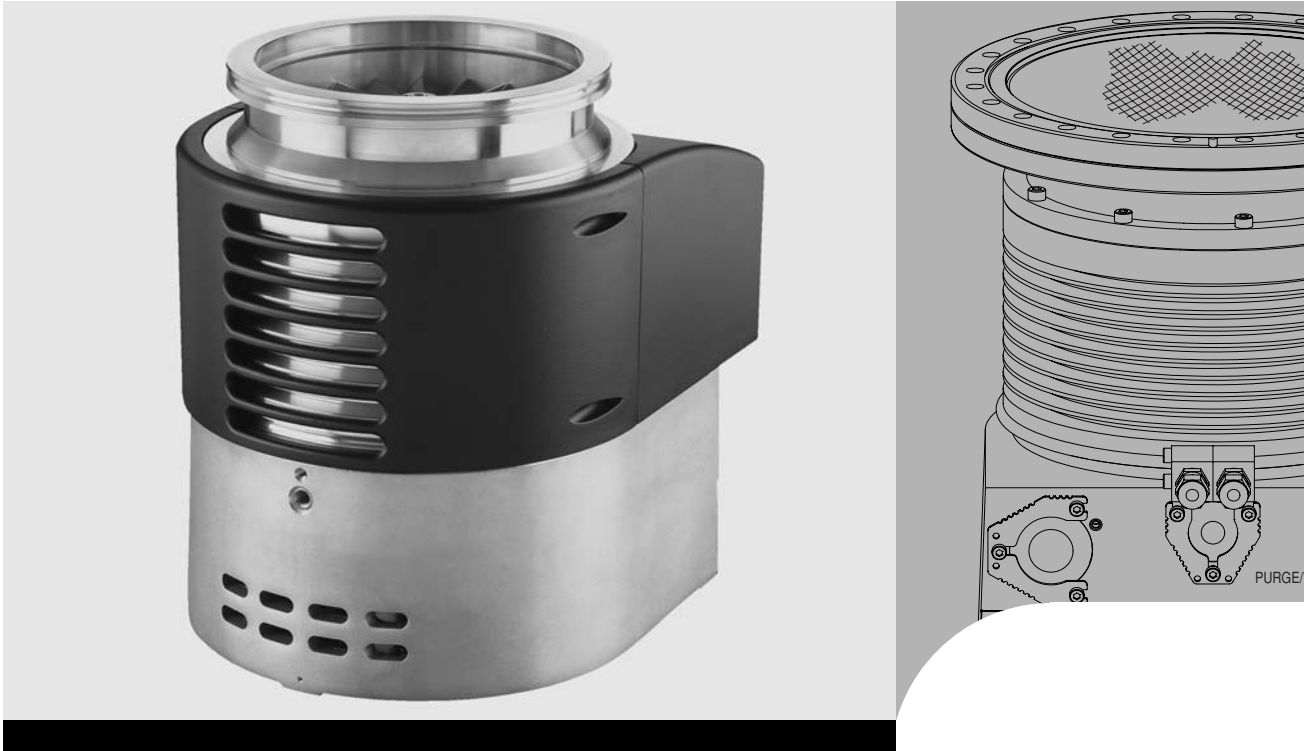


# OPERATING INSTRUCTIONS

GA05149\_0602



## TURBOVAC

### TW 701

Turbomolecular Pump with  
Integrated Frequency Converter

**Part Nos.**

800051V0022 to  
800051V0122  
and pumps modified by  
Leybold Vacuum

 **Leybold**  
vacuum

# Contents

Section	Page
<b>General safety information</b> .....	<b>3</b>
<b>1 Description</b> .....	<b>6</b>
Use and media compatibility .....	6
1.1 Design .....	6
1.2 Standard equipment .....	7
1.3 Ordering data .....	8
1.4 Technical data .....	10
<b>2 Installation</b> .....	<b>13</b>
2.1 Operating environment .....	14
2.2 Connecting the pump to the vacuum chamber .....	15
2.3 Forevacuum connection .....	17
2.4 Cooling the pump .....	18
2.5 Connecting the purge gas and venting valve .....	21
2.6 Electrical connection .....	24
Relay status .....	28
2.7 Interface description .....	29
Parameter list .....	33
Warning codes for parameter 227 .....	36
Error codes for parameter P171 .....	37
<b>3 Operation</b> .....	<b>39</b>
3.1 Switching on .....	39
3.2 Shutting down .....	40
Emergency off .....	40
3.3 Venting .....	41
3.4 Bakeout .....	42
3.5 Changing the start delay time .....	42
<b>4 Maintenance</b> .....	<b>43</b>
4.1 Removing the pump from the system .....	43
4.2 Cleaning .....	44
4.3 Service by Leybold .....	44
4.4 Disposal .....	44
<b>5 Troubleshooting</b> .....	<b>45</b>
<b>6 Spare parts</b> .....	<b>48</b>
<b>EC Manufacturer's Declaration</b> .....	<b>49</b>
<b>EC Conformance Declaration</b> .....	<b>50</b>
<b>Index</b> .....	<b>53</b>

# General safety information

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

**Warning**

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

**Caution**

The Leybold TW 701 vacuum pump system is designed for safe and efficient operation when used properly and in accordance with this manual. It is the responsibility of the user to carefully read and strictly observe all safety precautions described in this section and throughout the manual. The turbomolecular pump **must only be operated in the proper condition and under the conditions described in the Operating Instructions**. It must be operated and maintained by trained personnel only. Consult local, state, and national agencies regarding specific requirements and regulations. Address any further safety, operation and/or maintenance questions to your nearest Leybold Vacuum office.



**Failure to observe the following precautions could result in serious personal injury:**

### Mechanical hazards

Never expose any parts of the body to the vacuum.

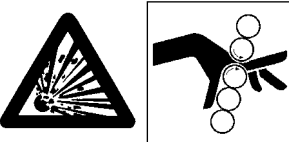
**Warning**

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



The high-vacuum flange must be firmly mounted to the vacuum chamber. If the mounting is not sturdy enough, pump blockage could cause the pump to break loose; internal pump components could be thrown in all directions.

**Warning**



Never operate the pump (in bench testing, for example) without proper flanging to the vacuum chamber.

Turbopumps as described in the following operation manual contain a high portion of kinetic energy due to their high rotational speed in combination with the specific rotor mass.

In case of a malfunction of the system, for example rotor/stator contact or even a rotor crash, the rotational energy is released.

To avoid the destruction of the equipment and to prevent injuries of the operating staff the leading European manufacturers of vacuum pumps strictly recommend to follow the installation instructions as given in this manual.

After a mains power failure the pump can run up automatically once more.



## Safety information

### Electrical hazards

Warning



The pump must only be connected to power supplies which meet the requirements for functional extra-low voltages with positive isolation in accordance with IEC 364 (or local regulations) (SELV).

The OEM power supply unit must only be connected by qualified electrical personnel.

Unplug any connectors only when the mains voltage is switched off **and** the pump does no longer turn (the green LED is off).

When the connector cable is attached, the outputs at the frequency converter are not free of voltage.

### 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 respectively 3.55.

Warning



### Thermal hazards

During operation the pump can become so hot that there is a danger of burns ( $\geq 70$  °C, 158 °F).

Provide protection against contact with the hot components.

Warning



### Hazards caused by materials and substances

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

If the pump has previously handled hazardous gases, implement the proper precautionary measures before opening the intake or exhaust connection.

If necessary, use gloves, a respirator and/or protective clothing and work under an exhaust hood.

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



### Failure to observe the following precautions could result in damage to the pump:

The pumps are **not suitable** for pumping aggressive or corrosive media or those which contain dust.

Install a micropore filter when pumping media which contain dust.

Observe the information on media compatibility in Section 1 of these operating instructions.

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

For the pumps with stainless steel housing self-protection of the pump is not ensured in case of insufficient cooling.

Make sure to avoid dripping water or humidity.

The water-cooled pumps need cooling air for the frequency converter.

Ensure correct polarity when connecting the TURBO.DRIVE.

A wrong polarity may cause the internal SMD fuse to blow. The fuse can only be changed by the Leybold Service.

The interface connectors have UNC 4-40 threads. Do not use connectors with M3 threads.

The pump may be operated only with suitable connector cables. Route all cables so as to protect them from damage.

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

Disconnect and connect the cable connections only while the pump is turning no longer (green status LED off) and with the mains power switched off (yellow power LED off). Otherwise there is the risk of damaging the frequency converter.

After replacing the pump or when switching on the supply voltage without a connected pump, all changed parameter values will be reset to factory defaults.

This pump is only intended for operation with its nominal speed. Do not try to change the operating frequency.

The pump must only be opened by such persons who have been authorised by Leybold to do so.

### Caution

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

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

Retain the Operating Instructions for further use.

### Figures

# 1 Description

## Use and media compatibility

The TURBOVAC TW 701 is a turbomolecular pump with compound stage.

**Use** The pump is designed to evacuate vacuum chambers down to pressure levels in the high vacuum range. It is suitable for pumping air and/or clean gases.

The TW 701 has been manufactured according to the state-of-the-art and approved safety regulations. Even so in the case of improper installation or when improperly used there can be risks or damage may be caused.

A forevacuum pump and a frequency converter are required for the pump's operation. The frequency converter is integrated into the TW 701.

These pumps are **not** suitable for

- pumping liquids
- pumping corrosive or reactive gases
- operation **without** a forevacuum pump.

If reactive gases in low concentrations or ionizing gases must be pumped please consult Leybold.

**Danger of ignition** During operation the pressure inside the pump is so low that there is no danger of ignition (at pressures below about 20 mbar). A hazardous condition will be created if flammable mixtures enter the hot pump at pressures above 20 mbar. During operation the pump can reach temperatures as high as 110°C (230 °F). Ignition sparks could occur in case of damage to the pump and these could ignite explosive mixtures.

We would be glad to consult with you as regards the media which can safely be handled with this unit.

## 1.1 Design

The pumps comprise essentially the pump housing, a multi-stage rotor with the stator group, and the drive.

The rotor consists of a turbomolecular pumping stage and a compound pumping stage (= Holweck stage). The Holweck pumping stage increases the permissible forevacuum pressure level markedly when compared with the classic turbomolecular pump.

The rotor shaft runs in two ceramic ball bearings, lubricated with grease.

**Bearings** The pump is driven by a canned DC motor. In this motor the rotor and stator windings are separated by a vacuum-tight can. Consequently the rotor runs inside the vacuum while the stator is outside the vacuum. This eliminates any need of vacuum feedthroughs.

**Motor**

**Frequency converter** The integrated frequency converter is cooled by integrated fans. The pump is either equipped with fans for air cooling or with a cooling coil for water cooling. For protection it is equipped with temperature sensors.

**Cooling**

The pumps have a purge gas device.

The integrated TURBO.DRIVE 700 frequency converter takes care of pump control. It is supplied with power by an external power supply.

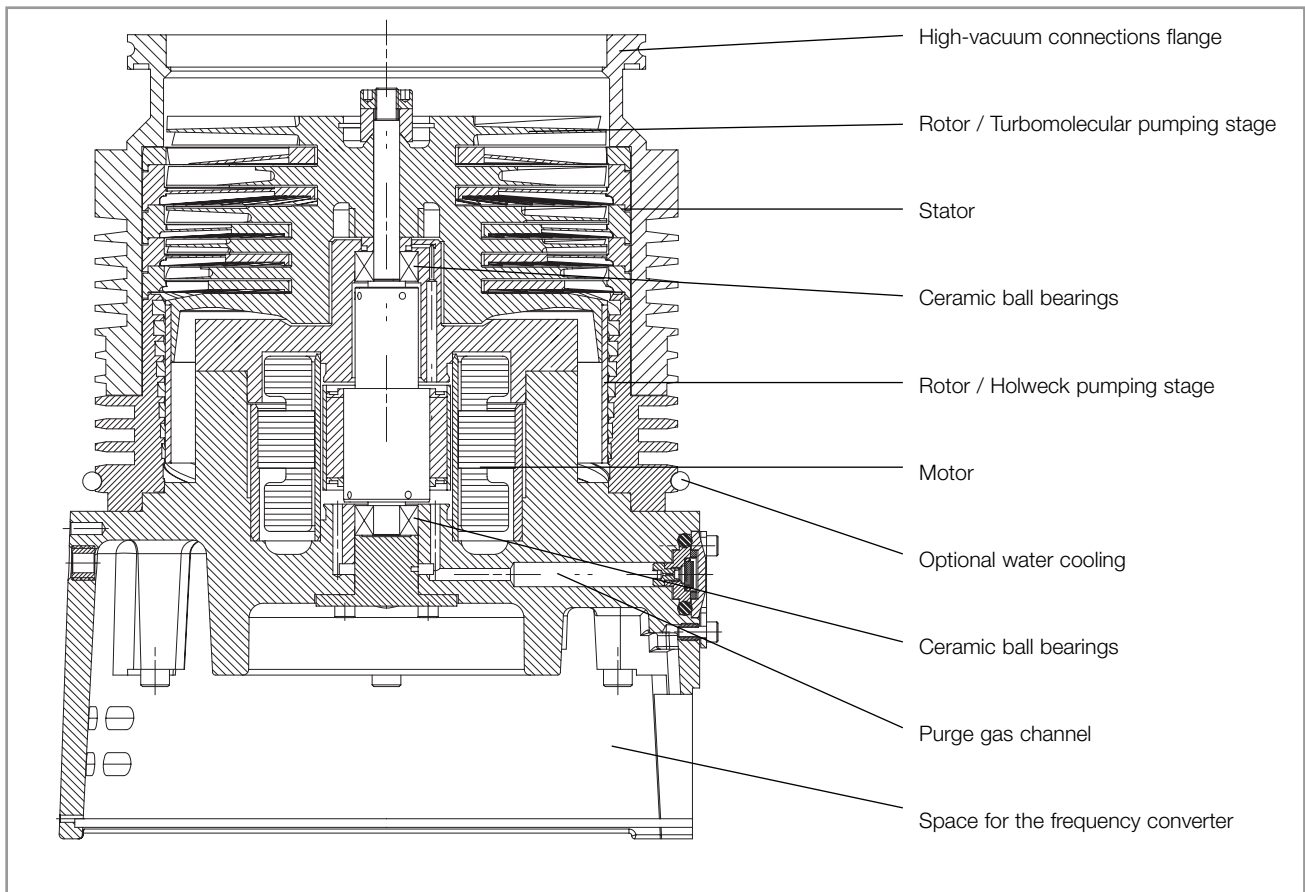


Fig. 1 Section through a TW 701; simplified representation

## 1.2 Standard equipment

The pumps are shipped sealed in a PE bag with a desiccant to absorb moisture. The maximum useful life of the desiccant is one year.

The KF flanges are blank-flanged with centering ring with FPM sealing ring and a clamping yoke.

The high-vacuum connections elements are **not** part of the standard equipment.

A splinter guard is part of the standard equipment for Part No. 800051V0022.

PE = Polyethylene

FPM = Fluororubber, resistant to temperatures up to 150°C (302 °F)

## Description

### 1.3 Ordering data

			Part No.	Remarks
<b>TURBOVAC TW 701</b>				
HV flange	cooling	interface		
DN 200 CF with splinter guard	water	RS 232	800051V0022	≅ TW 700: 800051V0002
DN 160 ISO-K	water	RS 485	800051V0023	≅ TW 700: 800051V0003
DN 160 ISO-K	air	RS 485	800051V0024	≅ TW 700: 800051V0004
DN 160 ISO-K	water	RS 232	800051V0025	≅ TW 700: 800051V0005
DN 160 CF	water	RS 485	800051V0026	≅ TW 700: 800051V0006
DN 160 CF	air	RS 485	800051V0027	≅ TW 700: 800051V0007
DN 160 ISO-K	air	RS 232	800051V0121	
DN 160 ISO-K	water	Profibus	800051V0122	

#### Accessories

Splinter guard DN 160 ISO-K	200 00 307	
Splinter guard DN 160 CF	200 17 247	
Power supply and control unit TURBO.CONTROL 700	800101V0001	
Mains cable with US plug, 3 m	800102V1002	
Mains cable with Euro plug, 3 m	800102V0002	
DC control cable to TURBOVAC		for DC power and control
1 m long	800093V0100	
3 m long	800093V0300	
5 m long	800093V0500	
10 m long	800093V1000	
20 m long	800093V2000	
Power supply unit for the TURBOVAC TW 701	864 45	Input: 88 - 265 V AC, 50/60 Hz; Output: 59 V DC; Max. power consumption at 220 V: 900 VA; with constant current limitation (previous 200 04 680); certified as per EN 60950, EN 61010, UL 60950, and CSA 22.2; see Fig. 4
Mains cable with US plug, 3 m	800102V1001	
Mains cable with Euro plug, 3 m	800102V0001	
59 V DC-connections cable, 3 m long	200 12 729	3 way connector —
5 m long	200 12 730	3x cable lug M5: + 59 V DC, 0 V DC, GND
10 m long	200 12 731	
20 m long	200 15 064	
Adapter cable TDL — TD 700	800110V0004	



**Accessories for serial interfaces**

PC software "Turbo.Drive Server"	800110V0102	for Windows 95 and higher, CD-ROM <ul style="list-style-type: none"> <li>■ Display, change, save and compare parameter lists</li> <li>■ Integration of customer's software</li> <li>■ Record parameter data (new parameter library for TURBO.DRIVE 700 is required, please ask us for a quotation)</li> </ul> <p>The software can also be downloaded from <a href="http://www.leybold.com">www.leybold.com</a> in the menu Support &amp; Downloads</p>
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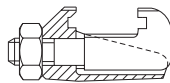
Adaptor RS232/RS485 for 220 V/Euro plug	800110V0101	
9 way connector for PLC interface socket (REMOTE X1)	152 48	with integrated ON/OFF switch for the pump

<b>Purge gas and venting valve</b>	121 33	24 V DC, 0.6 mbar·l/s (previous 200 91 587)
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Connecting piece, pipe 1/4" OD — ISO pipe OD 1/4"	200 91 672	See Section 2.5 on how to operate the valves
Connecting piece, pipe — VCR	200 91 674	
VCR nut 1/4"	200 91 675	

<b>Water cooling</b> complete	200 04 882	G 1/8" connectionss
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Accessories for the water connectionss		
Adapter G 1/8" — 1/4" pipe	200 91 671	2x
Gasket	224 01 207	2x
Adapter G 1/8" — 10 mm hose nozzle	200 18 366	2x
Gasket	230 02 106	2x
Adapter G 1/8" — NPT 1/8"	200 12 742	2x
Gasket	238 20 110	2x

<b>Clamps</b> (Set of 4 pieces)		
Galvanized steel, clamping range 19 to 27 mm	267 01	
Galvanized steel clamping range 25 to 35 mm	267 02	
Stainless steel, clamping range 19 to 27 mm	887 99	

**Recommended forevacuum pumps**

■ TRIVAC B series		see Leybold catalog
■ Diaphragm pump DIVAC 4.8 VT	127 92	

## 1.4 Technical data

### Technical data for pumps

High-vacuum connections	DN 160 ISO-K DN 160 CF DN 200 CF
Pumping speed* for N <sub>2</sub> /Ar	680 l·s <sup>-1</sup>
Pumping speed* for He	530 l·s <sup>-1</sup>
Pumping speed* for H <sub>2</sub>	300 l·s <sup>-1</sup>
Ultimate pressure*	
with two-stage, oil-sealed rotary vane pump	< 10 <sup>-9</sup> mbar
with diaphragm pump achieving ultimate pressure < 5 mbar	< 10 <sup>-7</sup> mbar
Max. permissible forevacuum pressure (see also Fig. 11)	14 mbar
Operating speed	48,000 r.p.m.
Run-up time, approx.	5 min
Forevacuum connections	DN 25 KF
Purge gas connections	DN 16 KF
Cooling water	
Connections, internal threads	G 1/8"
Temperature	15 - 35 °C
Flow	see Section 2.4

\* as per PNEUROP

### Technical data for the integrated frequency converter

Nominal supply voltage	59 V $\overline{\text{---}}$
Residual ripple	< 2%
Power consumption	
maximum	480 W
at ultimate pressure	150 W
Max. DC current	8 A
DC supply voltage	≥ 53 V < 60 V
Max. length of the DC cable	
at 3 x 1,5 mm <sup>2</sup>	5 m
at 3 x 2,5 mm <sup>2</sup>	20 m
Load rating, relay output	42 V, 0.5 A

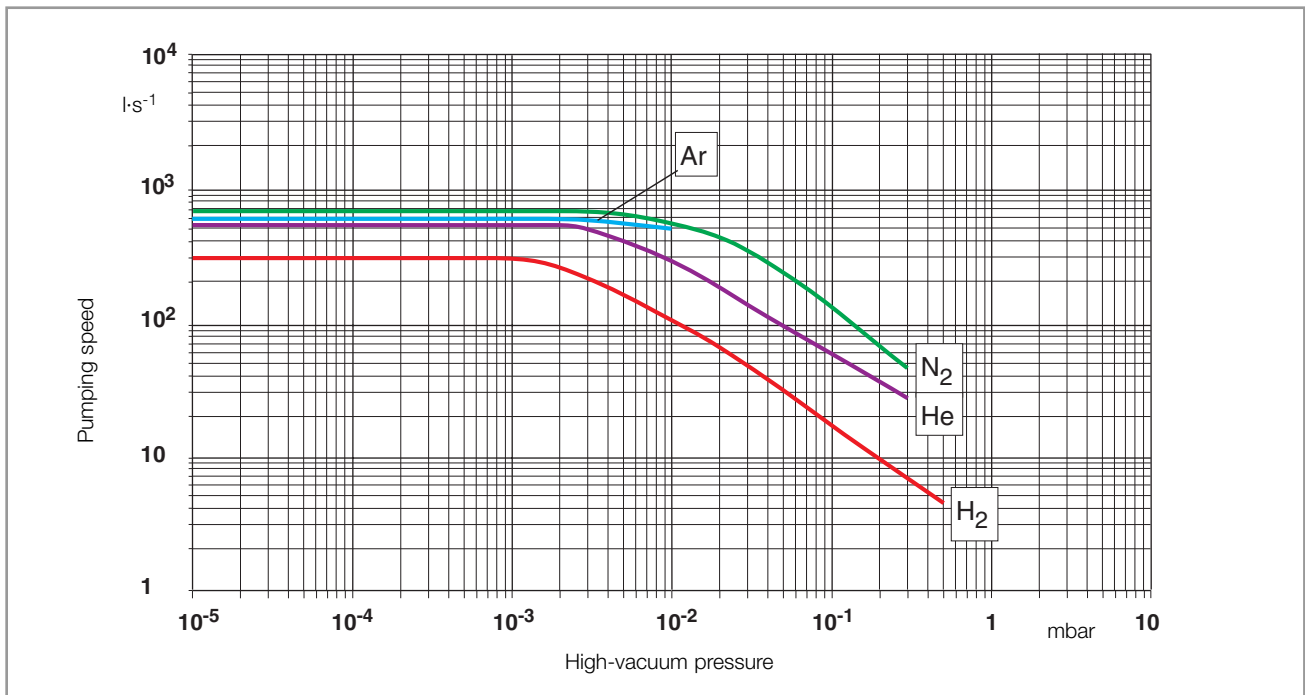


Fig. 2 Pumping speed curves for the TURBOVAC TW 701 with DN 160 ISO-K, air oder water cooled

### Technical data for pump and frequency converter

Weight of the ISO-K version, approx.	16.5 kg
Noise level	
air cooled	< 47 dB(A)
water cooled	< 44 dB(A)
Ambient temperature	
during operation	10 - 45 °C
at standstill	-15 - + 60 °C
see Fig. 11 for cooling requirements	
Relative air humidity	5 to 85 % non condensing
Overvoltage category	II
Contamination grade	2
Type of protection	IP 20

# Description

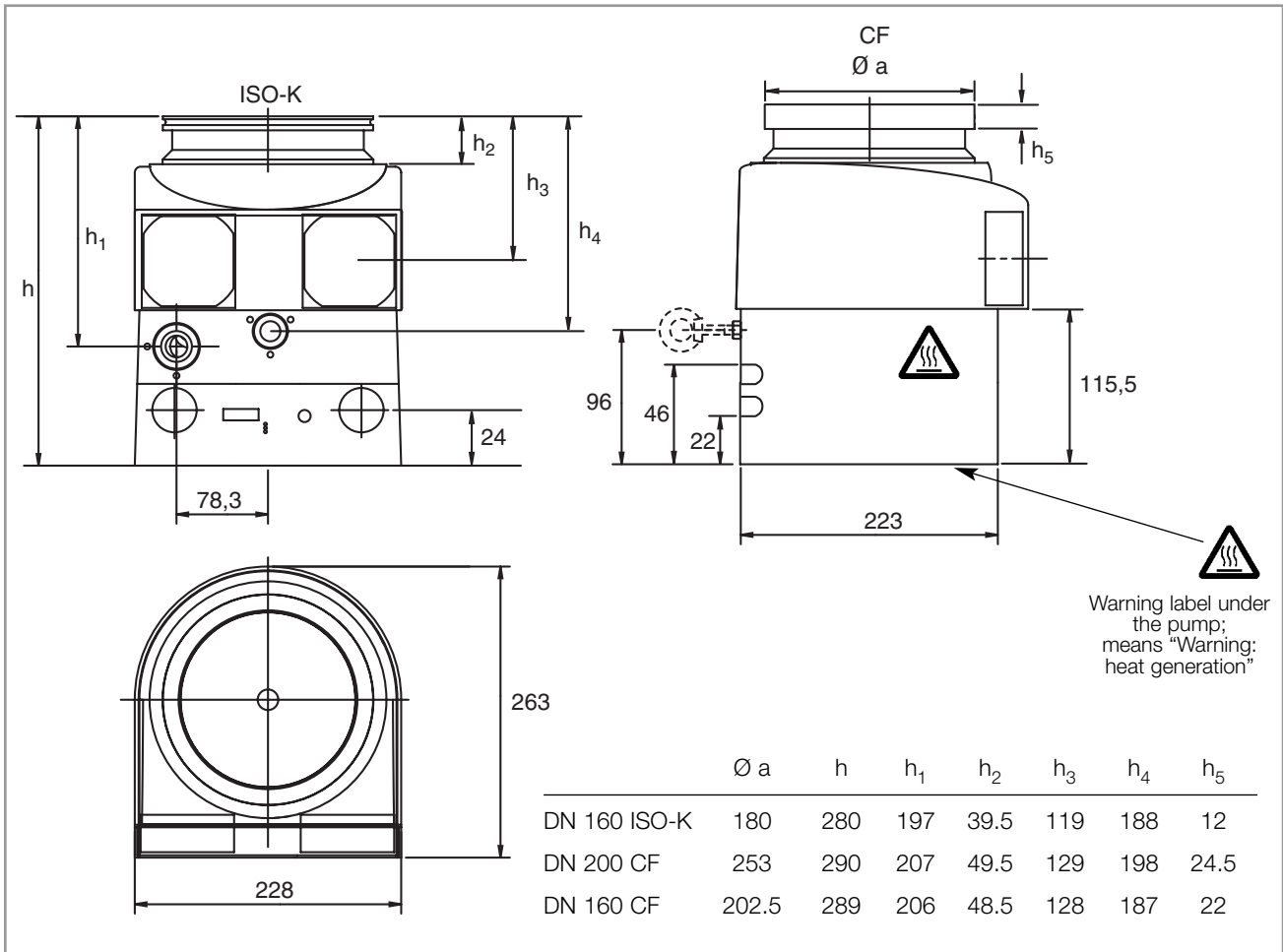


Fig. 3 Dimensional drawing, dimensions in mm

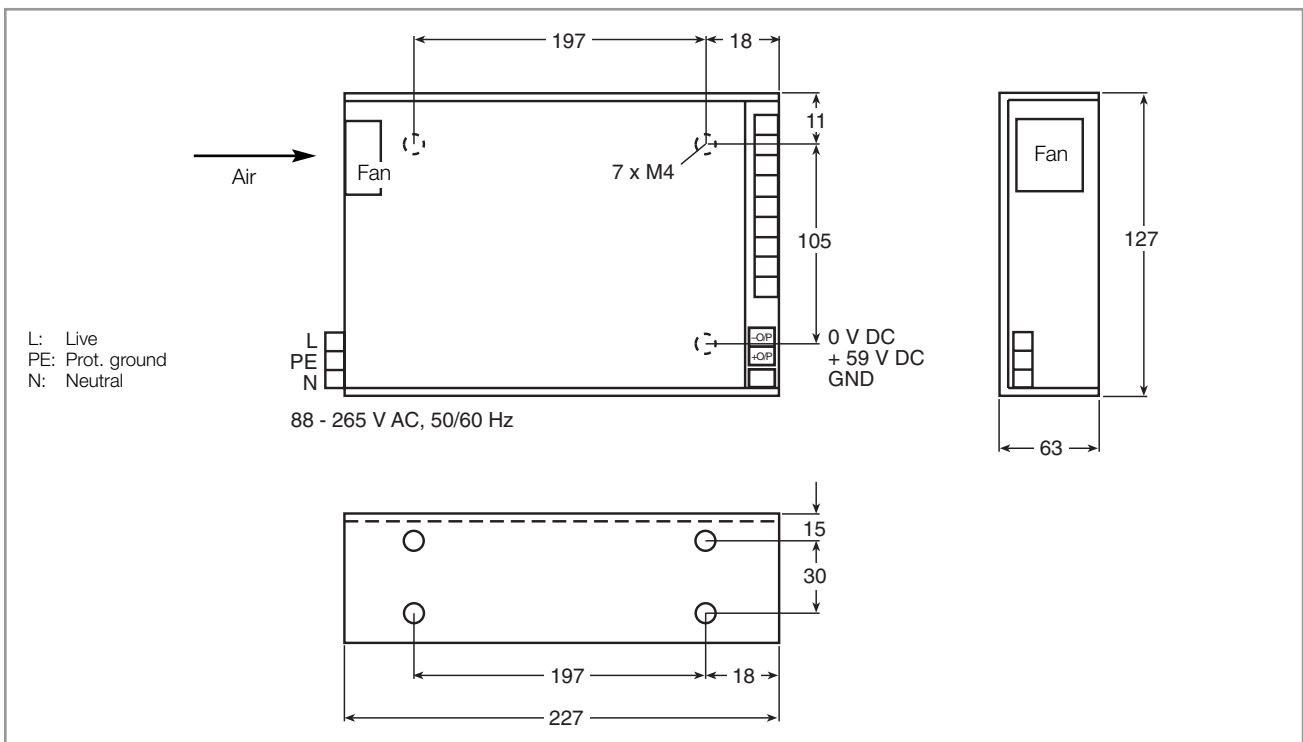


Fig. 4 Dimensional drawing of the power supply, dimensions in mm

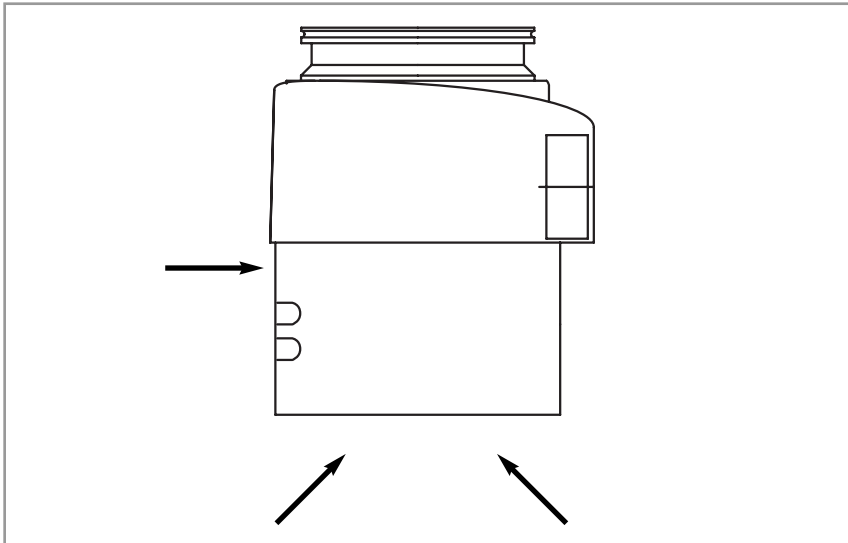


Fig. 5 Transport

## 2 Installation

The pumps are **not suitable** for pumping aggressive or corrosive media or those which contain dust.

**Caution**

Install a micropore filter when pumping media which contain dust.

Observe the information on media compatibility in Section 1 of these operating instructions.

For transporting the pumps, the bottom surfaces of the frequency converter are suited for accepting the fork of a fork lifter; see fig. 5. In addition a crane eyelet can be screwed into the pump's side (M8 thread)

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

**Caution**

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

Do not open the packaging until immediately before installation.

Do not remove the covers and blank flanges on the pump until just before attachment to the equipment to ensure that assembly is carried out under the cleanest possible conditions.

During operation the pump can become so hot that there is a danger of receiving burns ( $\geq 70\text{ }^{\circ}\text{C}$ ,  $158\text{ }^{\circ}\text{F}$ ).

Provide protection against contact with the hot components.

**Warning**



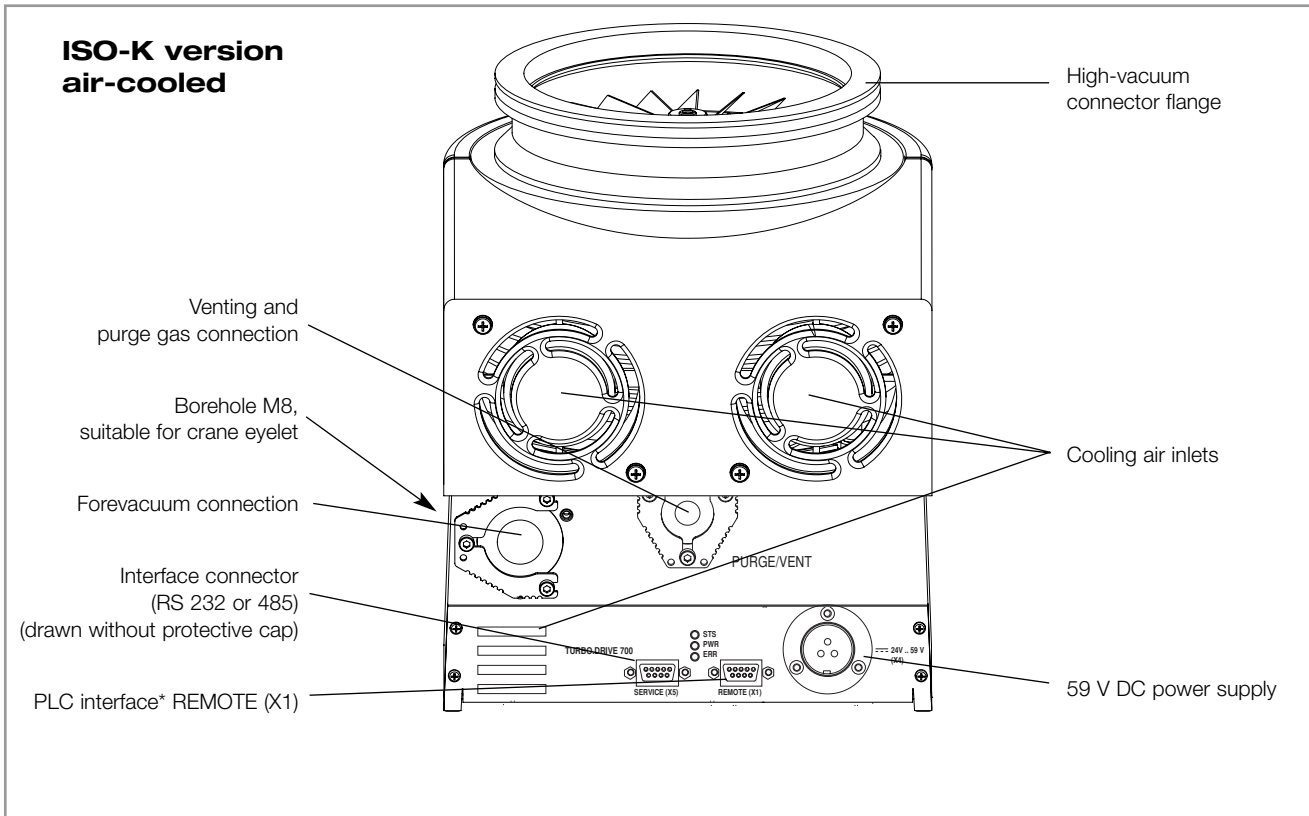


Fig. 6 Connection elements

## 2.1 Operating environment

The maximum permissible ambient temperature is 45 °C (113 °F). Do not expose the pump or the frequency converter to dripping or spraying water

### Altitudes

Places of installation up to 1000 m above sea level (3300 ft) are possible without restrictions. At altitudes over 1000 m heat dissipation by the ambient air is impaired. For higher places of installation, please ask Leybold.

The pump must only be used in rooms within buildings. It must not be operated in explosive gas atmospheres.

### Magnetic field

If the pump is used within a magnetic field, the magnetic induction at the surface of the pump housing may not exceed:

B = 5 mT if impinging radially and

B = 15 mT if impinging axially.

Install shielding equipment as appropriate if these values are exceeded.

The standard version is resistant to radiation up to 10<sup>3</sup> Gy.

1 mT (milli-Tesla) = 10 G (Gauss)

1 Gy (Gray) = 100 rad

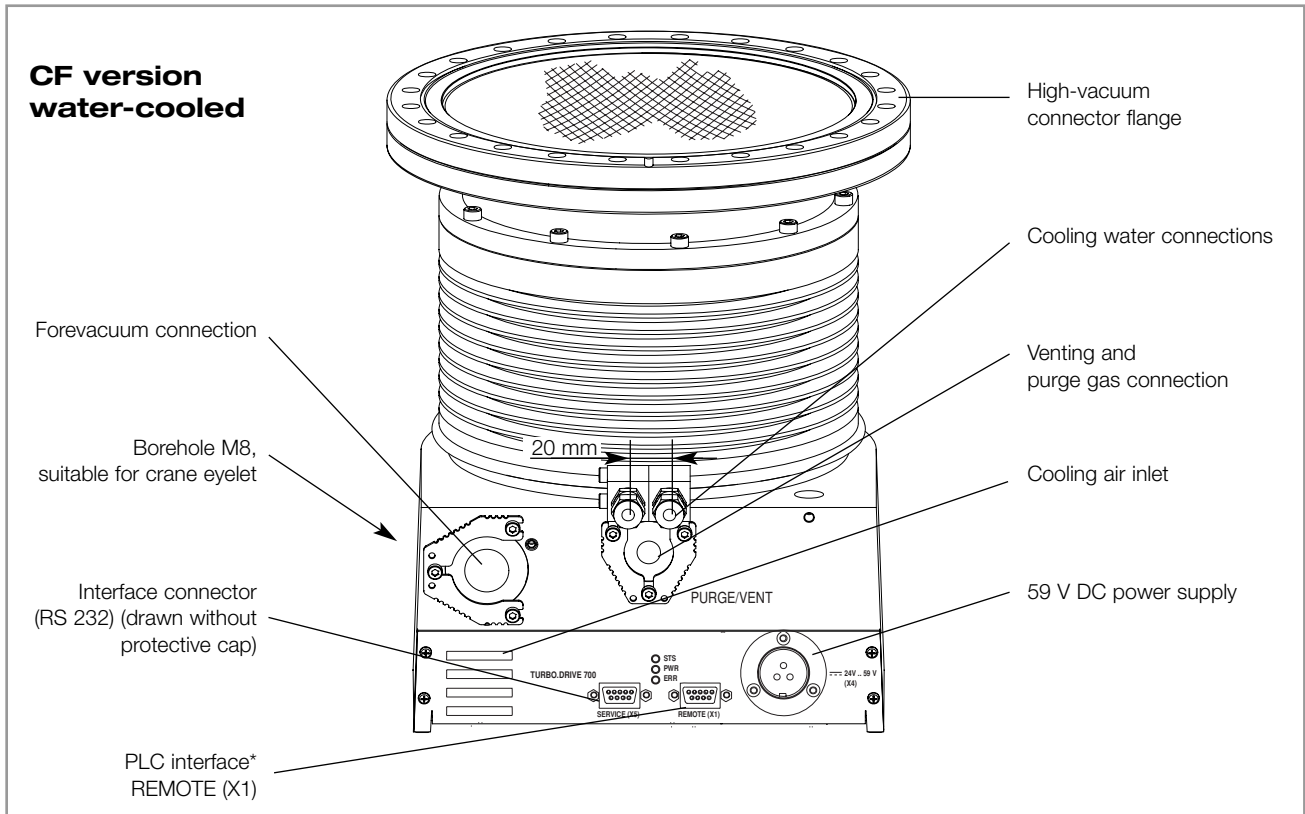


Fig. 7 Connection elements

\* PLC = Programmable Logic Control

## 2.2 Connecting the pump to the vacuum chamber

The high-vacuum flange must be firmly mounted to the vacuum chamber. If the mounting is not sturdy enough, pump blockage could cause the pump to break loose; internal pump components could be thrown in all directions.

Never operate the pump (in bench testing, for example) without proper flanging to the vacuum chamber.

If the pump should suddenly seize, an ensuing deceleration torque of up to 1680 Nm will have to be absorbed by the system. To accomplish this,

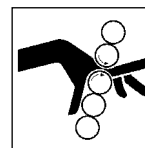
10 clamping bolts made of steel (torqued down to 35 Nm, 26 ft-lb) or

6 clamping bolts made of stainless steel (torqued down to 50 Nm, 37 ft-lb)

are required when securing an ISO-K type high-vacuum flange.

In most applications the pump is flanged to the high-vacuum flange at the apparatus. The pump can be mounted and operated in any orientation.

### Warning



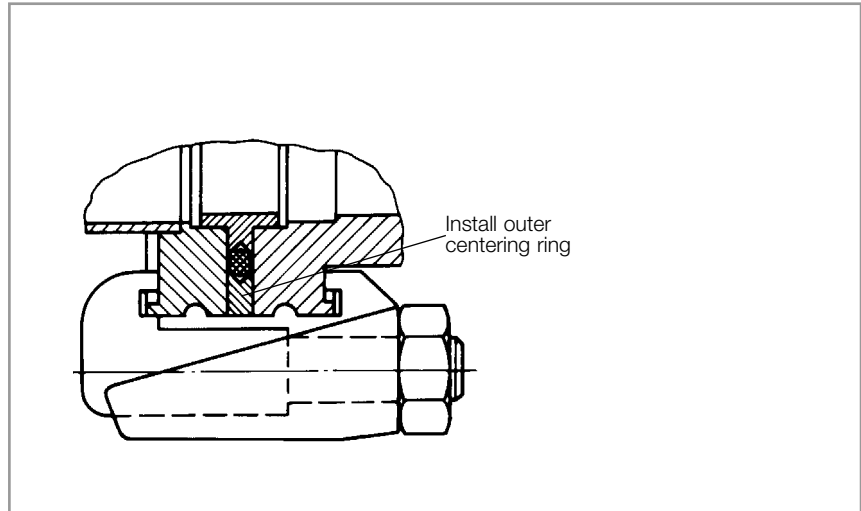


Fig. 8 Using type ISO-K flanges

**Splinter guard** If foreign objects could pass from the vacuum chamber into the pump, install a wire mesh splinter guard. Foreign objects which enter the pump through the intake can cause serious damage to the rotor. Damage resulting from foreign objects in the rotor section are excluded from our guarantee.

**Micropore filter** If dust could pass from the vacuum chamber into the pump, then a micropore filter must be installed between the vacuum chamber and the pump. The pump is precision balanced and is generally operated without a vibration absorbers.

Detach the shipping flange from the high-vacuum flange and remove the desiccant. Pay attention to scrupulous cleanliness when making the connection.

### Design with ISO-K clamp flange

Lay the O-ring on the centering ring.

The O-ring must be positioned so as to be smooth and flat; it must not be twisted. Then position the outer ring.

A collar flange with circlip and the appropriate gasket may also be used to connect the pump.

The order numbers for the flange components are given in the Leybold Catalog.



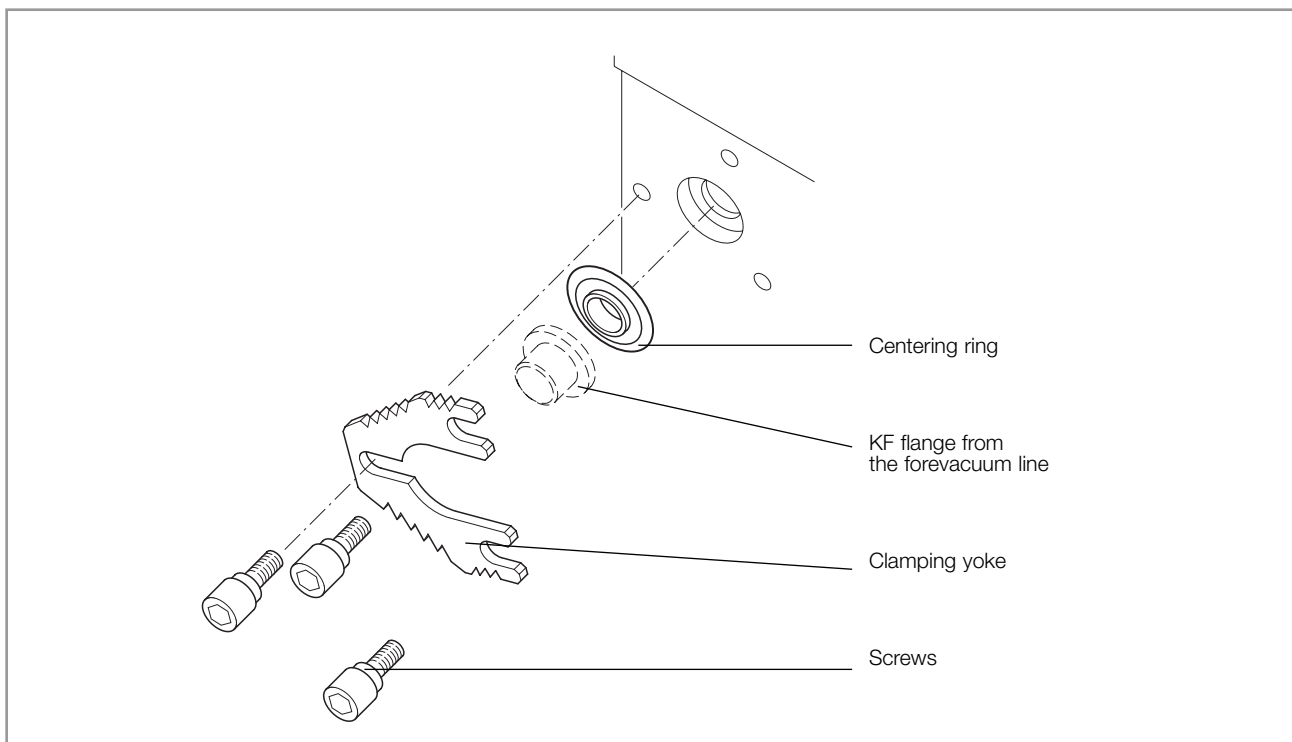


Fig. 9 Connecting the forevacuum line

## 2.3 Forevacuum connection

We recommend using a dry-running diaphragm vacuum pump or a two-stage TRIVAC rotary vane pump for this purpose.

Connect the forevacuum line.

To do so, remove the three screws and the clamping yoke. Remove the shipping flange.

Slide the KF flange from the forevacuum line onto the centering ring, slide the clamping yoke over the flange, insert and tighten the three screws.

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

Figure 10 is a schematic diagram of a pump system incorporating a turbomolecular pump and a TRIVAC forevacuum pump with an anti-suckback valve.

A separate safety valve must be provided for oil-sealed forevacuum pumps without an anti-suckback valve. The safety valve prevents oil flowing back from the forevacuum pump into the turbomolecular pump when the system is not running.

To ensure that the forevacuum space in the turbomolecular pump is kept largely free of oil vapors during operation as well, we recommend installing an adsorption trap in the forevacuum line.

Provide a roughing line to achieve the shortest cycle times.

Ensure that the pump is sufficiently isolated against vibrations generated by the forevacuum pump.

### Forevacuum pump

### Forevacuum line

### Warning



### Safety valve

### Adsorption trap

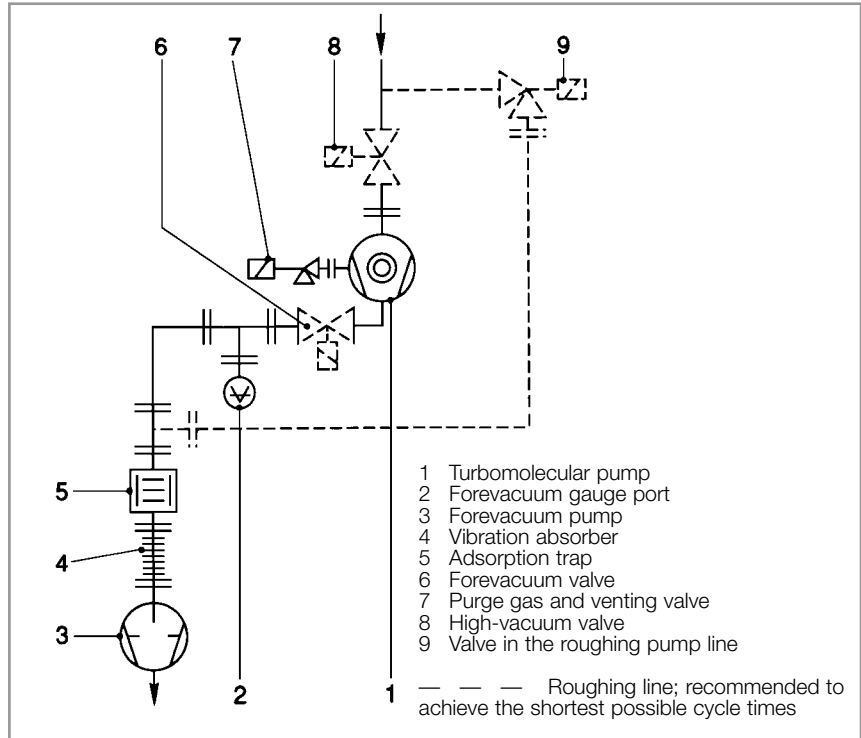


Fig. 10 Schematic of a turbomolecular pump system

## 2.4 Cooling the pump

The cooling for the TW 701 depends on the required pump performance and the ambient temperature; see Fig. 11.

When the pumps with ISO-K aluminium flange are insufficiently cooled they will shut down.

**Caution**

For the pumps with CF stainless steel flange self-protection of the pump is not ensured in case of insufficient cooling.

### Cooling water specifications

Inlet temperature	15 - 35 °C
Inlet pressure	3 to 7 bar absolute
Cooling water requirement	See Fig. 12
Appearance	Colorless, clear, free of oils and greases
Sediments	< 250 mg/l
Particle size	< 150 µm
pH value	7 to 8.5
Overall hardness (total alkaline earths)	max. 20 ° German hardness scale (= 3.57 mmol/l)

Further information on request.

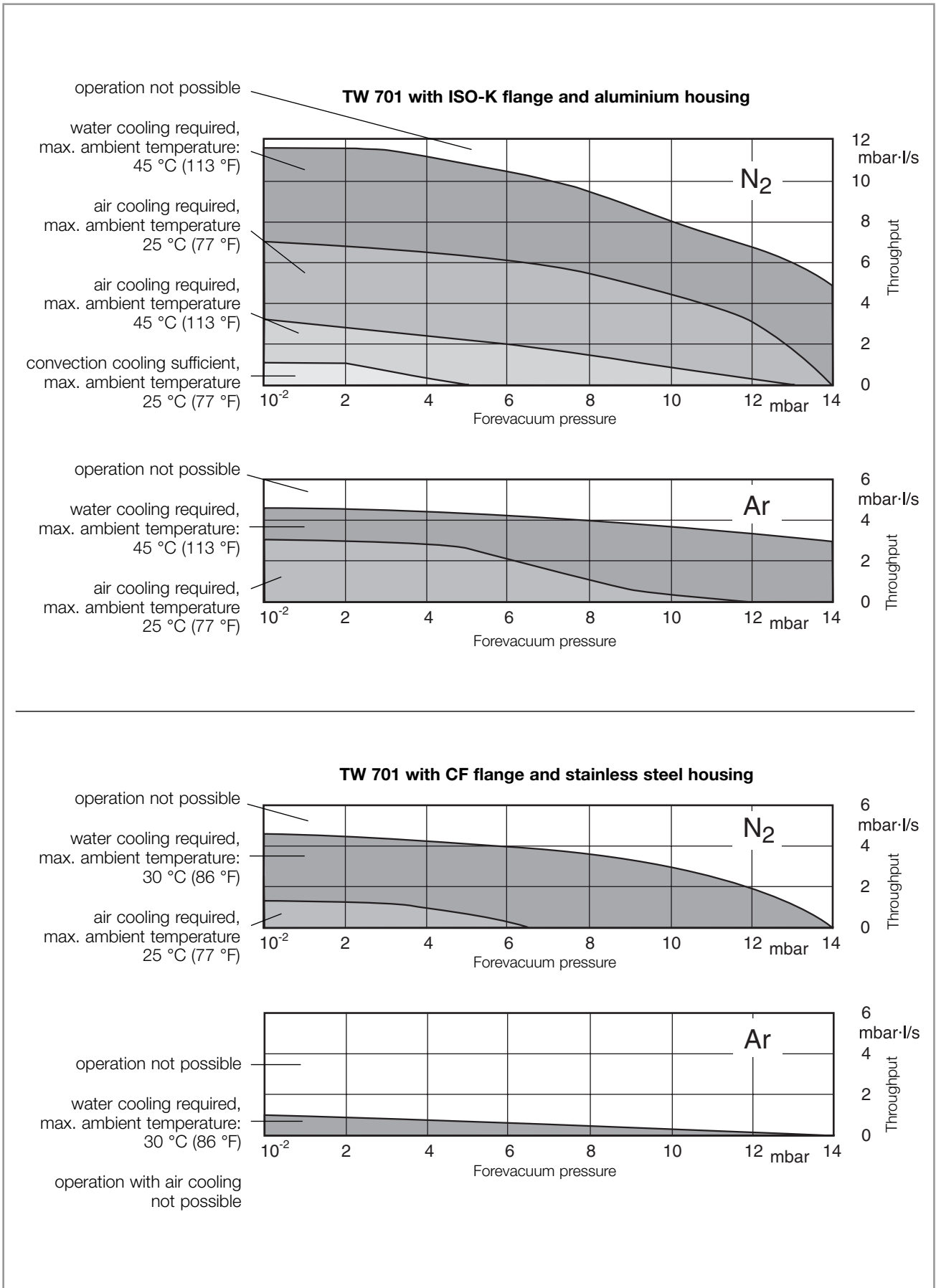


Fig. 11 Cooling requirements for the TW 701 when pumping Nitrogen/air (N<sub>2</sub>) or Argon (Ar); see also Section 3.4

## Installation

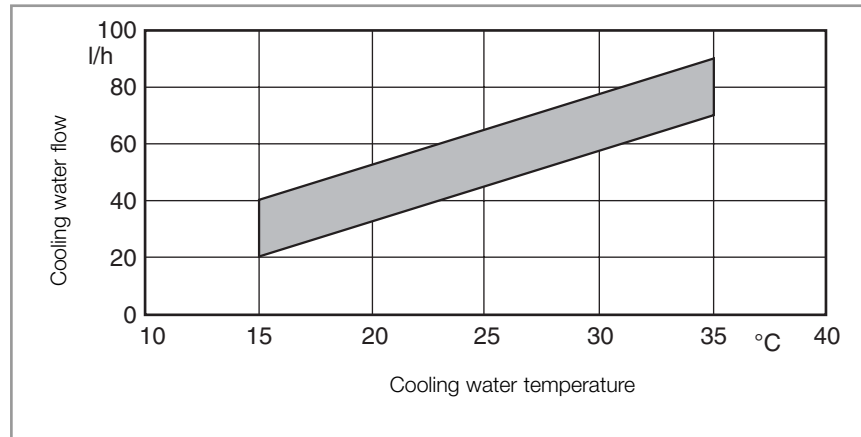


Fig. 12 Cooling water requirement

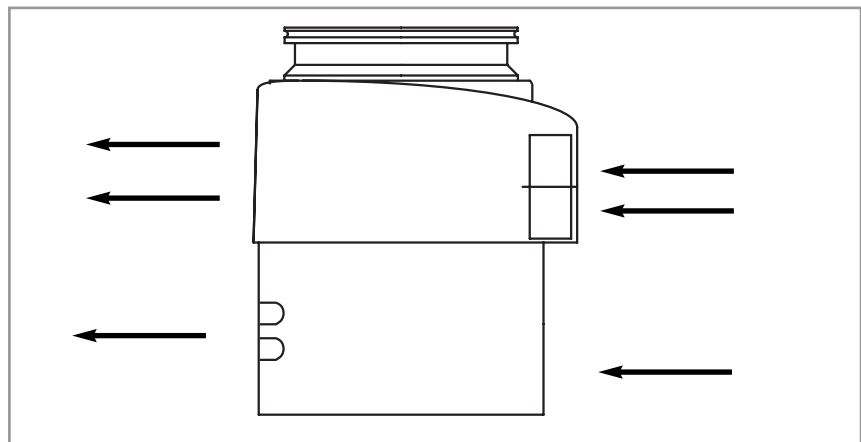


Fig. 13 Cooling air flow pattern

### Water cooling

Connect the coolant hoses and the screw connections carefully.

**Caution** Make sure to avoid dripping water or humidity.

If the coolant flow is turned on and off by means of a solenoid valve, make the electrical connection in such a way that coolant flow will be started and stopped together with the pump.

**Caution** The water-cooled pumps need cooling air for the frequency converter.

### Air cooling

The pump is equipped with internal fans which are fed by the DC supply of the frequency converter. When installing the pump into a housing, ensure that the flow of cooling air is not restricted; see Fig. 13.

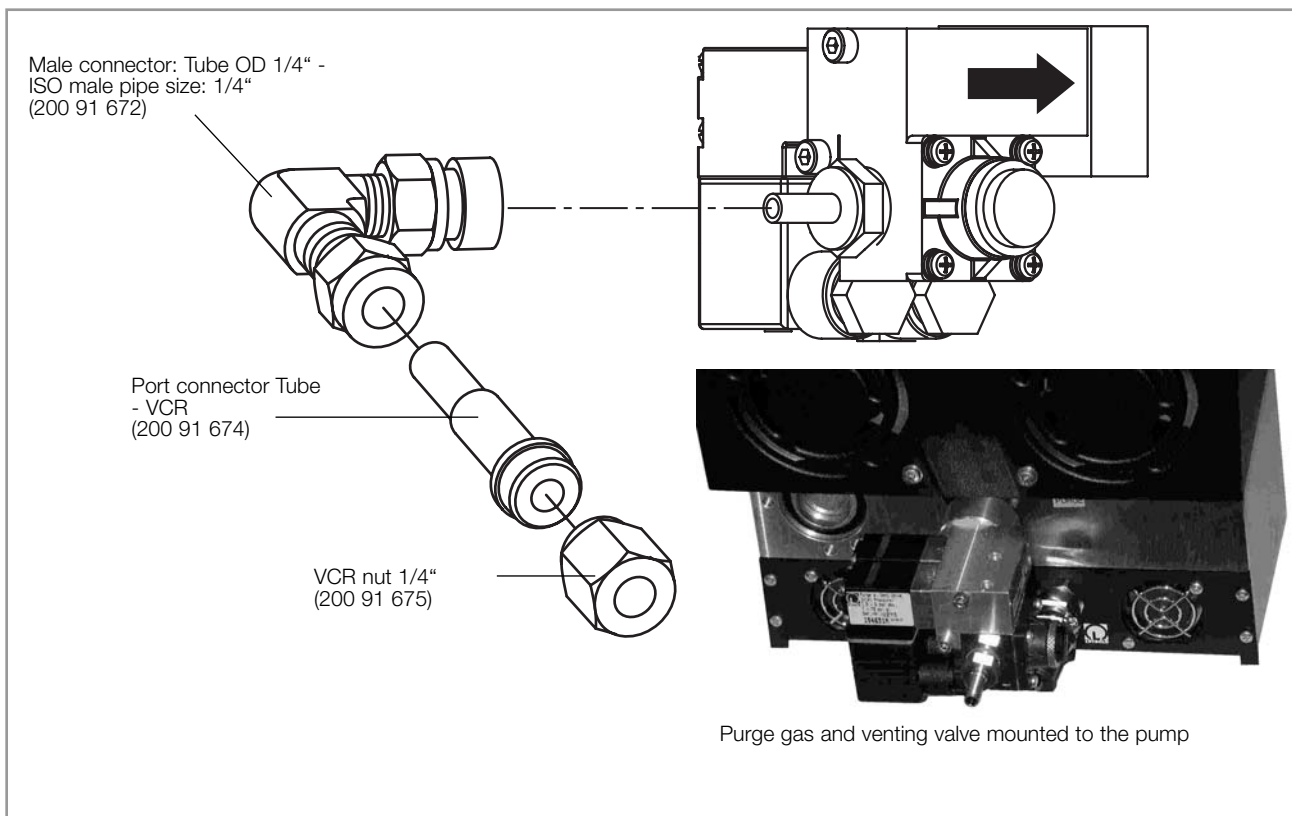


Fig. 14 Purge gas and venting valve with connection kit (optional)

## 2.5 Connecting the purge gas and venting valve

When having to decide which gases need or not need to be pumped with purge gas we are available to provide assistance.

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).

Depending on the degree of contamination of the purge gas used the filter will clog and will have to be exchanged (our experience indicates that this will become necessary after 1 to 6 months). In addition the sintered filter in the centering ring of the PURGE/VENT connection has to be cleaned or replaced.

When operating the TW 701 with purge gas, the pump needs to be vented via the purge gas valve after having shut down the pump (see Section 3.3).

### Suited gases

### Filters

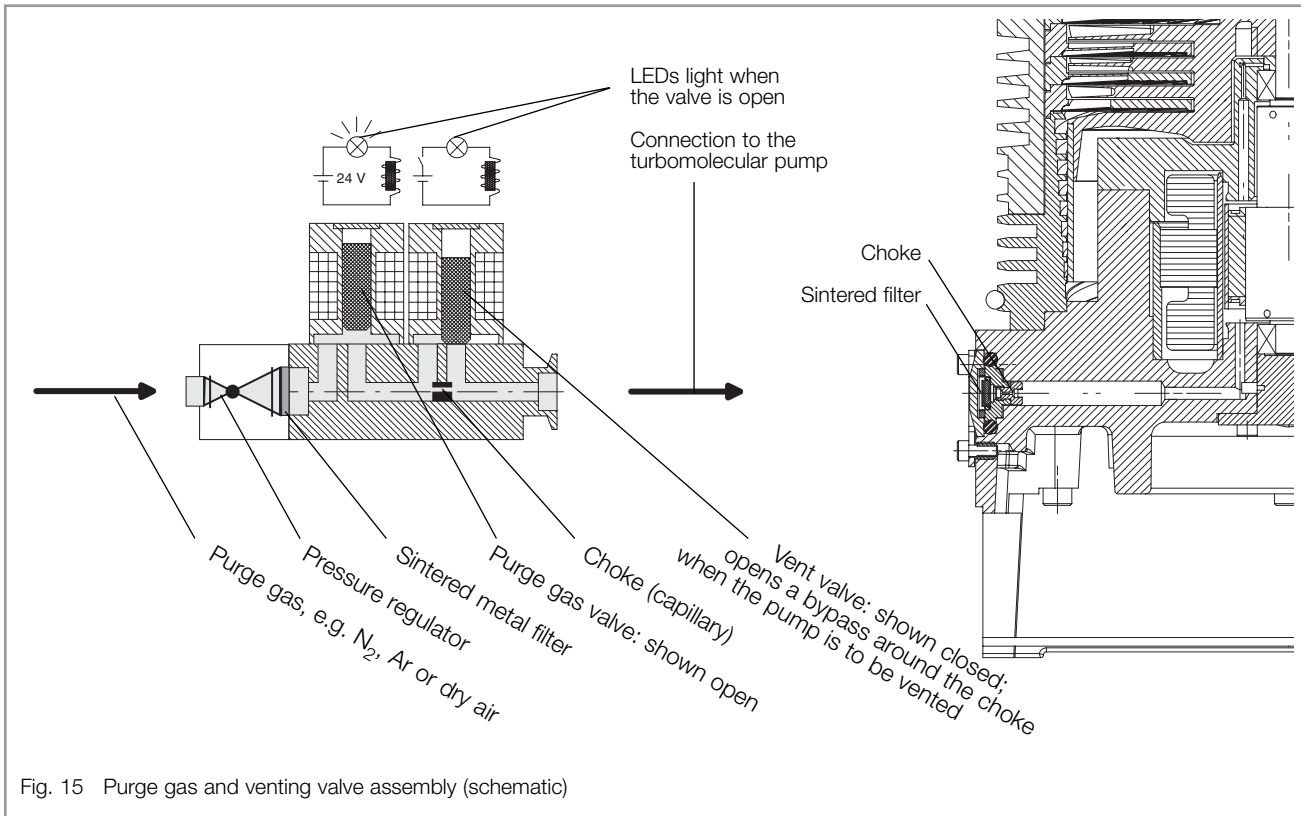


Fig. 15 Purge gas and venting valve assembly (schematic)

## Design and operation of the purge gas and venting valve, Cat. No. 121 33

This combined purge gas and venting valve offers the following advantages:

- At inlet pressures between 1.5 and 2.5 bar the purge gas flow is maintained at a constant level.
- Motor and ball bearings are protected against dust containing gases.
- Chemical reactions with the grease in the ball bearings are avoided.
- The TW 701 is vented reliably.

Depicted schematically in Fig. 15 is the design of this valve.

In the operating mode “pumping with purge gas” the purge gas enters via the pressure regulator into the valve, flows through the opened purge gas valve and enters into the pump via the choke. The venting valve is closed.

In the operating mode “venting” both the purge gas and the venting valves are open. Thus the pump is mostly vented via the choke’s bypass.

Purge gas and venting valve may be opened and closed independently of each other. Both valves are of the normally closed type. In order to open a valve 24 V DC needs to be applied.

## Technical data for the purge gas and vent valve

Purge gas valve	normally closed
Venting valve	normally closed
Purge gas pressure, absolute	1.5 to 2.5 bar
Purge gas	Nitrogen, argon or the like
Max. moisture content	10 ppm
Purge gas flow	36 sccm ± 5 sccm (36 sccm = 0.6 mbar·l/s)
Leak rate	< 10 <sup>-7</sup> mbar·l/s
Power supply	24 V DC
Max. power drawn	8 W
24 V connector plug	Angle connector DIN 43650-A; 2-pole; Transparent housing with LED
Safety class	IP 65
Max. purge gas temperature	80 °C
Weight	0.5 kg
Installation orientation	any
Connection	
Inlet	1/4" nipple
Outlet	DN 16 KF small flange

Depending on the process a venting valve can be connected to the PURGE/VENT connection. A choke integrated into the flange will ensure that the pump is vented without damage.

**Do not** replace the centering ring with choke and sintered filter with a centering ring without these parts.

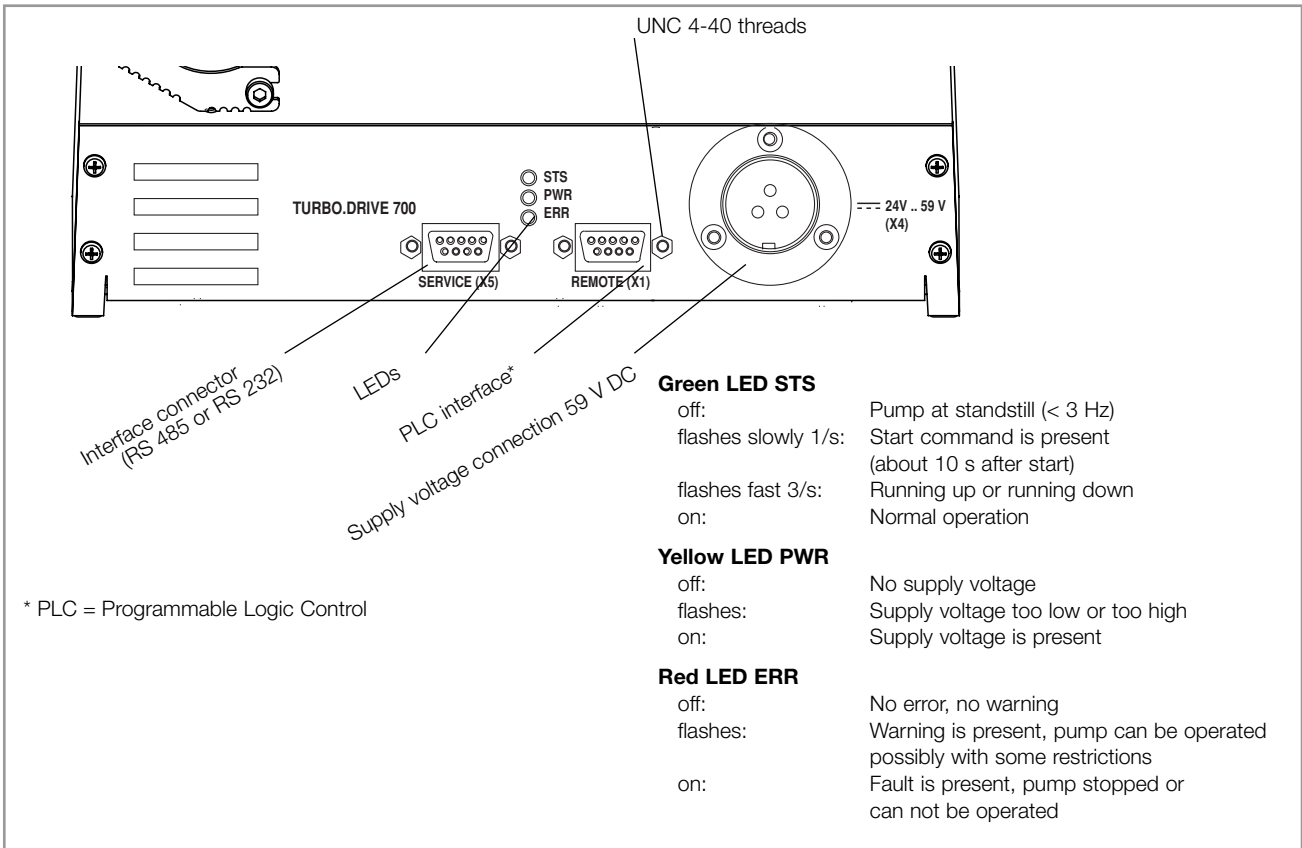


Fig. 16 View of the integrated frequency converter TURBO.DRIVE 700

## 2.6 Electrical connection

**Warning**



The pump must only be connected to power supplies which meet the requirements for functional extra-low voltages with positive isolation in accordance with IEC 364 (or local regulations) (SELV).

The OEM power supply unit must only be connected by qualified electrical personnel.

The power supply must meet the requirements given in Section 1.4. Peak currents in the kHz range may be present on the DC side. The power supply should have a current limiter or control.

**59 V DC cable**

Connect the pump to the 59 V DC power supply or to the TURBO.CONTROL 700.

**Caution**

Ensure correct polarity; see Fig. 17 to 19.

- Pin 1 + 59 VDC
- Pin 2 0 V
- Pin 3 GND

A wrong polarity may cause the internal SMD fuse to blow. The fuse can only be changed by the Leybold Service.



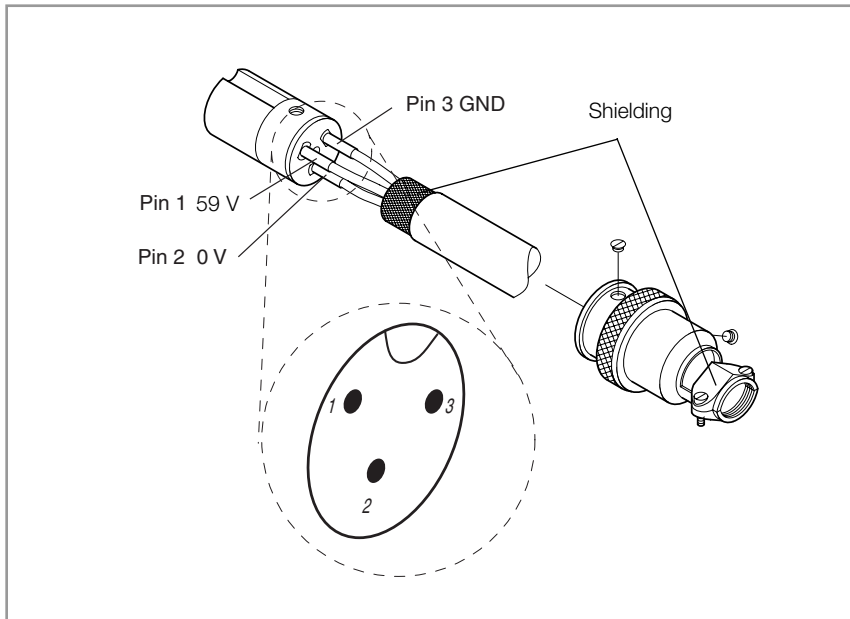


Fig. 17 Required pin assignment of the 3 pole connector model Hirose HS21P-3; view from the soldered side

Connect the power supply or the TURBO.CONTROL 700 to the mains.

The interface connectors have UNC 4-40 threads. Do not use connectors with M3 threads.

### Caution

The pump may be operated only with suitable connector cables. Route all cables so as to protect them from damage.

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

**Disconnect and connect the cable connections only while the pump is turning no longer (green status LED off) and with the mains power switched off (yellow power LED off). Otherwise there is the risk of damaging the frequency converter.**

If you want to operate the pump without interface control we recommend the plug for the PLC connector with integrated ON/OFF switch for the pump; order no. see Section 1.3.

# Installation

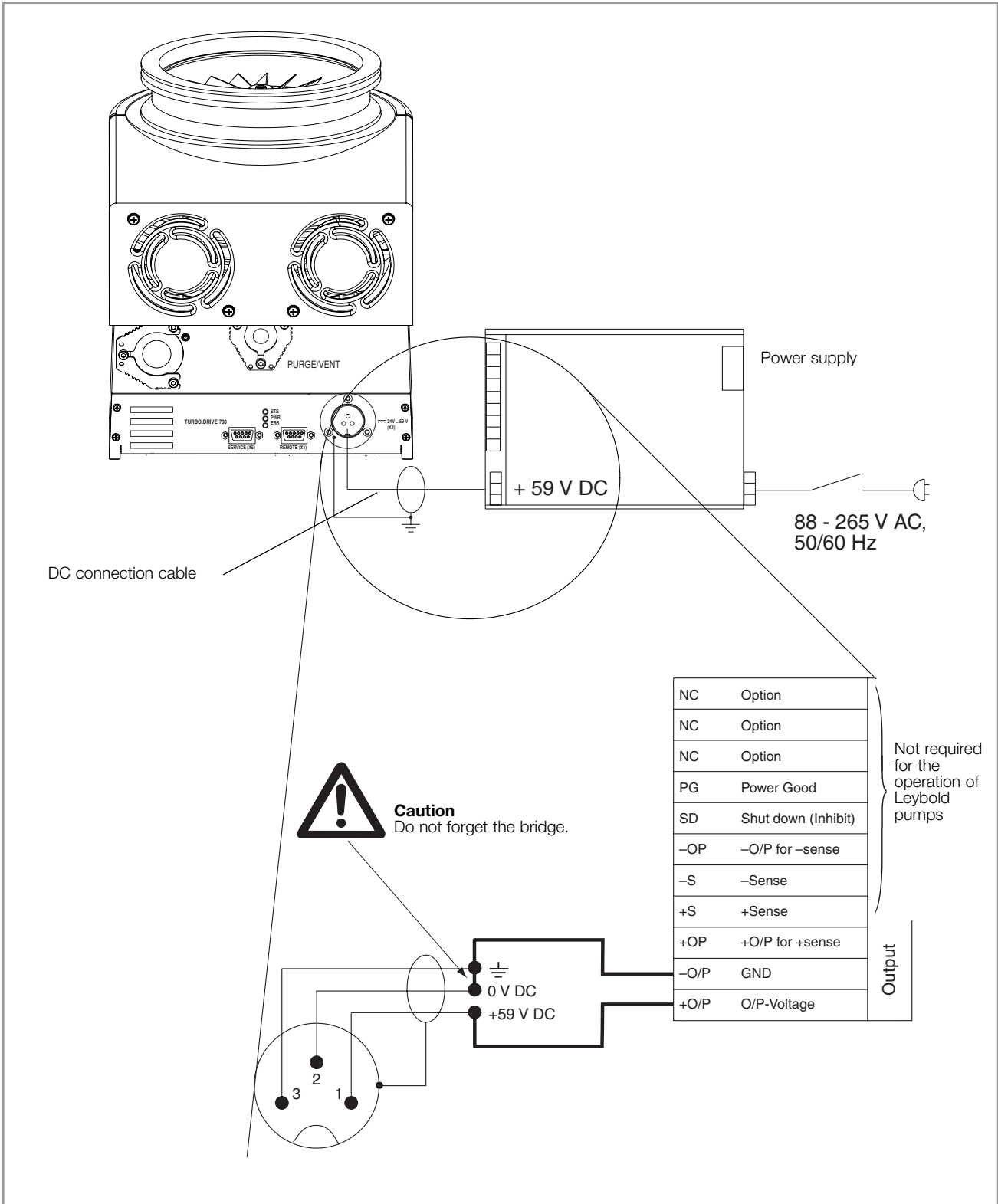


Fig. 18 Connection of the power supply

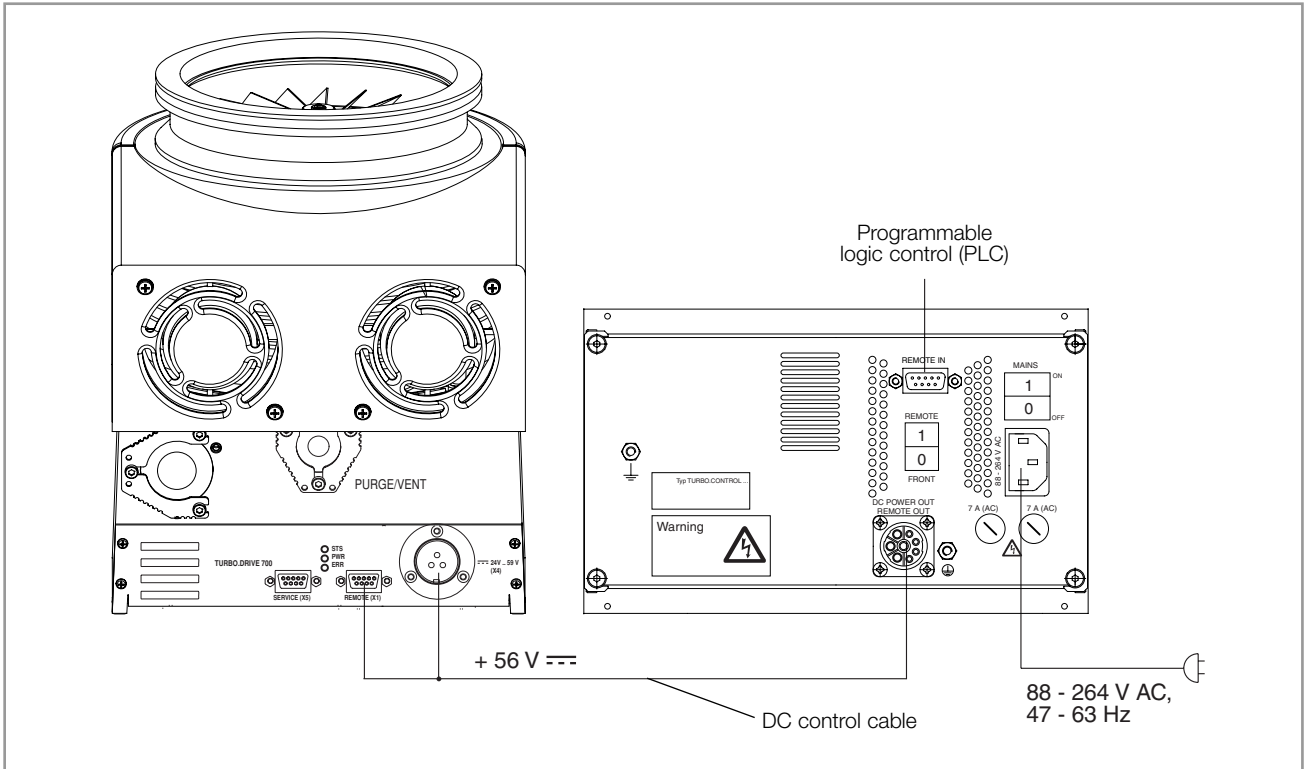


Fig. 19 Connection schematic for TURBO.CONTROL 700

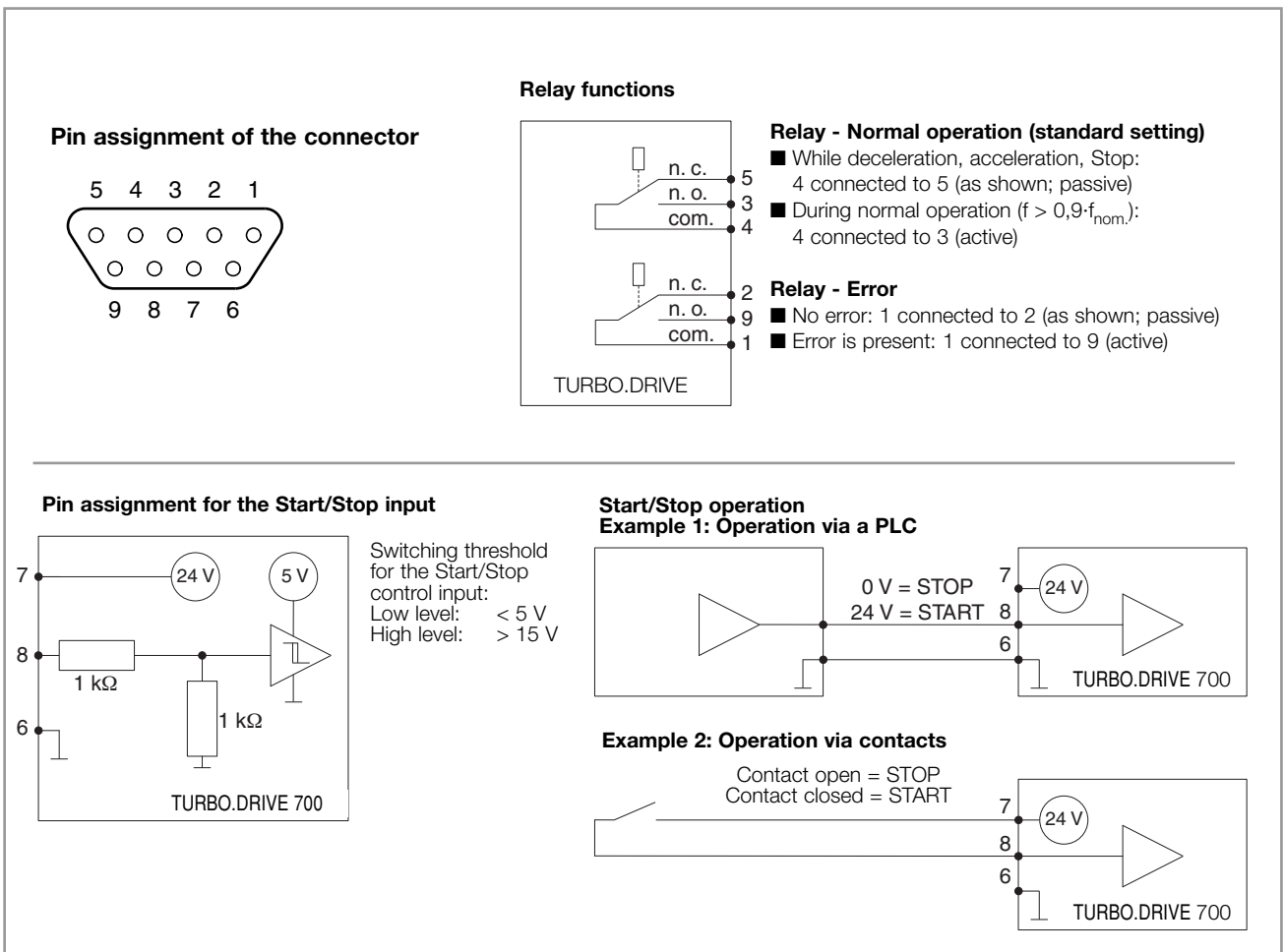


Fig. 20 Pin assignment of the REMOTE (X1) connector

## Installation

### Relay status

Input data / status				Output data					Operating mode
Start/ stop signal	Pump rotating	Normal frequency ≥ 90% of setpoint frequency	Error is present	Motor drive	Relay NORMAL OPERATION	Relay ERROR	LED STATUS	LED ERROR	Other modes are not possible; they indicate a failure affecting the TURBO.DRIVE.
Stop	no	no	no	off	passive	passive	off	off	Pump not operating
Stop	yes	no	no	off	passive	passive	flashes	off	Pump is decelerating
Stop	yes	yes	no	off	passive	passive	flashes	off	Just after stop; pump was in the normal operating mode before that
Start	no	no	no	on	passive	passive	off	off	Just after start
Start	yes	no	no	on	passive	passive	flashes	off	Pump is accelerating
Start	yes	yes	no	on	active	passive	green	off	Pump is in the normal operating mode
Stop	no	no	yes	off	passive	active	off	red	Error is present; pump is at standstill
Stop	yes	no	yes	off	passive	active	flashes	red	Error is present; pump is decelerating
Stop	yes	yes	yes	off	passive	active	flashes	red	Error has just occurred
Start	no	no	yes	off	passive	active	off	red	Error is present; pump is at standstill
Start	yes	no	yes	off	passive	active	flashes	red	Error is present; pump is decelerating
Start	yes	yes	yes	off	passive	active	flashes	red	Error has just occurred

## 2.7 Interface description

The frequency converter may be equipped with either of the following interfaces:

- RS 232 (standard)
- RS 485 (optional)
- Profibus DP (optional)

The TURBO.DRIVE is configured through the parameters according to the parameter list. Pxxx denotes parameter value xxx.

The PC software "TURBO.DRIVE Server" or a PDA display with the software "TURBO.DRIVE Panel" allow convenient access by the user to the parameters of the frequency converter.

For further information on the interfaces refer to Operating Instructions GA 05.281 "Serial Interfaces".

### Applications which can be implemented with the aid of the serial interface:

Application	Benefits to the customer	How to do it
Networking of several pumps and other equipment	Savings relating to the costs for signalling cables	With Field Bus systems like RS485 or Profibus
Automation	Savings related to repetitive manual work	For example by a control computer
Avoidance or warnings before overload operation or process changes	<ul style="list-style-type: none"> <li>■ Maintenance can be scheduled</li> <li>■ Improved reliability of sensitive production processes in a vacuum</li> </ul>	Monitoring of: <ul style="list-style-type: none"> <li>■ Motor current P5</li> <li>■ Ball bearing temperature P125 or P127</li> <li>■ Motor temperature P7</li> <li>■ Frequency converter temperature P11</li> </ul>
Troubleshooting	Quick analysis of problems	Reading of error memories P171(P174) and P176
Reducing the maximum motor current	Cost savings through smaller power supply units if peak loads can be reduced	With P17, maximum motor current or P139, motor current reduction factor
Starting the pump with a delay if a several consumers are connected to the same PSU	Cost savings through smaller power supply units if peak loads can be reduced	With P36, delay
Frequency converter as a simple pressure gauge, since motor current is dependent on the vacuum conditions	Dispensing with pressure gauges	Monitor motor current P5; second function for "Normal Operation" relay: relay switches as soon as the motor current threshold is tripped. Adjust second function: P29 Set motor current threshold: P27
Lowering the normal operation threshold	Normal operating mode is attained faster, processes can be started faster	Reduce frequency threshold through P25

# Installation

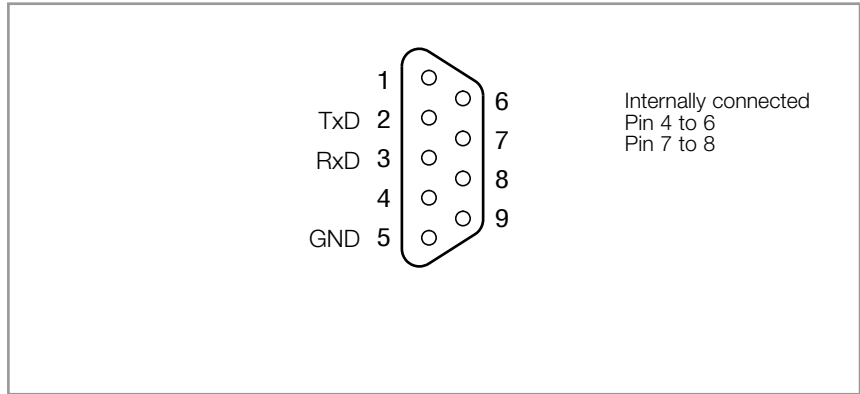


Fig. 21 Pin assignment for the socket at the frequency converter (female - RS 232)

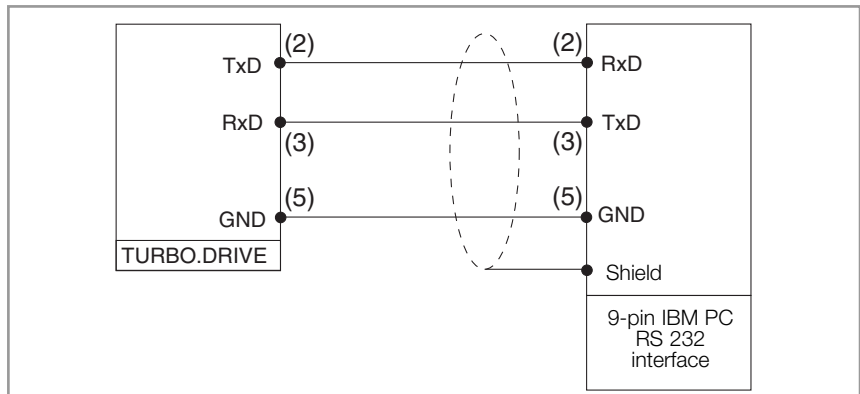


Fig. 22 Providing a RS 232 connection

## RS 232 interface

Standards	DIN 66020
Protocol	acc. to VDI/VDE 3689
Transmission rate	19200 baud fixed
Response delay	default setting 10 ms (parameter 180)
Address range	non-addressable
Max. cable length	5 m
Nominal voltage level (see also "Standards")	at the receiver logic "0": 3 ... 15 V logic "1": - 3 ... - 15 V
Interface connector	9 way Sub-D type, socket on the instrument (female) thread UNC4-40

Note: If on the controlling side an interface in accordance with the PC standard is present, then a commercially available straight through cable may be used.

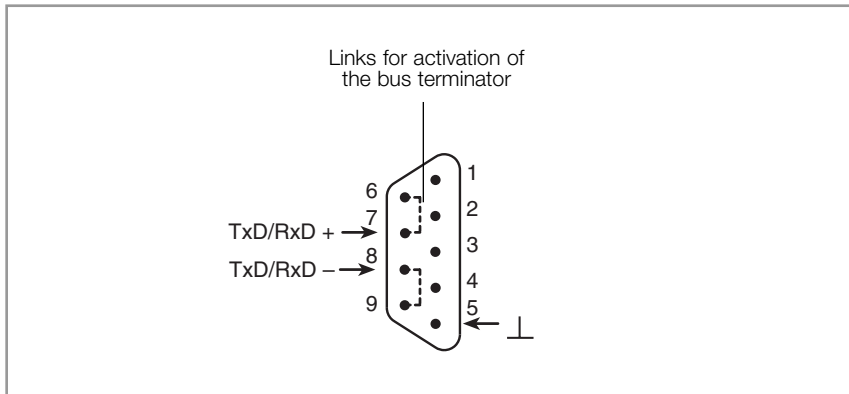


Fig. 23 Pin assignment for the socket at the frequency converter for RS 485 interface (male)

## RS 485 interface

Standards	ISO/IEC 8482, EIA 485
Protocol	acc. to VDI/VDE 3689
Transmission rate	19200 baud fixed
Response delay	default setting 10 ms (parameter 180)
Address range	0 ... 15
Max. cable length	50 m (with bus termination)
Type of cable	2 wire twisted pair (twisted pair cable)
Differential voltage levels (see also "Standards")	logic "0": transmitter: 1.5 ... 5 V receiver: > 0.3 V  logic "1": transmitter: - 1,5 ... - 5 V receiver: ≤ - 0,3 V
Interface connector	9 way Sub-D type, socket on the instrument (female) thread UNC4-40

Note: After having changed the bus address through the rotary switch, the frequency converter must be switched off (yellow power LED off) and then on again so as to enable the new address setting.

## Installation

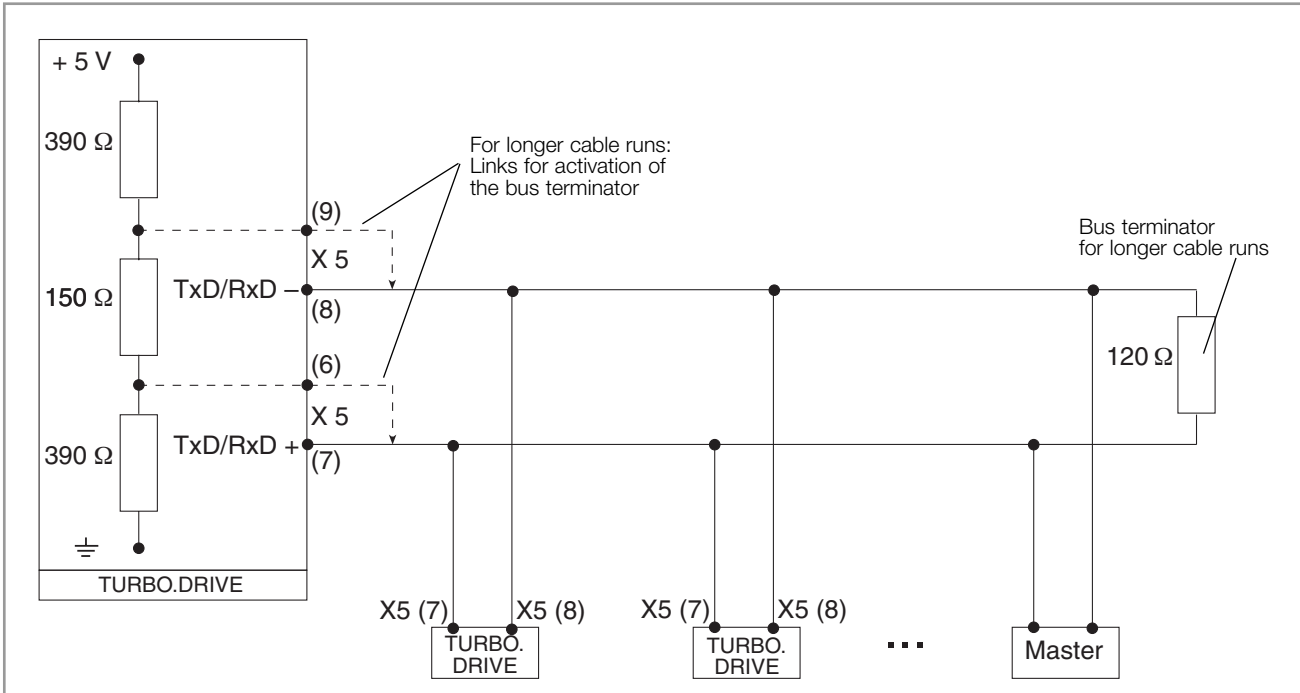


Fig. 24 Connection of the RS 485 bus

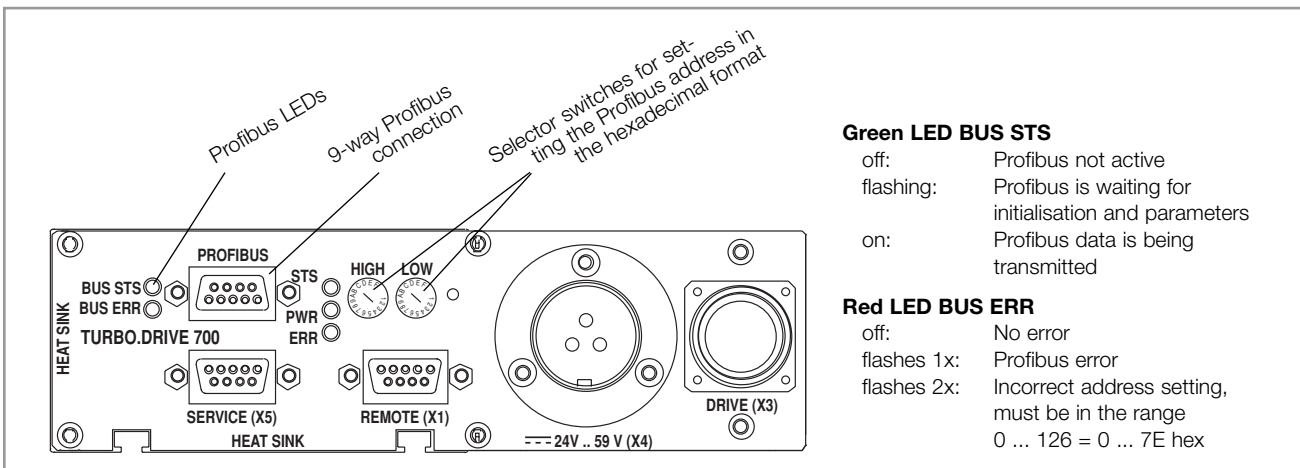


Fig. 25 TURBO.DRIVE 700 with additional Profibus interface

### Profibus DP

The Profibus DP used has been defined in the standards EN 50170, VDI/VDE 3689.

For more information on the Profibus system:

"The Rapid Way to Profibus",  
 Manfred Popp, Profibus Nutzerorganisation e.V., Germany  
 P/N 4.072

Upon request we shall be pleased to provide detailed information on the hardware and the protocol used for the data.



## Parameter list

No.	Designation	Range	Unit	Default	Format	r/w	Description
0	Dummy parameter	-	-	-	U16		No function
1	Type of frequency converter	132 / 134	-	-	U16	r	TURBO.DRIVE 700 = 134
2	Software version	xx.yy.zz	-	1.11.06	U16	r	xx.yy: version, zz: correction index
3	Actual rotor frequency	0...1300	Hz	-	U16	r	The max. frequency depends on the pump type.
4	Actual converter supply voltage	24...59	V	-	U16	r	Nominal value for TURBO.DRIVE 700: 59V
5	Setpoint for the motor current	0... 80	0.1A	-	U16	r	
7	Actual motor-temperature	0...150	°C	-	U16	r	Measured coil temperature for the motor
8	Permanently save the changed parameter data in the EEPROM	-	-	-	U16	w	A write command will cause the data to be saved. The parameter value itself is not processed and saved. After a reset or switching on the supply voltage with a different pump connected or without a pump, all parameters will be reset to their defaults.
11	Actual converter temperature	0...150	°C	-	U16	r	Measured internal converter temperature
12	Operating mode for	0...2	-	0	U16	r/w	P12 = 0 (default): via REMOTE (X1); P12 = 1: via serial interface P12 = 2: Start: REMOTE (X1) at Start <b>and</b> serial interface sends Start signal Stop: REMOTE (X1) at Stop <b>or</b> serial interface sends Stop signal.
16	Motor temperature warning threshold	30...150	°C	80 (70)	U16	r	Exceeding the motor temperature warning threshold results in a warning (value in brackets for water-cooled pump)
17	Max. value setting for motor current	5 ... 75	0,1 A	75	U16	r/w	Maximum permissible motor current
18	Nominal pump frequency	750...1200	Hz	800	U16	r	Highest permissible frequency
19	Minimum setpoint frequency for the pump	P20 ... P18	Hz	600	U16	r/w	Lowest permissible frequency
20	Minimum frequency level	0 ... P19	Hz	575	U16	r	When the pump is accelerating this frequency must be reached within the maximum passing time (P183). After the end of acceleration: Switch-off threshold because of overload; see error 106
23	Pump type	00...55	-	41	U16	r	41 = TW 701, 59V
24	Setpoint frequency	P19 ... P18	Hz	800	U16	r	Nominal pump frequency
25	Frequency dependent normal operation level	0..100	%	90	U16	r/w	If P29 = 0: Defines the normal operation level. Normal operation if $P3 \geq P24 \times P25$
27	Motor current dependent normal operation level	5...75	0,1 A	20	U16	r/w	If P29 = 1: Defines the normal operation level. Normal operation if $P5 \leq P27$

## Installation

No.	Designation	Range	Unit	Default	Format	r/w	Description
29	Selection of the relay functions	0 ... 4	-	0	U16	r/w	The normal operation and error relays can be set to special functions if required.
	P29 = 0 means:	the <b>normal operation relay</b> is active when the normal operation frequency is exceeded ( $P3 \geq P24 * P25$ ) the <b>error relay</b> is active in case of an error					
	P29 = 1 means:	the <b>normal operation relay</b> is active when the current falls below the normal operation threshold ( $P5 \leq P27$ ) the <b>error relay</b> is active in case of an error					
	P29 = 2 means:	the <b>normal operation relay</b> controls e.g. a venting valve, activated via the field bus interface (Bit 12 in the control word of the data transfer protocol) the <b>error relay</b> controls e.g. a purge gas valve, activated via the field bus interface (Bit 11 in the control word of the data transfer protocol) (makes only sense at interface operation)					
	P29 = 3 means:	the <b>normal operation relay</b> is active when the normal operation frequency is exceeded ( $P3 \geq P24 * P25$ ) the <b>error relay</b> is active when <b>no</b> error exists					
	P29 = 4 means:	the <b>normal operation relay</b> is active when the current drops below the normal operation threshold ( $P5 \leq P27$ ) the <b>error relay</b> is active when <b>no</b> error exists					
32	Maximum run up time	30...2000	s	720	U16	r/w	Max. permissible time during which the pump must attain the normal operation threshold ( $P24 * P25$ ) with the start signal present
36	Start delay time	0...255	0.1 min.	0	U16	r/w	Pause time after the Start command until the pump's drive is started
37	RS485 address	0 ... 31	-	0	U16	r/w	Parameterizable RS485 address; a change of this parameter setting will only be effective <ul style="list-style-type: none"> <li>■ after the power supply has been switched off and on and</li> <li>■ if the addresses 1, 2 and 3 are <b>not connection coded</b> via SERVICE (X5)</li> </ul>
38	Start counter	0 ... 65535	-	-	U16	r	Counts the total number of pump starts
40	Error counter	0 ... 65535	-	-	U16	r	Counts the total number of errors
90	Error mode	1/2	-	2	U16	r/w	Selection of the error code table which is saved in P171 2 = standard setting 1 = compatible to T1600
125	Current bearing temp.	0...150	°C	-	U16	r	Measured bearing temperature (identical to P127)
126	Bearing temperature warning threshold	30...150	°C	60	U16	r	Exceeding the bearing temperature warning threshold results in a warning
127	Current bearing temp.	0...150	°C	-	U16	r	Measured bearing temperature (identical to P125)
128	Bearing temperature warning threshold	30...150	°C	60	U16	r	Exceeding the bearing temperature warning threshold results in a warning
131	Bearing temperature shutdown level	30...150	°C	70 (53)	U16	r	Max. permissible bearing temperature; $P125 > P131$ causes the pump to be switched off (value in brackets for water-cooled pump)
132	Bearing temperature shutdown level	30...150	°C	70 (53)	U16	r	Max. permissible bearing temperature; $P125 > P132$ causes the pump to be switched off (value in brackets for water-cooled pump)

No.	Designation	Range	Unit	Default	Format	r/w	Description
133	Motor temperature shutdown level	30...150	°C	85 (70)	U16	r	Max. permissible motor temperature; P7 > P133 causes the pump to be switched off (value in brackets for water-cooled pump)
139	Current reduction factor	30...100	%	100	U16	r/w	Is used for the reduction of the maximum current drawn by the frequency converter, e.g. for adaption of low performance power supplies (Note: values < 100 reduce the pump performance and increase the run-up time) A change in the current reduction factor will only become effective after writing any value to parameter 8 and when switching after this the supply voltage off and on.
171	Error code memory for the last 40 error events	0...39	-	0	Array 0..39 U16	r	Sequential permanent memory; the individual error codes are accessed via parameter 171 with additional index no. in the parameter order identifier of the interface protocol. The last error code which has occurred is saved at the memory location with the index 0, the oldest is at index 39. See Section 4.6 for the error codes.
174	Rotor frequency at the time of error	0...1300	Hz	-	U16	r	Sequential permanent memory of the last 40 rotor frequency values, which have been saved at the time of an error. The individual error codes are accessed via parameter 174 with additional index no. in the parameter order identifier of the interface protocol. The last error code which has occurred is saved at the memory location with the index 0, the oldest is at index 39.
176	Error operating hours memory for the last 40 error events	0...19 years	0.01 h	-	Array 0..39 U32	r	Analogous to P171 (error code memory)
180	Response delay time	2...19	msec	10	U16	r/w	Pause time between received and transmitted interface protocol string of the frequency converter's serial interface RS 232 and RS 485. We recommend not to change the default setting (10 ms)
183	Max. passing time	10...2000	s	500	U16	r	Max. permissible time during which the pump must - with the start signal present - have passed through the critical speed range between 60 Hz and P20
184	Converter operating hours counter	0...19 Years	0,01h	-	U32	r	Totals the operating hours for the converter when the pump's drive is active
199	Converter date of manufacture	01.01.00 ... 31.12.99	-	-	U32	r	
227	Warnings bits 1	0 ... 65535	-	-	U16	r	Active warnings described bit per bit; for the meaning see Section 4.5

## Installation

No.	Designation	Range	Unit	Default	Format	r/w	Description
303	Pump status word	-	-	-	U16	r	Meaning of the bits: Bit 0 = 1 Normal operation Bit 1 = 1 Ready for switch on Bit 2 = 1 Speed is increasing Bit 3 = 1 Speed is dropping Bit 4 = 1 Generator operation Bit 5 = 1 Stand-by In case of an error P303 has the value of 0 (not ready to be switched on)
312	Cat. No. code	0 ... 2 <sup>31</sup> -1	-	-	U32	r	Abbreviated description of the Cat. No. of the pump or of the converter Examples: 800072V1003 = 721003 830070V0101 = 300700101
315	Serial No. code	1 ... 2 <sup>31</sup> -1	-	-	U32	r	The 9 least significant bits of the original serial No.
316	Hardware identifier	0...100	-	-	U16	r	Hardware version index of the converter

## Warning codes for parameter 227

Bit	Bit 15 ← MSB ... LSB →	Bit 0	Hexadecimal value	Decimal value	Designation	Condition / description of the warning
0	0000 0000 0000 0001		0001	1	Motor temperature warning	P7 > P16
1	0000 0000 0000 0010		0002	2	Converter temperature warning	P11 > 70 °C
2	0000 0000 0000 0100		0004	4	Bearing temperature warning	P125 > P126 or P127 > P128
3	0000 0000 0000 1000		0008	8	Bearing temperature warning	P127 > P128 or P125 > P126
4	0000 0000 0001 0000		0010	16	not used	-
5	0000 0000 0010 0000		0020	32	not used	-
6	0000 0000 0100 0000		0040	64	Overspeed warning	P3 > (P24 + 10 Hz)
7	0000 0000 1000 0000		0080	128	not used	-
8	0000 0001 0000 0000		0100	256	High load warning	P5 > (P17 * P21) effective P32 seconds after the start and if P21 < 100%
9	0000 0010 0000 0000		0200	512	not used	-
10	0000 0100 0000 0000		0400	1024	Switch-off threshold exceeded; can only be reset by the Leybold Service	P125 > P131 or P127 > P132
11	0000 1000 0000 0000		0800	2048	Overload warning	P3 < P25 * P24
12	0001 0000 0000 0000		1000	4096	not used	-
13	0010 0000 0000 0000		2000	8192	not used	-
14	0100 0000 0000 0000		4000	16384	Power supply warning	P4 > P805 or P4 < P806
15	1000 0000 0000 0000		8000	32768	not used	-

## Error codes for parameter P171

Code	Type of error	Condition / Description of the error	Pump switched off
0	No error	–	no
1	Overspeed error	Nominal speed of the pump (P 18) has been exceeded by over 10%	no
2	Pass through time error	Max. time for passing through the critical frequencies of 60 Hz to P20 has been exceeded: 60 Hz < P3 < P20 after P183 has elapsed with the start signal present	yes
3	Bearing temperature error	Maximum bearing temperature has been exceeded: P125 > P132 or P127 > P132	yes
4	Short circuit error	Short circuit in the pump's motor or the connecting cable	yes
5	Converter temperature error	Maximum temperature for the converter has been exceeded: P11 > 85°C	yes
6	Run up time error	Max. time after which the pump must enter its normal operation mode has been exceeded: P3 < P24 x P25 after P32 has elapsed with the start signal present	yes
7	Motor temperature error	Maximum motor temperature has been exceeded: P7 > P133	yes
8	Pump error	Pump could not be identified or no pump is connected.	yes
60	Short circuit error	Short circuit in the pump's motor	yes
61	Bearing temperature warning	Bearing temperature warning threshold has been exceeded: P125 > P126 or P127 > P128	no
62	Bearing temperature warning	Bearing temperature warning threshold has been exceeded: P127 > P126 or P125 > P128	no
101	Overload warning	The frequency has dropped below the normal operation frequency by high load: P3 < P25 * 24 (after normal operation has been reached)	no
103	Power supply error	No power supply during active operation of the pump	no
106	Overload error	Upper critical limit frequency has been exceeded by overload (P3 < P20 after P32 from start after run-up)	yes
116	Permanent overload error	Max. overload time has been exceeded: P3 < P25* P24 for longer than P32	yes
117	Motor current error	No motor current or motor current too low ( $I_{set} > 1 \text{ A}$ and $P5 < 0.2 \text{ A}$ )	yes
118	Motor connection error	Error in the motor connection cable	yes
125	High load warning	Max. permissible permanent current has been exceeded: P5 > P17 * P21 for longer than P32 from start after run-up	no
126	Bearing temperature sensor error	Error at the bearing temperature sensor (Resistance not in the plausible range; $-20 \text{ °C} < T < 150 \text{ °C}$ )	yes
127	Bearing temperature sensor error	Error at the bearing temperature sensor (Resistance not in the plausible range; $-20 \text{ °C} < T < 150 \text{ °C}$ )	yes
128	Motor temperature sensor error	Error at the motor temperature sensor (Resistance not in the plausible range; $-20 \text{ °C} < T < 150 \text{ °C}$ )	yes

## Installation

Code	Type of error	Condition / Description of the error	Pump switched off
131	Permanent high load error	Max. high load time has been exceeded: $P5 > P17 * P21$ for longer than $2 * P32$	yes
143	Overspeed error	Pumping speed has been exceeded by more than 15 % ( $P3 > P18 \times 1.15$ )	yes
144	Profibus address error	Wrong Profibus address set (must be 0 ... 126)	yes
145	Profibus error	Error during cyclic exchange of data over the Profibus, the watchdog timer has responded	yes
201	CPU error	Error in the micro computer	yes
202	PLL-synchronisation warning	Error in the pump's speed synchronisation wiring	no
203	Parameter value error	Parameter value internally not valid; data error	yes
205	Data plausibility error	Internal data error (open loop)	yes
207	Motor blocked error	Rotor blocked	yes
208	PLL error	PLL synchronisation error	yes
212	Shut down	Emergency off	
213	Overvoltage error	Power supply voltage too high ( $UZK > 80 \text{ V}$ )	yes
214	Undervoltage error	Power supply voltage too low (level depends on pump)	yes
216	Memory test error	Error in external memory	yes
217	Pump identification resistor error	Wrong or missing pump identification resistor	yes
222	Hardware test error		yes
223 - 226	Logical unit error	Error in the programmed logical unit	yes
227	Pump model can not be operated	No set of parameters defined for the recognized pump model	yes

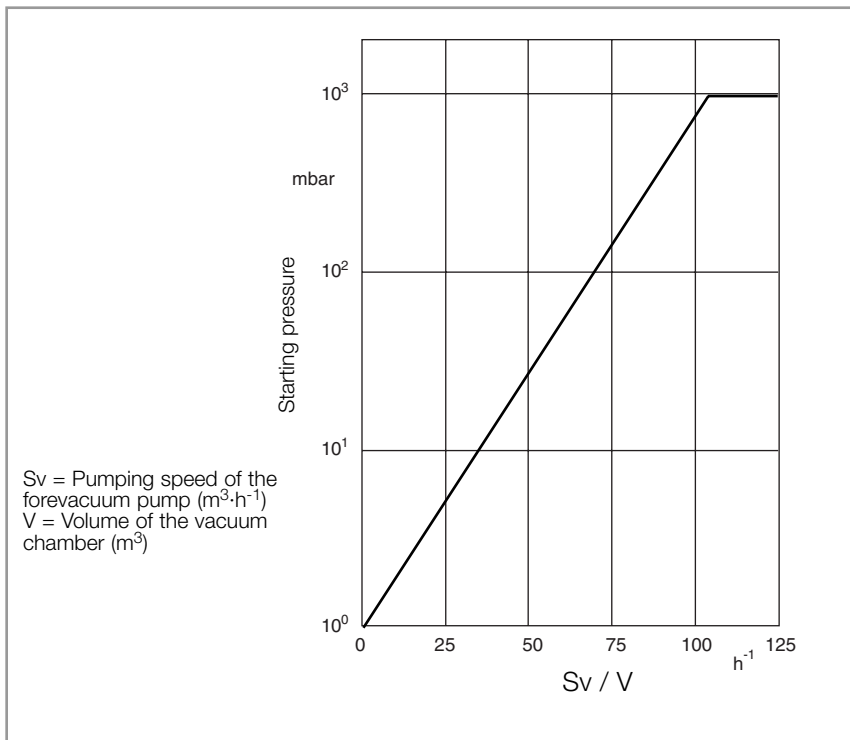


Fig. 26 Determining the starting pressure of a turbomolecular pump when evacuating large volumes

### 3 Operation

The turbomolecular pump must only be operated in the proper condition and under the conditions described in the Operating Instructions.

**Warning**



#### 3.1 Switching on

Connect the 59 V DC power supply or the TURBO.CONTROL 700 to the mains. The yellow LED at the frequency converter lights up.

The starting pressure for the turbomolecular pump can be taken from the graph in Figure 26.

**Starting pressure**

Switch on the turbomolecular pump

- via pins 7 and 8 of the socket REMOTE (X1) (For example via a remote control or with the aid of the plug with integrated ON/OFF switch).
- by a start command via the interface; see Section 2.7.
- For the power supply units offered or recommended by Leybold: If the contacts 7 and 8 at the REMOTE (X1) connector are closed the pump starts automatically when the DC voltage is switched on (provided parameter 12 is set to 0).

The turbomolecular pump runs up. The green LED flashes. When the pump reaches normal operation the green LED lights up permanently.

Avoid the influences of shock and vibration when the pump is running.

## Operation

### Warning



During operation the pump can become so hot that there is a danger of receiving burns ( $\geq 70\text{ }^{\circ}\text{C}$ ,  $158\text{ }^{\circ}\text{F}$ ).

### Warning



After a mains power failure the pump can run up automatically once more.

### Caution

This pump is only intended for operation with its nominal speed. Do not try to change the operating frequency.

## 3.2 Shutting down

### Warning



Unplug any connectors only when the mains voltage is switched off **and** the pump does no longer turn (the green LED is off).

Switch off the pump at the frequency converter.

- via contacts 7 and 8 of the socket REMOTE (X1), if parameter 12 = 0.
- apply a stop command via the interface, if parameter 12 = 1 or 2.
- for the power supply units offered or recommended by Leybold switch off the DC voltage.

After switching off, the green status LED will flash until the rotor of the turbomolecular pump is at standstill. This may take several minutes. With the DC power supply off, the turbomolecular pump will act as a generator supplying the frequency converter with energy as indicated by the yellow power LED.

### Generator operation

Switch off the forevacuum pump.

### Venting

When using oil-sealed forevacuum pumps, vent the turbomolecular pump before it comes to a stop; refer to Section 3.3.

When using TRIVAC pumps the built-in anti-suckback valve will close automatically, shutting off the forevacuum line. In forevacuum pumps without a vacuum retention valve, close the valve in the forevacuum line.

When the system is not operating, ensure that neither ambient air nor cleaning media can enter the pump.

If a failure occurs the turbomolecular pump will be shut down automatically. The red LED at the frequency converter lights up.

## Emergency off

In the case of an emergency shut down, the pump is switched off as described above. The rotor of the turbomolecular pump may be stopped faster by venting the pump.



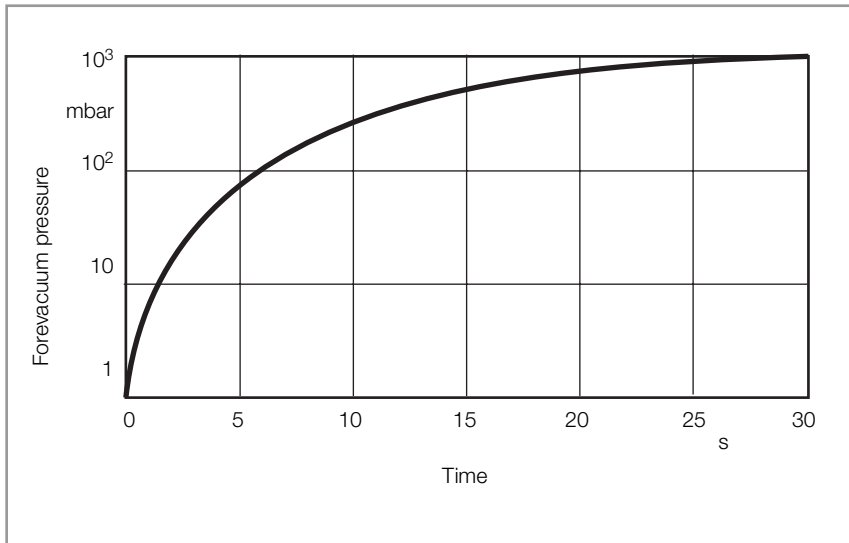


Fig. 27 Maximum rise in pressure

### 3.3 Venting

When using oil-sealed forevacuum pumps, vent the pump each time it is shut down to prevent possible return diffusion of oil vapors from the forevacuum line to the high-vacuum side.

As to suitable gases, see Chapter 2.5.

#### Venting Methods

There are three different methods of venting the turbomolecular pump.

In the case processes requiring a purge gas, the pump must be vented via the purge gas and venting valve when shutting the pump down.

#### Purge gas and venting valve

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 area of the ball bearings compared to the remaining vacuum area. This will prevent particles, dust or aggressive gases from being forced through the bearings into the not yet vented motor chamber of the pump.

Depending on the process a venting valve can be used. A choke integrated into the flange will ensure that the pump is vented without damage.

#### High vacuum side

Cautious venting of the pump is possible from the high vacuum side, since here the bearing forces will be lowest. When doing so, no free jet of gas must be allowed to form on the rotor so as to avoid exposing the rotor to additional forces.

When venting the pump through its foreline connection, neither oil nor particles may be entrained in the gas flow from the forevacuum side into the pump.

#### Foreline connection

### Speed of the Pressure Rise

<b>Speed</b>	All turbomolecular pumps may be vented at full speed. However, the pressure must not increase faster than specified through the pressure rise curve, see Fig. 27.
<b>Pressure rise curve</b>	
<b>Particles</b>	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 speed of the pressure rise during venting of the running pump will greatly influence the load on the rotor/stator pack and the bearings. The slower the pump is vented, the longer the service life of the bearings will be.  The pump must not be vented to pressures above atmospheric pressure.

## 3.4 Bakeout

For TURBOVACs with CF flange

If pressures in the range of  $10^{-8}$  mbar or below are to be developed, the vacuum chamber and the components installed therein will have to be baked out. The high vacuum flange must not be heated to more than 100 °C (212 °F).

Protect the rotor against intensive, direct heat radiation. When baking out at the forevacuum side – at a sorption trap, for example – ensure that the components attached direct are not heated to more than 100 °C (212 °F).

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

## 3.5 Changing the start delay time

Generally it will make sense to let the turbomolecular pump run up immediately after applying the start command. However when operating two or more turbomolecular pumps off a single power supply unit, it may make sense to start the pumps one after the other. One way of achieving this is to enter a start delay time differing from 0.

To set up the start delay time proceed as follows:

With the aid of a Windows PC and the PC software “TURBO. DRIVE Server” change the setting for the parameter 36 “Start delay time”.

So as to retain the value saved for parameter 36 when switching the pump off, the parameter value needs to be saved permanently. For this enter any value (for example 1) for parameter 8. Thereafter changed parameters will be saved permanently.

**Caution** After replacing the pump or when switching on the supply voltage without a connected pump, all changed parameter values will be reset to factory defaults.

For special applications further parameters can be changed. Please ask us.

## 4 Maintenance

During all work on the pump the system must be protected against being switched on. For this disconnect the DC power supply.

After approx. one year of operation a standard bearing exchange will be required. Please contact the Leybold Service for the carrying out.

After every 15,000 operating hours at the latest a standard bearing exchange will be required. This can only be done by Leybold Service.

Moreover we recommend to have the rotor assy. exchanged after 50,000 operating hours. This can only be done by Leybold Service. For this ask for a quotation.

### When using purge gas valves

Depending on the degree of contamination of the purge gas used the filter will clog and will have to be exchanged (our experience indicates that this will become necessary after 1 to 6 months). In addition the sintered filter in the centering ring of the PURGE/VENT connection has to be cleaned or replaced.

### When using an adsorption trap

Regenerate or renew the adsorption agent regularly; refer to the operating instructions provided with the trap.

The pump must only be opened by such persons who have been authorised by Leybold to do so.

### 4.1 Removing the pump from the system

Shut down the pump and vent as described in Sections 3.2 and 3.3.

If the pump has previously handled hazardous gases, implement the proper precautionary measures before opening the intake or exhaust connection.

If necessary, use gloves, a respirator and/or protective clothing and work under an exhaust hood.

Disconnect the pump only when it has come to a full stop. The green LED at the frequency converter must have gone out.

Then switch the mains power off and wait until the yellow power LED is off. Then only disconnect any cable connections.

The pumps may have been contaminated with process gases. These gases may be toxic and hazardous to health. In addition, deposits with similarly dangerous properties may have formed. Many of these gases and deposits form acids when they come into contact with humid air. This will result in serious corrosion damage to the pump.

To avoid health hazards and corrosion damage when the pumps are detached from the system, fasten a container of desiccant under the transport

**First bearing change**

**Following bearing changes**

**Rotor change**

**Filters**

**Caution**

**Warning**



**Hazardous gases**

**Deposits**

**Desiccant**

cover of the high-vacuum connection and then close the pump immediately at all flange connections. Store the pump, with a desiccant, in an airtight PE bag.

Corrosion damage due to faulty packing will void the warranty.

**Pack the pump** Pack the pump so that it cannot be damaged during shipping and storage. Pay particular attention to protection for the flanges and the electrical plug. Observe the instructions in Section 4.3 if you forward the pump to Leybold.

## 4.2 Cleaning

If required clean the turbomolecular pump with a dry cloth.

## 4.3 Service by Leybold

**Contamination** Whenever you send a pump to Leybold, indicate whether the pump is contaminated or is free of substances which could pose a health hazard. If it is contaminated, specify exactly which substances are involved. You must use the form we have prepared for this purpose; we will forward the form on request.

**Form** A copy of the form is printed at the end of these operating instructions: „Declaration of contamination of vacuum equipment and components“. Another suitable form is available from the Leybold homepage: [www.leybold.com](http://www.leybold.com) under the headline “Support & Download”.

Attach the form to the pump or enclose it with the pump.

This statement detailing the contamination is required to satisfy legal requirements and for the protection of our employees.

Pumps which are not accompanied by a contamination statement will be returned to the sender.

Please, state also the reason of return or the reason for a repair.

## 4.4 Disposal

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

**Warning**



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

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

If you send a pump to Leybold mind the regulations given in Section “4.3 Service by Leybold”.

# 5 Troubleshooting

When the connector cable is attached, the outputs at the frequency converter are not free of voltage.

**Warning**



Before you start searching for the source of the problem, you should carry out a few simple checks:

Are the connections in good working order?

- Power supply - mains,
- DC power supply to the frequency converter,

Is the forevacuum pressure sufficient?

After having removed the cause for the error reset the error message at the TURBO.DRIVE:

- In case of errors with error codes 1 to 7 by applying a STOP signal via the socket REMOTE (X1) or a reset sequence via the serial interface or by switching the mains power off.
- In case of error code 8 by switching the mains power off.

The error codes can only be read if a serial interface is present. (RS 232, RS 485, Profibus).

The following table has been provided as a guide when determining the causes of errors.

To remove possible faults, staff having different qualifications is required:

- **Operator** of the system
- Qualified **maintenance staff** of the system operator or qualified staff from the vendor erecting the system
- Staff from **Leybold-Service**

In some cases also a combination of the above will be needed, for example, check by the operator, rectification of the fault by maintenance staff.

## Troubleshooting

Malfunction	Possible cause	Corrective action	Responsible
Red ERROR LED is on: Error code1: Overspeed error	EMC influence	Check connecting cable, insert it properly Switch the power supply voltage off and then on again	Operator/ maintenance staff Operator
	TURBO.DRIVE faulty	Replace frequency converter.	Maintenance staff/ Leybold service
Red ERROR LED is on: Error code 2 + 6: pass through timer error and run up time error ■ Pump runs up too slowly ■ Pump loses its speed	Forevacuum or high-vacuum pressure too high.	Check the forevacuum pump and use a different forevacuum pump if necessary.	Operator/ maintenance staff
	Gas volume too great.	Seal leak; install a higher-capacity vacuum pump if necessary.	Maintenance staff
	Power supply overloaded	Reduce the number of consumers or use a stronger power supply or switch on the consumers one after the other.	Operator/ maintenance staff
	Bearing defective.	Repair the pump.	Leybold service
Red ERROR LED is on: Error code 3 + 7: bearing temperature error and motor temperature error	Forevacuum pressure too high.	Check the forevacuum pump and use a different forevacuum pump if necessary.	Operator/ maintenance staff
	Gas volume too great or leak in the system.	Seal leak; install a higher-capacity vacuum pump if necessary.	Maintenance staff
	Fan defective.	Replace the fan.	Leybold service
	Ambient temperature too high.	Feed cooler air to the pump or install water cooling.	Maintenance staff
	Bearing defective.	Repair the pump.	Leybold service
Red ERROR LED is on: Error code 4: Short circuit error	Short circuit in the pump's motor	Repair the pump.	Leybold service
	Short circuit in the connecting cable	Check to see if the connecting cable is undamaged, exchange it if required.	Operator/ maintenance staff
Red ERROR LED is on: Error code 5: converter temperature error	Inadequate cooling of the pump; operation at too high loads	See error code 3 + 7.	–
	Ambient temperatures too high. Inadequate cooling of the TURBO.DRIVE	Improve the cooling situation: E.g. avoid exposure to the heat generated by other equipment.	Maintenance staff
Red ERROR LED is on: Error code 8: pump error TURBO.DRIVE can not detect the type of connected pump.	Pump not connected to TURBO.DRIVE	Check connecting cable	Operator
	Power supply builds up the DC too slowly	Use power supply recommended by Leybold	Maintenance staff
	Power supply overloaded	Reduce the number of consumers when switching on or use a stronger power supply.	Operator/ maintenance staff

Malfunction	Possible cause	Corrective action	Responsible
Yellow power LED is not on.	No DC power	Check cables and power supply.	Operator/ maintenance staff
	DC power miswired.	Ensure correct polarity of the DC cable.	Maintenance staff
	Frequency converter defective.	Replace frequency converter. The following may damage the frequency converter: <ul style="list-style-type: none"> <li>■ Disconnection of the DC cable while the pump was still rotating</li> <li>■ Non-compliance with the note related to connecting several pump to a single power supply.</li> </ul>	Maintenance staff/ Leybold service
Red LED flashes.	Warning message. See Section "2.7 Warning codes" for the possible reasons of the warning.	The pump can continue to run, as long as operation limits are only exceeded for a short time. In case of longer exceeding send pump and frequency converter to the Leybold Service.	Operator/ Leybold service
Yellow LED flashes.	Warning message: Supply voltage too low or too high.	The pump can continue to run. Check the reason for wrong voltage and eliminate the fault.	Operator/ maintenance staff
Turbomolecular pump does not start, ERROR LED does not light.	Operation mode set wrongly, e. g. with TURBO.DRIVE Panel or Server.	Change parameter 12.	Operator/ Maintenance staff
	Interface protocol error	Use USS protocol.	Operator/ Maintenance staff
	No communication via the serial interface.	Connect bus as shown in Section 2.7.	Maintenance staff
	REMOTE connector (X1) connected wrongly.	Connect as shown in Fig. 20.	Maintenance staff
	Wrong Profibus address set.	Set address between 0 and 126	Operator/ Maintenance staff
Turbomolecular pump produces loud running noises and vibrations.	Rotor out of balance.	Balance the rotor.	Leybold service
	Bearing defective.	Replace the bearing.	Leybold service
Turbomolecular pump does not reach ultimate pressure.	Measurement instrument defective.	Inspect the measurement sensor.	Operator/ Maintenance staff
	Measurement sensors soiled.	Clean or replace the sensors.	Maintenance staff
	Leaks at the equipment, lines or the pump.	Check for leaks.	Maintenance staff
	Pump soiled.	Clean the pump.	Leybold service
	Forevacuum pump provides insufficient pumping speed or ultimate pressure which is too high.	Check the ultimate pressure of the forevacuum pump and install a higher-capacity vacuum pump if necessary.	Operator/ maintenance staff
	Frequency parameters programmed wrongly.	Check parameters.	Operator/ Maintenance staff
Green LED blinks, yellow LED lights up weakly.	Frequency converter defective.	Wait for pump standstill (several minutes), then switch off the power supply for 5 seconds and switch it on again.	Operator
Running pump can not be stopped via X1.	Pump has been started via the serial interface, the interface controls the pump.	Disconnect the DC supply or connect serial interface and stop via bus. Check parameter 12.	Operator/ Maintenance staff

## 6 Spare parts

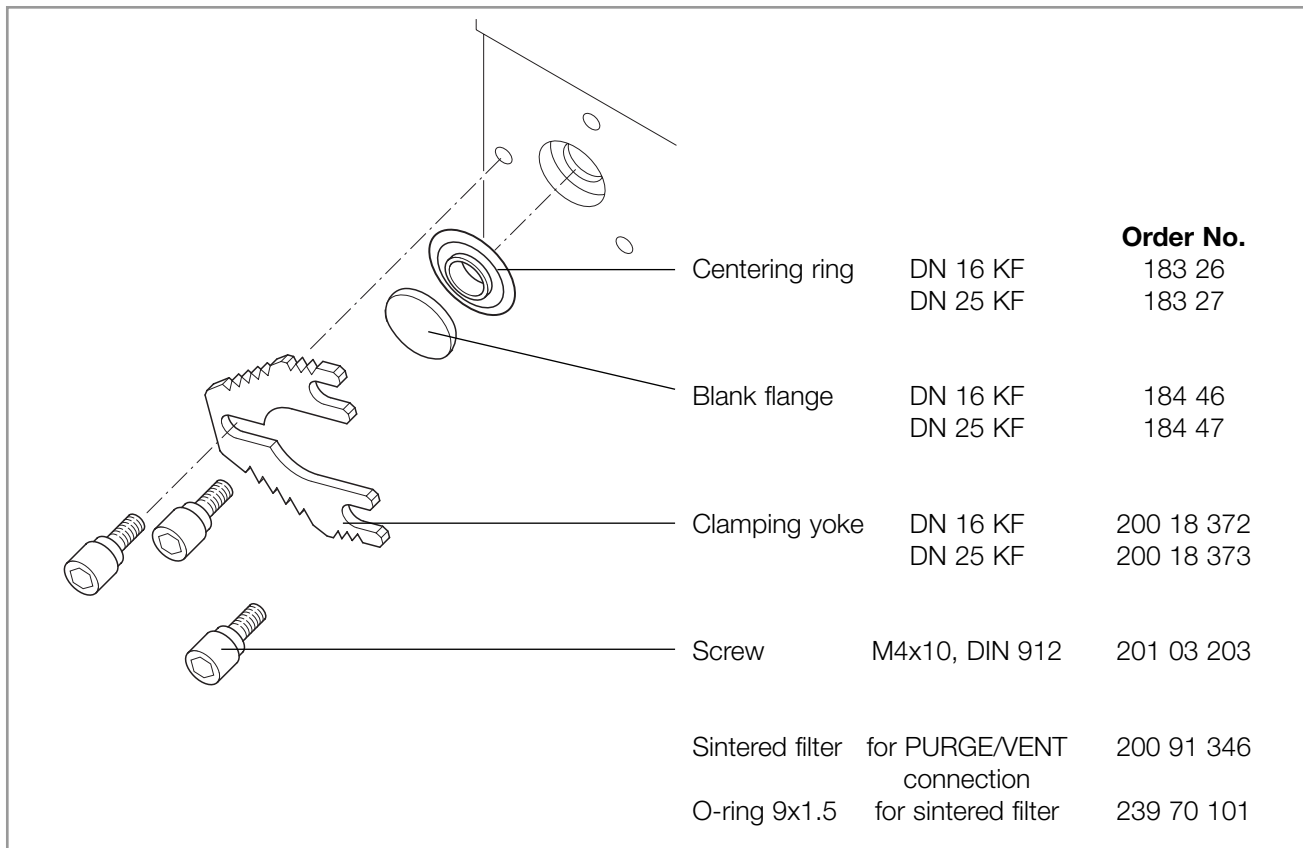


Fig. 28 Spare parts

### Spare parts which may only be changed by the Leybold service

	Order No.
Frequency converter TURBO.DRIVE 700 with RS 232/485 interface	800574V0001
with Profibus interface	800574V0004
Fan	200 15 099



# EC Manufacturer's Declaration

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

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

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

Designation of the products      Turbomolecular pump with integrated frequency converter

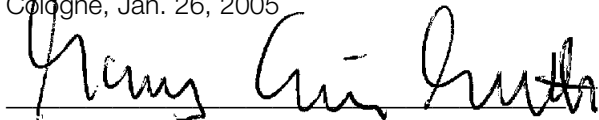
Model:                                      **TW 701**

Part Nos.:                                800051V0022 to 800051V0027,  
800051V0121, 800051V0122

## Related, harmonized standards

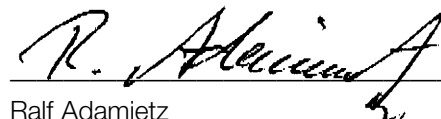
- EN 1012 - 2: 1996 Compressors and vacuum pumps. Safety requirements.  
Part 2: Vacuum pumps

Cologne, Jan. 26, 2005



Marcus Eisenhuth  
Vice-President  
Head of Product Development

Cologne, Jan. 26, 2005

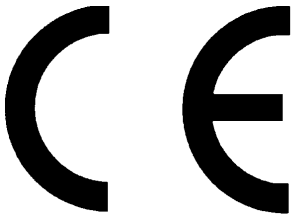


Ralf Adamietz  
Head of Design

**Leybold**  
vacuum

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

[www.leybold.com](http://www.leybold.com)



# EC Conformance Declaration

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

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

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

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

Designation of the products      Frequency converter  
Model:                                    **TURBO.DRIVE 700**  
Part No.:                                800 057

## The products comply to the following guidelines

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

## Related, harmonized standards

- EN 61010 - 1: 2001 Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements
- EN 61326/A1/A2 2001  
Electrical equipment for measurement, control, and laboratory use - EMC requirements

Cologne, Jan. 26, 2005

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Vice-President  
Head of Product Development

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Alois Greven  
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vacuum

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Phone: ++49 (0)221 347-0  
Fax: ++49 (0)221 347-1250  
documentation@leybold.com

[www.leybold.com](http://www.leybold.com)



The system TURBOVAC TW 700 / TURBO.DRIVE L, turbomolecular pump with integrated frequency converter, has been tested by the TÜV Rheinland of North America according to the requirements of

■ **NRTL**

(applied standards UL 3101-1/10.93)

It complies with the standards stated.

NRTL Report No. E 9972081 E 01

The system TURBOVAC TW 701 / TURBO.DRIVE 700 complies with the same requirements and standards, but has not yet been tested by the TÜV.



## Declaration of Contamination of Compressors, Vacuum Pumps and Components

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

**A separate declaration has to be completed for each single component.**

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

Customer/Dep./Institute: _____ _____ Address _____ _____ Person to contact: _____ Phone: _____ Fax: _____ End user: _____	<b>Reason for return</b> <input checked="" type="checkbox"/> applicable please mark <input type="checkbox"/> <b>Repair</b> <input type="checkbox"/> chargeable <input type="checkbox"/> warranty <input type="checkbox"/> <b>Exchange</b> <input type="checkbox"/> chargeable <input type="checkbox"/> warranty <input type="checkbox"/> exchange already arranged / received <b>Return only:</b> <input type="checkbox"/> rent <input type="checkbox"/> loan <input type="checkbox"/> for credit <b>Calibration:</b> <input type="checkbox"/> DKD <input type="checkbox"/> Factory calibration <input type="checkbox"/> Quality test certificate DIN 55350-18-4.2.1
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<b>A. Description of the Leybold product</b> Material description: _____ Catalog number: _____ Serial number: _____ Type of oil (Forevacuum pumps): _____	Failure description: _____ Additional parts: _____ Application Tool: _____ Application Process: _____
---	--

<b>B. Condition of the equipment</b>																																																																	
1. Has the equipment been used <sup>1)</sup> <input type="checkbox"/> 2. Drained (Product/service fluid) <input type="checkbox"/> 3. All openings sealed airtight <input type="checkbox"/> 4. Purged <input type="checkbox"/> If yes which cleaning agent: _____ and which method of cleaning: _____ 1) if answered with "No" go to <b>D.</b>	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: center; width: 10%;">No<sup>1)</sup></td> <td style="width: 10%; border-left: 1px solid black;"></td> <td style="text-align: center; width: 10%;">Yes</td> <td style="width: 10%; text-align: center;">No</td> <td style="width: 10%;"></td> <td style="width: 10%;"><b>Contamination:</b></td> <td style="width: 10%; text-align: center;">No<sup>1)</sup></td> <td style="width: 10%; text-align: center;">Yes</td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td style="border-left: 1px solid black;"></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;">→</td> <td>toxic</td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td style="border-left: 1px solid black;"></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td></td> <td>corrosive</td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td style="border-left: 1px solid black;"></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td></td> <td>flammable</td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td style="border-left: 1px solid black;"></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td></td> <td>explosive<sup>2)</sup></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td style="border-left: 1px solid black;"></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td></td> <td>radioactive<sup>2)</sup></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td style="border-left: 1px solid black;"></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td></td> <td>microbiological<sup>2)</sup></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td style="border-left: 1px solid black;"></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td></td> <td>other harmful substances</td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> </tr> </table>	No <sup>1)</sup>		Yes	No		<b>Contamination:</b>	No <sup>1)</sup>	Yes	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	→	toxic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>		corrosive	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>		flammable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>		explosive <sup>2)</sup>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>		radioactive <sup>2)</sup>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>		microbiological <sup>2)</sup>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>		other harmful substances	<input type="checkbox"/>	<input type="checkbox"/>
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<b>C. Description of processed substances (Please fill in absolutely)</b>	
1. What substances have come into contact with the equipment: Trade name and / or chemical term of service fluids and substances processed, properties of the substances; According to safety data sheet (e.g. toxic, inflammable, corrosive, radioactive)	
Tradename: _____	Chemical name: _____
a) _____	_____
b) _____	_____
c) _____	_____
d) _____	_____
2. Are these substances harmful? <input type="checkbox"/> No <input type="checkbox"/> Yes	
3. Dangerous decomposition products when heated? <input type="checkbox"/> No <input type="checkbox"/> Yes If yes, which? _____	

**2) Components contaminated by microbiological, explosive or radioactive products/substances will not be accepted without written evidence of decontamination.**

<b>D. Legally binding declaration</b>	
<b>I / we hereby declare that the information supplied on this form is accurate and sufficient to judge any contamination level.</b>	
Name of authorised person (block letters): _____	
Date _____	Signatur of authorised person _____
	<div style="border: 1px dashed black; width: 100px; height: 40px; margin: 0 auto;"></div> firm stamp

# Index

## A

address **30-32**, 34, 38, 47, 52  
 adsorption trap **17**, 18, 43  
 air 6, 8, 11, 12, 14, 17-22, 40, 46  
 ambient temperature 11, 14, 18, 19, 46  
 Argon 19, 21, 23

## B

bearing temperature 29, 34, 36, 37, 46

## C

clamping yoke 7, **17**, 48  
 compound stage 6  
 connection elements 14, 15  
 coolant 13, 20  
 cooling 6, 7, 9-11, 14, 15, **18-20**, 46

## D

DC control cable 8, 27  
 desiccant 7, 16, 43  
 dimensional drawing 12  
 dust **13-16**, 19, 20, 22, 41

## F

failure 28, 40  
 fans 6  
 forevacuum pressure 6, **10**, 19, 41, 45, 46  
 forevacuum pump 6, **17**, 18, 39, 40, 42, 46, 47  
 functional extra-low voltages 24  
 fuse 24

## G

gases **6**, 17, 21, 22, 41, 43

## H

high-vacuum 7, 10, 11, **14-16**, 18, 41, 46  
 Holweck 6, 7  
 humidity 11, 17, 20, 21

## L

LED 23, **24**, 25, 28, 31, 32, 39, 40, 46, 47  
 liquids 6

## M

magnetic field 14  
 media 6, 13, 40  
 motor temperature 29, 33, 34, 36, 37, 46

## N

Nitrogen 19, 21, 23

## O

ON/OFF switch 9, 25, 39  
 operating hours 35, 43

## P

particles 41, 42  
 power supply 6, 8, 12, 14, 15, **23-26**, 34, 36-47  
 Profibus 8, **29, 32**, 38, 45, 47, 48  
 purge gas 6, 7, 9, 10, 14, 15, 18, **21-23**, 34, 41, 43

## R

relay 10, **27-29**, 34  
 REMOTE 9, 14, 15, 27, 33, 39, 40, 45, 47  
 rotor frequency 33, 35  
 RS 232 8, 14, 15, 24, **30**, 35, 45, 48  
 RS 485 8, 24, **31, 32**, 35, 45

## S

sintered filter 21-23, 43, 48  
 speed 10, 11, 35, 37, 38, 39, 42, 46, 47  
 splinter guard 7, 8, **16**  
 start delay time 34, 42

## V

venting 9, 14, 15, 18, 21-23, 34, **40-42**  
 vibration absorbers 16

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