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# TURBOTRONIK NT 30 M

Electronic
Frequency converter

Cat. No.
857 25/26/27

**Operating Instructions**

***Contents***



***Warning***

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

***Caution***

Indicates procedures which must be strictly observed to prevent damage to or destruction of the TURBOTRONIK.

***Figures***

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

We reserve the right to alter the design or any data given in these Operating Instructions.

The illustrations are not binding.

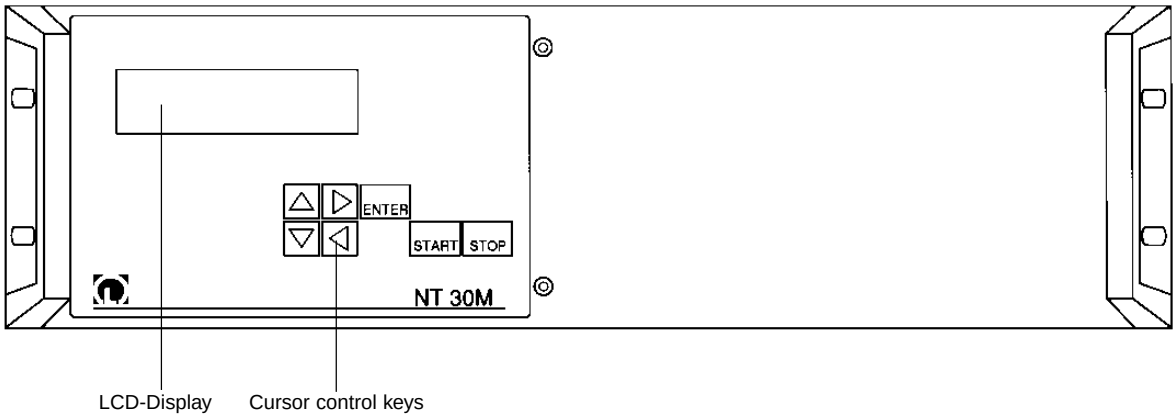



Fig. 1 Front panel

# 1 Description

## 1.1 Design and Function

The TURBOTRONIK NT 30 M is an electronic frequency converter used to drive the MAG 1200 C and 1200 CT turbomolecular pumps.

The TURBOTRONIK converts the single-phase mains voltage into a regulated DC power supply. The unit's electronic circuitry then switches this DC power supply cyclically to the four stator windings of the DC motor (non-commutator type) in the MAG.

This electronic control system, utilizing Hall probes, eliminates the commutator normally found in DC motors. A digital controller keeps motor speed constant.

The TURBOTRONIK also powers and regulates the magnetic bearing unit. Switching the motor to the generator mode keeps the magnetic bearing unit in operation even in case of a mains power failure.

A counter-current braking system makes it possible to decelerate the pump down to a standstill.

Sensors integrated into the MAG and the TURBOTRONIK ensure safe and reliable operation of the entire system. Potential-free external control and monitoring equipment such as the LEYBOTRONIK I can be connected by means socket-type terminals located at the rear; these terminals are used both for remote control operation and to pick up the status signals for the pump system.

Control for the forepump, the heater, the valves and a temperature regulation for the MAG is possible.

An RS-232 interface provides a print-only mode for test purposes.

At the front of the TURBOTRONIK are the START, STOP and ENTER keys, four cursor-control keys and an LCD display with two lines of 16 characters each. These are used to control the pump, read out information and modify settings for the TURBOTRONIK.

## 1.2 Standard Specifications

- Electronic frequency converter with housing
- Two power cords, 2.5 m long
- Microfuses: 4 x T[1)] 10 A, 2 x F[2)] 8 A, 2 x T[1)] 2.5 A,
- Three equipment plugs
- Two 16-pole Phoenix plugs
- One 8-pole Phoenix plug
- 2-pole coupler socket

1) T = slow-blow
2) F = fast-blow

# 1.3 Technical Data

| | |
|---|---|
| Mains voltage, with selector switch | 100/120/200/230 V,±10% |
| Mains frequency | 50/60 Hz |
| Power drawn by the MAG (drive and bearing) | 1000 VA |
| Max. power for peripheral units (separate mains plug) | 10 A |
| Nominal MAG speed | see the pump's oper. instr. |
| Minimum MAG speed | 6,000 rpm |
| Output for the motor | |
| Nominal voltage | 55 V |
| Current limitation | |
| without temperature control | 3 A |
| with temperature control | 3.5 A |
| during acceleration | 10 A |
| Output to the magnetic bearing unit | |
| Rated voltage | 40 V |
| Current limiting | 10 A |

***Control inputs***

| | |
|---|---|
| | digital, zero-potential |
| per terminal | 25 $V_{eff}$. AC, 60 V |
| DC | |
| | against protective ground |
| | compatible with LEYBOTRONIK I |
| high level between „+" and „-" terminals | 13 to 33 V / max. 10 mA |
| low level between „+" and „-" terminals | 0 to 7 V |
| Pulse duration for control inputs | > 200 ms |

***Analog input for speed setpoint***

| | |
|---|---|
| | not isolated from potential |
| Adjustment range | 0 to 10 V |
| Rated speed | 0 V |
| Minimum speed | 10 V |

***Control outputs***

| | |
|---|---|
| Relay | |
| Current | max. 2 A |
| Voltage | max. 120 V AC or 50 VDC, for mains and low voltage max. 250 V AC, if only mains is switched |
| NORMAL | N. O. contact |
| ACCEL | N. O. contact |
| FAIL | change-over contact |
| READY FOR PROCESS | N. O. contact |
| Analog voltage | 0 to 10 V |
| proportional to the speed or the motor current, or base flange temperature | |
| Load capacity | max. 5 mA |
| Ripple | < 30 mV |
| Measured value refresh | |
| Speed | 1s |
| Motor current | 0.2 s |
| Basic flange temperature | 0.6 s |
| Time constant | |
| Speed | - |
| Motor current | ≈ 5 s |
| Basic flange temperature | ≈ 5 s |
| Accuracy | |
| Speed | < 3% |
| Motor current | < 5% |
| Basic flange temperature | < ±3°C |
| Resolution for 0...10 V | |
| Speed | 320 Steps |
| Motor current | 256 Steps |
| Basic flange temperature | 320 Steps |
| Reference voltage (potentials for speed potentiometer and remote control inputs are not isolated) | 15 V, max. 100 mA |
| FOREPUMP | |
| Relay contact | 6 A, 750 VA, 250 V AC |

***Voltage supply outputs***

| | |
|---|---|
| Mains connection POWER PERIPHERY; | |
| Voltage value | 90-250 V AC |
| (can be selected independently from the mains voltage for the drive) | |
| VALVE (relay contact) | max. 100 VA |
| HEATER (silicon relay) | max. 500 VA |
| COOLER (silicon relay) | max. 100 VA |

***Interface***

| | |
|---|---|
| Print-only-mode | RS 232/V.24 |
| Connector | 25-pin, sub-D shell, female |
| Baud rate | 9600 |
| Operating temperature with sufficient convection space | 0 to 40°C (32 - 104°F) |
| Storage temperature | -25°C to +70°C (-77 to + 158°F) |
| Weight | approx. 20 kg |

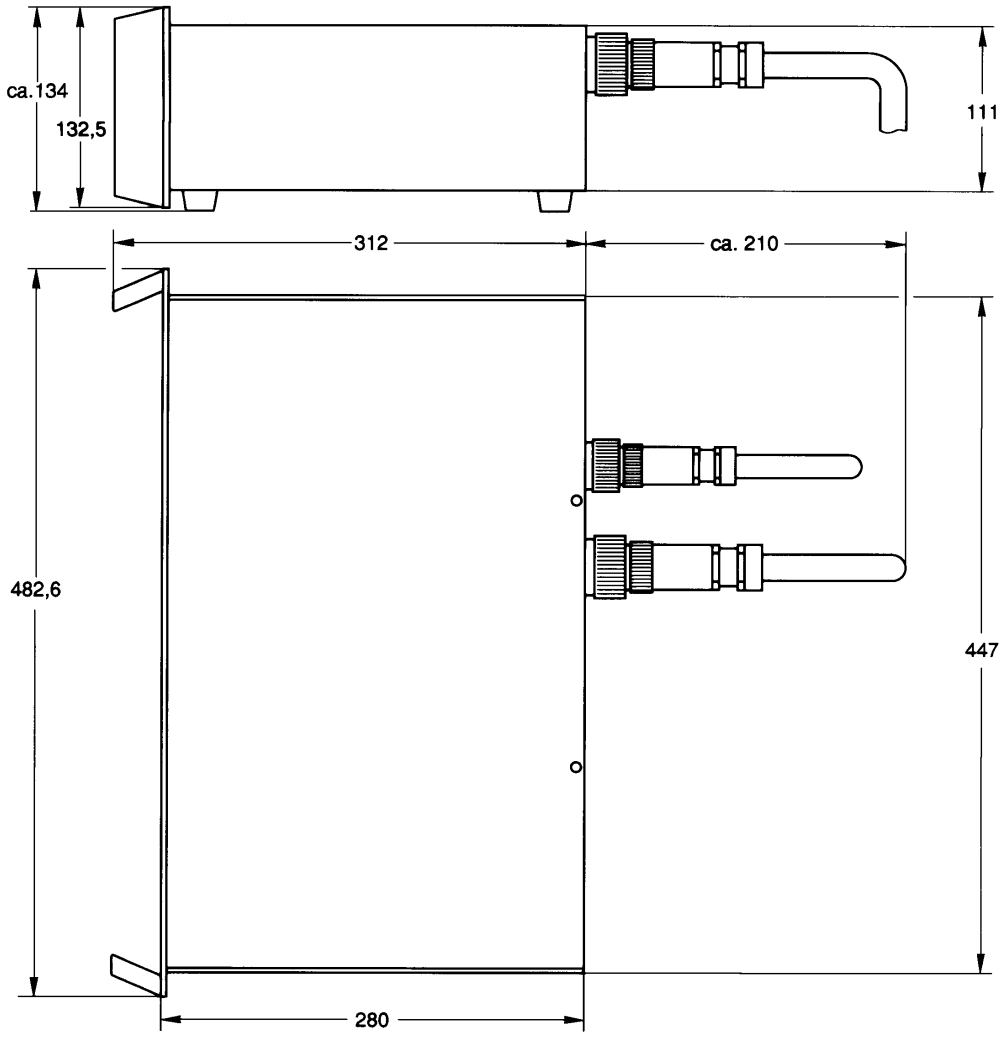



Fig. 2 Dimensional drawing

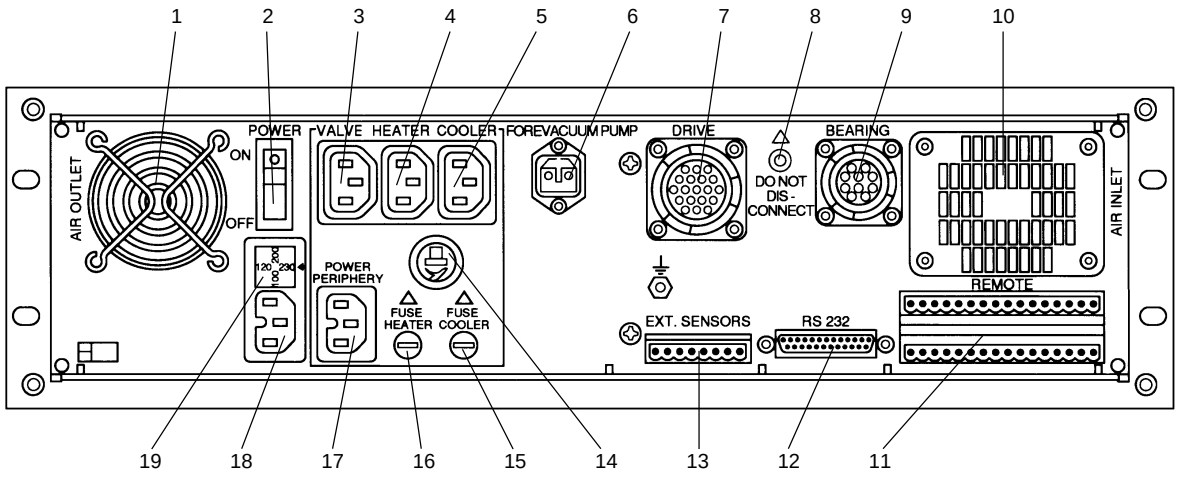
Dimensions in mm

# *1.4 Ordering Data*

| | Ref. No. |
|---|---|
| Electronic frequency converter TURBOTRONIK NT 30 M | |
| 230 V | 857 25 |
| 120 V | 857 26 |
| 100 V | 857 27 |
| Pump system control, LEYBOTRONIK I | 013 10 |
| Power supply unit for LEYBOTRONIK I | upon request |
| Gauge head Pirani TR 301 | 157 43 |
| Gauge head Penning | 157 35 |
| Set of connection cables for MAG | |
| 3 m long | 857 75 |
| 5 m long | 857 76 |
| 10 m long | 857 77 |

| | | Order No. |
|---|---|---|
| Power cord with US-plug | | 200 27 550 |
| Power cord with Euro-plug | | 200 27 549 |
| Microfuses | T 10 A | 520 25 405 |
| | F 8 A | 200 61 221 |
| | T 2.5 A | 200 61 222 |
| Equipment plug | | 200 60 109 |
| 2-pole coupler socket | | 200 59 875 |

| | |
|---|---|
| Set of connection cables for temperature control | |
| 3 m long | 857 95 |
| 5 m long | 857 96 |
| 10 m long | 857 97 |




**Key to Fig. 3**

1 Cooling air outlet
2 Mains power switch
3 Connection for additional valve
4 Heating connection
5 Connection for water cooling solenoid valve
6 Relay contact output for forevacuum pump ON/OFF
7 Connection for MAG motor
8 LED red, magnetic bearing unit operational
9 Connection for MAG magnetic bearing unit
10 Cooling air inlet
11 Remote control terminal strip; see also Fig. 5
12 RS 232 interface connection
13 Terminal strip for external sensors; see also Fig. 6
14 Fuse for peripheral equipment
15 Fuse for solenoid valve for water cooling
16 Fuse for heating
17 Mains power supply for peripheral equipment
18 Mains power supply for TURBOTRONIK
19 Fuse with socket plug for mains voltage selection

Fig. 3 Rear panel

# 2 Connection and Start-up

**Warning**

The connections for the forepump, cooler, purge gas valve, power failure airing valve and flange heater must be made only by a qualified technician in accordance with VDE or local codes.

Prior to starting the frequency converter the connections (3/7) and (3/9) must be connected at the MAG.

Prior to disconnecting the connection cables to the MAG, the MAG must have come to a standstill and the frequency converter must be switched off.

We recommend first connecting the MAG in accordance with its Operating Instructions and then the TURBOTRONIK.

## 2.1 Setting the Mains Voltage (optional)

The mains voltage setting of the TURBOTRONIK can be changed; see „Technical data“.

**Caution**

The TURBUTRONIK will be damaged if the voltage selector switch is set incorrectly when connected to the mains.

To change the mains voltage setting, use a screwdriver to pry up the dummy plug (3/19) and re-insert the plug in accordance with the voltage settings embossed on the unit. The arrow must point directly to the desired voltage.

The TURBOTRONIK has two mains connection sockets. The TURBOTRONIK and the MAG are supplied through the POWER connection. The POWER PERIPHERY connection supplies the VALVE, HEATER and COOLER outlets. The voltage valve for POWER PERIPHERY can be different from the valve für POWER.

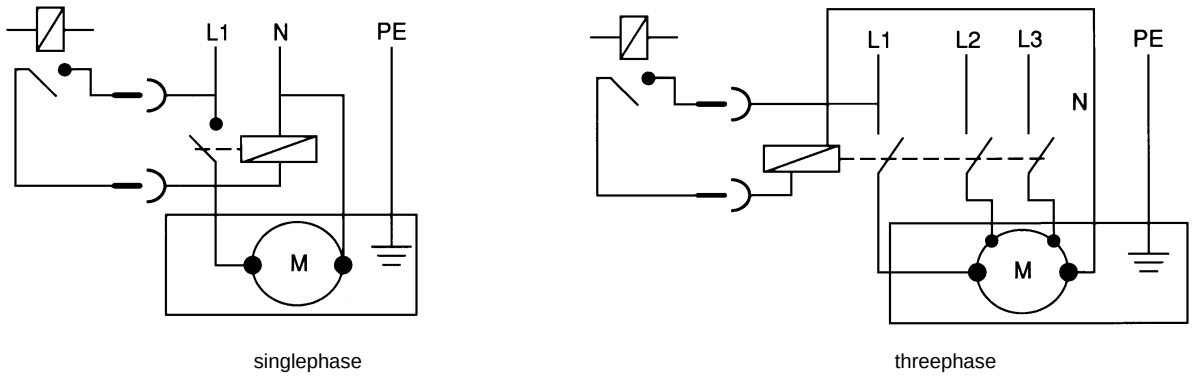



Fig. 4 Examples for wiring the forevacuum pump motor

Attach both mains power cords in the sockets (3/17) and (3/18).

If the mains switch (3/2) is in the OFF position, the supply outputs are likewise deenergized.

## 2.2 Connecting the MAG

Attach and secure the connector cable to the MAG motor at (3/7) and at the MAG itself.

Attach and secure the connector cable for the stabilizer and axial sensor at (3/9) and at the MAG itself. These plugs are designed to prevent confusion.

## 2.3 Connecting the Forevacuum Pump

Connect the forevacuum pump via the relay contact output (3/6). When the START button is pressed, the contact is closed without delay, switching on the forevacuum pump.

The forevacuum pump is switched off when the MAG is set to STOP; see Figure 4 for wiring examples.

It is possible to specify delayed starting for the MAG; see Section 3.4.

## 2.4 Connecting the Cooling Water Magnetic Valve or the Temperature Control

In case of need, the cooling water magnetic valve opens the cooling water supply fo the base flange. The temperature control of the MAG 1200 CT keeps the temperature of the MAG base flange within a narrow regulation range by heating or cooling as required.

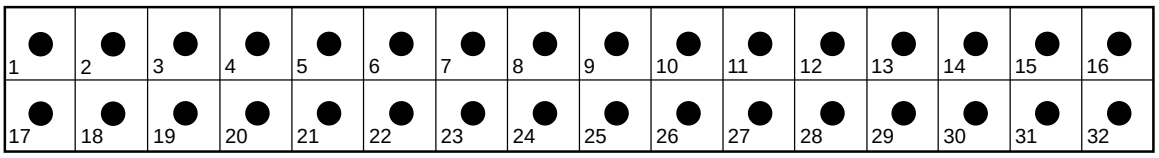
Attach the connector cable for the coolant control solenoid valve at the solenoid valve on the MAG and at the socket marked COOLER (3/5).

Attach the connector cable for the heating collar at the MAG heating collar and at the socket marked HEATER (3/4).

When starting the TURBOTRONIK, activate the temperature control feature and enter the setpoint value for the pump base flange temperature.

The temperature control can be activated through a digital input (base flange temp. control; see Figure 5) or at the keyboard. See in this regard Section 3.4 „Adjustment options.“ The setpoint can be entered in either °C or °F; the adjustment range is from 40°C to 65°C (104°F to 149°F).

If the mains voltage which is applied to the heating collar is considerably lower than 120 V or 230 V respectively, it will take a very long time for the temperature controller to heat the base flange up to its nominal temperature (set point) because the pump's housing is cooled down continuously. In such a case, the cooling water supply must be turned off completely during the heating phase. This may be done through an additional cooling water valve which is connected to the socket marked VALVE.




**Outputs**

| | | |
|---|---|---|
| 1 | | NORMAL |
| 2 | | |
| 3 | | FAIL NO ⊐ FAIL |
| 4 | | FAIL C |
| 5 | | FAIL NC ⊐ READY |
| 6 | | ACCEL |
| 7 | | |
| 8 | | READY FOR PROCESS[1)] |
| 9 | | |
| 10 | | n.c. |
| 11 | | n.c. |
| 12 | | + 15 V |
| 13 | | ⊥ |
| 14 | | Delayed vent (24 V) |
| 15 | | ⊥ |
| 16 | | Analog out |

**Inputs**

| | | |
|---|---|---|
| 17 | - | REMOTE |
| 18 | + | |
| 19 | - | STOP |
| 20 | + | |
| 21 | - | START |
| 22 | + | |
| 23 | - | HEAT |
| 24 | + | |
| 25 | - | Base Flange Temp. Control[1)] |
| 26 | + | |
| 27 | - | Purge o.k.[1)] |
| 28 | + | |
| 29 | | + 15 V |
| 30 | | Common minus |
| 31 | | ⊥ |
| 32 | | Analog in |

Fig. 5 Circuit assignment at the REMOTE socket (3/11)

1) For explanation see Section 2.7

If no water cooling magnetic valve is connected, the socket COOLER may be used for other appliances. A voltage is present at this socket only when the MAG is turning. The maximum load is 100 VA.

If no additional cooling water magnetic valve is connected, the socket VALVE may be used for other appliances. Mains voltage will be applied to the VALVE socket immediately upon START. Power will be cut off with STOP, FAIL or mains off at the power switch (3/2); maximum load is 100 VA.

## 2.5 Connecting the Flange Heater

(only for pumps with the CF connection flange)

A flange heater can be controlled by the TURBOTRONIK only when no base flange temperature control is connected.

POWER PERIPHERY voltage is present at the socket (3/4) „Heating on“ or „Heating permanent.“ has been selected; see in this regard Section 3.4 „Adjustment options“.

The maximum load is 500 VA.

Connect the MAG flange heater at the socket (3/4) marked HEATER.

## 2.6 Connecting the Purge Gas Valve or Power Failure Airing Valve

A purge gas valve or power failure airing valve operating at 24 V DC max. 5 W is connected at pins 13 and 14 of the socket marked REMOTE.

The TURBOTRONIK will delay the start of venting when the unit is switched off or in case of a power failure. This delay period can be set for any value between 0 and 5 minutes; see Section 3.4 in this regard.

This delay period prevents pump venting if there is a brief interruption in the current.

## 2.7 Connecting the Remote Control

The terminal strip (3/11) is wired as shown in Figure 5.

See Figure 7 for wiring examples.

Refer to Section 1.3 for technical data.

The relay states are to be found in the table.

Inputs - Remote control operational

REMOTE: Disables the keyboard and enables the remote control inputs; continuous high signal = enabled

The display indicates remote control by “R” at the left end of the first line.

STOP pump: Pulse or continuous low signal = enabled

In the interest of safety, the STOP function (low-active) is dominant.

START pump: Pulse or continuous high signal = enabled

To start the TURBOTRONIK using the remote control, it is necessary that the

REMOTE inputs be enabled
i.e. high level between the „+“ and „-“ terminals;

STOP inputs be disabled,
i.e. high level between the „+“ and „-“ terminals;

START inputs be enabled,
i.e. high level between the „+“ and „-“ terminals.

HEAT: flange heater ON/OFF
Static signal: high = on, low = off.

***Base flange temperature control:***

High level between the „+“ and „-“ terminals and the “Purge OK” signal will enable the base flange temperature control. The setpoint value for the base flange temperature can be changed at the keyboard.

***Purge OK:***

High level between the „+“ and „-“ terminals indicates to the TURBOTRONIK that essential process conditions have been satisfied, e.g.

- there is a sufficient flow of purge gas, or

- the purge gas pressure is sufficient, or

- the coolant flow is sufficient.

One or more switches, wired in series, can be connected here.

The READY FOR PROCESS output is closed whenever three conditions are fulfilled:

- the „purge OK“ signal is present

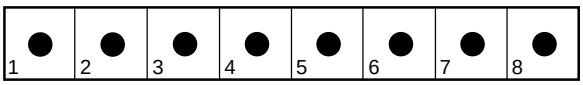
- the temperature control feature is operational

- the base flange is at the selected temperature (plus or minus the tolerance)

The evaluation of the „purge OK“ signal for the READY FOR PROCESS output is possible only if the temperature regulation circuity is operational.

***ANALOG IN***

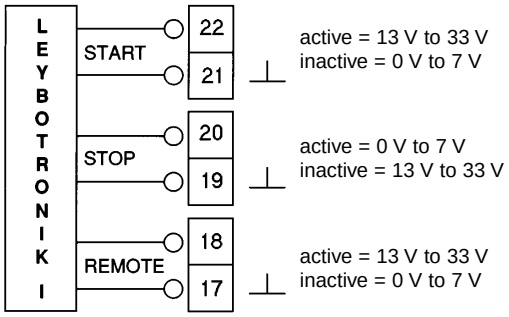
Speed (setpoint value) - analog signal; allows for a nominal speed reduction



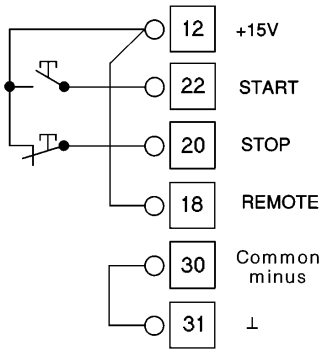

TM: Current input e. g. THERMOVAC = Pirani gauge head
1 Analog IN 4 ... 48 mA
2 ⊥
3 + 24 V
4 ⊥

PM: Voltage input e. g. PENNINGVAC = Penning gauge head
5 Analog IN 0 ... 10 V
6 ⊥
7 + 24 V
8 HV ON (Voltage output: HV ON = H = + 24 V)

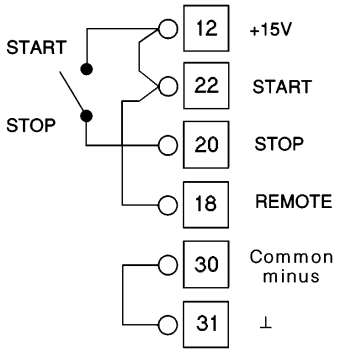
Fig. 6 Assignment at the EXT. SENSORS (3/13)




Active control with a voltage signal;
compatible with the LEYBOTRONIK I




By means of continuous contact, remote control by
push button; passive control with contacts




By means of continuous contact, ON/OFF
switch; passive control with contacts

Fig. 7 Options for switching on via remote control

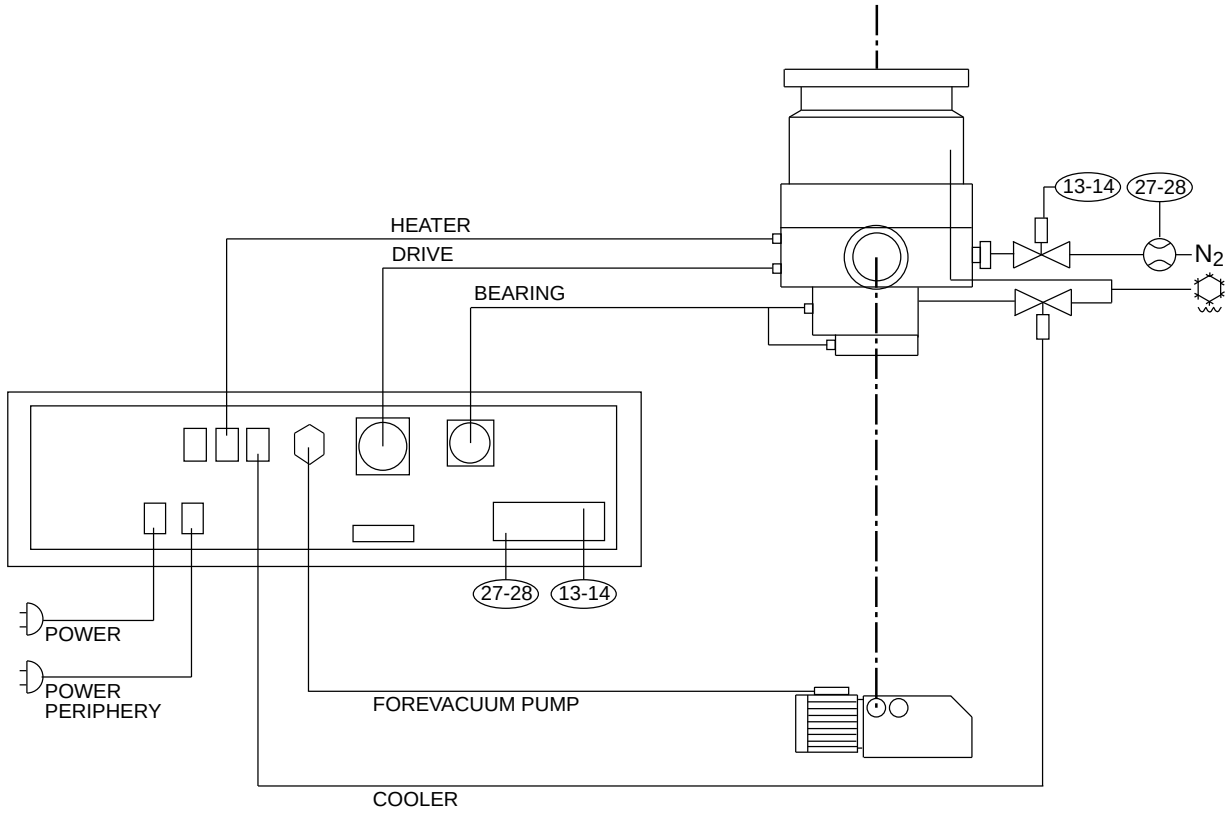



Fig. 8 Block wiring diagram for the turbomolecular pump system

# 2.9 Installing the TURBOTRONIK

The TURBOTRONIK is designed for mounting in a standard 19" rack.

The cooling air inlet and discharge at the rear of the TURBOTRONIK must not be restricted. Ensure that there is sufficient ventilation. The ambient temperature must not exceed 40°C (104°F) during operation.

The fans of the TURBOTRONIK are controlled via internal temperature sensors.

If the rear of the TURBOTRONIK will not be accessible after installation, turn on the power switch (3/2) before installing the unit.

**Warning**

If the TURBOTRONIK is built into a rack the mains plug is not within easy reach. Therefore install a separation between the TURBOTRONIK and the mains when you build it into a rack.

**Warning**

Do not operate the TURBOTRONIK with the standard mains lead in chemically aggressive surroundings. If you operate the TURBOTRONIK in chemically aggressive surroundings replace the mains lead by a resistant one.

# 2.9 Start-up

Connect **both** line cords. Insert the mains plug POWER PERIPHERY only if the supply outputs are used.

Turn on the power switch (3/2).

At this point the MAG stabilizer is operational and the rotor lifts off.

The display remains off for about 5 s, then all characters light up for about 3 s, afterwards which the following appears for about 2 s:

```
LEYBOLD AG  NT 30 M
SW Version x.yy
```

followed by this message:

```
READY
```

***Activating the temperature control feature***

You must enable the temperature control feature and specify the setpoint temperature for the pump's base flange.

Temperature control can be activated at a digital input (see Figure 5) or at the keyboard. Refer also to Section 3.4, "Adjustment options".

The setpoint can be entered in either °C or °F; the adjustment range is from 40°C to 65°C (104°F to 149°F).

If a purge gas valve or power failure airing valve is connected to delay venting, activate the delay feature and set the delay period; see Section 3.4 for details.

## *Table for relay modes*

| | Voltage: POWER PERIPHERY | | | | | Floating relay contacts | | | | | | + 24 V |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Relay | | Semiconductor relay | | | | | REMOTE plug | | | | |
| | VALVE | | HEATER | COOLER Valve current-less closed | | FORE-VACUUM PUMP | NORMAL | FAIL | | USER RELAIS (ACCEL) | READY FOR PRO-CESS | Delayed Vent |
| | Auxiliary mains sockets | | | | | | | | | | | |
| Operating mode | BF active | BF not active | | BF active | BF not active | | 1-2 | 3-4 | 4-5 | 6-7 | 8-9 | 14 |
| Mains off | off | off | off | off | off | open | open | open | closed | open | open | 0 V |
| Generator | off | off | off | off | off | open | open | open | closed | open | 1) | 24 V* |
| READY | 2) | off | 3) | cont | off | open | open | closed | open | open | 1) | 0 V |
| DELAY (Start) | 2) | on | 3) | cont | off | closed | open | closed | open | closed | 1) | 24 V |
| ACCEL | 2) | on | 3) | cont | on | closed | open | closed | open | closed | 1) | 24 V |
| NORMAL | 2) | on | 3) | cont | on | closed | closed | closed | open | open | 1) | 24 V |
| LOAD | 2) | on | 3) | cont | on | closed | closed | closed | open | open | 1) | 24 V |
| BRAKE | 2) | off | 3) | cont | on | open | open | closed | open | open | 1) | 0 V |
| FAILURE | 2) | off | 3) | cont | on | open | open | open | closed | open | 1) | 24 V |
| FAILSTOP | 2) | off | 3) | cont | off | open | open | open | closed | open | 1) | 0 V |

### *Key to Table*

BF Base flange temperature control

open Floating contact open

closed Floating contact closed

on The voltage applied to POWER PERIPHERY is switched on via a relay contact or a semiconductor relay

off The voltage applied to POWER PERIPHERY is switched off via a relay contact or a semiconductor relay

cont The voltage applied to POWER PERIPHERY is controlled by a semiconductor relay

Three position controller: HEATER on- COOLER off
HEATER off- COOLER off
HEATER off- COOLER on

1) Closed when
- base flange temperature control is active
- the signal PURGE OK is present
- the base flange has attained the selected temperature (± tolerance)

Open otherwise

2) ON for $T < (T_{set\ point} - 3\ K)$

Off otherwise

3) Controlled when the base flange temperature control is active (see "cont")
Otherwise controlled via keyboard or remote control (HEATER function)

24 V* 24 V for the preselected period of time (as long as available in the generator mode, at the latest when the speed decreases 100 Hz)

**Power outputs: Auxiliary mains sockets**

VALVE For connection of a purge gas valve or a venting valve or an additional cooling water valve

HEATER Semiconductor relay for base flange heater or flange heater

COOLER Semiconductor relay for base flange cooling

**Status outputs: Floating relay outputs on Phoenix terminal strip (REMOTE plug)**

When one output has been connected to the mains the other outputs are no longer touch-protected in the sense of the VDE regulations, i.e. it is then no longer permissible to connect extra-low voltages.

Ratings of the relays:
250 $V_{rms}$ AC, 2 A /500 VA
60 V DC / 2 A (resistive load)
in the case of inductive loads spark quenching measures must be introduced by the user

NORMAL Normally open

FAIL Changeover contact

USER RELAIS (ACCEL) Normally open

In later software releases the function of the USER RELAY may be changed by the user.

READY for PROCESS Normally open

DELAYED VENT +24 V for purge gas or venting valve for delayed venting

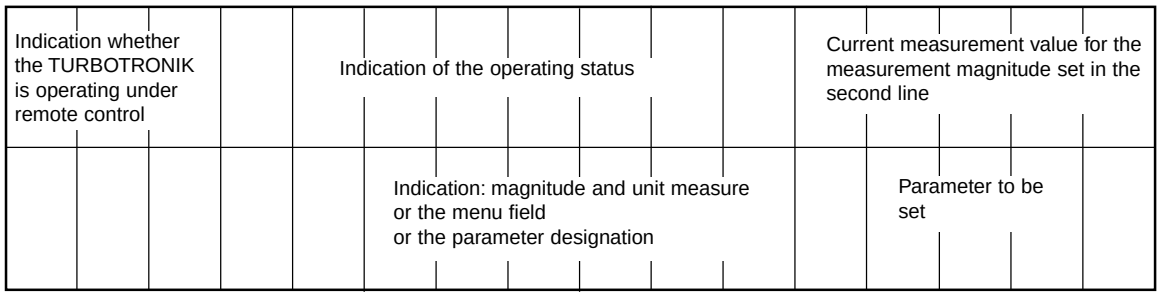



Fig. 9 TURBOTRONIK display

# 3 Display and Adjustment Options

The TURBOTRONIK NT 30 features an LCD with two lines of 16 characters each, four cursor control keys and an ENTER key, making it possible to read out information and to modify settings at the TURBOTRONIK.

If you do not wish to utilize these options, you may skip this chapter and continue reading about the operation of the TURBOTRONIK in Section 4.

# *3.1 Display*

The display indicates at the left end of the first line whether or not the TURBOTRONIK is operating under remote control.

„R“ = Remote: TURBOTRONIK operating under remote control. The status REMOTE is activated via a digital input. You can nothing enter via the buttons and display but only read out.

No „R“: The TURBOTRONIK is operated with the START and STOP buttons.

***Operating states***

The operating state is shown in the center of the first line. The following are possible:

| | |
|---|---|
| READY | Pump ready for operation but not yet started. |
| DELAY | START has been activated but the starting delay period has not yet elapsed. |
| ACCEL | Acceleration phase: The setpoint speed has not yet been achieved and the permissible acceleration time has not been exceeded. |
| NORMAL | Normal operation: Rotational speed > 95% of the setpoint speed |
| LOAD | Operating under load: Reduced speed: 100 Hz < n < 95% of setpoint speed<br><br>Possible reasons for high-load operation<br>- high temperature at the TURBOTRONIK<br>- high temperature at the pump<br>- high load (current limit)<br><br>It is possible to read from the menu what is causing operation at elevated load; please refer to Section 3.3. |
| BRAKE | Braking after the STOP button was actuated; pump continuing to rotate. |
| FAILURE | Failure, leads to switching off the drive; pump brakes due to failure |
| FAILSTOP | Failure, leads to switching off the drive; pump at standstill due to failure |
| Generator | Mains failure. Pump rotates with n > 100 Hz and generates via the pump motor the energy for the magnetic bearing control. At n < 80 Hz the rotor seats on the touchdown bearing. |

Whenever malfunctions occur, they will be shown in alternation with the normal contents of the first line, changing once a second.

Where the menu has not been activated, a measured value will be shown at the right end of the first line; the second line indicates which magnitude is being measured and the unit of measure in which it is displayed.

Examples: With the start delay feature operational and START activated, the display will show

| | |
|---|---|
| READY | 35 |
| Start Delay/s | |

the time remaining in the start delay period.

During acceleration and normal operation, the pump rotational speed will be shown in Hz.

| | |
|---|---|
| ACCEL | 320 |
| | Speed/Hz |

You may select which measured value will be shown; refer to Section 3.3 for instructions. When it shipped from the factory, the TURBOTRONIK is set up as shown in the examples.

# 3.2 Menu Structure

Any field in the menu can be accessed by pressing the cursor control keys >, <, \/ and /\; see Figure 10.

The menu is hierarchical in its arrangement, similar to the tree structure.

There are three main menus:

- Display select: Measurement value display selection

- Parameters: Setting the operating parameters

- Service: Service settings

Press the > cursor control key to move to the next lower menu level.

Press the \/ or /\ cursor control key to move between the items in a given menu level.

Press the < cursor control key to move to the next higher menu level.

Press and hold the < cursor control key for longer than 0.5 seconds to exit the menu entirely.

There are two adjustments possible

***1. Adjusting by selection***

The \/ or /\ cursor keys allow for any settings. The currently active one is marked by the cursor at the leftmost. An other setting is activated via pressing the ENTER key once the setting is visible.

***2. Adjusting by modification***

Once the lowest menu level has been reached and a setting can be changed, pressing the > key again will switch the system to the parameter specification routine. A blinking cursor in the background indicates that a setting can be changed.

The settings (e.g. on, off) or numerical values can be changed with the cursor control keys \/ or /\. If one of these cursor keys is held down the numbers will advance continuously, slowly at first and then faster.

The corresponding momentary measured value is shown in the first line of the display; the previously entered setpoint value is shown in the second line. If it is not possible to display a logical momentary value in the first line, then nothing will be shown.

Once the desired value is reached, store the setting or the numerical value by pressing ENTER. The value is stored even in case of a mains failure.

Then continue with the cursor control keys.

***Example:***
***Switch on heater for the intake flange***

Press the cursor key or ENTER; the following message appears in the display:

```
Display select >
```

Press the \/ key once more; the second line will show:

```
Parameters >
```

Press the > cursor control key; in the second line you will see:

```
Heating                >
```

Press the > cursor key; the second line will read out:

```
Heating off
```

Press the > cursor key; the cursor will move to the word „off“.

Press the \/ or /\ cursor key until the display reads:

```
Heat. Permanent
```

Press the ENTER key. The heating will be switched on. The cursor will be below the word „Heating“.

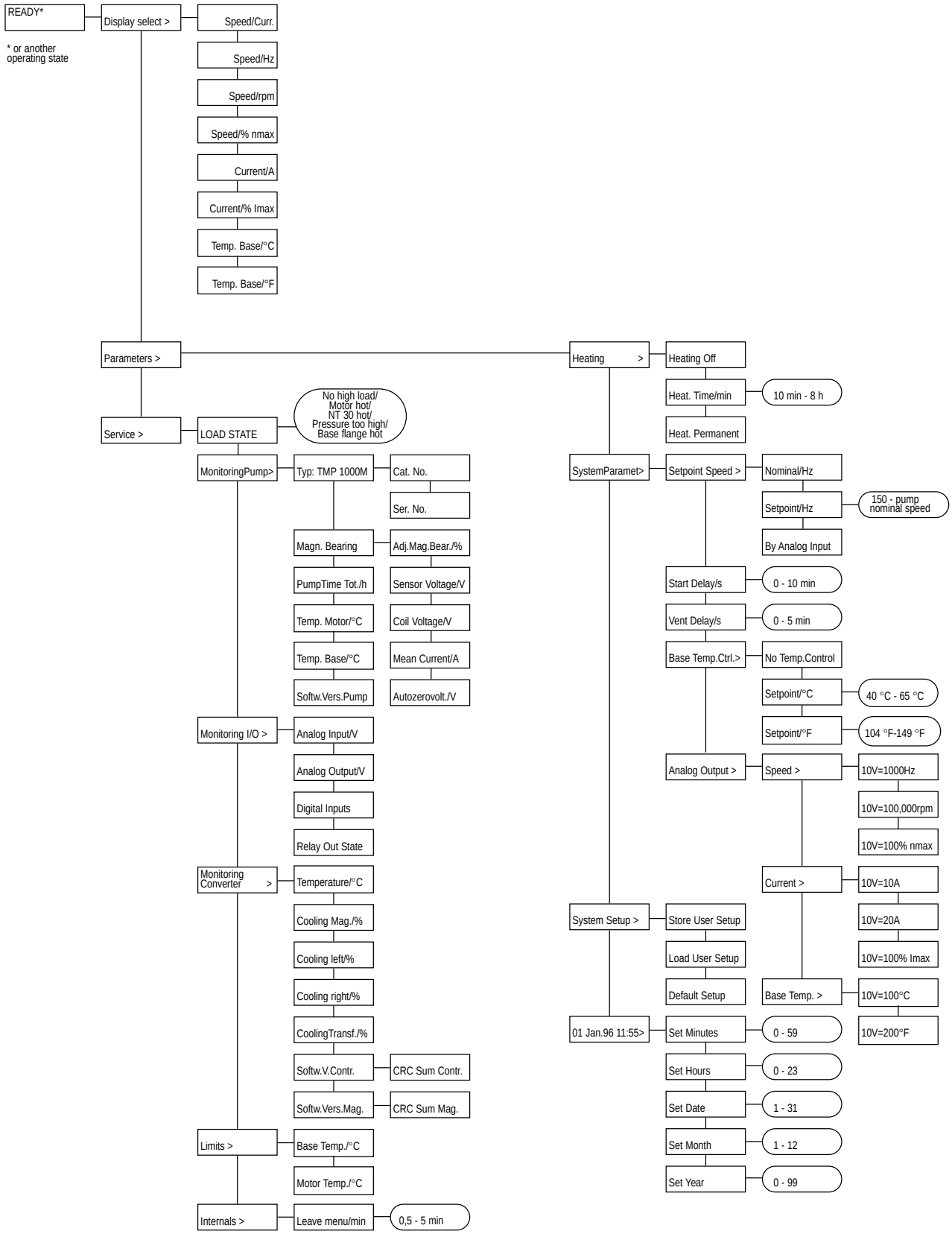



Fig. 10 Menu structure

# *3.3 Measured Values*

The following measured values can be shown:

1. **Speed**

   Rotational speed in Hz or rpm or % of rated speed

2. **Current**

   Motor current in A or % of maximum value.

   **Speed/Curr**

   Automatic switching between rotational speed and motor current

3. **Temp. Base**

   Base flange temperature in °C or °F

Measured values 4 to 8 are accessed from the „Service“ menu level.

4. **LOAD STATE**

   Cause for operation at excessive load

   - **No high load:** no load operation
   - **Motor hot:** The motor winding is hot
   - **NT 30 hot:** The TURBOTRONIK is hot
   - **Pressure too high:** Pressure in the MAG too high, motor current at limit value
   - Base flange hot: Pump base flange temperature is too high

5. **Monitoring Pump**

   Pump status

   - **Type:** Pump type, cat. nos. and serial nos. are read out by the converter from the EEPROM's pump. On pumps without EEPROM, 00000 will appear for the cat. nos., which has no influence on the function. If the display shows „Typ TMP?“ the converter reads the EEPROM which will take 15 s.
   - **Magn. Bearing:** Status of magnetic bearing Adj. Magn. Bear./%: Pressing the ENTER key, the magnetic bearing will be adjusted once again.

     Sensor Voltage/V: sensor voltage in V

     Coil Voltage/V: mean value of the deflecting voltage; relative value for the axial unsteadiness of the pump.

     Mean Current/A: Mean current in A

     Autozerovolt./V: Voltage for calibrating the rotor position control.

     **PumpTimeTot/h:** time which the converter has driven a connected pump.

     **Temp.Motor/°C:** Measured value of the temperature sensor in the motor windings

     **Temp.Base/°C:** Measured value of the temperature sensor at the base flange of the pump.

     **Softw.Vers. Pump:** Software-version of the pump

6. **Monitoring I/O**

   Status at the inputs and outputs

   - **Analog Input:** Value of the analog input in V
   - **Analog Output:** Display of the analog output signal in V
   - **Digital Inputs:**

     In the first line of the display there appears a series of ones and zeros. „1“ means that the input signal is present; „0“ means that the input signal is not present.

     The digits refer, from left to right, to the following input signals:

     Remote; Stop; Start; Heat; Temp. Control; Purge

   - **Relay Out States:** self-explanatory

     In the first line of the display there appears a series of ones and zeros. „1“ means that the relay contacts are closed; „0“ means that the relay contacts are open.

     The digits refer, from left to right, to the following relays:

     VALVE, HEATER, COOLER, FOREPUMP,
     NORMAL, FAIL, USER RELAIS,
     READY FOR PROCESS, DELAYED VENT

7. **Monitoring Converter**:

   Evaluation of measured temperature values in the frequency converter at different points; displayed in %, not linear, trigger point 100 %.

   **Softw.V.Contr.:** Software version of the converter's p.c.b.

   **Softw. Vers. Mag.:** Software version of the converter's magnetic bearing p. c. b.

8. **Limits**

   Limit values for reaching the operating states FAILURE or FAILSTOP.

   **Flange Temp./°C:** base flange temperature in °C
   **Motor Temp./°C:** motor temperature in °C

***Proceed as follows to have the measured values read out:***

Refer to Section 3.2 and Fig. 10 for information on the menu structure.

Press the cursor control key or ENTER; the second line in the display will show:

Display select >

Only for LOAD STATE, Monitoring Pump, Monitoring I/O and Monitoring Converter: Press the \/ cursor key two more times; the second line in the display will read:

Service >

Press the > cursor control key; the speed value (in Hz) will appear. Use the \/ or /\ cursor key to show the other measured values.

To have a measured value appear continuously, press the ENTER key while the desired measured value is in the display.

## *3.4 Adjustment Options*

To be able to set up the pump and the TURBOTRONIK to correspond ideally to the process, settings for the TURBOTRONIK can be changed. The following settings are possible:

**1. Heating**

**Heating Off:** Do not bake out the intake flange

**Heat. Time/min:** Bake out the intake flange for a certain period of time between 10 min and 8 hours.

The flange heating can be switched on only when no temperature control has been set up for the base flange; see No. 5.

**Heat Permanent:** Bake out the intake flange

**2. Setpoint Speed**

Target speed

**Nominal:** Nominal speed or

**Setpoint:** Value entered (adjustment range 150 to the rated speed of the pump or

**By Analog Input:** Speed proportional to the analog voltage entered
(10 V = 150 Hz , 0 V = Nominal speed)

**3. Start Delay**

Start delay period

Adjustment range 0 to 10 min.

**4. Vent Delay**

Period by which venting is to be delayed when the MAG is in the generator mode.

Adjustment range is from 0 to 5 min.

**5. Base Temp Ctrl.**

Temperature control for the base flange temperature

**No Temp. Control:** Self-explanatory

**Setpoint/°C:** Target value in °C

**Setpoint/°F:** Target value in °F

Adjustment range is from 40°C to 65 °C
(104°F to 149°F).

**6. Analog Output**

Function assigned to the analog output

**Speed:** Voltage is proportional to speed

The following can be selected:
10 V = 1000 Hz or
10 V = 100000 rpm or
10 V = 100% of the target value

**Current:** Voltage is proportional to the motor current

The following can be selected:
10 V = 10 A or
10 V = 20 A or
10 V = 100%

**Base Temp:** Voltage is proportional to the base flange temperature

The following can be selected:
10 V = 100°C or
10 V = 200°F

7. **System Setup**

**Store User Setup**

A complete set of settings can be stored and afterwards be activated again. You can note the individual settings of the stored setup in the table below.

**Load User Setup**

The set of adjustments stored with „Store User Setup“ is activated.

**Default Setup**

A complete set of adjustments is stored permanently. On delivery this set is activated. It can be reactivated at any time. The table below contains the settings of the Default Setup.

In case of a mains failure the currently activated set of adjustments will be stored. It is active once the mains has been again switched on.

**8. Date/Time**

- is displayed provided it has been entered
- may be entered or changed in the following menu items

The setting 9 is accessible via the menu level Service.

9**. Internals**

Internal adjustments

Leave menu/min: Time after which the MAG will return to the basic status if no button is pressed.

## *Table System Setup*

| Setting | Default Setup | Store Setup Date: | Store Setup Date: | Store Setup Date: |
|---|---|---|---|---|
| | | | | |
| Display select | Speed/rpm | | | |
| Heating | Off | | | |
| Setpoint Speed | Nominal | | | |
| Start Delay | Off | | | |
| Vent Delay | 30 s | | | |
| Base Temp Ctrl. | Off | | | |
| Analog Output | Speed; 10 V = 100% nmax | | | |
| Leave menu | 2.5 min | | | |

# 4 Operation and Control

## 4.1 Starting the MAG

When the first line of the display shows:

```
READY
```

then the MAG is ready for starting.

Press the START button. This will initiate the acceleration phase at the MAG; if a forevacuum pump is connected, it will start immediately.

If a starting delay period has been specified, the display will show the time remaining in the start delay period:

```
READY
Start Delay/s
```

During acceleration and normal operation, the pump rotational speed will be shown in Hz.

```
ACCEL          200
             Speed/Hz
```

You may select which measured value will be shown; refer to Section 3.3 for instructions.

If the MAG exceeds the minimum speed within a period of 8 minutes but does not achieve 95% of the setpoint speed, it will go into the LOAD operating status.

## 4.2 Baking out the Intake Flange

Bake-out is possible only with the MAG CF version.

There are two ways in which to activate the flange heater:

1. Continuously: „Heat Permanent“ In this case the heating will have to be switched off manually as required.

2. For a certain period of time (heating time) between 1 and 8 hours.

To activate the heating, press the cursor key or ENTER; the second line in the display will read out

```
Display select >
```

Press the \/ key once more; the second line will show:

```
Parameters >
```

Press the > cursor control key one time; in the second line you will see:

```
Heating                >
```

Press the > cursor key; the second line will show:

```
Heating Off
```

The cursor will move to the word „off“.

Press the \/ or /\ cursor key repeatedly, until the display reads:

```
Heat. Time/min
```

or

```
Heat. Permanent
```

Press the ENTER key when the desired setting is shown in the display. If „Heating Time“ was selected, use the cursor keys, \/ or /\, to adjust the numerical value as required. Store the modified numerical value by pressing the ENTER key.

## 4.3 Operation

During normal operation the MAG will run at the setpoint speed. The first line of the display will read:

NORMAL

If there is an increased load (e.g. increased pressure due to leaks) the motor speed will be compensated by drawing additional power.

A further increase in pressure, beyond the point of maximum power limiting will, due to increasing gas friction, cause a drop in speed.

The speed will also be reduced if the temperature of either the MAG or the TURBOTRONIK is too high.

If the actual speed falls below 95% of the setpoint speed, the first line of the display will read out

LOAD

Instructions for having the reason shown are given in Section 3.3, at measured value 6.

If the speed falls below a critical value (100 Hz), the MAG is switched off and the first line of the display will first read out:

FAILURE

and then

FAILSTOP

If the temperature regulation feature is operational, the TURBOTRONIK will keep the temperature of the base flange at the MAG within a narrow regulation range. Regulation is achieved by switching a heating collar on and off and opening and closing the cooling water supply to the base flange.

## 4.4 Shutting down the MAG

Pressing the STOP button will switch off the pump drive and energize the brakes.

The forevacuum pump is switched off if it is connected via (3/6); the MAG is vented if the purge gas valve or the power failure airing valve is connected via (3/3); venting is delayed if the purge gas valve or the power failure airing valve is connected at pins 13 and 14 of the REMOTE plug.

The first line of the display will read

BRAKE

The motor then actively brakes the pump until it reaches a standstill.

After a malfunction, the STOP button can be used to reset the malfunction display, provided that the malfunction has been rectified.

The rotor will be „held captive“ in the magnetic bearings for as long as the TURBOTRONIK is switched on.

## 4.5 Venting the MAG

Vent the MAG every time it is switched off to prevent any possibility of return diffusion of oil vapors from the forevacuum line to the high-vacuum section.

When connected appropriately (see Section 2.6) the TURBOTRONIK will control venting automatically.

## 4.6 Mains Power Outage - Power Cord Disconnect

If there is a power outage or if the mains cord should accidentally be disconnected, the TURBOTRONIK will automatically switch the MAG drive motor to the generator mode. In this way the active magnetic bearing unit regulation circuits will be kept in operation until such time as the rotor, at low speed, seats on the touch-down bearings.

If there is an interruption in the line between the MAG and the TURBOTRONIK, the automatic generator mode and the emergency supply of the active magnetic bearing unit will be inoperative. In this case the rotor will drop directly to the touch-down bearings, generating considerable running noise while rotating. The destruction of the touch-down bearings cannot be excluded in such a situation.

The connecting line to the TURBOTRONIK is secured to protect against accidental disconnection. Should this nonetheless happen, as a result of mechanical destruction, for instance, then brake the MAG by venting until the rotor comes to a standstill.

## 4.7 Switching off the TURBOTRONIK

Press the STOP button and wait until the pump has come to a stop.

The first line in the display will show

READY

Move the main power switch (3/2) into the „0“ position.

Once the red LED (3/8) has gone out, the connector lines to the MAG may, if necessary, be disconnected.

**Caution**

The main power switch is to be moved to the „0“ position only after the MAG has come to a standstill.

If the TURBOTRONIK should ever be switched off inadvertently, switch it on immediately.

## 4.8 Maintenance

The TURBOTRONIK requires no maintenance.

# 5 Troubleshooting

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

FAILURE

When the pump has come to a complete standstill the display changes to

FAILSTOP

The malfunction messages are inserted in the first line of the screen alternating with the normal contents at one-second intervals.

In case of too high temperature the pump drive will be switched off, the malfunction message will only be displayed when the the temperature keeps too high for over 2 minutes. If the temperature decreases within 2 minutes the drive will be switched on again.

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

### Warning

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

| Malfunction message in the display | Possible cause | Corrective Actions |
|---|---|---|
| No Connection ? | Fault in the drive line (temperature sensor, coding) | Check connectors. |
| Coding Error | Measured coding resistance out of the permissible range. | Check whether the correct pump is connected or not. |
| Speed too low | Minimum speed has not been reached or speed has dropped below the minimum. | Check operating conditions of the pump.<br>Intake or forevacuum pressure is too high. |
| NT 30 Temperature | Temperature of the frequency converter is too high. | Improve cooling of the frequency converter. |
| Base Temperature | Base flange temperature ≥ 73 °C for over 2 minutes. | Check and improve cooling. |
| Motor Temperature | Motor temperature ≥ 110 °C for over 2 minutes. | Check pressure/load conditions. |
| IIC Failure | Internal failure of the digital inputs or outputs. | Check for interferences on the frequency converter; if required introduce shielding measures. |
| Warn: Data lost | Fault during storing or reading of parameters. | The default parameters are used. |
| Internal Link | Fault during internal communication between controller and magnetic bearing. | Check for interferences on the frequency converter; if required introduce shielding measures. |
| Levitation Fail | Magnetic bearing was unsuccessful in capturing the rotor. | --- |
| Mag. Bearing Curr | Magnetic bearing current outside nominal range. | Check magnetic bearing cable and sensor cable. |
| Mag. Bearing Volt | Magnetic bearing voltage outside nominal range. | Check magnetic bearing cable and sensor cable. |
| Bearing Sensor | Sensor voltage outside nominal range. | Insert the sensor plug at the pump or at the converter |
| Mag. Supply Temp. | Load too high for the bearing supply. | Check the magnetic bearing and sensor connection. |
| Mot. line shorted | Drive line(s) short circuited. | Check the line. |
| ext 15/24 V short | External supply voltage has been short circuited. | Ensure that the supply lines are connected correctly:<br><br>+ 15 V on 32-pole Phoenix strip: pin 12, 29<br>+ 24 V on 32-pole Phoenix strip: pin 14<br>+ 24 V on 8-pole Phoenix strip: pin 3, 7 |
| No Serial to TMP | Connection to the pump's EEPROM malfunctioning. | Check the magnetic bearing and sensor connection; switch the converter off and then again on. |
| Dataloss in TMP | Data are missing in the pump's EEPROM, pump can not run. | --- |
| CRC-Fail MagBear | Magnetic bearing software is malfunctioning. | --- |
| SW Vers incompat | The software version of the magnetic bearing and the p. c. b. are not compatible. | --- |
| TMP EEcode Error | The pump's EEPROM contains a code which is not compatible with the converter. | Check whether the converter matches the pump. |
| Selftest Error | Fault in the RAM; poss. due to mains malfunction. | Switch the converter off and then again on. |

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