

Vacuum Solutions

Application Support

Service



LEYBOLD VACUUM

GA 05.147/3.02



TURBOVAC TW 700

Turbomolecular Pump with
Integrated Frequency Converter

Cat. No.
800051V0001 to
800051V0007
and modified pumps

Operating Instructions

Contents

	Page
1 Description	2
1.1 Design	2
1.2 Standard equipment	3
1.3 Ordering data	4
1.4 Technical data	6
2 Connections	9
2.1 Operating environment	9
2.2 Attaching the pump to the vacuum chamber ..	11
2.3 Forevacuum connection	12
2.4 Cooling the pump	14
2.5 Connecting the purge gas and venting valve ..	16
2.6 Electrical connection	18
2.7 Interface description	22
3 Operation	28
3.1 Switching on	28
3.2 Shutting down	28
3.3 Venting	29
3.4 Bakeout	29
3.5 Removing the pump from the system	30
4 Maintenance	31
4.1 Cleaning	31
4.2 Service by LEYBOLD	31
5 Troubleshooting	32
6 Spare parts	34

Figures

The references to the diagrams, e.g. (2/10), consist of the figure number and the item number, in that order.

Warning

Identifies working and operating procedures which must be strictly observed to prevent hazards to persons.

Caution

Indicates working and operating procedures which must be strictly observed to prevent damage to or destruction of the appliance.

We reserve the right to alter the design or any data given in these operating instructions.

The illustrations are not binding.

1 Description

The TURBOVAC TW 700 is a turbomolecular pump with compound stage. The frequency converter is integrated. 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. A forevacuum pump is required for its operation.

These pumps are **not** suitable for

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

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

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.

Warning

Never expose any parts of the body to the vacuum.

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.

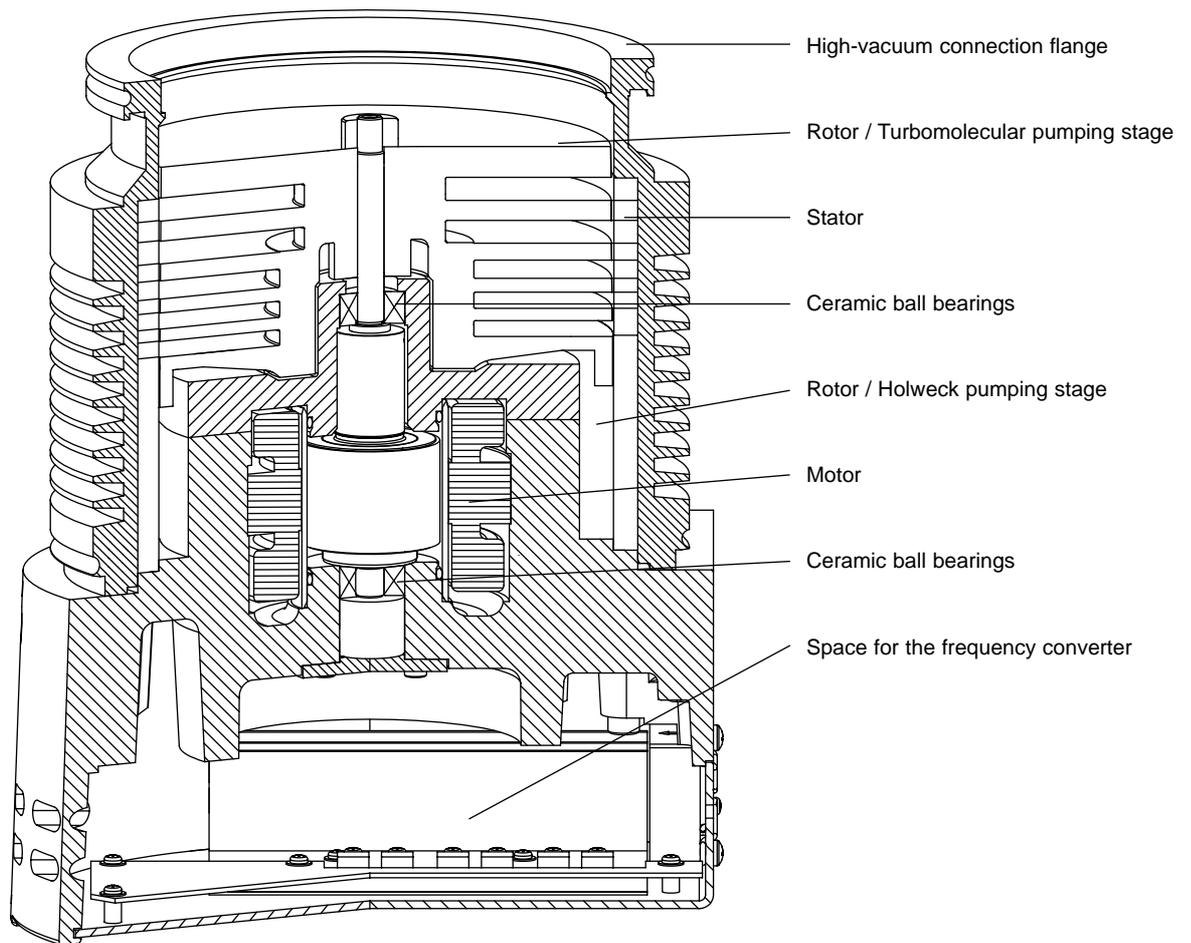


Fig. 1 Section through a TW 700; simplified representation

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.

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.

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.

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.

These Operating Instructions and a Declaration of Contamination of Vacuum Equipment are part of the standard equipment.

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

A splinter guard is part of the standard equipment for one version with CF flange.

PE = Polyethylene

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

1.3 Ordering data

	Part No.	Remarks
TURBOVAC TW 700		
DN 160 ISO-K, air cooled, RS 232 interface	800051V0001	(previous 864 31)
DN 160 ISO-K, water cooled, RS 485 interface	800051V0003	(previous 864 37)
DN 160 ISO-K, air cooled, RS 485 interface	800051V0004	(previous 864 36)
DN 160 ISO-K, water cooled, RS 232 interface	800051V0005	(previous 864 32)
DN 200 CF, water cooled, RS 232 interface, splinter guard	800051V0002	(previous 136 33)
DN 160 CF, water cooled, RS 485 interface	800051V0006	(previous 114 43)
DN 160 CF, air cooled, RS 485 interface	800051V0007	(previous 136 28)
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 700	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 1950, 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-connection cable,		3 way connector —
3 m long	200 12 729	3x cable lug M5: + 59 V DC, 0 V DC, GND
5 m long	200 12 730	
10 m long	200 12 731	
20 m long	200 15 064	
3 way connector for the 59 V DC connection cable Hirose HS21P-3	200 12 740	Alternative to the 59 V DC connecting cable

Accessories for serial interfaces

Display Palm M100/105*	800110V0105	Display unit for parameters, requires the software "Turbo.Drive Panel"
Required "Turbo.Drive Panel" software	800110V0104	for the display Palm M100/105, 3.5" floppy
PC software "Turbo.Drive Server"	800110V0102	for Windows 95 and higher, CD-ROM* <ul style="list-style-type: none"> • Display, change, save and compare parameter lists • Integration of customer's software • Record parameter data
Adaptor RS232/RS485 for 220 V/Euro plug	800110V0101	
* Can be used in connection with the following interfaces: <ul style="list-style-type: none"> - For frequency converters with RS232 interface. - For frequency converters with RS485 interface, a RS232/RS485 adaptor is required. 		
9 way connector for PLC interface socket (REMOTE X1)	152 48	with integrated ON/OFF switch for the pump
Purge gas and venting valve	121 33	24 V DC, 0.6 mbar·l/s (previous 200 91 587)
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	
Water cooling complete	200 04 882	G 1/8" connections
Accessories for the water connections		
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

Recommended forevacuum pumps

- TRIVAC B series, ECODRY series see Leybold catalog
- Diaphragm pump DIVAC 4.8 VT 127 92

1.4 Technical data

Technical data for pumps

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

* as per PNEUROP

Technical data for the integrated frequency converter TURBO.DRIVE L

Nominal supply voltage	59 V DC
Residual ripple	< 2%
max. supply voltage	60 V DC
min. supply voltage	53 V DC
Max. power consumption	500 W
Max. continuous current	7.5 A
Max. current	8.5 A
Max. length of the DC cable at 3 x 2.5 mm ²	20 m
Load rating, relay output	48 V, 0.5 A

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. 10 for cooling requirements	
Relative air humidity acc. to DIN EN 60721	Class F
Type of protection	IP 20

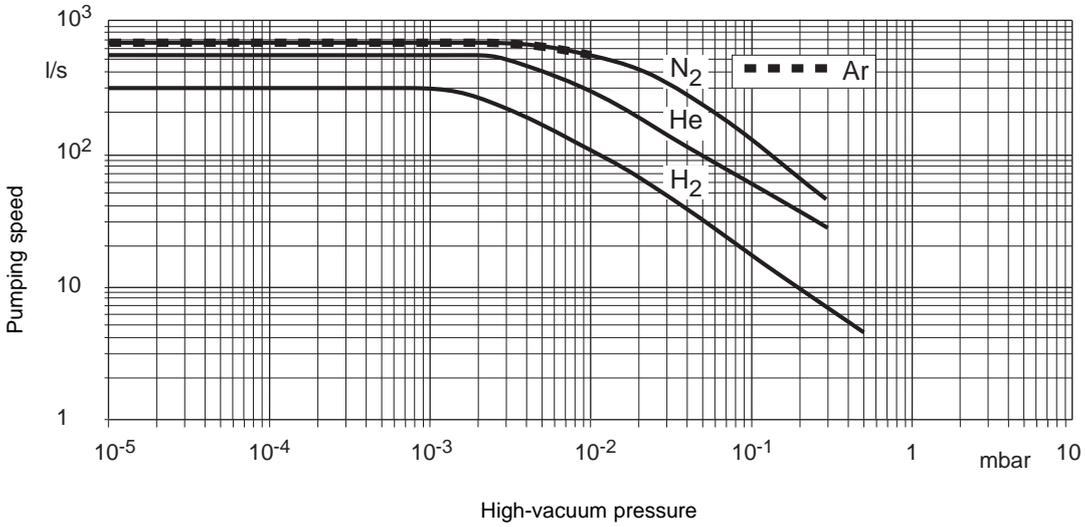


Fig. 2 Pumping speed curves for the TURBOVAC TW 700

Description

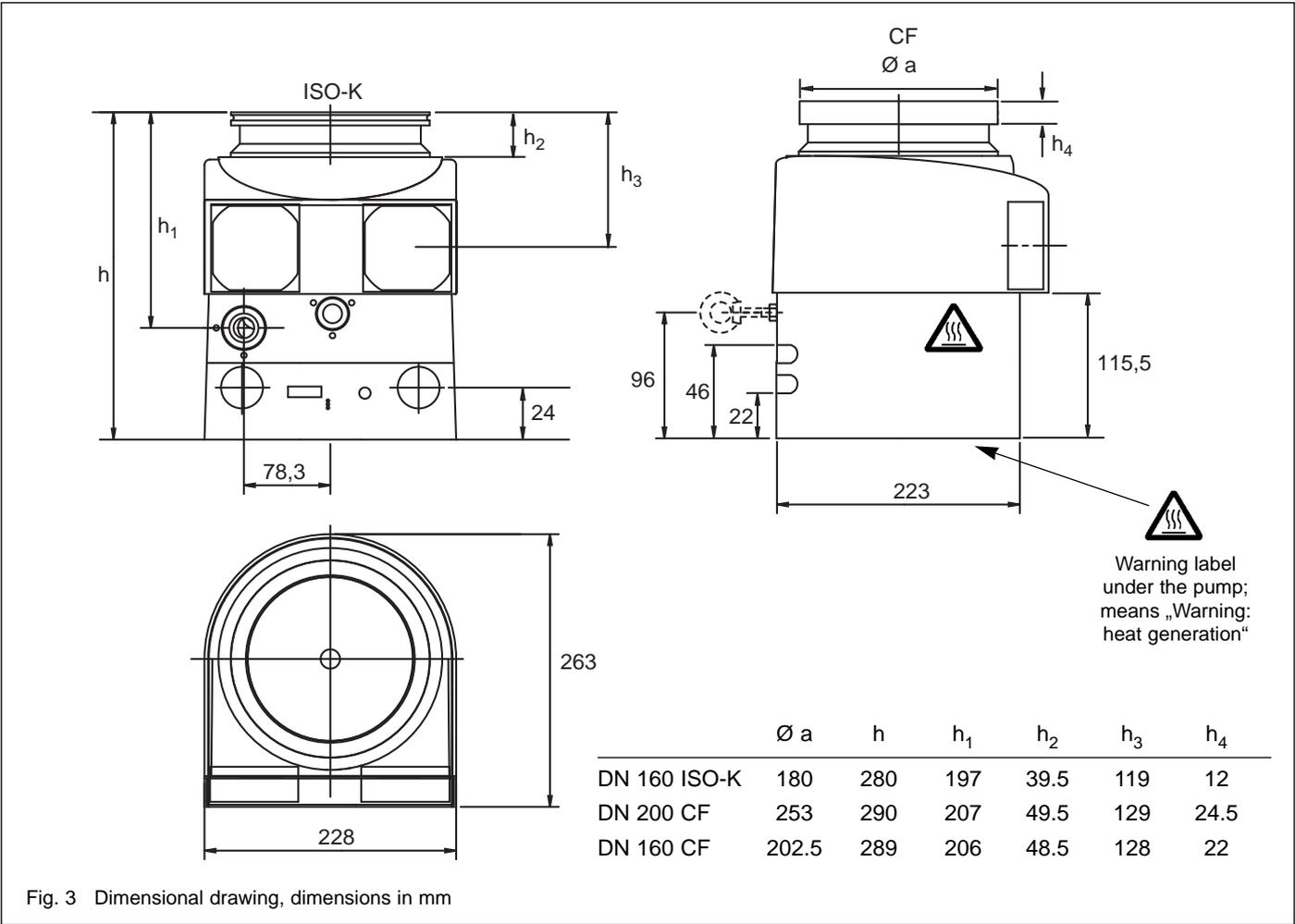


Fig. 3 Dimensional drawing, dimensions in mm

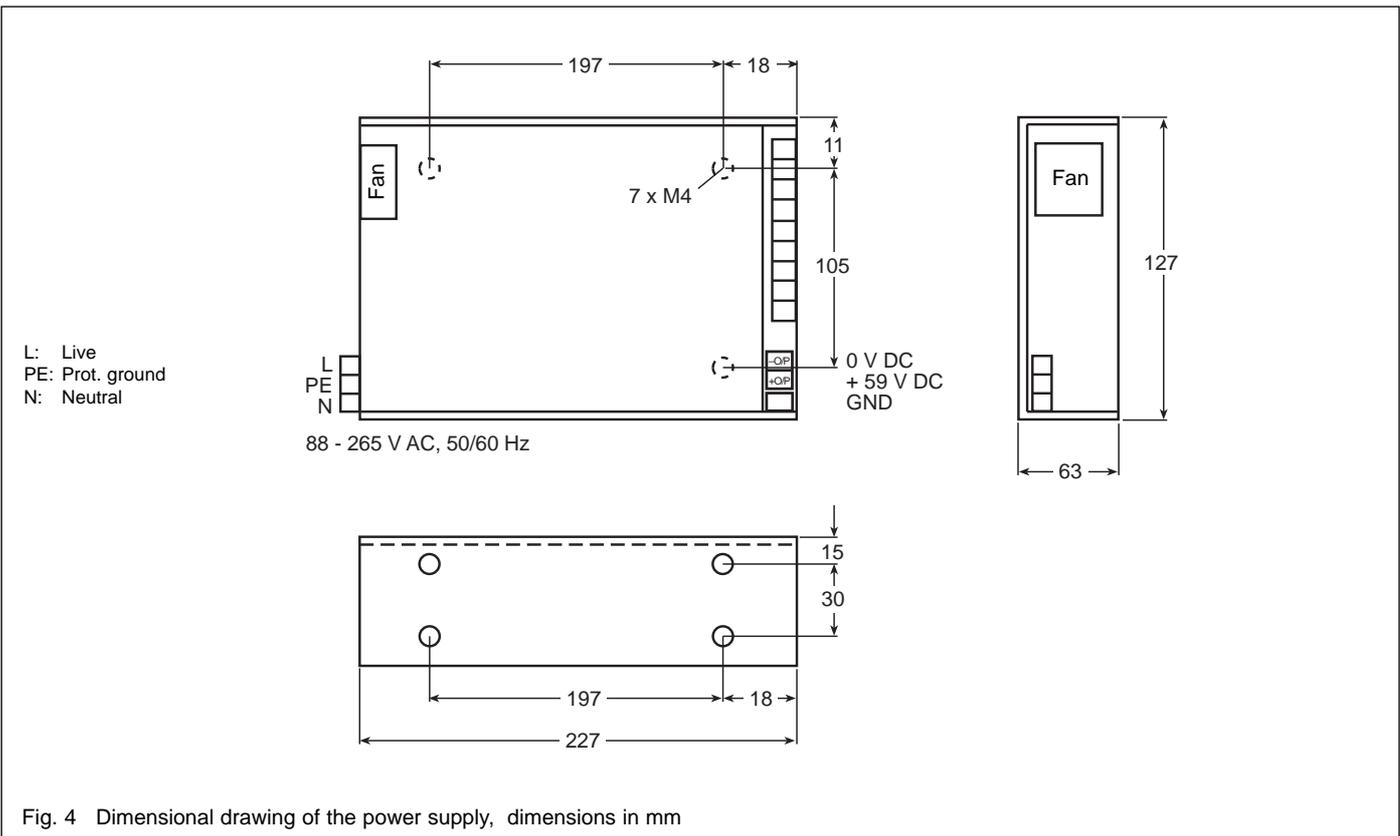


Fig. 4 Dimensional drawing of the power supply, dimensions in mm

2 Connections

Caution

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 at the beginning 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)

Caution

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

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.

Warning



During operation the pump can become so hot that there is a danger of receiving burns (up to approx. 80°C).

Provide protection against contact with the hot components.

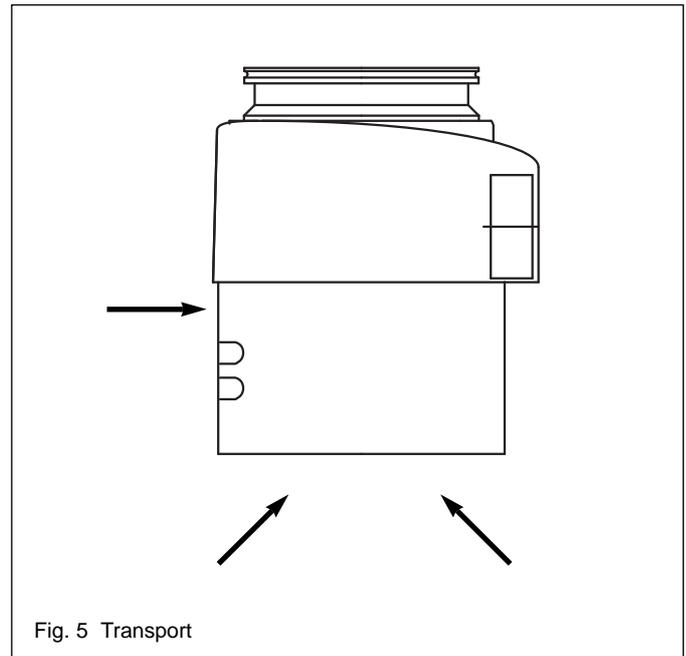


Fig. 5 Transport

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

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.

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 10³ Gy.

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

1 Gy (Gray) = 100 rad

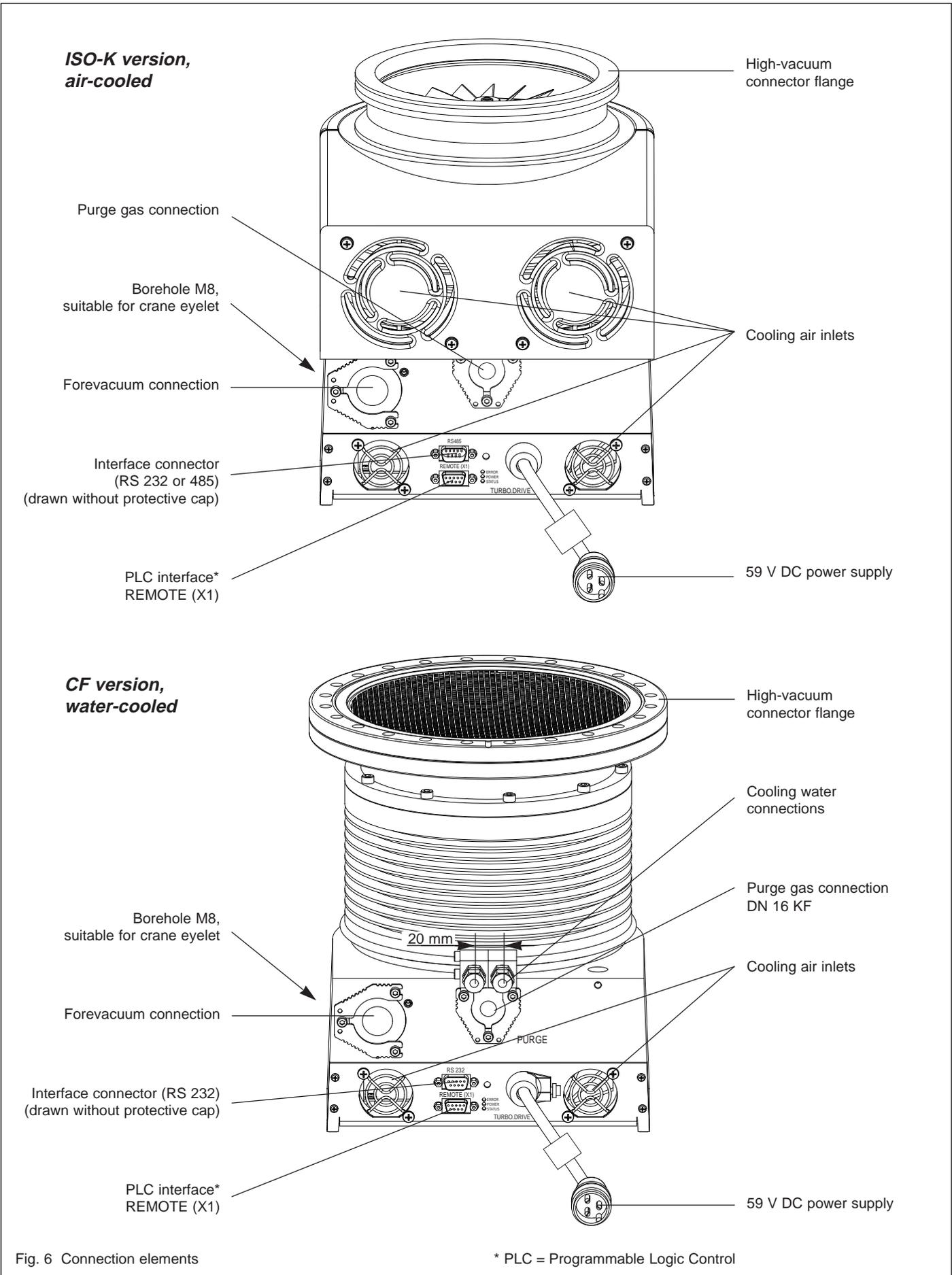


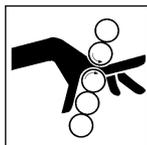
Fig. 6 Connection elements

2.2 Attaching the pump to the vacuum chamber

Warning



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.

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.

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.

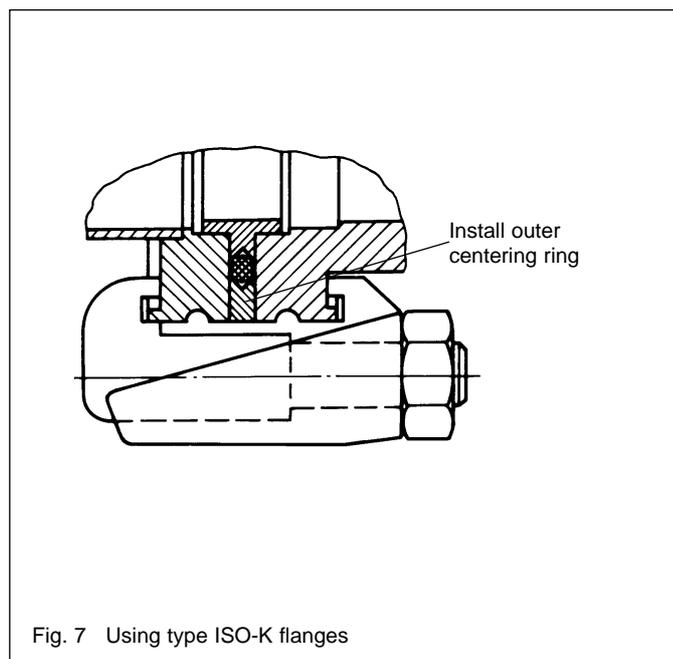


Fig. 7 Using type ISO-K flanges

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.

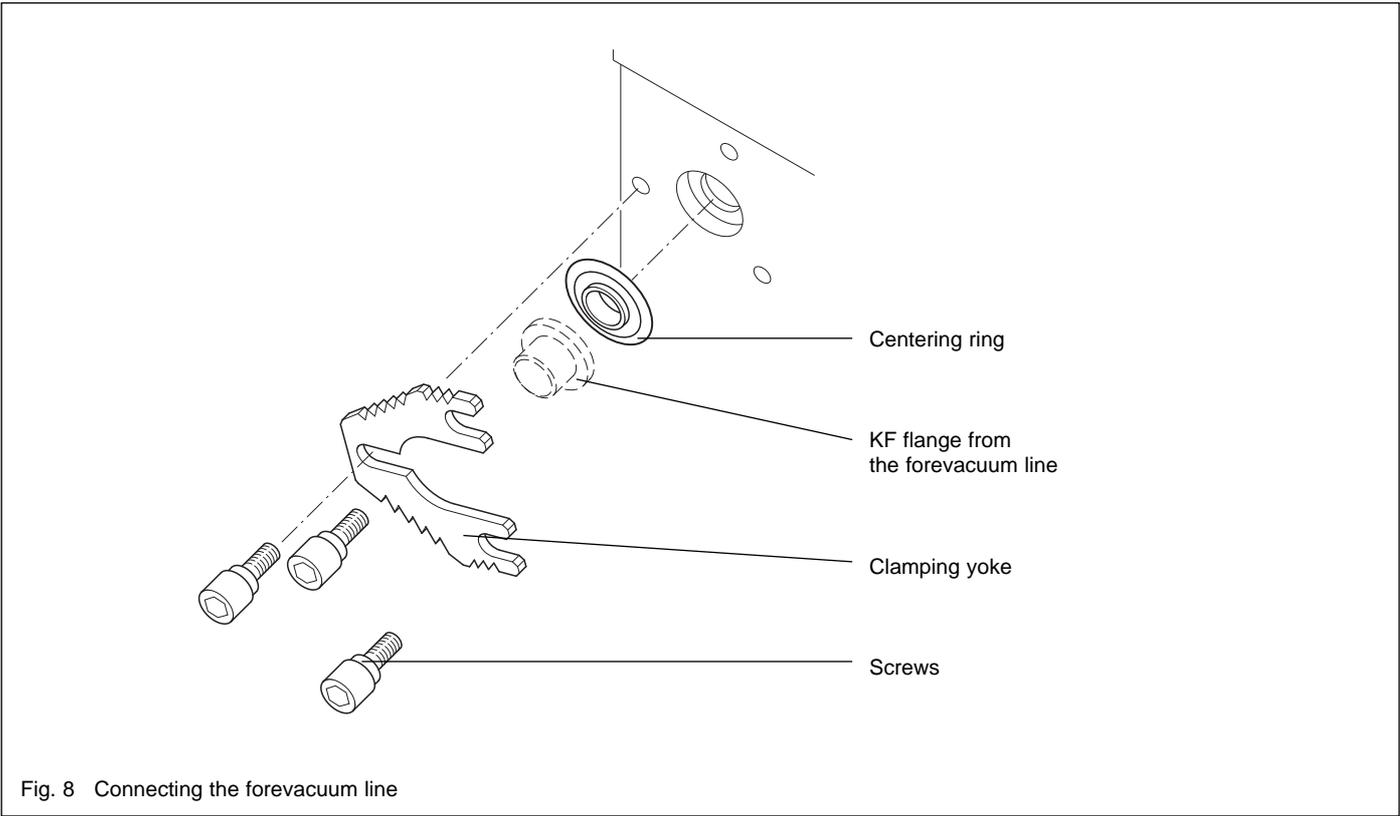


Fig. 8 Connecting the forevacuum line

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; refer to Figure 8.

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.

Warning



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

Figure 9 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.

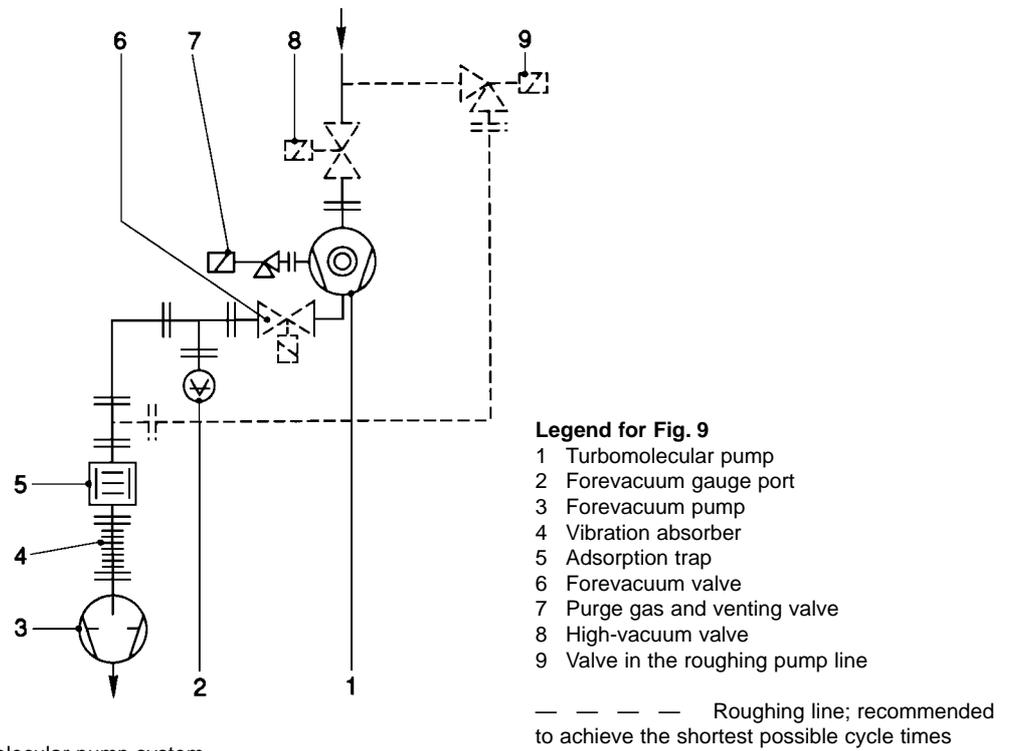
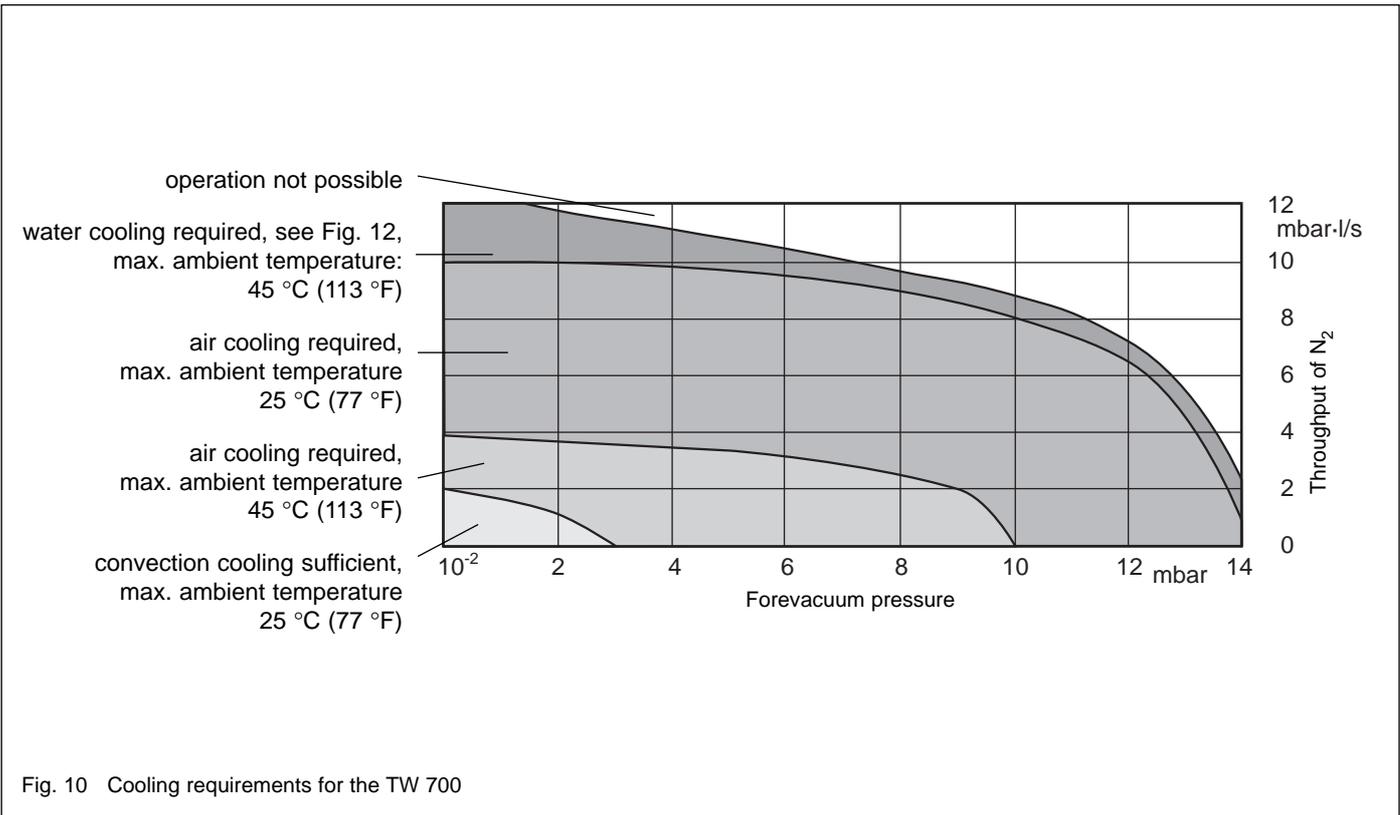


Fig. 9 Schematic of a turbomolecular pump system



2.4 Cooling the pump

The cooling for the TW 700 depends on the required pump performance and the ambient temperature; see Fig. 10. The pump will be switched off in case of insufficient cooling.

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. 11.

Water 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.

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.

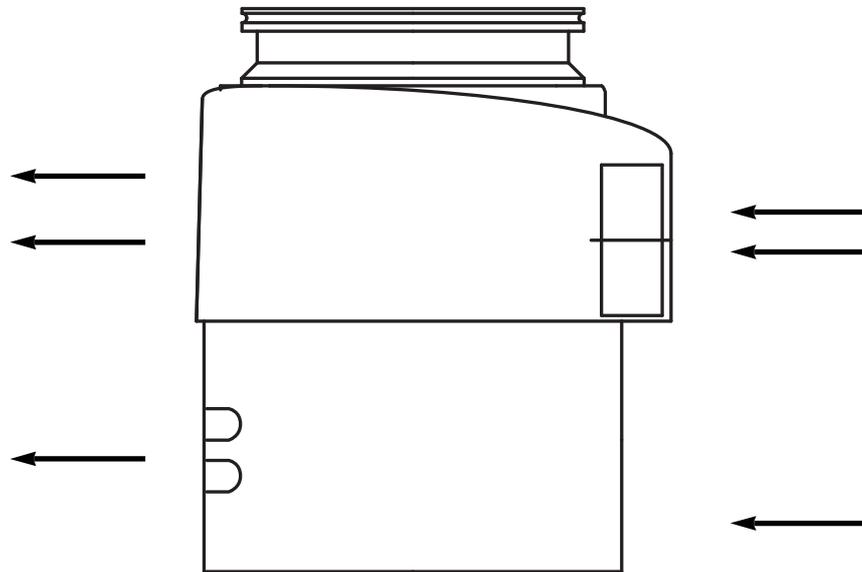


Fig. 11 Cooling air flow pattern

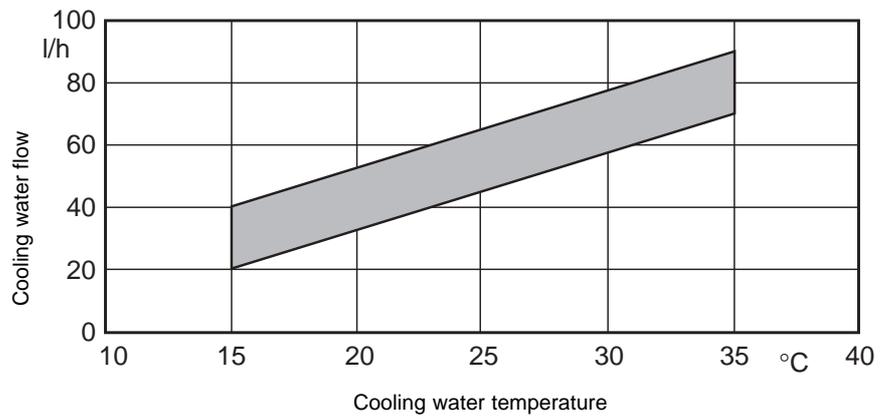
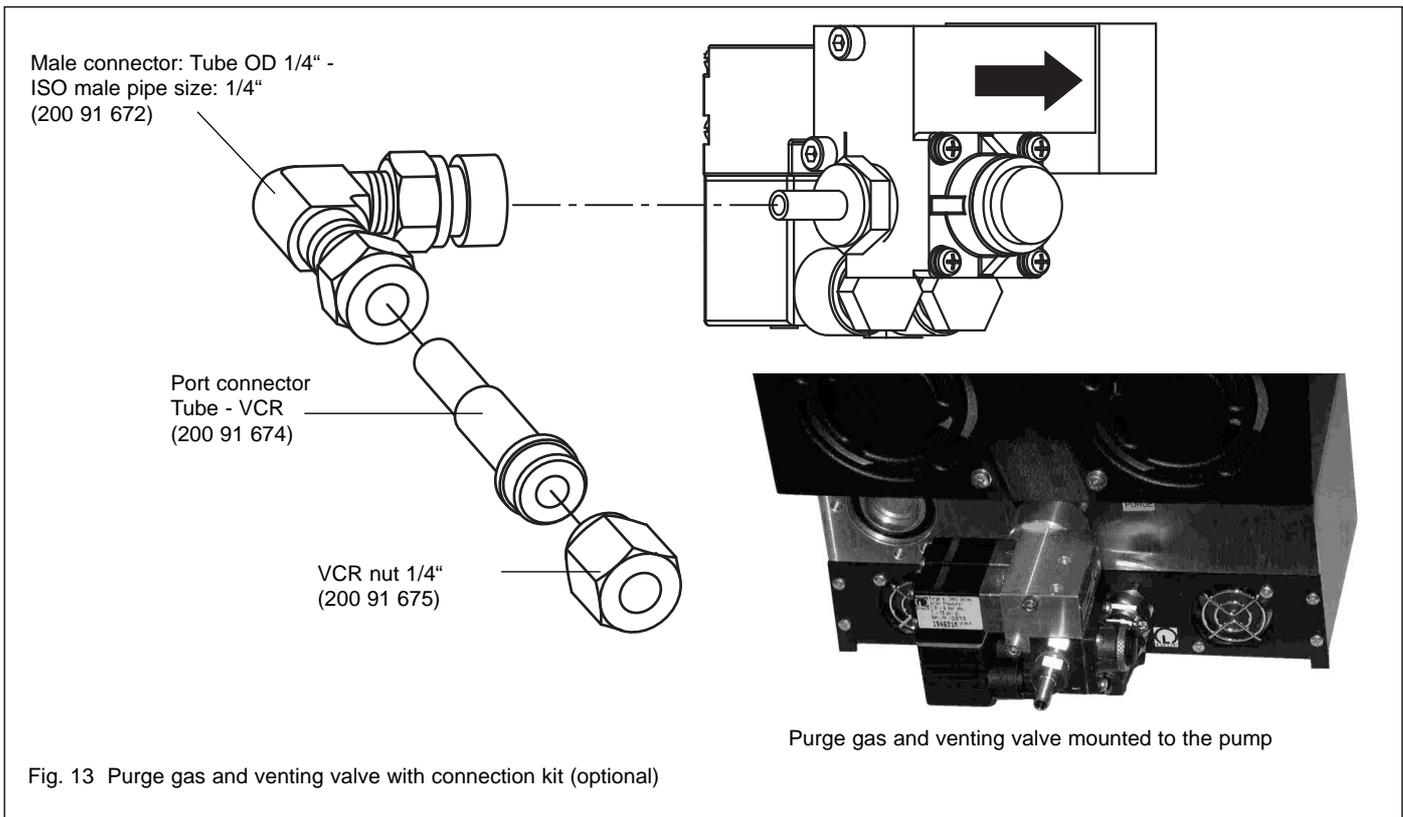


Fig. 12 Cooling water requirement



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).

Change the filters after some time, at least annually.

When operating the TW 700 with purge gas, the pump needs to be vented via the purge gas valve after having shut down the pump (see Section 3.3).

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:

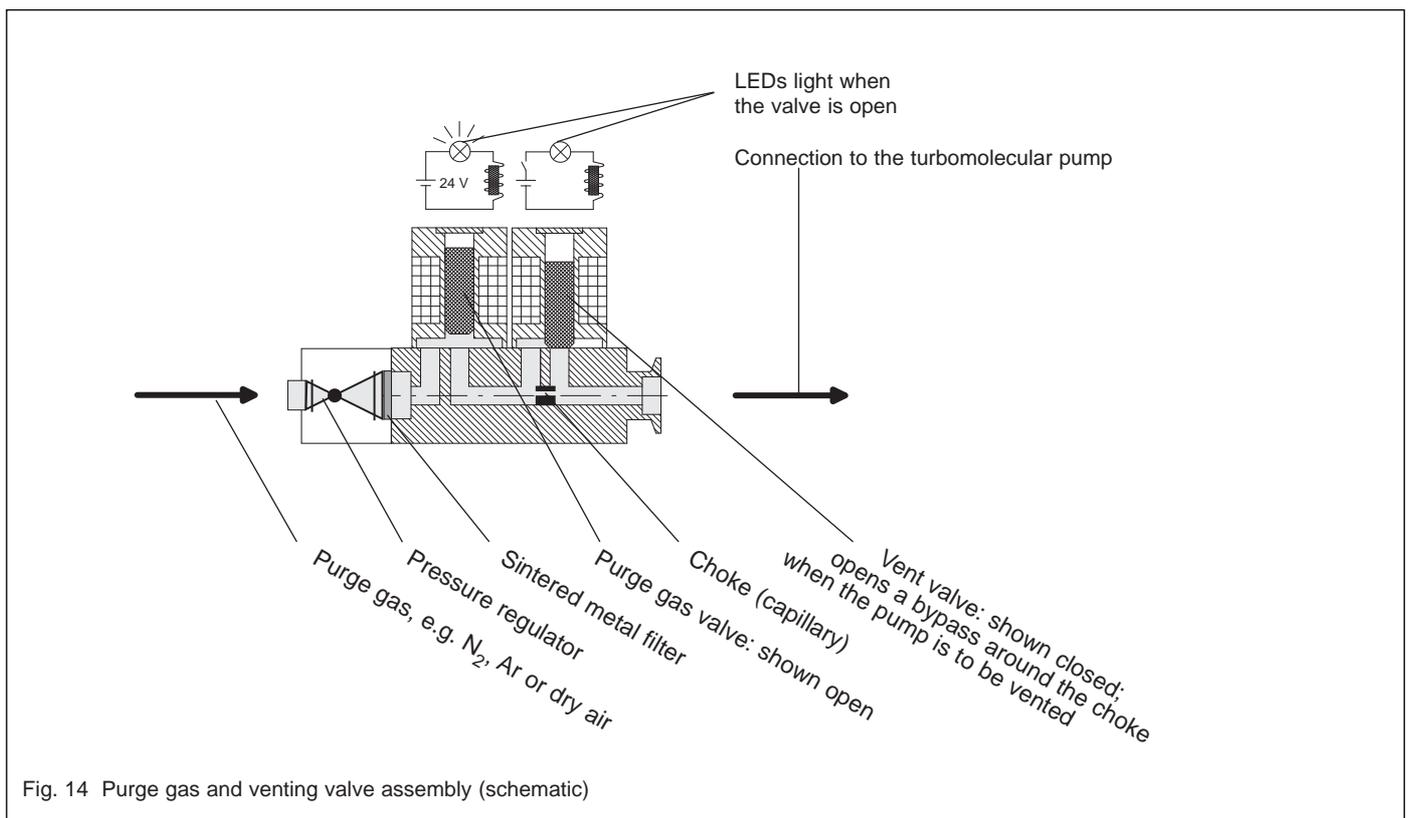
- At inlet pressures between 1.5 and 6.0 bar the purge gas flow is maintained at a constant level.
- Motor and ball bearings are protected against dust containing gases.
- Chemical reactions with the grease in the ball bearings are avoided.
- The TW 700 is vented reliably.

Depicted schematically in Fig. 14 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.

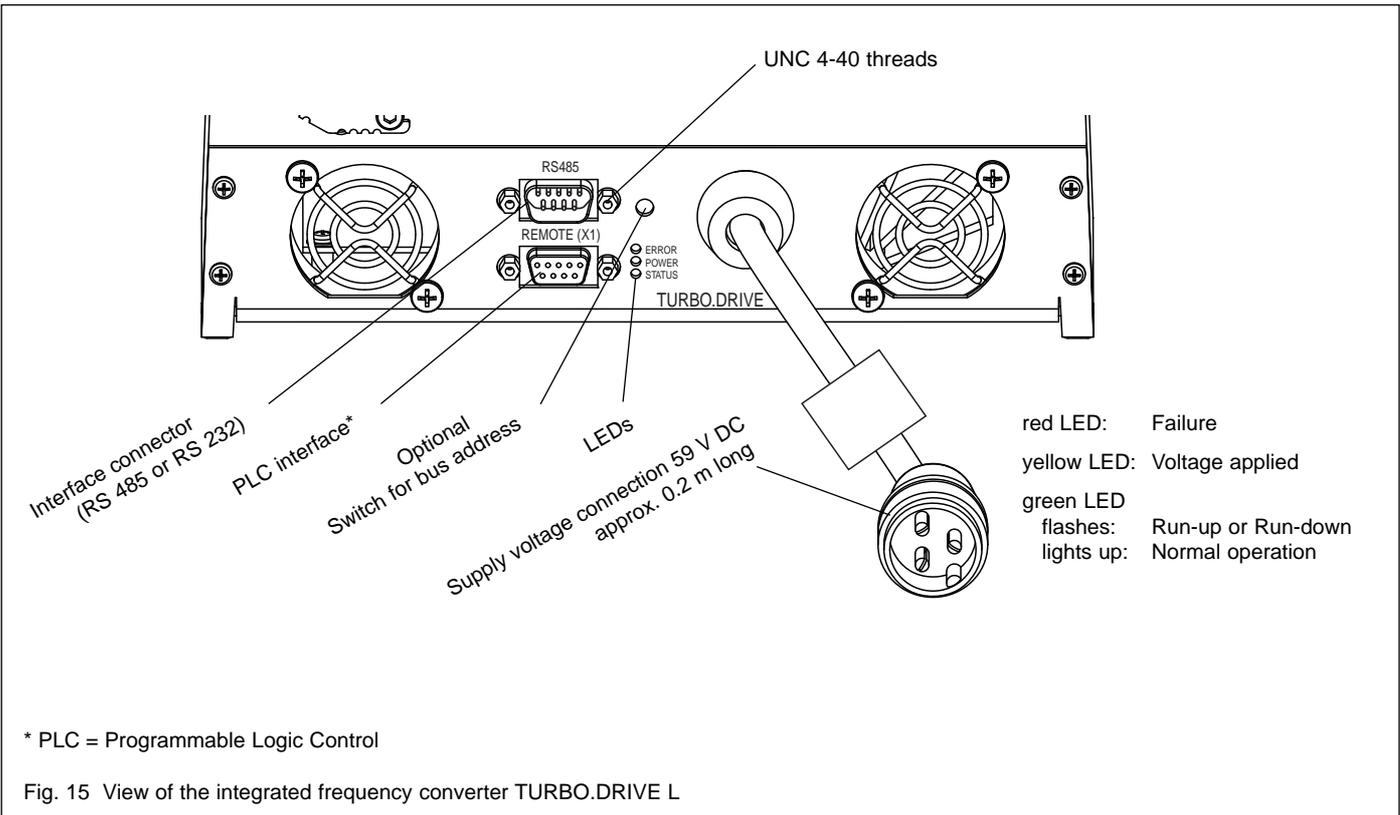
In the operating mode "venting" both the purge gas and the venting valves are open. Thus the pump is mostly vented via the choke's bypass.

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 6.0 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 ⁻⁷ 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



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 (VDE 0100, Part 410, or local regulations) (SELV).

The OEM power supply unit must only be connected by a trained electrician in the sense of the VDE (Association of German Electrotechnical Engineers).

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.

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

Caution

Ensure correct polarity; see Fig. 16 and 17.
 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.

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

Caution

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.

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.

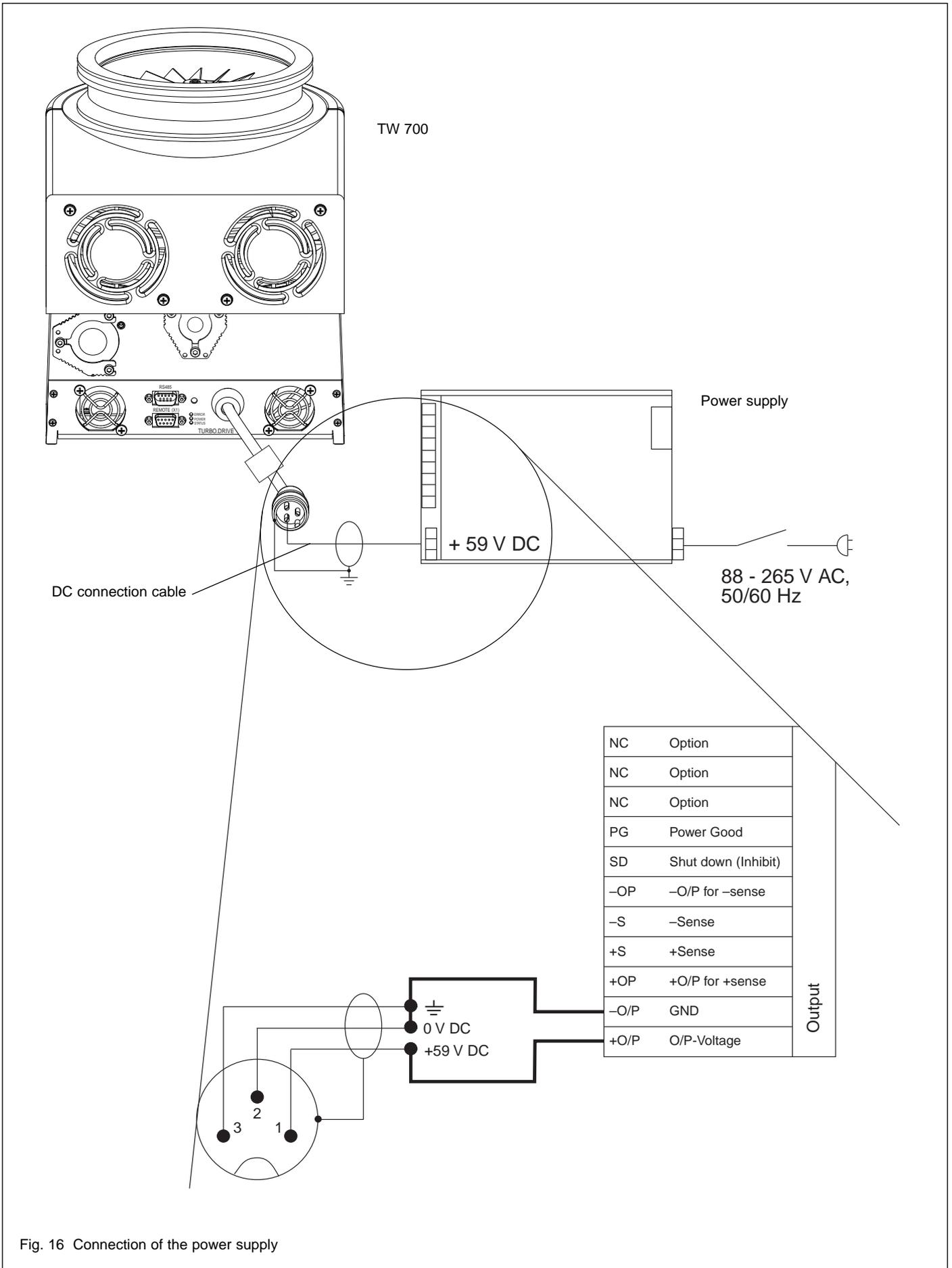


Fig. 16 Connection of the power supply

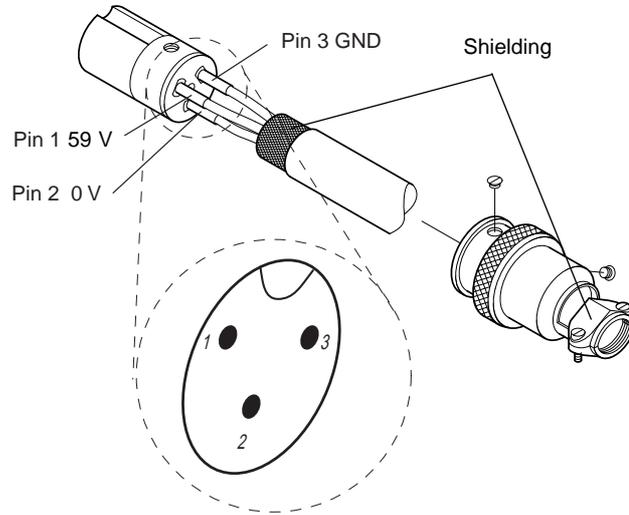
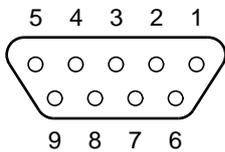
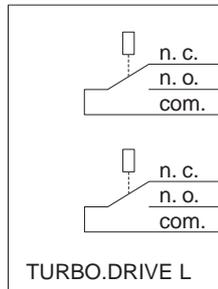


Fig. 17 Required pin assignment of the 3 pole connector model Hirose HS21P-3; view from the soldered side

Pin assignment of the connector



Relay operation



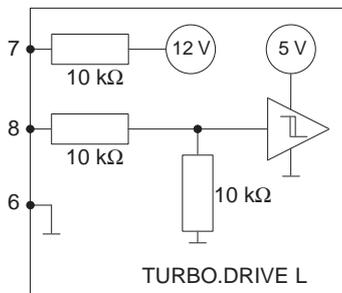
Relay - Normal operation (standard setting)

- While deceleration, acceleration, Stop: 4 connected to 5 (as shown; passive)
- During normal operation ($f > 0,9 \cdot f_{nom.}$): 4 connected to 3 (active)

Relay - Error

- No error: 1 connected to 2 (as shown; passive)
- Error is present: 1 connected to 9 (active)

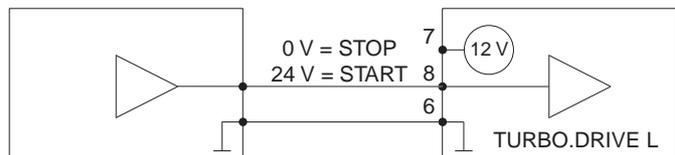
Pin assignment for the Start/Stop input



Switching threshold for the Start/Stop control input:
 Low level: $< 3 \text{ V}$
 High level: $> 7 \text{ V}$

Start/Stop operation

Example 1: Operation via a PLC



Example 2: Operation via contacts

Contact open = STOP
 Contact closed = START

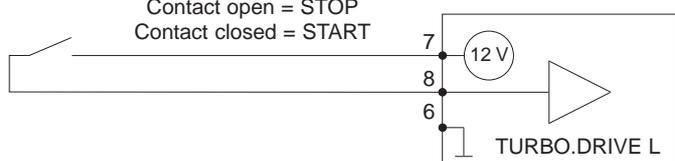


Fig. 18 Pin assignment of the REMOTE (X1) connector

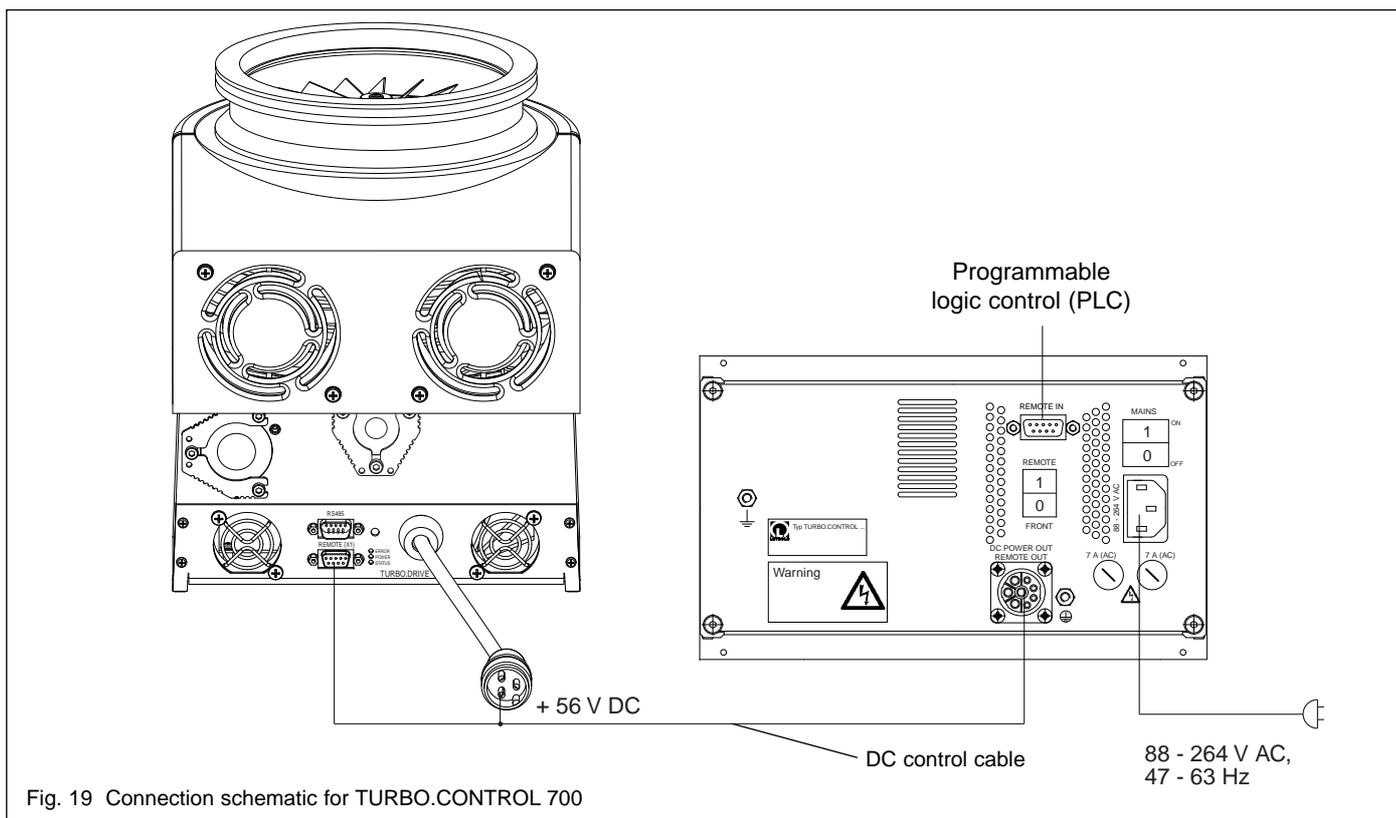


Fig. 19 Connection schematic for TURBO.CONTROL 700

Relay status (standard settings)

Input data / status				Output data					Operating mode
Start/ stop signal	Pump rotating	Normal frequency $\geq 90\%$ of setpoint frequency	Error is present	Motor drive	Relay NORMAL OPERATION (see Fig. 18)	Relay ERROR (see Fig. 18)	LED STATUS (green)	LED ERROR (red)	
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

Other modes are not possible; they indicate a failure affecting the TURBO.DRIVE.

2.7 Interface description

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

- RS 232
- RS 485

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

The PC software "TURBO.DRIVE Server" and the display "Palm M100/105" 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"> • Improved reliability of sensitive production processes in a vacuum 	Monitoring of: <ul style="list-style-type: none"> • Motor current P5 • Ball bearing temperature P125 or P127 • Motor temperature P7 • Frequency converter temperature P11
Standby operation	<ul style="list-style-type: none"> • Extending the service life for the ball bearings • Cutting energy consumption 	Reducing the rotor's frequency through P24
Troubleshooting	Quick analysis of problems	Reading of error memories P171 and P176
Slow pressure control by changing the pumping speed	Dispensing with a flow controller	Changing the rotor frequency through parameter 24
Reducing the maximum motor current	Cost savings through smaller power supply units if peak loads can be reduced	With P17, maximum motor current
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
Lowering the normal operation threshold	Normal operating mode is attained faster, processes can be started faster	Reduce frequency threshold through P25

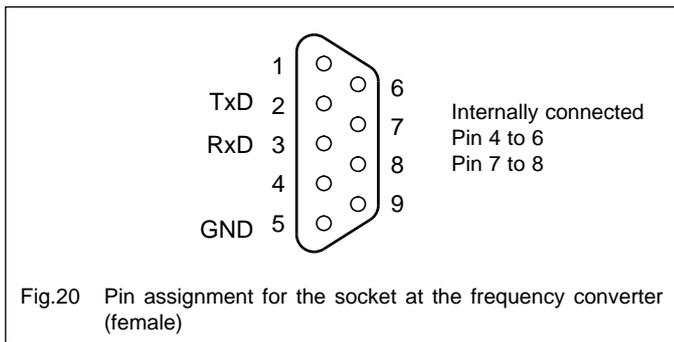


Fig. 20 Pin assignment for the socket at the frequency converter (female)

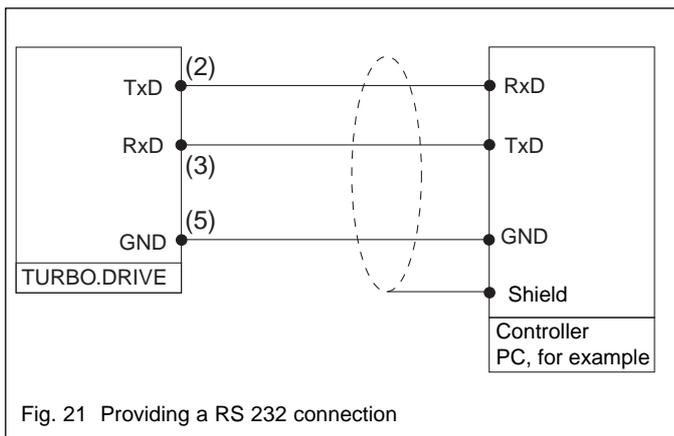


Fig. 21 Providing a RS 232 connection

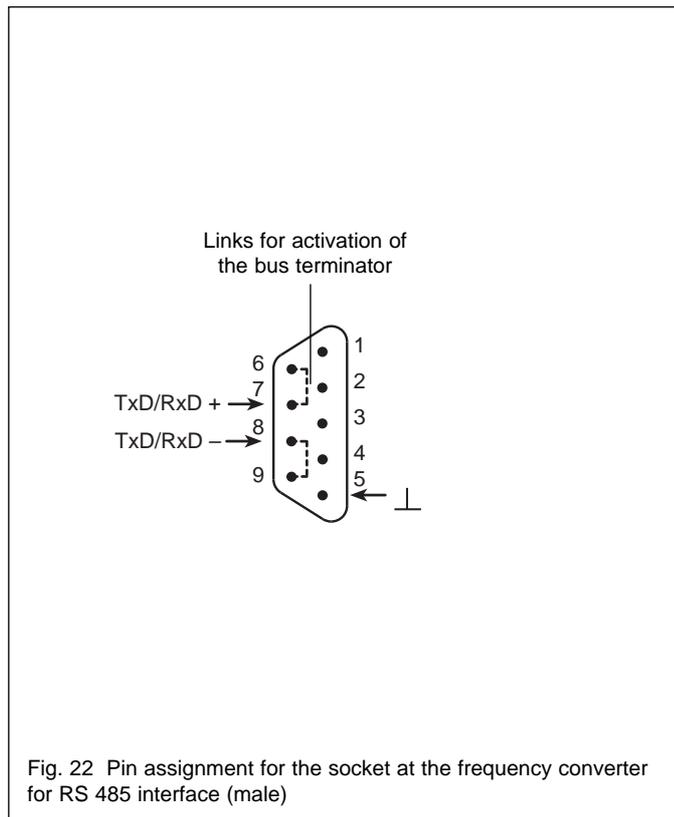


Fig. 22 Pin assignment for the socket at the frequency converter for RS 485 interface (male)

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.

RS 485 interface

Standards	ISO 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.

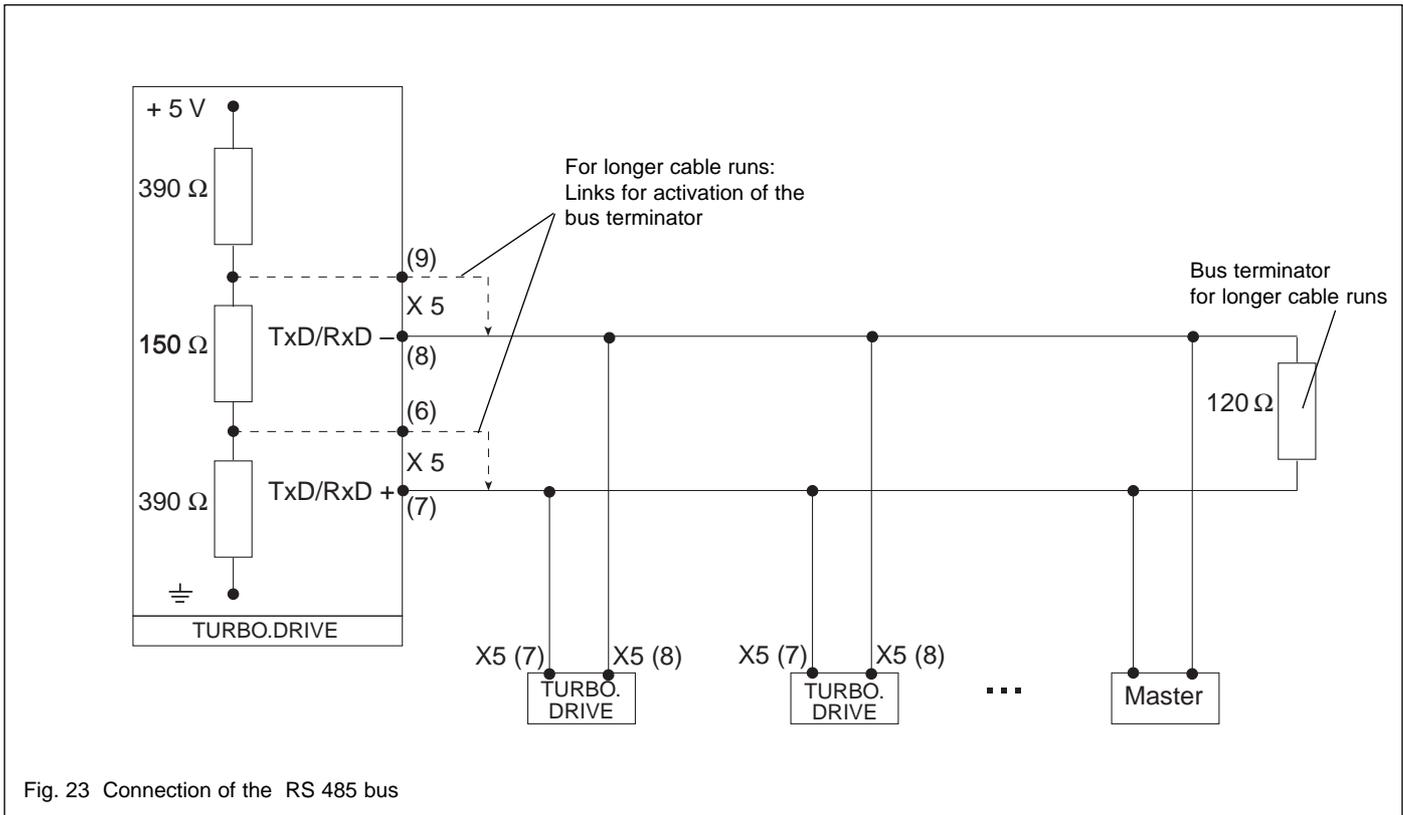


Fig. 23 Connection of the RS 485 bus

Parameter list

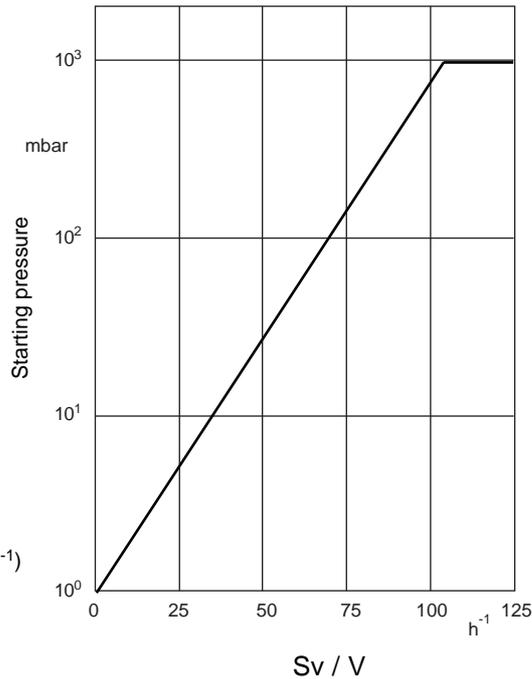
r = readable, w = writable

No.	Designation	Range	Unit	Default	Format	r/w	Description
0	Dummy parameter	-	-	-	U16		No function
1	Type of frequency converter	130 / 131	-	-	U16	r	TURBO.DRIVE L = 131
2	Software version	e.g. 2.02.01	-	-	U16	r	
3	Actual rotor frequency	0...800	Hz	-	U16	r	The max. frequency depends on the pump type.
4	Actual converter supply voltage		V	-	U16	r	Nominal value for TURBO.DRIVE L: 59 V
5	Setpoint for the motor current	0... 75	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.
11	Actual converter temperature	0...150	°C	-	U16	r	Measured internal converter temperature
12	Operating mode for Start/Stop	0...2	-	0	U16	r/w	P12 = 0 (default): via REMOTE (X1); see Fig. 18 P12 = 1: via serial interface P12 = 2: Start: REMOTE (X1) at Start and serial interface sends Start signal Stop: REMOTE (X1) at Stop or serial interface sends Stop signal
17	Max value setting for motor current	5 ... 75	0,1 A	75	U16	r/w	Maximum permissible motor current
18	Nominal pump frequency	800	Hz	800	U16	r	Highest permissible frequency
19	Minimum setpoint frequency for the pump	550	Hz	550	U16	r	Lowest permissible frequency
20	Minimum frequency level	550	Hz	550	U16	r	When the pump is accelerating this frequency must be reached within the maximum passing time (P183).
23	Pump type	1	-	1	U16	r	1 = TW 700
24	Setpoint frequency	P19 ... P18	Hz	800	U16	r/w	Adjustable between P19 to P18
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 $P5 \leq P27$
29	Selection of the normal operation function	0 / 1	-	0	U16	r/w	Normal operation relay function: 0 = frequency dependent (see P25) 1 = current dependent (see P27)

No.	Designation	Range	Unit	Default	Format	r/w	Description
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 x 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
125	Current bearing temp.	0...150	°C	-	U16	r	Measured bearing temperature (identical to P127)
127	Current bearing temp.	0...150	°C	-	U16	r	Measured bearing temperature (identical to P125)
132	Bearing temperature shutdown level	30...150	°C	65	U16	r	Max. permissible bearing temperature; P125 > P132 causes the pump to be switched off
133	Motor temperature shutdown level	30...150	°C	85	U16	r	Max. permissible motor temperature; P7 > P133 causes the pump to be switched off
171	Error code memory for the last 8 error events Error codes see table on the following page	0...8		0	Array 0..7 U16	r	Sequential permanent memory; the last error code which has occurred is saved at the memory location with the index 0, the oldest is at index 7
176	Error operating hours memory for the last 8 error events	0...19 years	0.01 h	-	Array 0..7 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 USS 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
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 In case of an error P303 has the value of 0 (not ready to be switched on)
312	Cat. No. code	0 ... 65535	-	-	U16	r	8000yyV00xx = yyxx
315	Serial No. code	1 ... 2 ³¹ -1	-	-	U32	r	The 9 least significant bits of the original serial No.
316	Hardware identifier	0...100	-	2	U16	r	Hardware version index of the converter

Error codes for parameter P171

Code	Type of error	Description of the error
0	No error	–
1	Overspeed error	Nominal speed of the pump (P 18) has been exceeded by over 10%
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
3	Bearing temperature error	Maximum bearing temperature has been exceeded: P125 > P132; P127 > P132
4	Short circuit error	Short circuit in the pump's motor or the connecting cable
5	Converter temperature error	Maximum temperature for the converter has been exceeded: P11 > 65°C
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
7	Motor temperature error	Maximum motor temperature has been exceeded: P7 > P133
8	Pump error	Pump could not be identified or no pump is connected.



Sv = Pumping speed of the forevacuum pump (m³·h⁻¹)
 V = Volume of the vacuum chamber (m³)

Fig. 24 Determining the starting pressure of a turbomolecular pump when evacuating large volumes

3 Operation

Warning



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

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 24.

Switch on the turbomolecular pump

- via pins 7 and 8 of the socket REMOTE (X1) (see Fig. 18) (For example via a remote control or with the aid of the plug with integrated ON/OFF switch: see Section 1.2 Ordering data).
- by a start command via the interface; see Section 4.
- 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.

Warning



During operation the pump can become so hot that there is a danger of receiving burns (up to approx. 80°C, 176 °F).

Warning



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

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) (see Fig. 18), 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.

Switch off the forevacuum pump.

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.

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.

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.

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.

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.

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, see Fig. 25.

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.

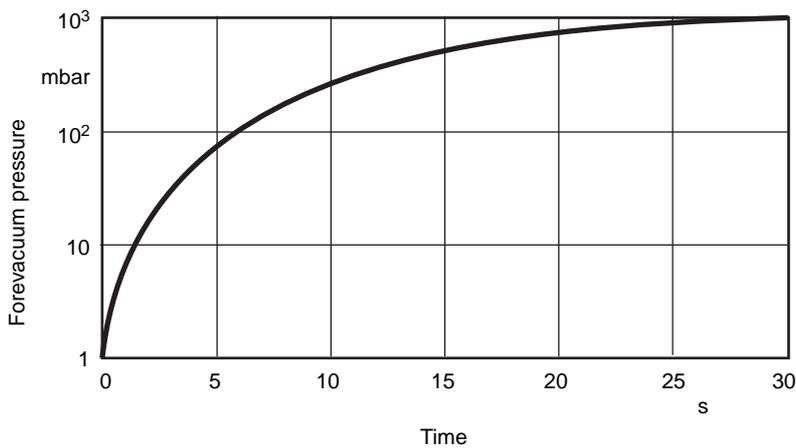


Fig. 25 Rise in pressure

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. In addition, the TURBOVAC can be baked out using the flange heater provided for this purpose.

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.

3.4 Removing the pump from the system

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

Warning



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

Corrosion damage due to faulty packing will void the warranty.

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 4.2 if you forward the pump to Leybold.

4 Maintenance

After 15,000 operating hours at the latest a standard bearing exchange will be required. 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).

When using an adsorption trap

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

Caution

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

4.1 Cleaning

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

4.2 Service by LEYBOLD

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.

A copy of the form is printed at the end of these operating instructions: „Declaration of contamination of vacuum equipment and components“.

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.

5 Troubleshooting

Warning



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

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?

- Mains connection,
- 59 V DC cable to the frequency converter,
- Connector cable between the frequency converter and the pump

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 the serial interface or by switching the mains power off.
- In case of error code 8 by switching the mains power off.

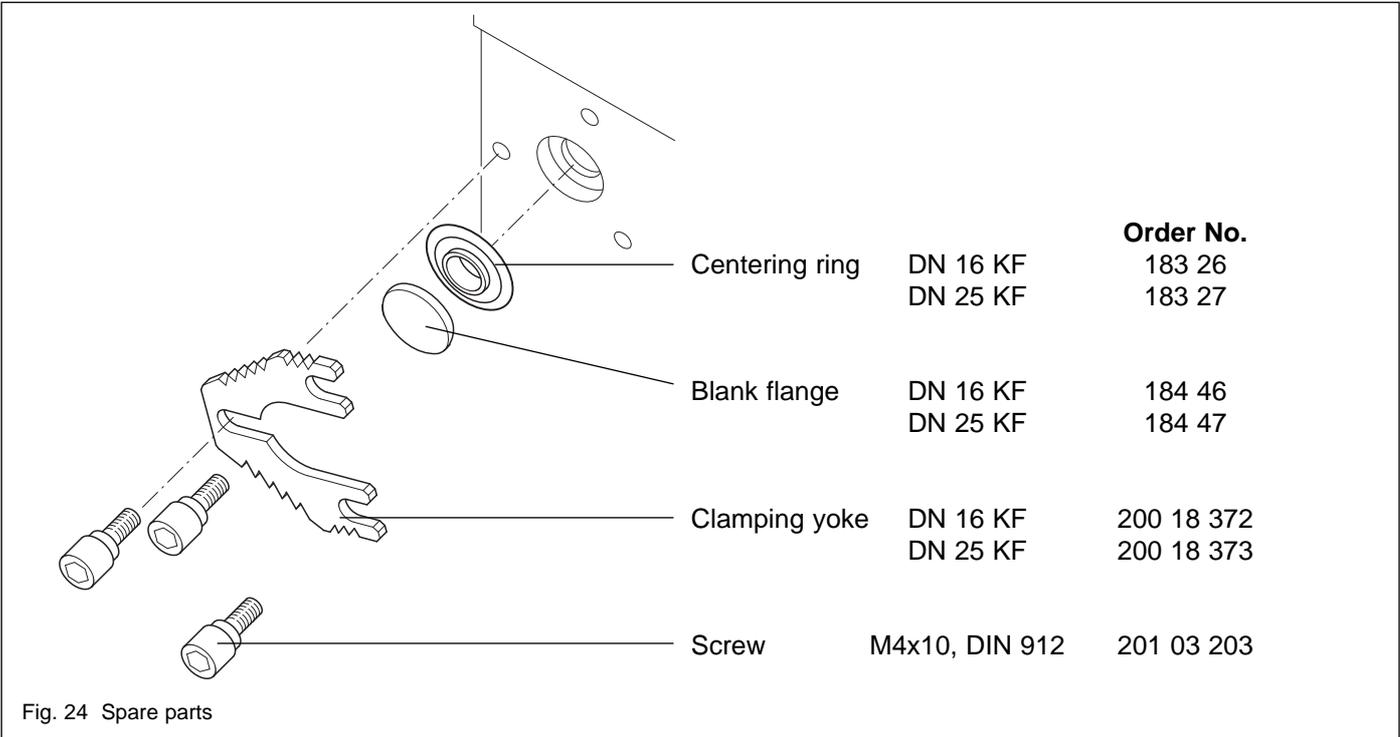
The error codes can only be read if a serial interface is present.

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

Malfunction	Possible cause	Corrective action
Red ERROR LED is on: Error code 1: Overspeed error	EMC problems TURBO.DRIVE faulty	Check connecting cable, insert it properly. Switch the power supply voltage off and then on again Inform Leybold Service.
Red ERROR LED is on: Error code 2 or 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. Gas volume too great. Power supply overloaded Power supply voltage output too low. Bearing defective.	Check the forevacuum pump and use a different forevacuum pump if necessary. Seal leak; install a higher-capacity vacuum pump if necessary. Reduce the number of consumers or use a stronger power supply or switch on the consumers one after the other. Use another power supply. Have the pump repaired (may be done only by a Leybold service technician).
Red ERROR LED is on: Error code 3 or 7: bearing temperature error and motor temperature error	Forevacuum pressure too high. Gas volume too great or leak in the system. Fan defective. Ambient temperature too high. Bearing defective.	Check the forevacuum pump and use a different forevacuum pump if necessary. Seal leak; install a higher-capacity vacuum pump if necessary. Replace the fan (may be done only by a Leybold service technician). Feed cooler air to the pump or install water cooling. Have the pump repaired (may be done only by a Leybold service technician).
Red ERROR LED is on: Error code 4: Short circuit error	Short circuit in the pump's motor Short circuit in the connecting cable	Inform Leybold Service. Check to see if the connecting cable is undamaged, exchange it if required.

Malfunction	Possible cause	Corrective action
Red ERROR LED is on: Error code 5: converter temperature error	Inadequate cooling of the pump operation at too high loads Ambient temperatures too high. Inadequate cooling of the TURBO.DRIVE.	See corrective action for error code 3 / 7. Improve the cooling situation: E.g. avoid exposure to the heat generated by other equipment.
Red ERROR LED is on: Error code 8: pump error TURBO.DRIVE can not detect the type of connected pump.	Power supply builds up the DC too slowly Power supply overloaded	Use power supply recommended by Leybold Reduce the number of consumers when switching on or use a stronger power supply.
Yellow power LED is not on.	No DC power Internal fuse has blown	Check cables and power supply. Disconnect the power at the power supply for 5 seconds and re-connect. Inform Leybold Service. The following may cause a blown fuse: <ul style="list-style-type: none"> • DC power miswired • Disconnection of the DC cable while the pump was still rotating • Non-compliance with the note related to connecting several pump to a single power supply.
Green LED blinks, yellow LED lights weaker.	Frequency converter faulty.	Wait some minutes until the pump comes to a standstill, then disconnect the power at the power supply for 5 seconds and re-connect.
Turbomolecular pump does not start, ERROR LED does not light, yellow power LED lights.	Operation mode set wrongly, e.g. with TURBO.DRIVE Panel or Server. Interface protocol error No communication via the serial interface. REMOTE connector (X1) connected wrongly. DC supply ≤ 53 V or ≥ 63 V.	Change parameter 12. Use USS protocol. Connect bus as shown in Section 2.7. Observe bus termination. Connect as shown in Fig. 18. Improve DC supply.
Turbomolecular pump produces loud running noises and vibrations.	Rotor out of balance. Bearing defective.	Switch off the pump immediately. Then have the rotor balanced by a Leybold service technician. Switch off the pump immediately. Then have the bearing replaced by a Leybold service technician.
Turbomolecular pump does not reach ultimate pressure.	Measurement instrument defective. Measurement sensors soiled. Leaks at the equipment, lines or the pump. Pump soiled. Forevacuum pump provides insufficient pumping speed or ultimate pressure which is too high. Frequency parameters programmed wrongly.	Inspect the measurement sensor. Clean or replace the sensors. Check for leaks. Have the pump cleaned (may be done only by a Leybold service technician). Check the ultimate pressure of the forevacuum pump and install a higher-capacity vacuum pump if necessary. Check parameter 24; observe Section 2.7.
Running pump cannot be stopped via X1.	Pump has been started via the serial interface. Serial interface has the control priority.	Interrupt DC connection or connect serial bus and stop the pump via the serial interface. Check parameter 12.

6 Spare parts



Spare parts which may only be changed by the Leybold service

	Order No.
Frequency converter	
with RS 232 interface	800071V0002
with RS 485 interface	800071V0003
Fan	200 15 099

EEC Manufacturer's Declaration

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



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.

At the same time we herewith certify conformity with the EEC Directive on Low-Voltages 73/23/EWG and the EMC Directive 89/336/EWG.

When using the appropriate Leybold accessories, e.g. connector lines, valves, or fans, the protection level prescribed in these Directives will be attained.

Designation: Turbomolecular pump

Model: TW 700

Catalog numbers: 800051V0001 to
800051V0007

Applied harmonized standards:

- | | |
|---------------------|-----------|
| • EN 292 Part 1 & 2 | Nov. 1991 |
| • EN 1012 Part 2 | 1996 |
| • EN 60 204 | 1993 |
| • EN 61 010-1 | 1993 |

Applied national standards and technical specifications:

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

Cologne, June 27, 2002

Dr. Beyer, Design Dept. Manager

Cologne, June 27, 2002

Henry, Project Manager
Turbomolecular pumps



**NRTL
LISTED**



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



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