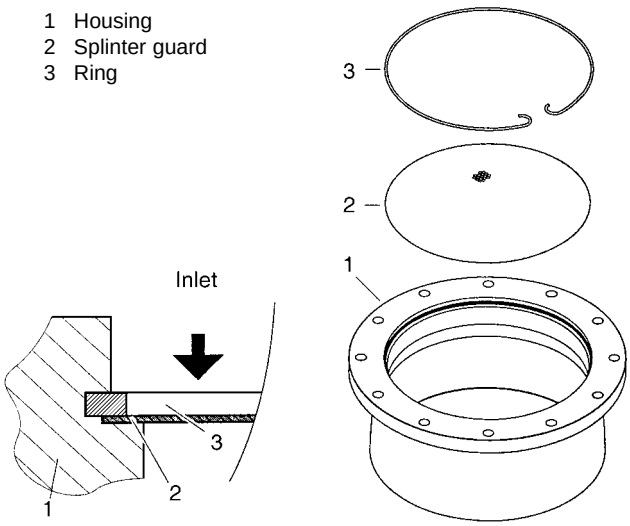
12 bolts M10 x 35
Installation torque per bolt: 35^{+5} Nm
Bolt quality:12.9 according to DIN 898 with coating
0,2% yield strength > 1080 N/mm^2
Max. pump torque 65 kNm

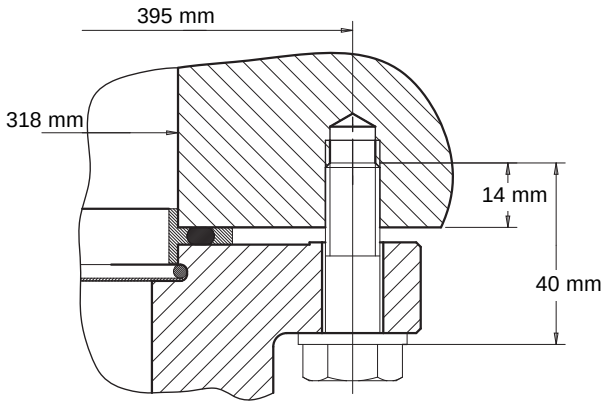
Fig. 22 Connection elements, installing the splinter guard and fixing the intake flange for the MAG W 2800 C, CT

MAG W 3200 CT with DN 320 ISO-F



1 Housing
2 Splinter guard
3 Ring

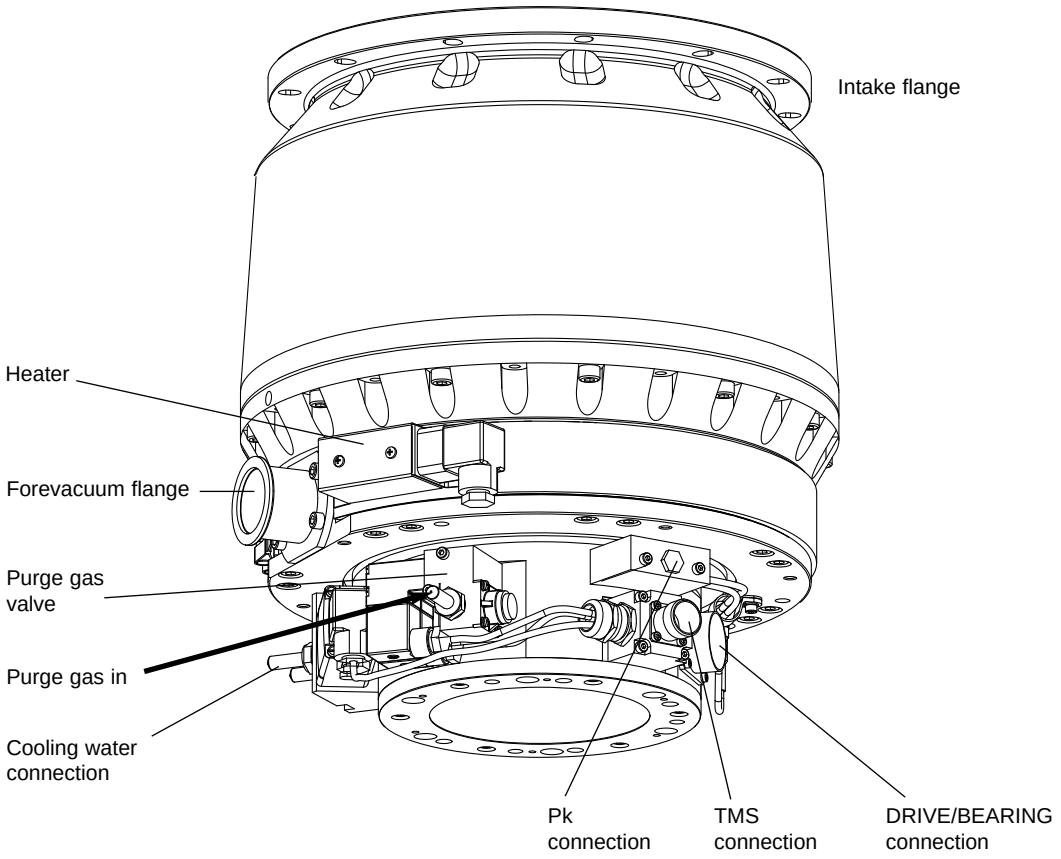




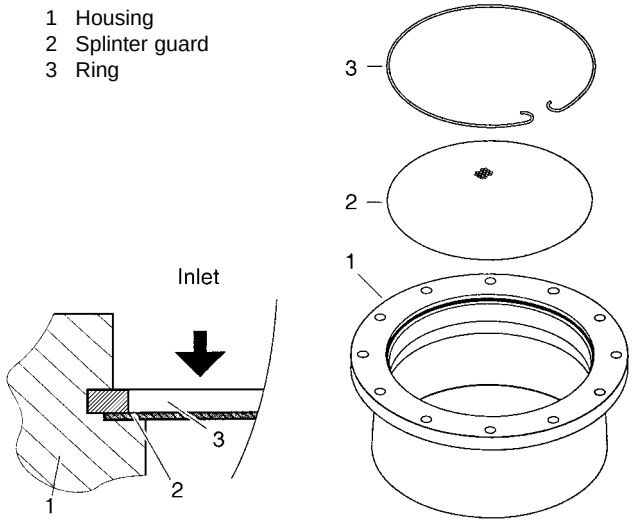
10 bolts M12 x 40
Installation torque per bolt: 45^{+5} Nm
Bolt quality:12.9 according to DIN 898 with coating
0,2% yield strength > 1080 N/mm^2
Max. pump torque 65 kNm

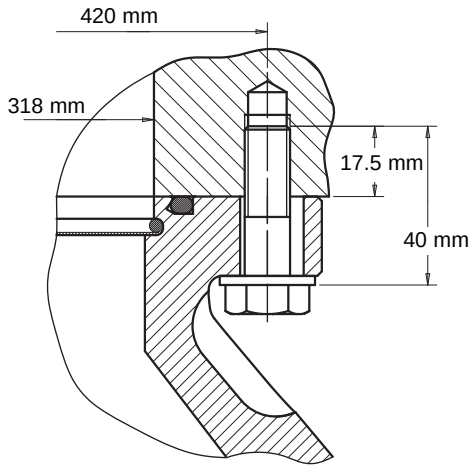
Fig. 23 Connection elements, installing the splinter guard and fixing the intake flange for the MAG W 3200 CT with DN 320 ISO-F flange

MAG W 3200 CT with VG 350 JIS



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 DIN 898 with coating
0,2% yield strength > 1080 N/mm^2
Max. pump torque 65 kNm

Fig. 24 Connection elements, installing the splinter guard and fixing the intake flange for the MAG W 3200 CT with VG 350 JIS flange

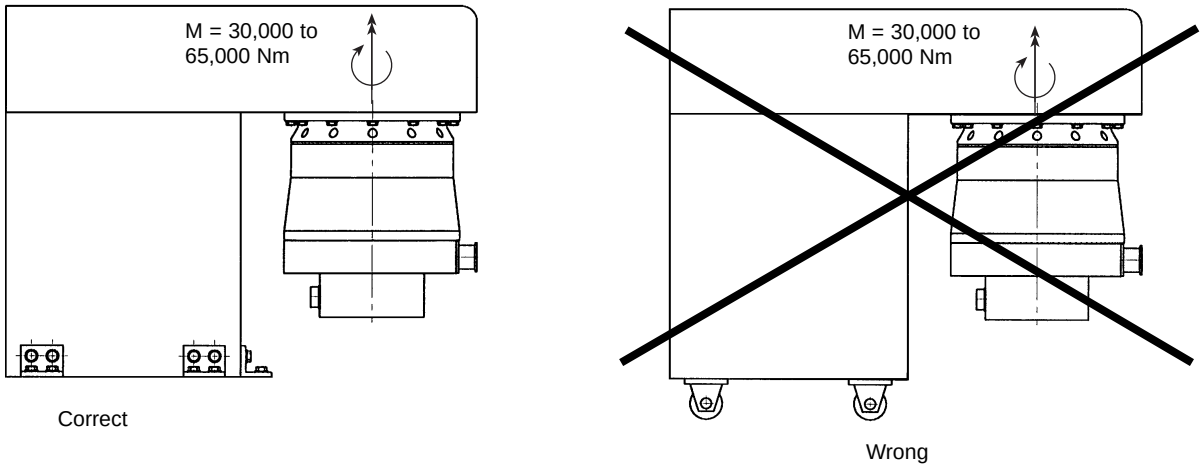


Fig. 25 Vacuum chamber fixed to the floor

2.4 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 (15/2) and remove the aluminum cover. We recommend saving the transport seal for maintenance.

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, the deceleration torque of 30,000 to 65,000 Nm will have to be absorbed by the system. To accomplish this, use all bolts provided by Leybold for fastening the high-vacuum flange; see one of the Fig. 16 to 24.

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 drawing.

Key to Fig. 22

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 andTMS cable

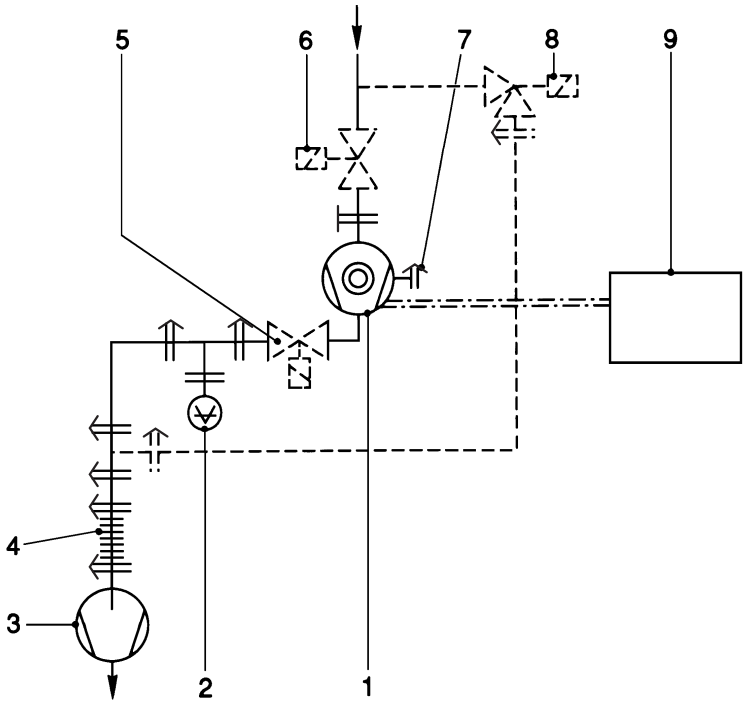


Fig. 26 Layout of a turbomolecular pump system

Earthquake protection

For earthquake protection fix the pump as shown in Fig. 16 to 24. 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. 9.

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.

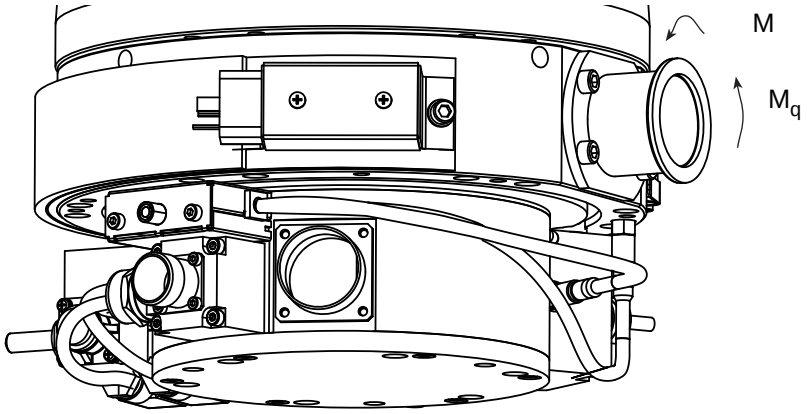


Fig. 27 Maximum torques for the forevacuum connection

2.5 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. 26 shows schematically the design of a pump system incorporating a MAG with an additional foreline valve and an isolation valve between chamber and MAG.

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.

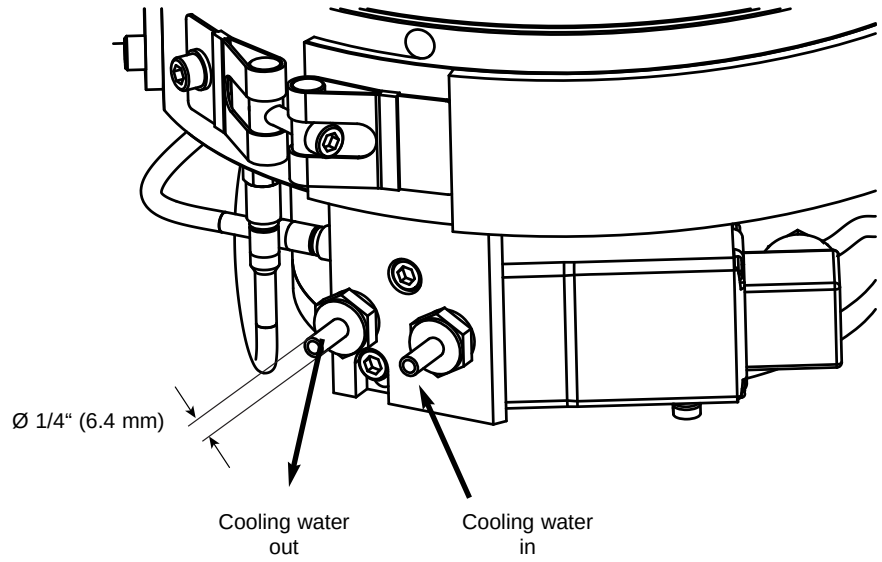
Connect the forevacuum flange of the MAG to the backing pump.

The torque on the forevacuum connection flange must not exceed the values shown in Fig. 27.

Warning

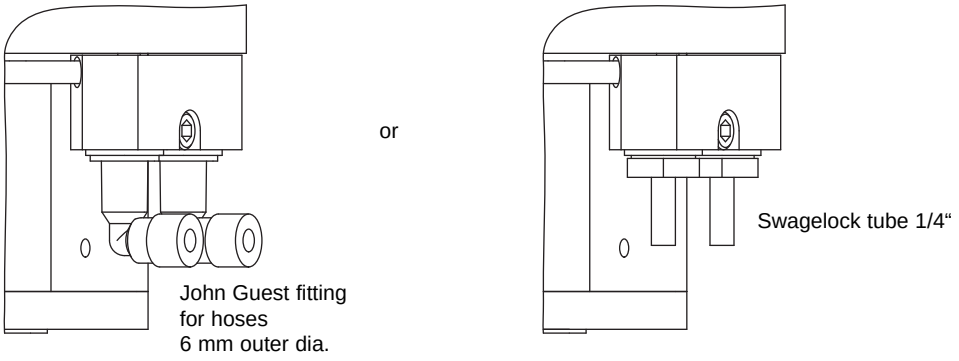
The forevacuum line must be tight. Hazardous gases can escape at leaks or the gases being pumped can react with the air or humidity. We recommend a leak check.

MAG (W) 1500, 2800, 3200

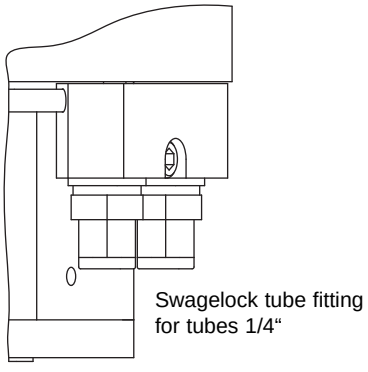


Do not mix up the inlet and the outlet!

MAG W 1300 C



MAG W 830 C



MAG W 2200 C

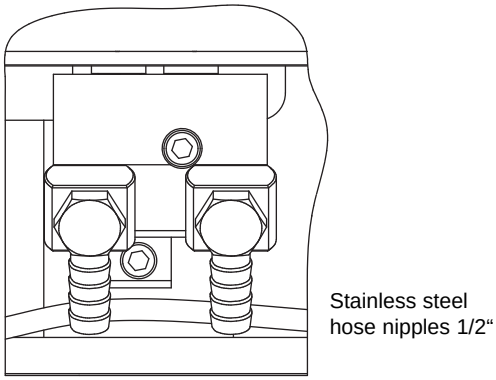
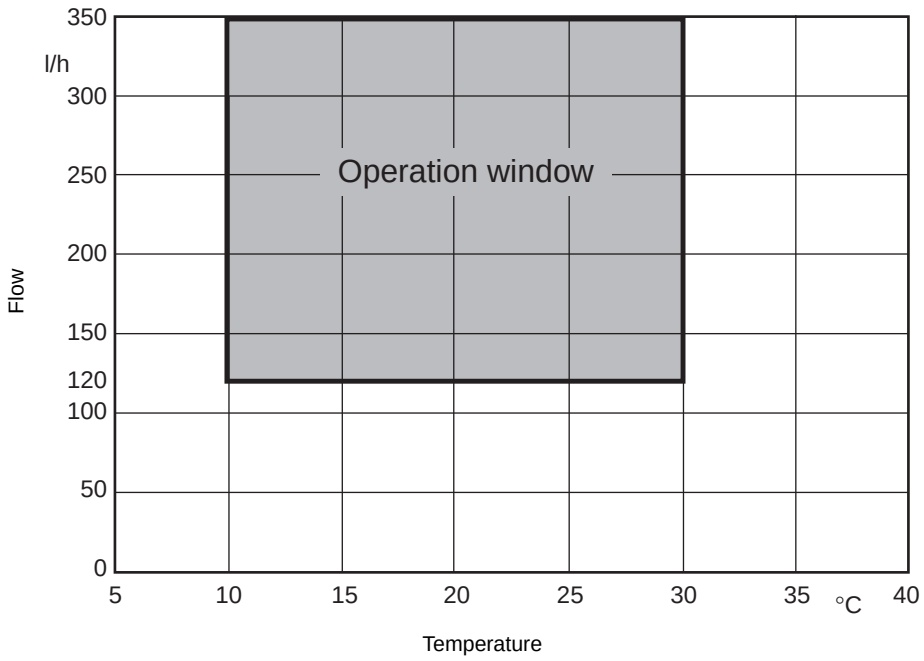


Fig. 28 Connecting the cooling water



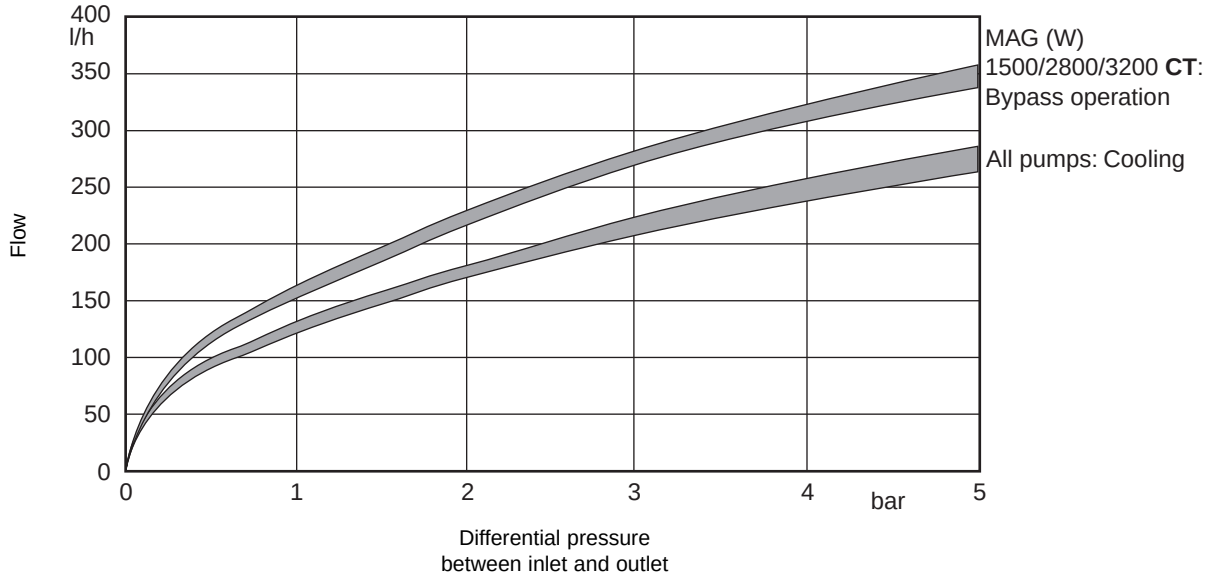


Fig. 29 Recommended cooling water flow

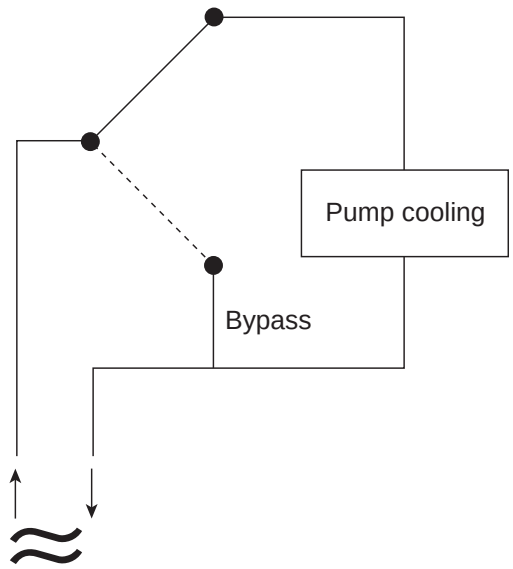


Fig. 30 Schematic of the cooling water flow for MAG (W) 1500, 2800, 3200 CT

2.6 Connecting the cooling water

Cooling water specifications

Inlet temperature	10 - 30 °C
Inlet pressure	2 to 7 bar absolute
Cooling water requirement	See Fig. 29
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. 28.

Caution for CT versions

The CT versions have a cooling water by-pass.
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.

2.7 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).

Change the filters after some time, at least annually.

Different venting methods are described in Chapter 3.1.

MAG (W) 1500, MAG W 2800, MAG W 3200

The MAG is equipped with a purge gas and venting valve. It is controlled by the MAG.DRIVE*digital*. Additional monitoring with a flow controller is not necessary.

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 31 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±10% sccm
Leak rate	< 10^{-7} mbar·l/s
Connection: VCR Nut	1/4“

MAG W 830, W 1300, W 2200

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 and W 1300.

Warning

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.

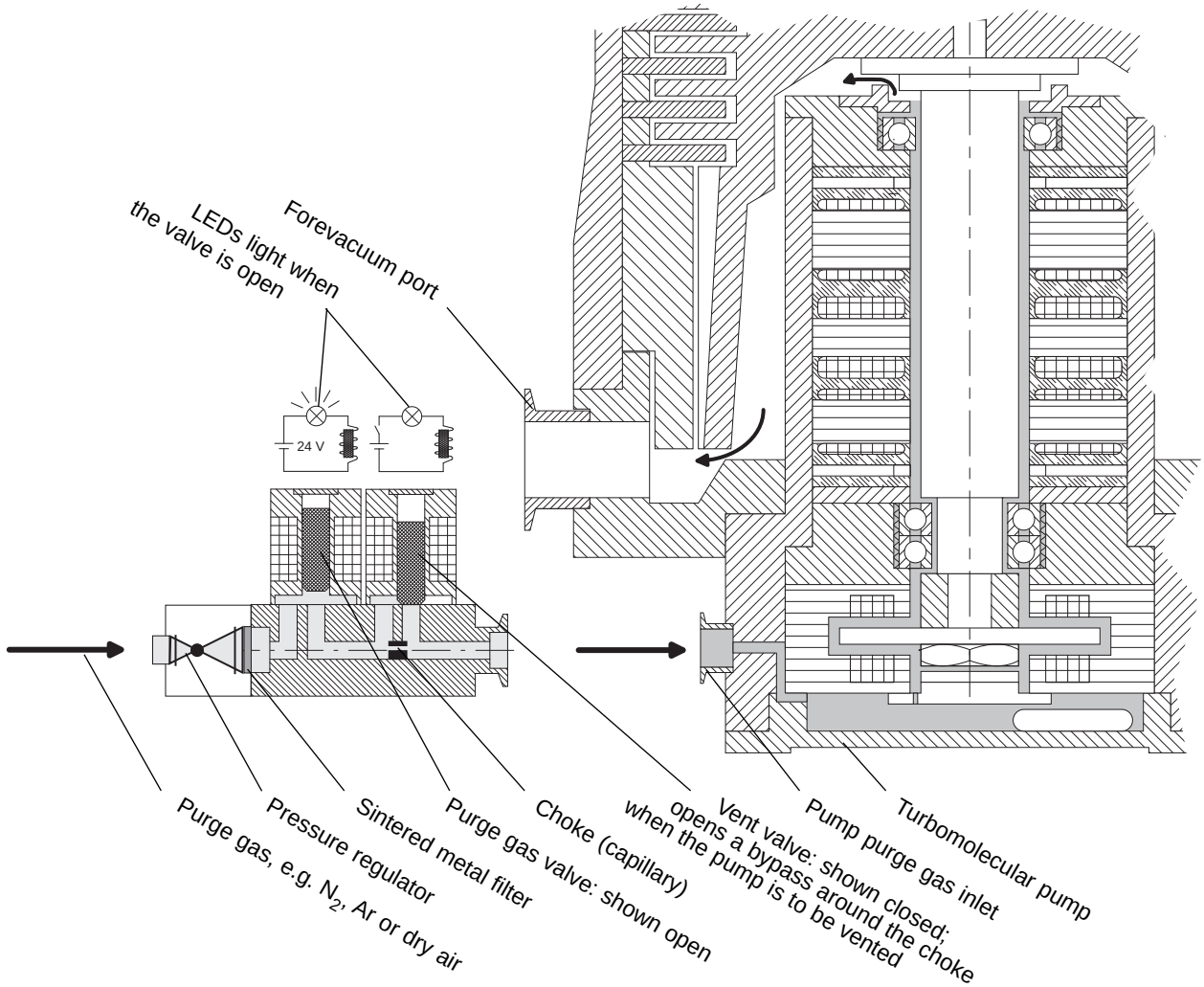


Fig. 31 Purge gas and vent valve assembly and turbomolecular pump (schematic)

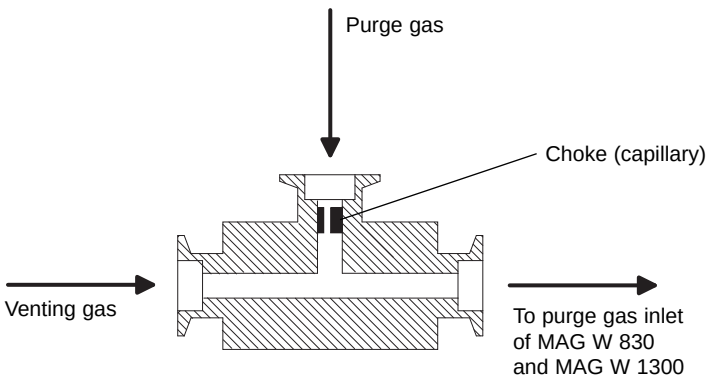


Fig. 32 Schematic drawing of the purge gas Tee

2.8 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).

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.

Warning

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.

Warning

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.

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.

2.8.1 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

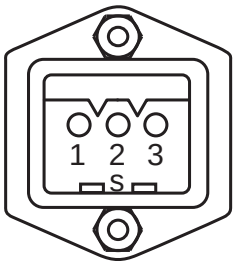
The converter will be damaged if it is operated with the incorrect supply voltage.

2.8.2 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.



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

Fig. 33 Connector assignment X19, supply connection

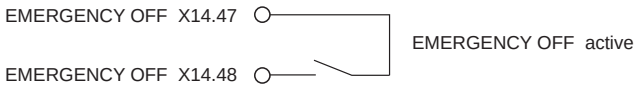


Fig. 34 Control plug X14: Emergency off

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

Also refer to Fig. 35.

Make sure that you have fixed all cables properly.

2.8.3 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

The selection of signals for the option relay and the adjustment of their thresholds can be achieved via the operator control menu; see Section 4.3.4.

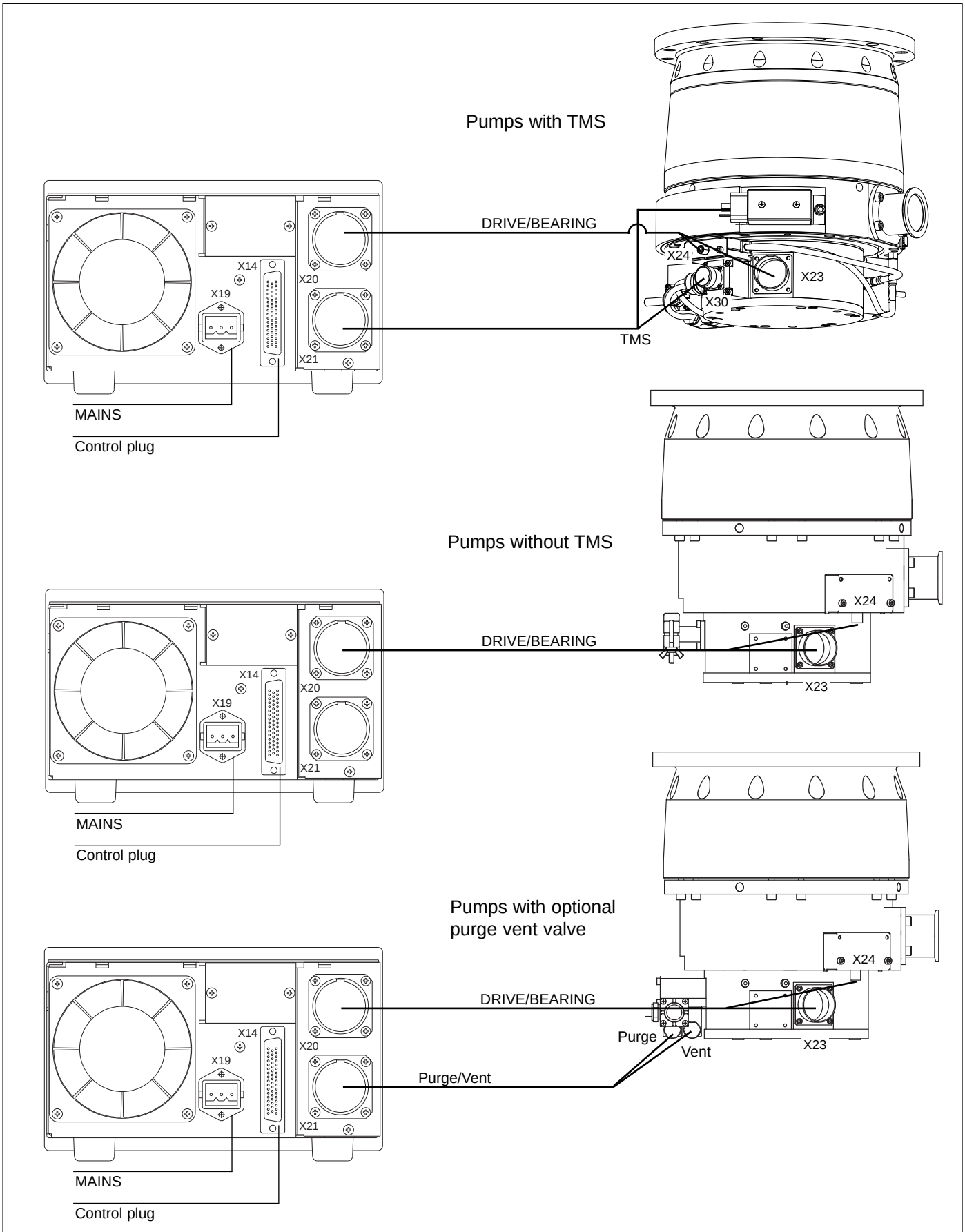
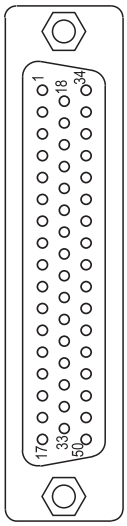


Fig. 35 Block wiring diagram



X14 50 pole Sub-D I/O

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

Fig. 36 Assignment control plug X14

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 4.3.4 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 4.3.4:

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

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

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.

2.8.4 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.

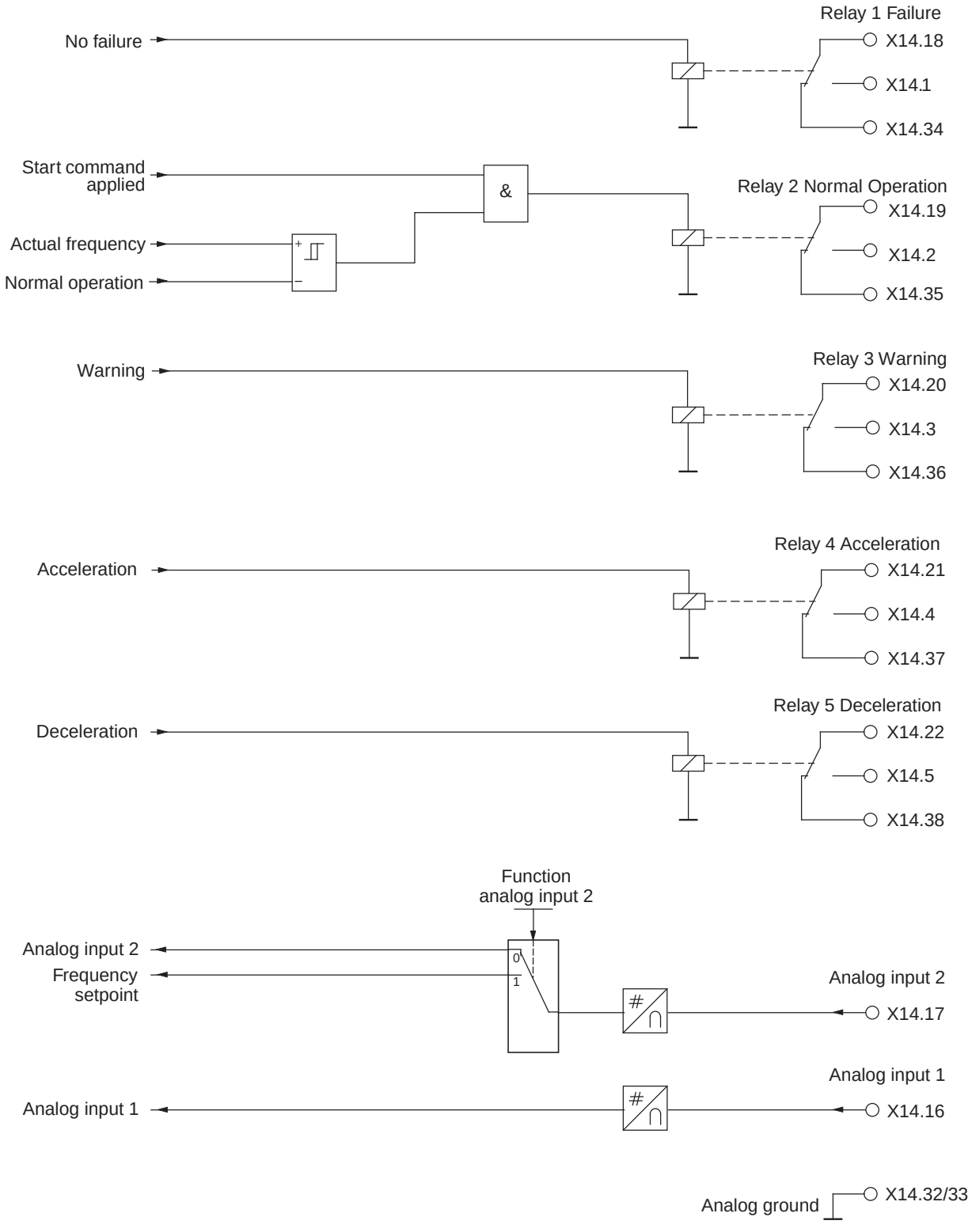


Fig. 37 Function diagram outputs, Part 1 & inputs

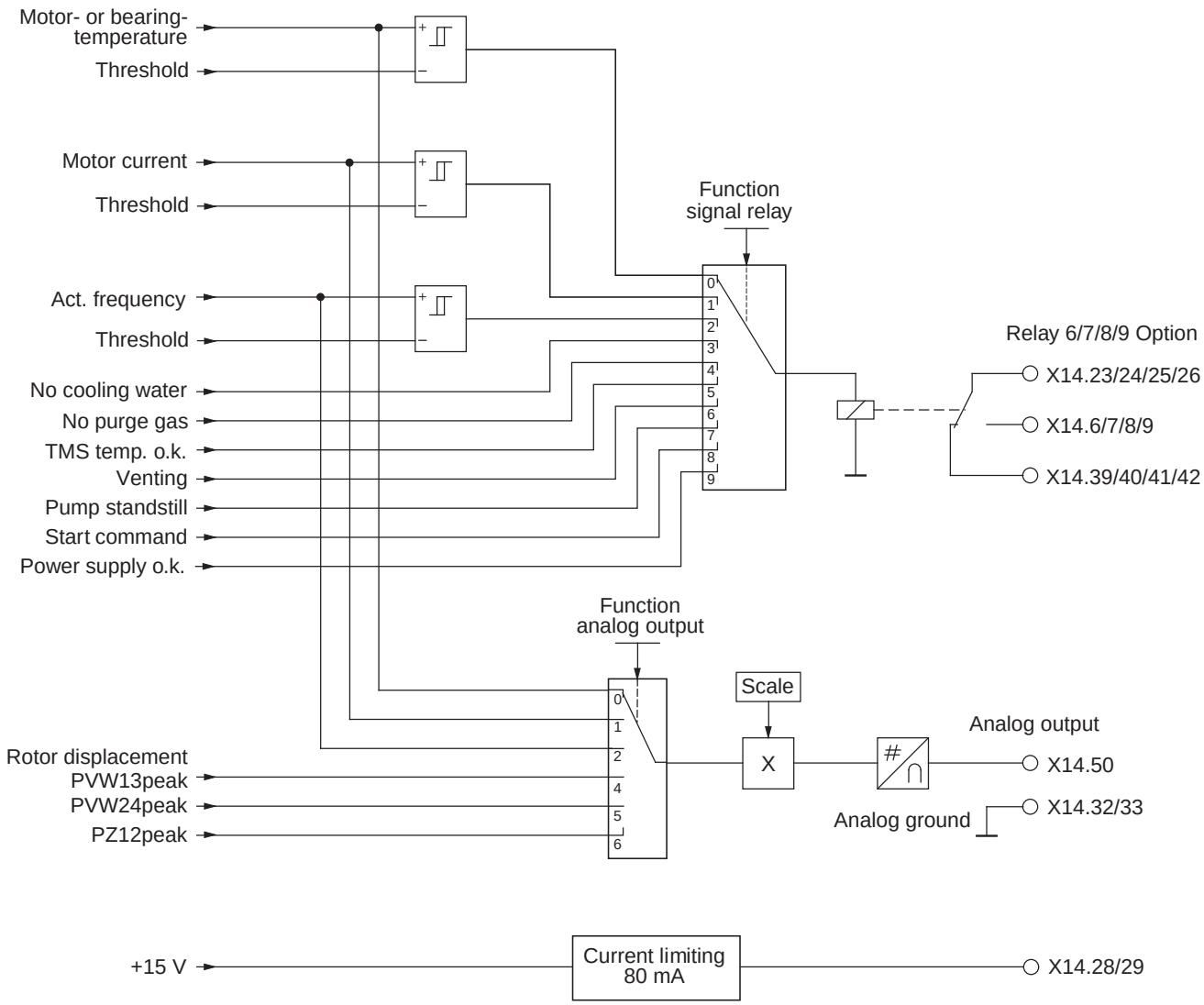
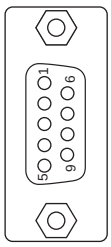


Fig. 38 Function diagram outputs, Part 2



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. 39 Connector assignment, interface X7 (front side)

3 Operation

3.1 General operation rules

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 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*digital* while they are operating. If MAG and MAG.DRIVE*digital* 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 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.

Refer to Section 2.7.

Warning

The pump will be hot during operation. Burn hazard!

Venting

As to suitable gases, see Chapter 2.7.

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.

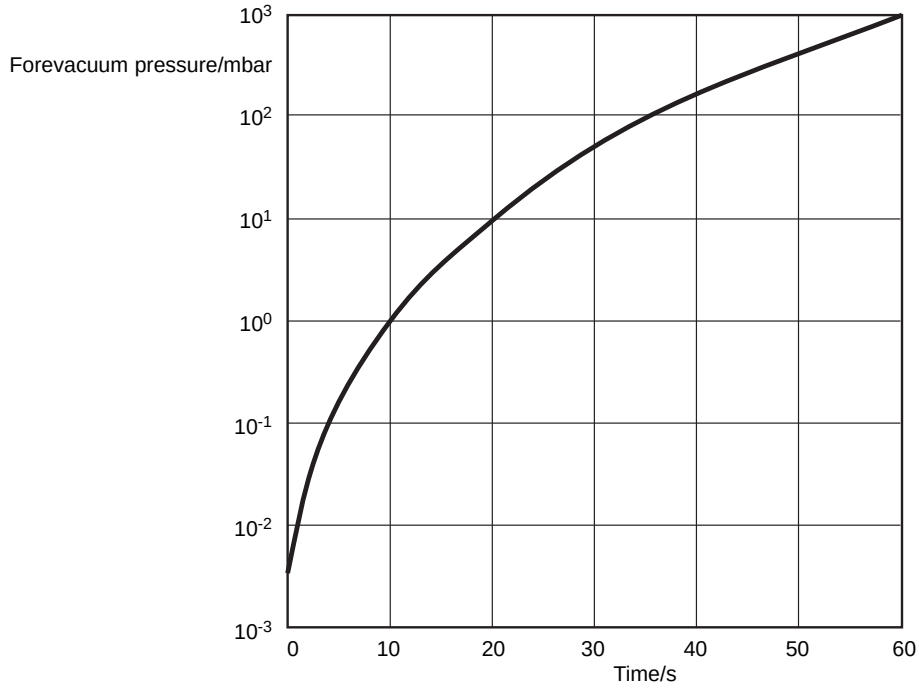


Fig. 40 Curve for safe venting of the MAG; pressure rise as a function of venting time

3.2 Operation with the START and STOP keys

Switching on

- Switch on the MAG.DRIVE*digital*.

The MAIN LED lights green.

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.

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.

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

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.

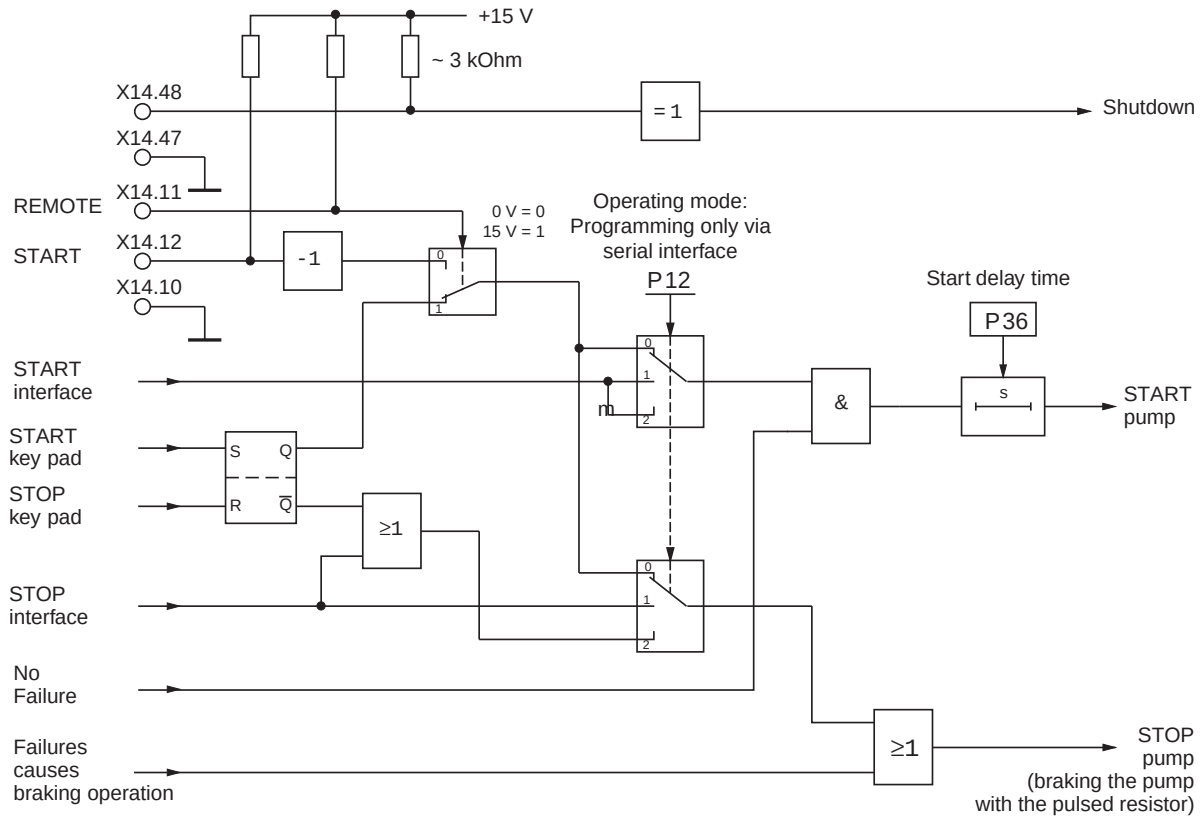
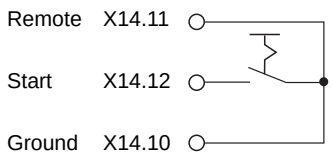


Fig. 41 Function diagram START/STOP



Switch closed: START
Switch open: STOP

Fig. 42 Connecting-up example remote control

3.3 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

4 Plug-in control

4.1 Operation with plug-in control

Observe the general operation rules given in Section 3.1

Switching on

- Switch on the MAG.DRIVE*digital*. The display reads

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

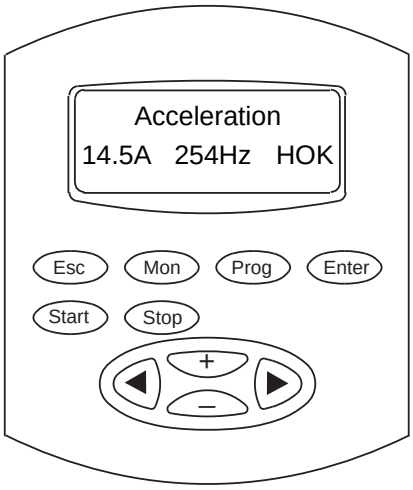
Ready	
0.0 A	0 Hz

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.

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.



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 (only from the basic menu) • 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. 43 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 4.4 “TMS”

* only for pumps with TMS

Fig. 44 Display

4.2 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 or the serial interface.

The basic menu parameters (refer to 4.3, 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.

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.

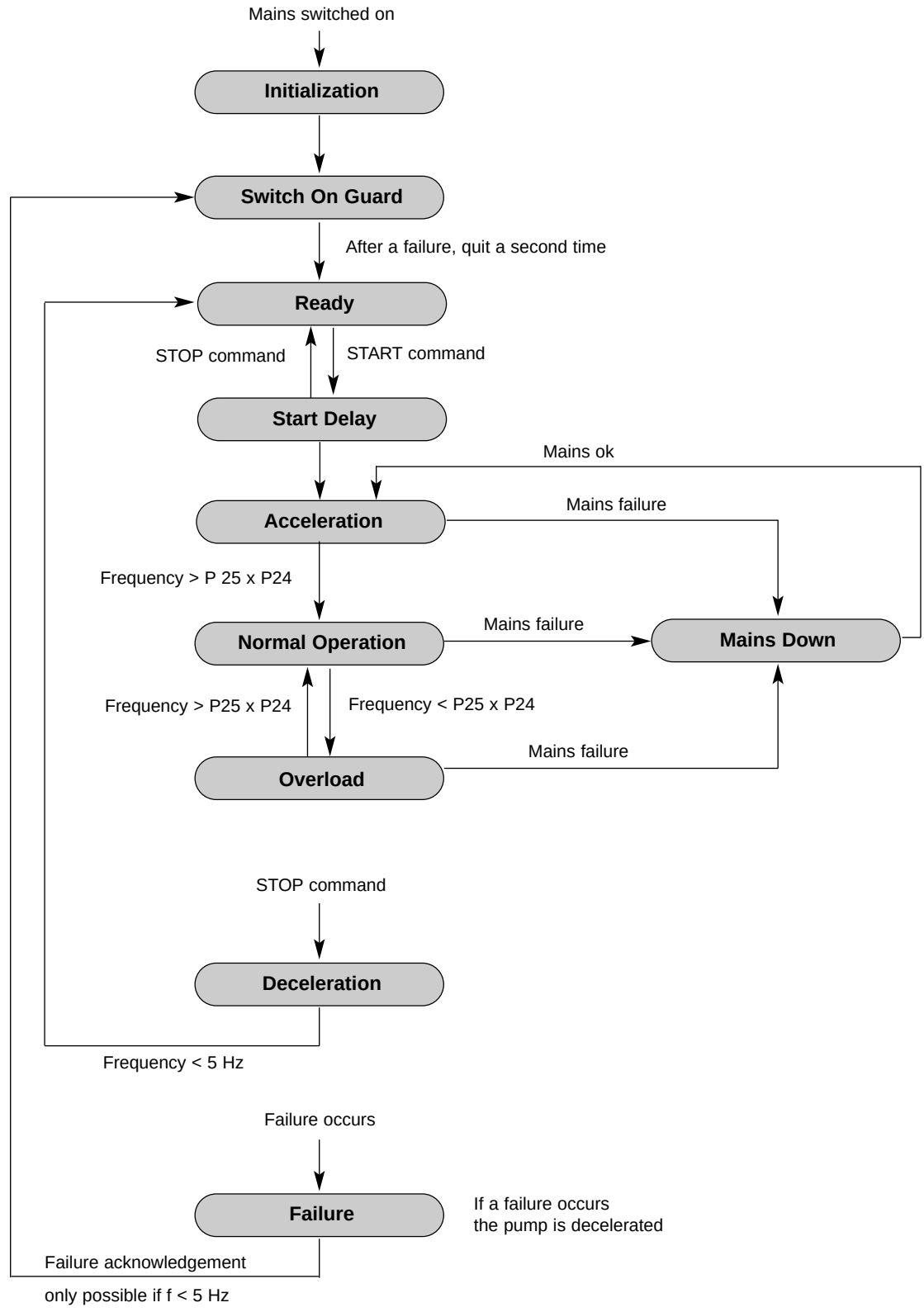
The acceleration time is now restarted. If the converter hasn’t gone into the normal operating mode after the monitoring time, it is shutdown with the failure message “Accel. Time”.

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 serial interface, when the pump stands still (f < 5 Hz).



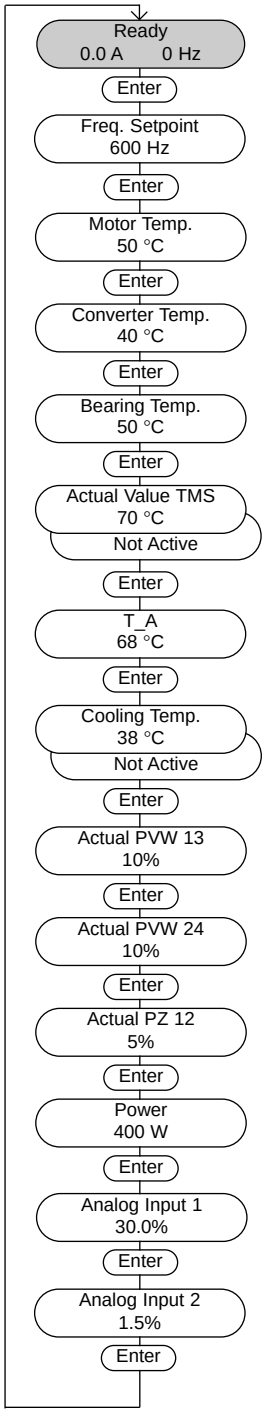
Parameter:
P24 = Frequency setpoint
P25 = Factor normal operation

Fig 45 Diagram: Operation status

4.3 Operating menu

4.3.1 Basic Menu

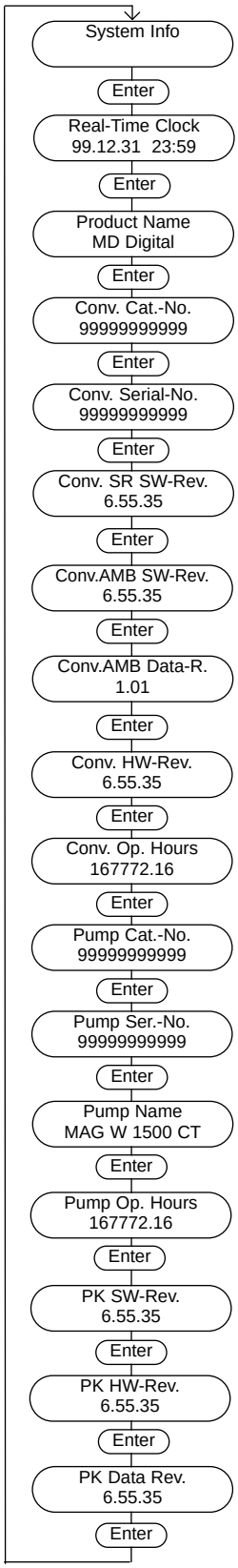
Menu item	Description	Adjustable value / option				Access
		min. value	max. value	standard	Unit	
Ready	Operating display	-	-	-	-	-
Freq. Setpoint	Sets the speed for operation !! Every change is directly written into the pump's data storage and is valid immediately!!	150	*	*	Hz	r/w on
Motor Temp.	Motor 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



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

* 400 Hz = 24,000 rpm for MAG W 830
600 Hz = 36,000 rpm for MAG (W) 1300 & 1500
490 Hz = 29,400 rpm for MAG W 2200
480 Hz = 28,800 rpm for MAG W 2800 & 3200

4.3.2 Menu System Info

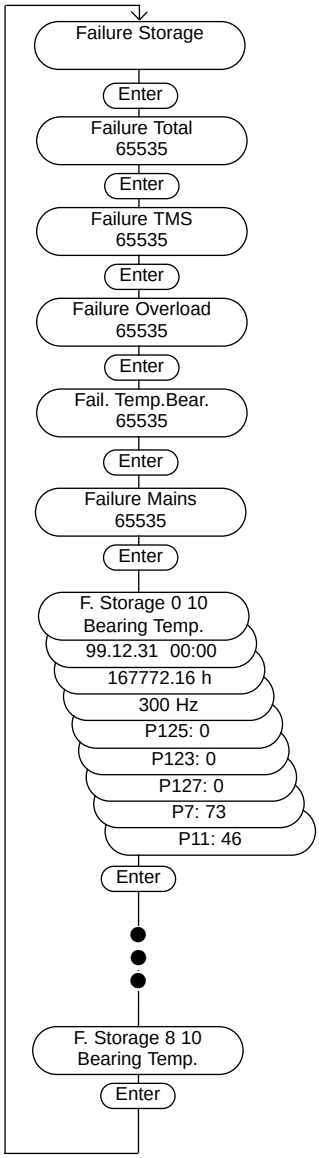


Menu item	Description	Adjustable value / option				Access
		min. value	max. value	de-fault	Unit	
Real-Time Clock 99.12.31 23:59	Real-Time Clock Format: YY.MM.DD HH:MM Greenwich-Mean-Time (GMT) Reference-Time for false memory		actual value		-	r
Product Name MD Digital	Actual product name of the converter		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 167772.16	Operation hours of the pump		actual value		h	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

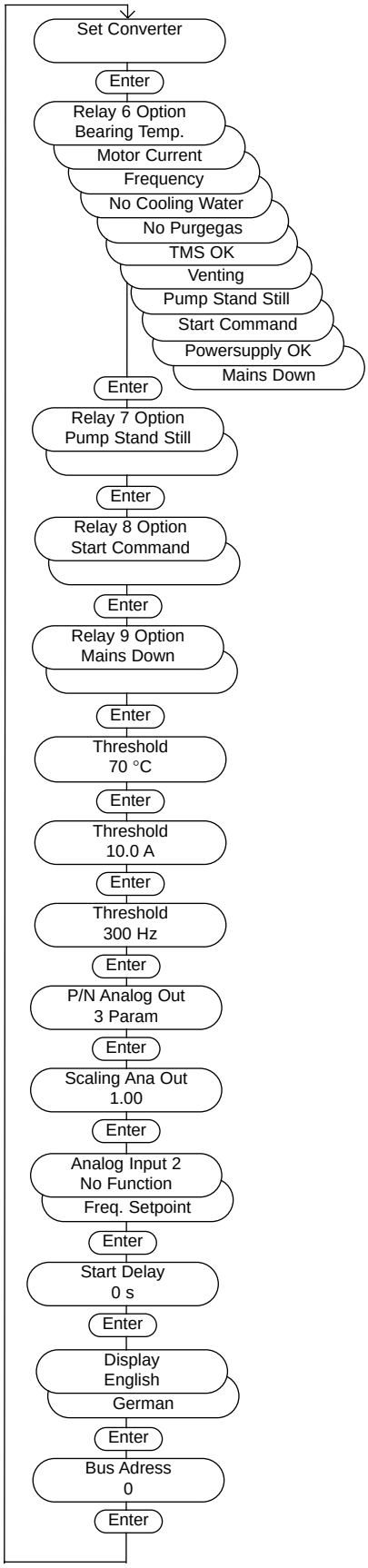
r (read) = value can **only** be read
r /w (read/write) = value can be read and written
on (online) = value can be changed always
off (offline) = value can only be changed when the pump stands still

4.3.3 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



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



4.3.4 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

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

Table A "Option relays"

Function of the option relays

Refer to Set Converter/Relay option (section 4.3.4).
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 Purgegas	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

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	%

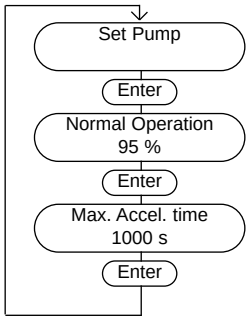
Example: P/N Analog Out (section 4.3.4) is set to parameter P125 (bearing temp.).

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

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

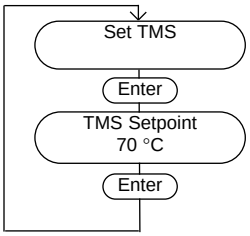
P125 (bearing temp.) / °C	Scale factor Analog out	$U_{Ana\ out}$ / V
20	1.00	**1.43**
40	2.50	**7.14**
75	1.87	**10.00**
100	1.00	**7.14**

4.3.5 Menu Set Pump



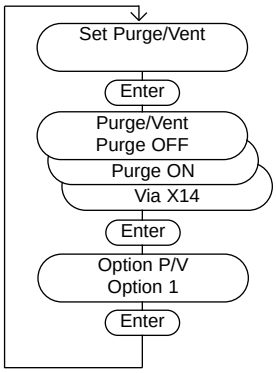
Menu item	Description	Adjustable value / option				Access
		min. value	max. value	standard	Unit	
Normal Operation	Threshold for normal operation corresponding to the frequency setpoint	35	99	95	%	r/w off
Max. Accel. Time	Monitor time for acceleration and overload	600	3600	1000	s	r/w off

4.3.6 Menu Set TMS



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

4.3.7 Menu Set Purge / Vent

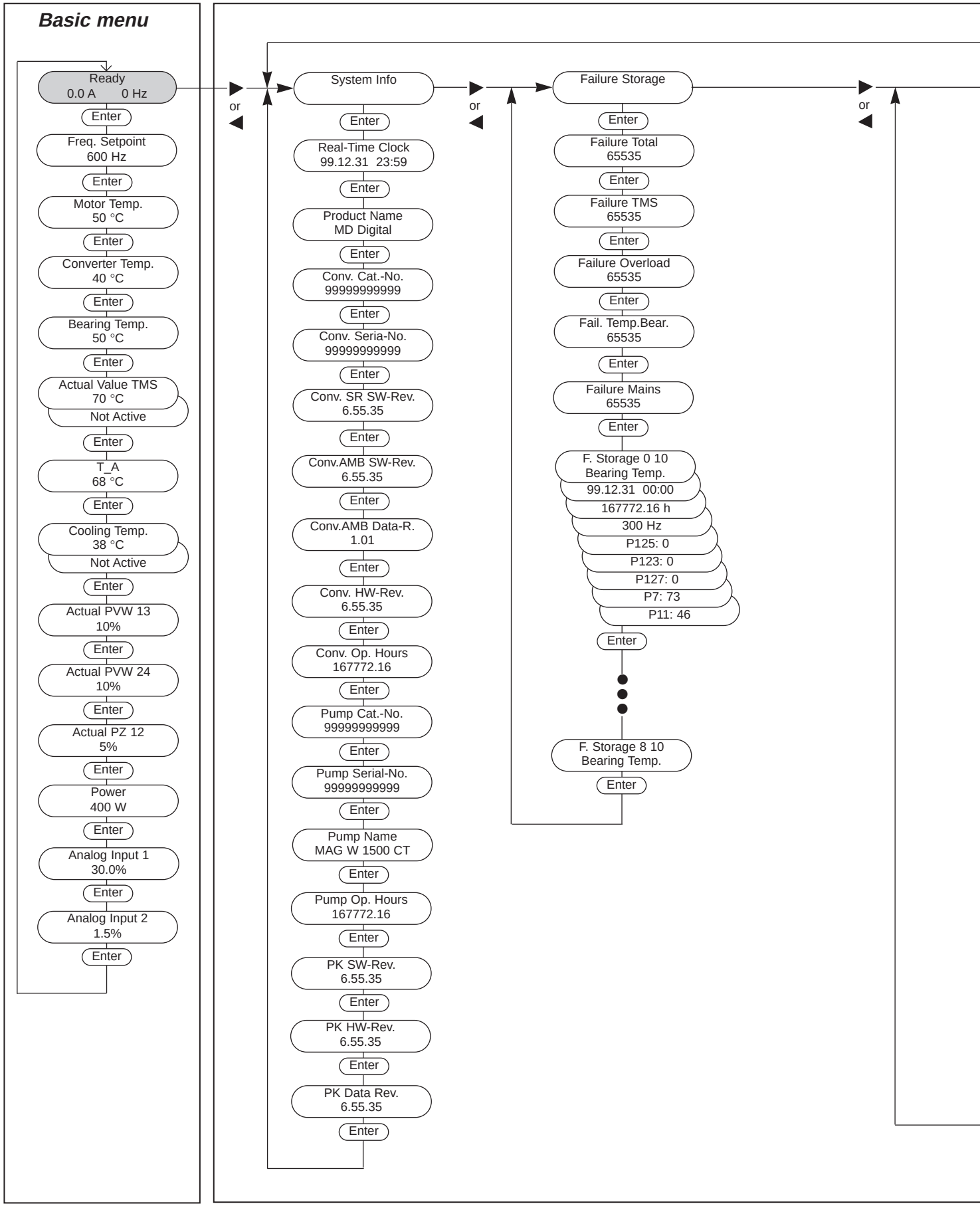


Menu item	Description	Adjustable value / option				Access
		min. value	max. value	standard	Unit	
Purge / Vent	The operator can select one of the beside standing options for purge and vent	purge OFF			-	r/w on
		purge ON			-	
		Controlling purge / vent via control plug X14			-	
Option P / V	Displays the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

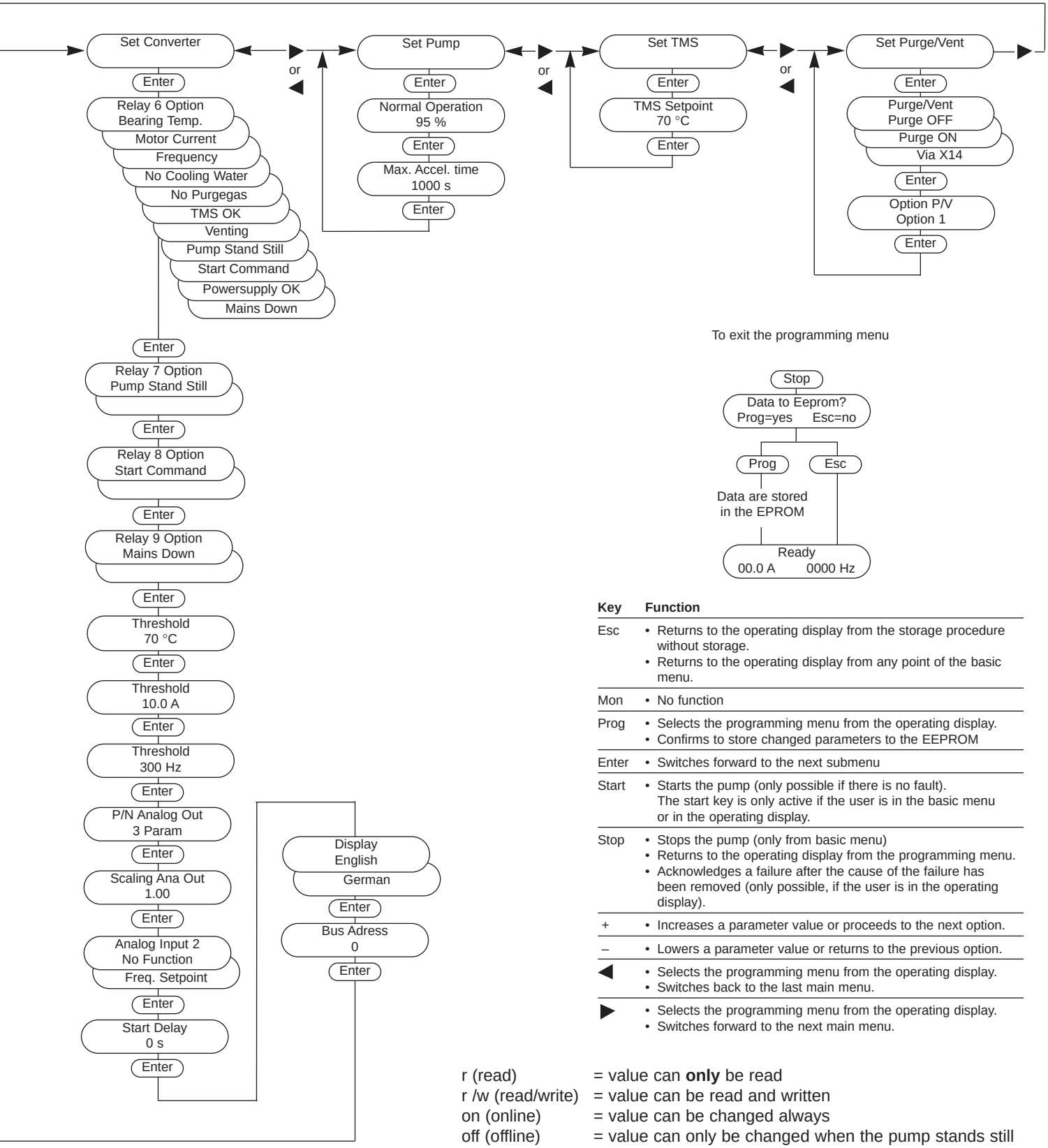
r (read) = value can **only** be read
r /w (read/write) = value can be read and written
on (online) = value can be changed always
off (offline) = value can only be changed when the pump stands stillstands still

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

4.3.8 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 (only from basic menu) • 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

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

4.4 Temperature Management System

Function description

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 $\leq T_{TMS} \leq T_{set} + 5$ 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 4.3.6 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 2.6).

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 2.6.

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 4.3.1 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)

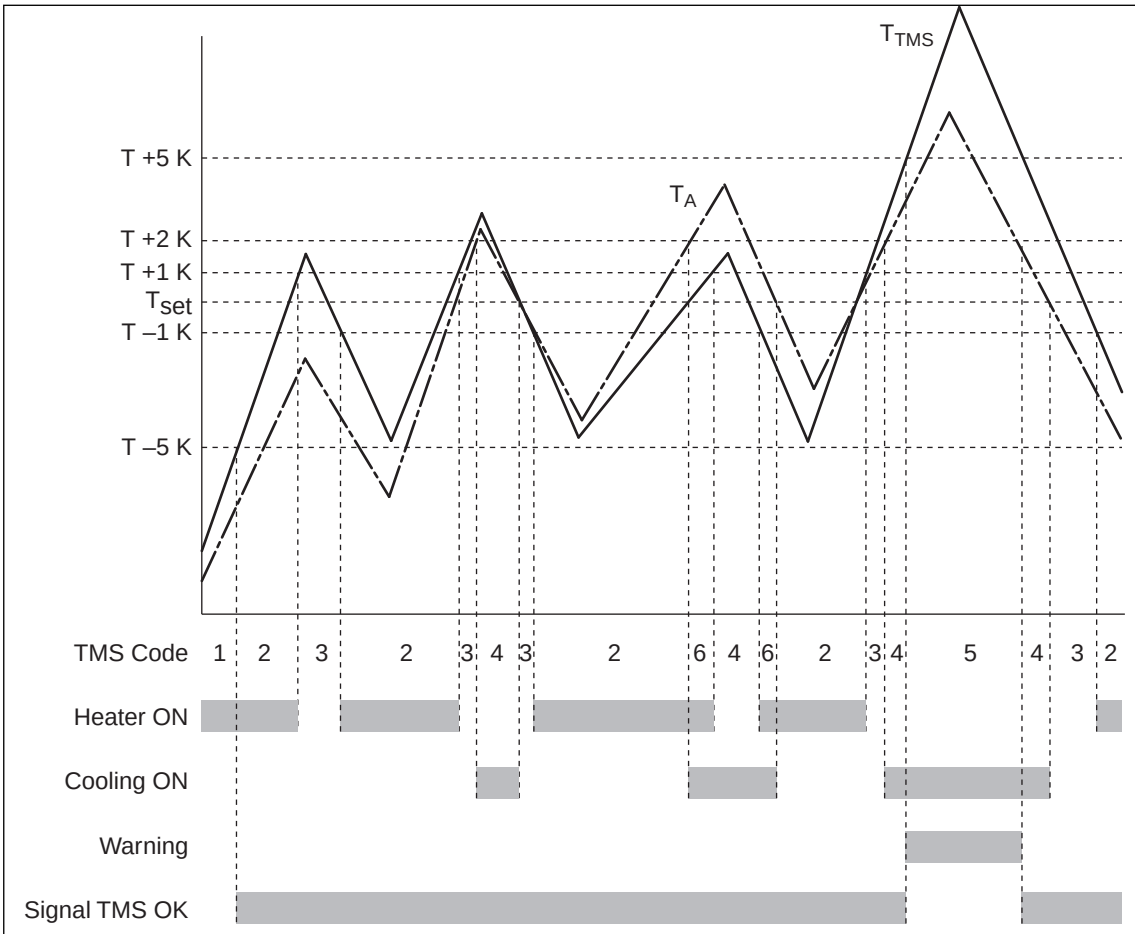


Fig. 46 Typical function diagram TMS for the MAG.DRIVE*digital*

4.5 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.

5 Maintenance

5.1 Cleaning

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

5.2 Changing the rotor

The rotor has to be changed

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

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 4.3.2).

Only the Leybold service can change the rotor.

5.3 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.

5.4 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.

5.5 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.

To prevent corrosion damage during storage and shipping, use the seal kit.

Failure to seal a contaminated MAG voids the warranty.

The seal kit contains the following

- dry cartridge,
- plastic cap for forevacuum connection flange,
- plastic adhesive film and
- aluminum cover and screws for the high-vacuum connection flange.

Caution

For safety reasons we recommend to use a metal seal kit (order no. 200 07 901; see Fig. 48) for shipping of contaminated pumps. For storage of contaminated pumps during tool maintenance a standard seal kit can be used.

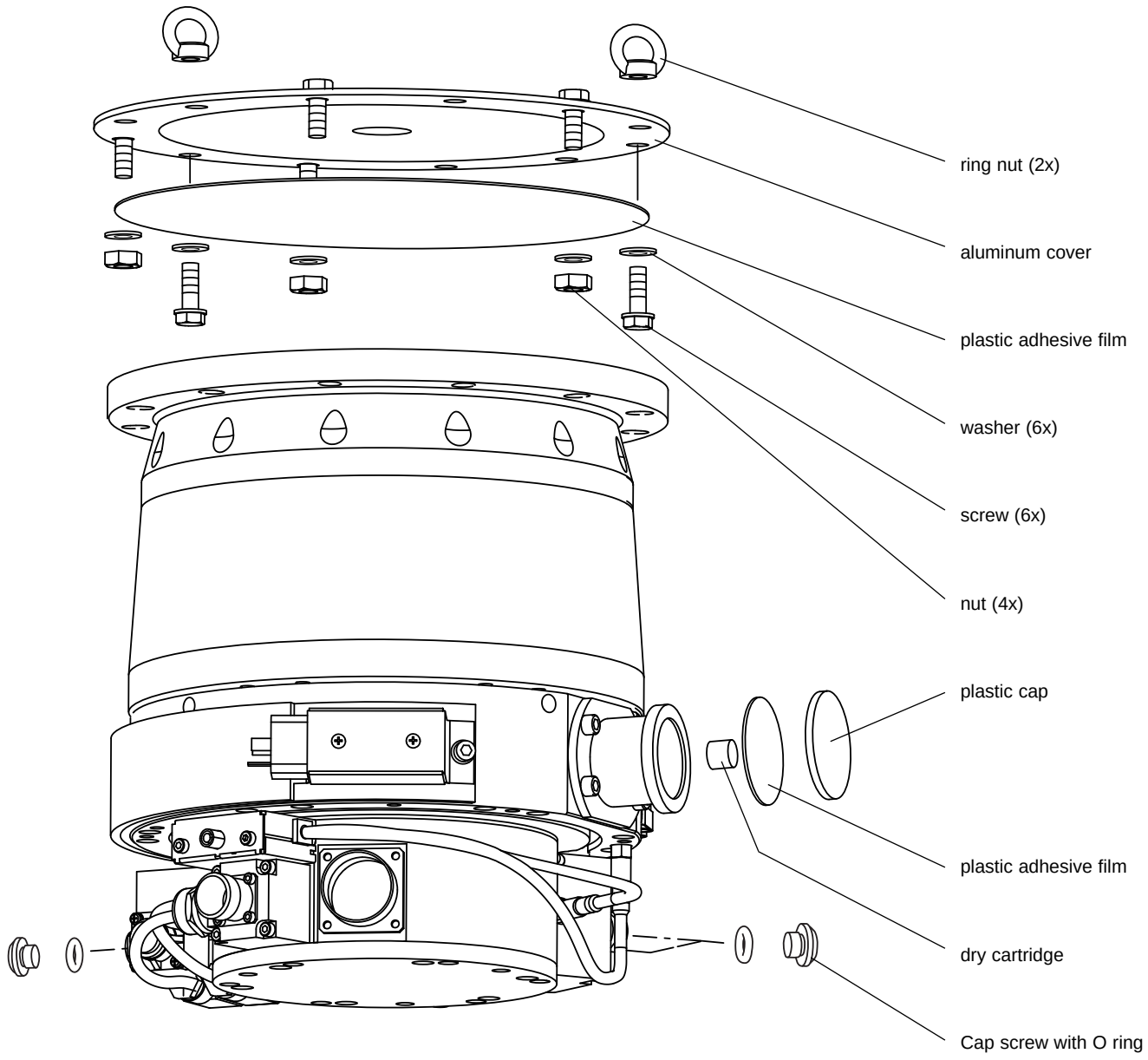


Fig. 47 Sealing the MAG tightly

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*digital* 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.

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.

Only for MAG with DN 160 or 200
As the plastic adhesive film is too large for the high-vacuum connection flange slit it a little bit at the screw holes.

5.6 Service at Leybold’s

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.

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.leyboldvac.de 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.

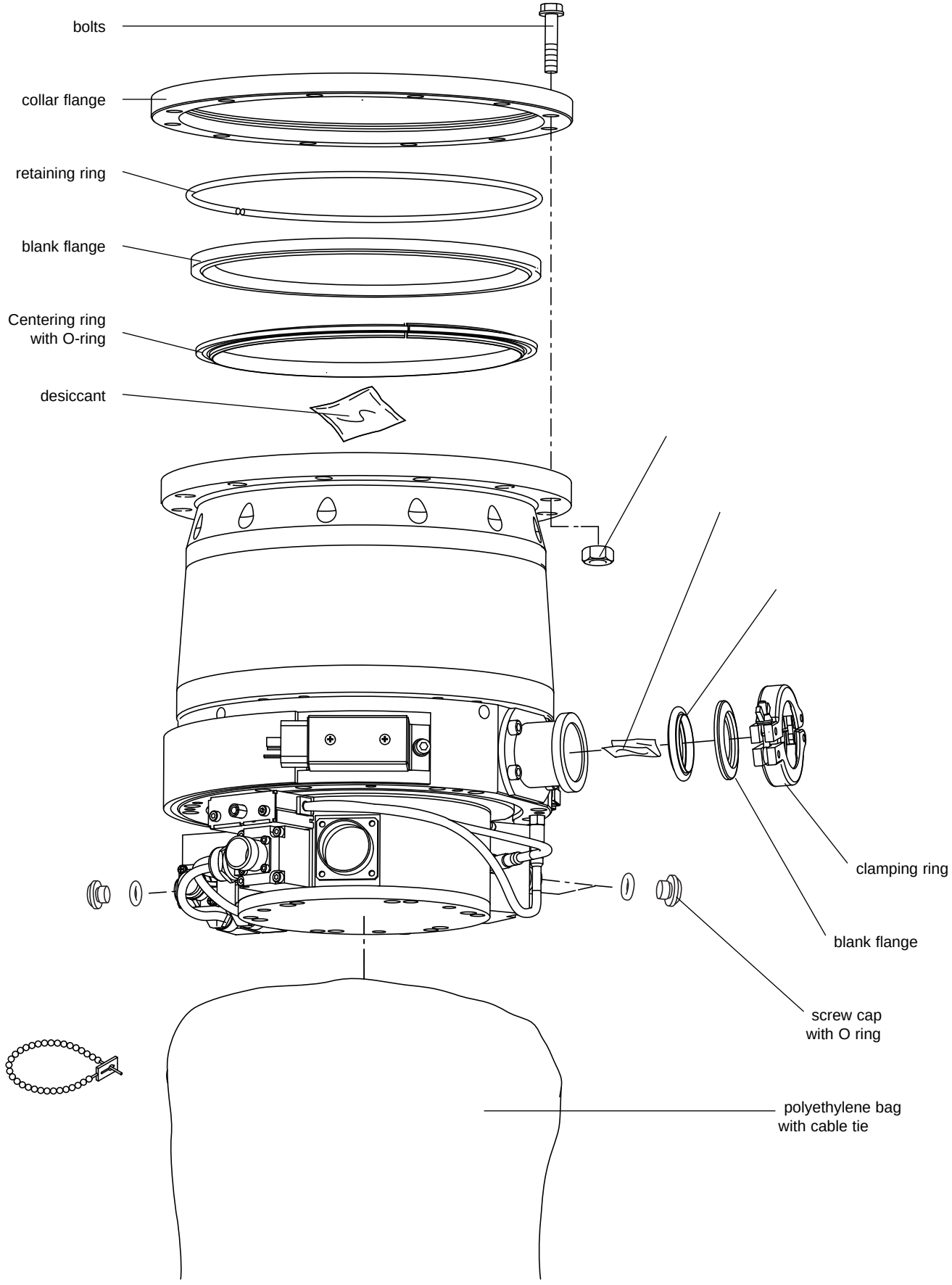


Fig. 48 Sealing the MAG tightly with the metal seal kit

6 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 serial interface).

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.

6.1 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 4.3.1. 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 2.6.
	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 2.8 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 2.6.
TMS TMS temperature sensor reads a temperature higher than the TMS setpoint +5 °C. **This message does not exist from software rev. 302.18. Because of new software functions it is no longer needed.**	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 2.6.
	Wrong TMS temperature setpoint.	Check the TMS setpoint (default 70 °C). For the correct setting refer to Section 4.3.6.

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 4.3.5.
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

6.2 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 4.3.1. 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 2.6.
	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 2.6.
	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 2.8 for the correct mounting of the converter in a rack; max. ambient temperature 45 °C.
	Converter failure.	Contact Leybold service.
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.

Failure Message on Display	Possible Cause	Measures
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. Shock venting. Converter failure.	Acknowledge failure message and restart the pump. If failure message persists contact Leybold service. Check the chamber pressure during the operation. Refer to Section 3.1 for correct venting of the pump. Contact Leybold service.
Starting Time The frequency has not reached 40 Hz 2 minutes after the start command was applied.	Backing pressure too high during start-up. Rotor blocked.	Reduce backing pressure. 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. Parameter “Accel. Time” is not set correctly.	Reduce backing pressure. Set parameter “Accel. Time” to default 1000 s; see Section 4.3.5.
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. Parameters “Accel. Time” or “Normal Operation” are not set correctly.	Reduce backing pressure. Additionally check process gas flow. Set parameter “Normal Operation” to default 95 % and parameter “Accel. Time” to default 1000 s; see Section 4.3.5.
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.
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.

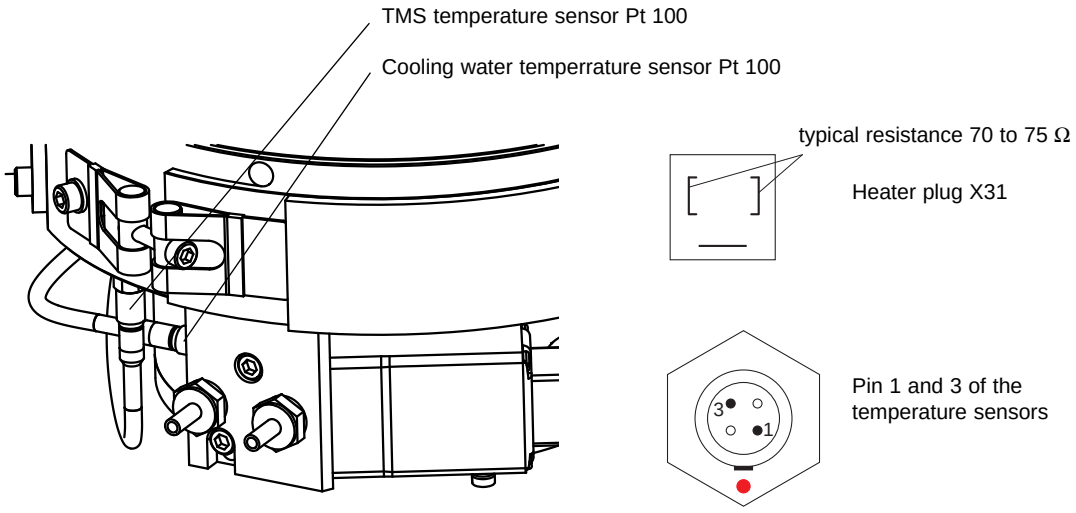


Fig. 49 Temperature sensors

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. BEARING cable short-circuited. Converter failure.	Repeat step 1 of “failure Motor Temp.”. Contact Leybold service if the resistance of the sensor is less than 1.62 kΩ. Repeat step 2 of “failure Motor Temp.”. Contact Leybold service if the resistance of the sensor is less than 1.62 kΩ. 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%. Converter failure.	Acknowledge failure message. If failure persists contact Leybold service. Contact Leybold service.
No Motor Current	On START command: DRIVE cable not connected or connectors damaged. Resultant message after activating “Emergency off”. DRIVE cable interrupted during operation of the MAG.	Check cables and connectors, straighten pins if required. Deactivate “Emergency off” via control plug X14 and acknowledge failure message. 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.	**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).
	Pt 100 damaged.	**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.	Check cable connections.
	Drive / Bearing Cable or connector damaged	Check cable. Replace the cable if it is damaged
	Controller is not able to operate with the connected pump	Contact Leybold service. Principally controllers with SR-Software Revision 302.18 or higher can be updated for new pumps (see 4.3.2 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.	Check cable connections.
	Drive / Bearing Cable or connector damaged.	Check cable. Replace cable if it is damaged.
	PK-.. or converter failure	Contact Leybold service.

6.3 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.

EEC Manufacturer's Declaration

in the sense of EEC Directive on Machinery 89/392/EWG, Annex IIb

We - Leybold Vakuum 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.

At the same time we herewith certify conformity with EEC Directive on Low-Voltages 73/23/EWG.

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

Designation : Turbomolecular pump

Models:
MAG W 830
MAG W 1300 C
MAG (W) 1500 C(T)
MAG W 2200 C
MAG W 2800 C(T)
MAG W 3200 CT

Part numbers:
400000Vxxxx
400003Vxxxx
400004Vxxxx
400020Vxxxx
400021Vxxxx
400026Vxxxx
400027Vxxxx
400028Vxxxx
400030Vxxxx
400081Vxxxx
400100Vxxxx
400110Vxxxx

x = 0 to 9

Applied harmonized standards:

• EN 292 Part 1 & 2	Nov. 1991
• EN 1012 Part 2	1996
• EN 60 204	1993

Applied national standards and technical specifications:

• DIN 31 001	April 1983
• DIN ISO 1940	Dec. 1993

Cologne, May 29, 2002

Dr. Beyer, Design Department Manager

Cologne, May 29, 2002

Adamietz, Designer

Declaration of Conformity

as defined by the EMC guideline 89/336/EWG
with revisions 91/263/EWG and 93/68/EWG

Product: MAG.DRIVE*digital*

RIR-MAG.DRIVE-EMV
2000-12-07

We herewith declare sole responsibility for the product

1. Product:	Frequency converter
2. Manufacturer:	Indramat Refu GmbH Uracher Straße 91 72555 Metzingen / Germany
3. Type:	MAG.DRIVE*digital*, MD3000, MDdigital
4. from date of manufacture:	2000-07-01
5. Applicable standards:	EN 50081 Part 2: Electromagnetic compatibility (EMC) / Generic emission standard 06/93 EN 50082 Part 2: Electromagnetic compatibility (EMC) / Generic immunity standard

meet the requirements outlined in the EG requirements on 89/336/ EWG (EMC guideline) with revisions 91/263/EWG and 93/68/EWG.

Explanation

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. The legal requirements made of resistance to interference and resistance to emission of interference limit values and standards are outlined in the above-referenced documentation.

This Indramat Refu product is intended for installation into an end product. The test results are not applicable to every installed state in every end product. This declaration does not therefore guarantee the EMC characteristics of the end product.

Metzingen, 2000-12-07

Michael Kimmich
Head of Quality Management

Stephan Scholze
Head of Development

We reserve the right to make changes in the conformity declaration.
Presently applicable edition can be obtained upon request.

Indramat Refu GmbH
Uracher Straße 91 • D-72555 Metzingen
Phone +49 (0) 71 23 / 9 69-0 • Fax +49 (0) 71 23 / 9 69-120

Declaration of Conformity

as per EG Low-Voltage Guidelines 73/23/EWG,
Attachment lll B

Product: MAG.DRIVE*digital*

RIR-MAG.DRIVE-NSR
2000-12-07

We herewith declare sole responsibility for the product

1. Product:	Frequency converter
2. Manufacturer:	Indramat Refu GmbH Uracher Straße 91 72555 Metzingen / Germany
3. Type:	MAG.DRIVE*digital*, MD3000, MDdigital
5. from date of manufacture:	2000-07-01
6. Applicable standard:	EN 61010 Part 1: Safety requirements for electrical equipment for measurement, control and laboratory use., 03/94 EN 60204 Part 1: Safety of machinery - Electrical equipment of machines, 06/93

including the required accessories, as agreeing with EG guidelines 72/23/EWG, and 93/68/EWG.

Explanation

This product is a component intended for further assembly. Due to the features resulting therefrom, the product cannot initially meet requirements made of finished products, machines or plants. It must thus be used for mounting/assembly only.

An evaluation of electrical and mechanical safety, environmental conditions (e.g., extrinsic objects and/or humidity) must be performed after mounting/assembly in the finished product.

The EMC characteristics of this product can change in a mounted/ assembled state. An EMC check must thus be made for the finished product (final unit, machine or plant) by the manufacturer of the finished unit, machine or plant.

Metzingen, 2000-12-07

Michael Kimmich
Head of Quality Management

Stephan Scholze
Head of Development

We reserve the right to make changes in the conformity declaration.
Presently applicable edition can be obtained upon request.

Indramat Refu GmbH
Uracher Straße 91 • D-72555 Metzingen
Phone +49 (0) 71 23 / 9 69-0 • Fax +49 (0) 71 23 / 9 69-120

Semiconductor Equipment and Materials International

NRTL LISTED

LEYBOLD

The system MAG 1500

- turbomolecular pump
- connecting cables
- frequency converter

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

- **NRTL**
  (used standard UL 3101-1/10.93)
- **Semi S2-0200**
  used standards:
  SEMI S2-0200
  UL 3111 / UL 3101
  EU Low Voltage Directive
  EU Machinery Directive
  EU EMC Directive

The components are in compliance to the tested standards.

NRTL Report No. USA-JK/lt G 9972057.02

Certificate No. US 9971855 02

Evaluation Report file #E2110736.01

The MAG 830, MAG 1300, MAG 2200, MAG 2800 and MAG 3200 systems have been designed following the same standards but have not yet been tested.

LEYBOLD

VDMA

Declaration of Contamination of Vacuum Equipment and Components

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

This declaration can only be completed and signed by authorized and qualified staff.

1. Description of Vacuum Equipment and Components

- Equipment type/model: _____
- Code No.: _____
- Serial No.: _____
- Invoice No.: _____
- Delivery date: _____

2. Reason for Return

_____
_____
_____
_____
_____

3. Condition of the Vacuum Equipment and Components

- Has the equipment been used?
  yes ❒ no ❒
- What type of pump oil/liquid was used? _____
- Is the equipment free from potentially harmful substances?
  yes ❒ (go to Section 5)
  no ❒ (go to Section 4)

4. Process related Contamination of Vacuum Equipment and Components:

- toxic	yes ❒	no ❒
- corrosive	yes ❒	no ❒
- explosive*)	yes ❒	no ❒
- biological hazard*)	yes ❒	no ❒
- radioactive*)	yes ❒	no ❒
- other harmful substances	yes ❒	no ❒

*) Vacuum equipment and components which have been contaminated by biological explosive or radioactive substances,

Please list all substances, gases and by-products which may have come into contact with the equipment:

Trade name Product name Manufacturer	Chemical name (or Symbol)	Dangerous material class	Measures if spillage	First aid in case of human contact
1.				
2.				
3.				
4.				
5.				

5. Legally Binding Declaration

I hereby declare that the information supplied on this form is complete and accurate. The despatch of the contaminated vacuum equipment and components will be in accordance with the appropriate regulations covering Packaging, Transportation and Labelling of Dangerous Substances.

Name of organisation or company: _____

Address: _____ Post code: _____

Tel.: _____

Fax: _____ Telex: _____

Name: _____

Job title: _____

Date: _____ Company stamp:

Legally binding signature: _____

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 05.141/1.02 English (February 2000) preliminary		MAG 1500 C, CT MAG W 1500 C, CT Pumping speed curves, dimensional drawing and troubleshooting incomplete	MAG.DRIVE^{digital}
GA 05.141/2.02 English (March 2000) preliminary		MAG 1500 C, CT MAG W 1500 C, CT Pumping speed curves and dimensional drawing incomplete Current seal kit	MAG.DRIVE^{digital}
GA 05.141/3.02 English (July 2000)		MAG 1500 C, CT MAG W 1500 C, CT Pumping speed curves and dimensional drawing incomplete	MAG.DRIVE^{digital} From software versions Conv.SR 3.02.18 and Conv.AMB 1.01.02
GA 05.141/4.02 English (November 2000)		MAG 1500 C, CT MAG W 1500 C, CT MAG W 1900 C MAG W 2800 CT MAG W 3200 CT	MAG.DRIVE^{digital}
GA 05.141/5.02 English (June 2002)	GA 05.141/5.01 German (September 2002)	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 serial software version 302.18 with upgraded troubleshooting
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 with extended maintenance instructions	MAG.DRIVE^{digital} from serial software version 302.18
GA 05.152/1.02 English (March 2003)		MAG W 2200 C Part No. 400081V0020	MAG.DRIVE^{digital} from serial software version 303.00
GA 05.152/2.02 English (July 2003)		MAG W 2200 C Part No. 400081V0020 with extended maintenance instructions	MAG.DRIVE^{digital} from serial software version 303.00

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