A PASSION FOR PERFECTION

PFEIFFER VACUUM


# TC 400

**Electronic Drive Unit**

# Operating Instructions

EN

Translation of the original instructions

PT 0203 BEN/M (1406)

# Table of contents

# 1 About this manual

## 1.1 Validity

This operating manual is for customers of Pfeiffer Vacuum. It describes the functioning of the designated product and provides the most important information for safe use of the unit. The description follows applicable EU guidelines. All information provided in this operating manual refers to the current state of the product's development. The documentation remains valid as long as the customer does not make any changes to the product.

Up-to-date operating instructions can also be downloaded from www.pfeiffer-vacuum.com.

## 1.2 Conventions

### Safety instructions

The safety instructions in Pfeiffer Vacuum operating instructions are the result of risk evaluations and hazard analyses and are oriented on international certification standards as specified by UL, CSA, ANSI Z-535, SEMI S1, ISO 3864 and DIN 4844. In this document, the following hazard levels and information are considered:

| DANGER |
| --- |
| **Imminent danger**<br>Indicates an imminent hazardous situation that will result in death or serious injury. |

| WARNING |
| --- |
| **Possibly imminent danger**<br>Indicates an imminent hazardous situation that can result in death or serious injury. |

| CAUTION |
| --- |
| **Possibly imminent danger**<br>Indicates an imminent hazardous situation that can result in minor or moderate injury. |

| *NOTICE* |
| --- |
| **Command or note**<br>Command to perform an action or information about properties, the disregarding of which may result in damage to the product. |

## Pictographs

Prohibition of an action or activity in connection with a source of danger, the disregarding of which may result in serious accidents

Warning of a displayed source of danger in connection with operation of the unit or equipment

Command to perform an action or task associated with a source of danger, the disregarding of which may result in serious accidents

Important information about the product or this document

## Instructions in the text

➔ Work instruction: here you have to do something.

## Abbreviations

| | |
|---|---|
| **DCU:** | Display Control Unit |
| **HPU:** | Handheld Programming Unit |
| **TC:** | Electronic drive unit for turbopump |
| **TPS:** | Mains pack |
| **DI / DO:** | Digital input / digital output |
| **AI / AO:** | Analog input / analog output |
| **f:** | Rotation speed (derivated from frequency in Hz) |
| **[P:000]:** | Parameter of the electronic drive unit with number |

# 2 Safety

## 2.1 Safety precautions

**Duty to inform**

Each person involved in the installation or operation of the unit must read and observe the safety-related parts of these operating instuctions.

➔ The operator is obligated to make operating personnel aware of dangers originating from the unit or the entire system.

**WARNING**

**Danger of unsafe electrical installation**

Safe operation after installation is the responsibility of the operator.

➔ Do not independently modify or change the pump and electrical equipment.
➔ Make sure that the system is integrated in an emergency off safety circuit.
➔ Consult Pfeiffer Vacuum for special requirements.

**WARNING**

**Danger of electric shock**

In case of defect, the parts connected to the mains supply are under voltage.

➔ Always keep the mains connection freely accessible so you can disconnect it at any time.

- **Power supply:** The turbopump power supply must apply to the requirements of double insulation between mains input voltage and operating voltage according to the regulations of IEC 61010 and IEC 60950. Therefore Pfeiffer Vacuum recommends to use exclusively original-power packs and -accessories. Only in this case Pfeiffer Vacuum is able to guarantee the compliance of the European and North American guidelines.
- Observe all safety and accident prevention regulations.
- A safe connection to the protective earthing conductor (PE) is recommended (protection class III).
- Regularly check the proper observance off all safety measures.
- Before carrying out any work disconnect the unit and all associated installations safely from the mains.
- Do not loosen any plug connection during operations.
- The unit has been accredited with protection class IP 54. Take necessary measures when installing into ambient conditions, which afford other protection classes.
- Keep leads and cables well away from hot surfaces (> 70 °C).
- Only separate the pump and the electronic drive unit from each other after disconnecting the supply voltage and the complete standstill of the pump.

## 2.2 Proper use

**NOTICE**

**EC conformity**

The manufacturer's declaration of conformity becomes invalid if the operator modifies the original product or installs additional components.

➔ Following installation into a plant and before commissioning, the operator must check the entire system for compliance with the valid EU directives and reassess it accordingly.

- The electronic drive unit TC 400 operates designated Pfeiffer Vacuum turbopumps and their accessories.

## 2.3 Improper use

Improper use will cause all claims for liability and warranties to be forfeited. Improper use is defined as usage for purposes deviating from those mentioned above, especially:

- use of accessories or spare parts, which are not named in this manual
- operation of the devices in areas with ionizing radiation


**Closure seal**

The product is sealed at the factory. Damaging or removal of a closure seal leads to the loss of liability and warranty entitlements.

➔ Do not open the product within its warranty period!

➔ For process-related shorter maintenance intervals please contact the Pfeiffer Vacuum Service.

## 2.4 Functional safety

The drive unit (electronic drive unit) TC 400 performs the safety function "Safe Limited Speed" according to EN 61800-5-2. In case of excess rotation speed the commutation of the pump motor is switched off and the drive transferred into the safe condition.

Summary of characteristic data for use in safety-relevant applications:

| **Characteristics according to IEC 61508 and IEC 62061** | | | | |
|---|---|---|---|---|
| Characteristic | Safety Integrity Level | PFH | $PFD_{av}$ | Proof Test Interval T |
| Value | SIL CL 2 | $1.1 * 10^{-8}$ / h | $1 * 10^{-3}$ | 20 a |

| **Characteristics according to EN ISO 13849-1** | | | | |
|---|---|---|---|---|
| Characteristic | Performance Level | Category | $MTTF_d$ | Average Diagnostic Coverage DC |
| Value | PL d | Cat. 3 | high (135 a) | medium (90 % - <99 %) |

- During the expected device life span of up to 20 years no proof test is required.
- If the user calculates his safety application with the specified values for 20 years, the safety control system must be taken out of operation after 20 years and returned to the manufacturer. A proof test cannot be accomplished by the user.

# 3 Product description

## 3.1 Product identification

This product has been tested to the requirements of CAN/CSA-C22.2 No. 61010-1, second edition, including Amendment 1, or a later version of the same standard incorporating the same level of testing requirements.

For information about other certifications, if applicable, please see the signet on the product or:

- www.tuvdotcom.com
- TUVdotCOM-ID 0000021320

To correctly identify the product when communicating with Pfeiffer Vacuum, always have the information from the rating plate available.

### Product characteristics

The electronic drive unit TC 400 is an integrated component of the turbopump. It's purpose is to drive, monitor and control the entire pump.

| Characteristics | TC 400 | |
|---|---|---|
| Connection voltage TC | 24 V DC ± 5 % | 48 V DC ± 5 % |
| Connection panel | Standard (RS-485) | Standard (RS-485) |
| Turbopump HiPace | 300, 400, 700, 800 | 300, 400, 700, 800 |

To correctly identify the product when communicating with Pfeiffer Vacuum, always have the information from the rating plate available.

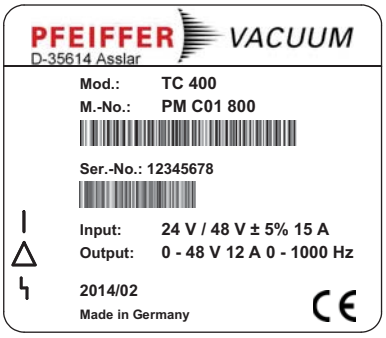



**Fig. 1: Example for a rating plate**

## 3.2 Range of application

Pfeiffer Vacuum electronic drive units TC 400 must be installed and operated in the following ambient conditions.

| | |
|---|---|
| Installation location | weather protected (indoors) |
| Protection category | IP 54 |
| Protection class | III |
| Temperature | +5 °C to +40 °C (up to +35 °C with air cooling) |
| Relative humidity | max. 80 %, at T ≤ 31 °C, up to max. 50% at T ≤ 40 °C |
| Atmospheric pressure | 750 hPa - 1060 hPa |
| Installation altitude | 2000 m max. |
| Degree of pollution | 2 |
| Overvoltage category | II |

## 3.3 Function

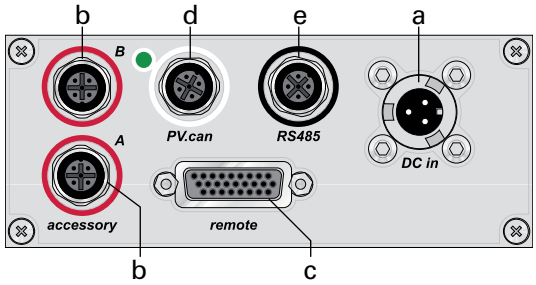
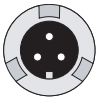



**Fig. 2: Standard panel for the TC 400**

| | | | |
|---|---|---|---|
| a | Mains connection "*DC in*" | d | Service connection "*PV.can*" |
| b | Connection "*accessory A+B*" | e | Connection "*RS-485*" |
| c | Connection "*remote*" | | |

## 3.4 General connection description

| | |
|---|---|
|  | ***DC in***[1]<br>Casing plug with bayonet locking for the voltage supply between Pfeiffer Vacuum mains packs and the electronic drive unit TC. |
|  | ***accessory***<br>M12 socket with screw coupling for the connection of Pfeiffer Vacuum accessories. The use of a Y-connector enables double assignment of one connection. |
|  | ***PV.can***<br>M12 casing socket with screw coupling and LED. The connection "PV.can" serves to service purposes exclusively. |
|  | ***remote***<br>High Density D-sub 26 pole female socket for the connection of a remote control. |
|  | ***RS485***<br>M12 socket with screw coupling for the connection of a Pfeiffer Vacuum control unit or a PC. The use of a Y-connector enables the series connection in a bus system. |
|  | Casing socket on the rear side of the electronic drive unit for the connection to the turbopump. |

1. "DC in" and "accessory" are already described in the operating instructions of the turbopump.

# 4 Connections diagram

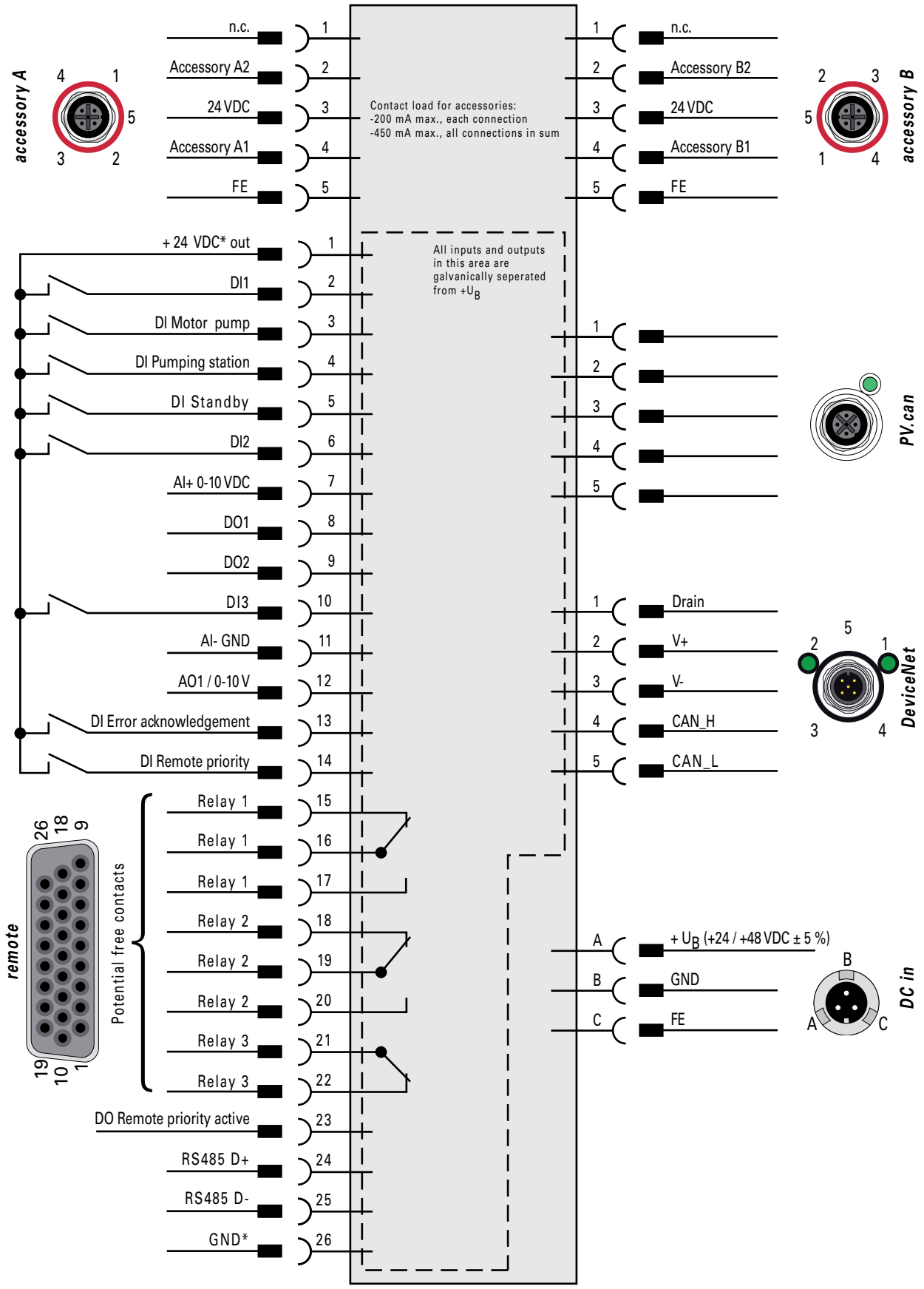
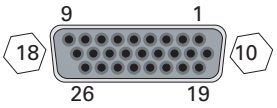



**Fig. 3: Connections diagram and assignment of the TC 400**

# 5 Connection "*remote*"




Remote control options are provided via the 26-pole D-sub connector with the designation ”*remote*“ on the electronic drive unit.

➔ Remove the remote plug from the TC 400 and connect a remote control unit. Pin assignment of the connector according to table.

➔ Shielded connectors and cables must be used.

**NOTICE**

**Danger of the drive unit being destroyed**

Cutting the plug connection "*remote*" can lead to the destruction of the electronic drive unit, when the power supply is still switched on.

➔ Before pulling the connector "*remote*" necessarily disconnect the power supply.

➔ Switch off the power supply unit.

**The following information display the factory setting. Configuration is possible using the Pfeiffer Vacuum parameter set.**

## 5.1 Pin assignment

| Pin | Function | Designation factory settings |
|---|---|---|
| 1 | +24 V DC output (V+) | Reference voltage for all digital in- and outputs |
| 2 | DI1 | Enable venting; open: no; V+: yes |
| 3 | DI Motor pump | Drive motor; open: off; V+: on |
| 4 | DI Pumping station | Open: off; V+: on and error acknowledgement |
| 5 | DI Standby | Standby rotation speed; open: off; V+: on |
| 6 | DI2 | Heating; open: off; V+: on |
| 7 | AI+ Rotation speed setting mode | Set value in rotation speed setting mode;<br>2-10 V DC = 20-100% of the nominal rotation speed |
| 8 | DO1 | Rotation speed switch point attained;<br>GND:no; V+: yes ($I_{max}$ = 50 mA/24 V) |
| 9 | DO2 | GND: error; V+: no error ($I_{max}$ = 50 mA/24 V) |
| 10 | DI3 | Sealing gas; open: off; V+: on |
| 11 | AI- Rotation speed setting mode GND | Set value in rotation speed setting mode; GND |
| 12 | AO1 | Actual rotation speed;<br>0-10 V DC is equivalent to 0-100%; $R_L$ > 10 kΩ |
| 13 | DI Error acknowledgement | Error acknowledgement: V+ pulse (min 500 ms) |
| 14 | DI Remote priority | Control via interface "remote"; open: off<br>V+: set and priority over other digital inputs |
| 15 | Relais 1 | Connection to Pin 16 if relay 1 is inactive |
| 16 | Relais 1 | Rotation speed switchpoint attained;<br>relay contact 1 ($U_{max}$ = 50 V DC; $I_{max}$ = 1 A) |
| 17 | Relais 1 | Connection to Pin 16 if relay 1 is active |
| 18 | Relais 2 | Connection to Pin 19 if relay 2 is inactive |
| 19 | Relais 2 | No error; relay contact 2 ($U_{max}$ = 50 V DC; $I_{max}$ = 1 A) |
| 20 | Relais 2 | Connection to Pin 19 if relay 2 is active |
| 21 | Relais 3 | Connection to Pin 22 if relay 3 is inactive |
| 22 | Relais 3 | Warning; relay contact 3 ($U_{max}$ = 50 V DC; $I_{max}$ = 1 A) |
| 23 | DO Remote priority | GND: off; V+: remote priority active |
| 24 | RS-485 D+ | according to specifications and Pfeiffer Vacuum protocol |
| 25 | RS-485 D- | according to specifications and Pfeiffer Vacuum protocol |
| 26 | Ground (GND) | Reference ground for all digital inputs and all outputs |

## 5.2 Operation via "*remote*" connection

### +24 V DC* Output / Pin 1

Inputs 2 - 6 and the connections to Pins 10, 13, 14 are activated by connecting them with +24 V DC to Pin 1 (active high). They can also be activated via an external PLC. The functions are deactivated by "PLC high level" and by "PLC low level".

- PLC high level: +13 V to +33 V
- PLC low level: -33 V to +7 V
- Ri: 7 kΩ
- $I_{max}$ < 210 mA (with RS-485, if existing)

### Inputs

The digital inputs at connection "*remote*" are used to connect various functions of the electronic drive unit. Functions are assigned to the inputs DI1 - DI2 ex factory. These can be configured via interface RS-485 and the Pfeiffer Vacuum parameter set.

**DI1 (Enable venting) / Pin 2**

V+ : Venting is enabled (venting according to venting mode)

open: Venting locked (no venting is performed)

**DI Motor pump / Pin 3**

After Pin 4 (pumping station) is activated and the electronic drive unit successfully completes the self-test, the turbopump is placed into operation. During operation, the turbopump can be switched off and on again, while the pumping station remains switched on. The turbopump is not vented thereby.

V+ : Turbopump motor on

open: Turbopump motor off

**DI Pumping station / Pin 4**

Connected pumping station components (e.g. backing pump, venting valve, air cooling unit) are triggered and, with Pin 3 (motor) simultaneously activated, the turbopump is placed in operation. Any ongoing error messages are reset when their cause has been eliminated.

V+ : Malfunction acknowledgement and pumping station on

open: Pumping station off

**DI Standby / Pin 5**

In standby mode, the turbopump operates at a specified rotor speed < nominal rotation speed. Factory setting and recommended operation are 66.7 % of the nominal rotation speed.

V+ : Standby activated

open: Standby off, operation at nominal rotation speed

**DI2 (Heating) / Pin 6**

V+ : Heating on

open: Heating off

**DI3 (Sealing gas) / Pin 10**

V+ : Sealing gas valve open

open: Sealing gas valve closed

**DI Error acknowledgement / Pin 13**

V+ : Reset ongoing error messages when cause has been eliminated with a pulse of min. 500 ms duration.

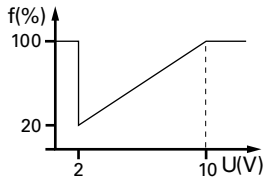
open: Inactive

**DI Remote priority / Pin 14**

V+ : The connection "*remote*" has operation priority over all other digital inputs.

open: Remote priority inactive

**AI Rotation speed setting mode / Pin 7 and Pin 11**




The analog input at the TC 400 defines the set rotation speed of the turbopump. An input signal of 2 - 10 V between AI+ (Pin 7) and AI- (Pin 11) corresponds to a rotation speed within the range of 20 - 100% of the nominal rotation speed. If the input is open or signals fall below 2 V, the pump is accelerated up to nominal rotation speed.

## Outputs

The digital outputs at the connection "*remote*" can be loaded with a maximum of 24 V / 50 mA per output. All outputs listed below are configurable by the Pfeiffer Vacuum parameter set via interface RS-485 (description related to factory settings).

**DO1 (Rotation speed switchpoint attained) / Pin 8**

Active high after the rotation speed switchpoint is attained. Rotation speed switchpoint 1 is factory-set to 80% of the nominal rotation speed. It can, for example, be used for a "pump operational" message.

**DO2 (No errors) / Pin 9**

When the supply voltage has been established, digital output DO2 permanently outputs 24 V DC which means "no errors". Active low in case of error (collective error message).

**DO Remote priority active / Pin 23**

Active high: The connection "*remote*" takes priority over any other connected control panels (e.g. RS-485). With active low, the connection "*remote*" is ignored.

**AO1 Analog output 0-10 V DC / Pin 12**

A rotation-speed-proportional voltage (0-10 V DC equals 0 - 100 % x $f_{Nominal}$) can be picked up via the analog output (load R ≥ 10 kΩ). Additional functions (optionally current/power) can be assigned to the analog output via DCU, HPU or PC.

## Relay contacts (invertible)

**Relay 1 / Pin 15, Pin 16 and Pin 17**

The contact between Pin 16 and Pin 15 is closed when the rotation speed switch point is underrun; relay 1 is inactive. The contact between Pin 16 and Pin 17 is closed when the rotation speed switch point is attained; relay 1 is active.

**Relay 2 / Pin 18, Pin 19 and Pin 20**

The contact between Pin 19 and Pin 18 is closed when a malfunction is present; relay 2 is inactive. The contact between Pin 19 and Pin 20 is closed when operation is malfunction free; relay 2 is active.

**Relay 3 / Pin 21 and Pin 22**

The contact between Pin 21 and Pin 22 is closed when no warning messages are active; relay 3 is inactive. The contact between Pin 21 and Pin 22 is open when a warning message is present; relay 3 is active.

## RS-485

One Pfeiffer Vacuum display and control panel (DCU **or** HPU) **or** an external PC can be connected respectively to the electronic drive unit via Pin 24 and Pin 25 of the connection "*remote*" on the electronic drive unit.

➔ Establish the connections according to the specification of the interface RS-485.

# 6 Connection "*RS-485*"

## 6.1 Connections

A Pfeiffer Vacuum display and control panel (DCU **or** HPU) **or** an external PC can be connected to the electronic drive unit via the connection designated "RS-485". The interface is electrically isolated from the maximum supply voltage of the electronic drive unit. The electrical couplings are optically decoupled internally.

| Designation | Value |
|---|---|
| Serial interface | RS-485 |
| Baud rate | 9600 bauds |
| Data word length | 8 bits |
| Parity | none (no parity) |
| Start bits | 1 |
| Stop bits | 1..2 |


| Pin | Assignment |
|---|---|
| 1 | RS-485: D+ |
| 2 | +24 V output, loadable with ≤ 210 mA (with remote - pin 1) |
| 3 | GND |
| 4 | RS-485: D- |
| 5 | not connected |

## 6.2 Connecting Pfeiffer Vacuum display and control units or PC

➔ Use the connection cable supplied with the control panel or from the range of accessories.

➔ The connection of respectively one external operating unit is possible on the interface RS-485.

➔ A USB interface (PC) can be connected via the USB/RS-485-converter.

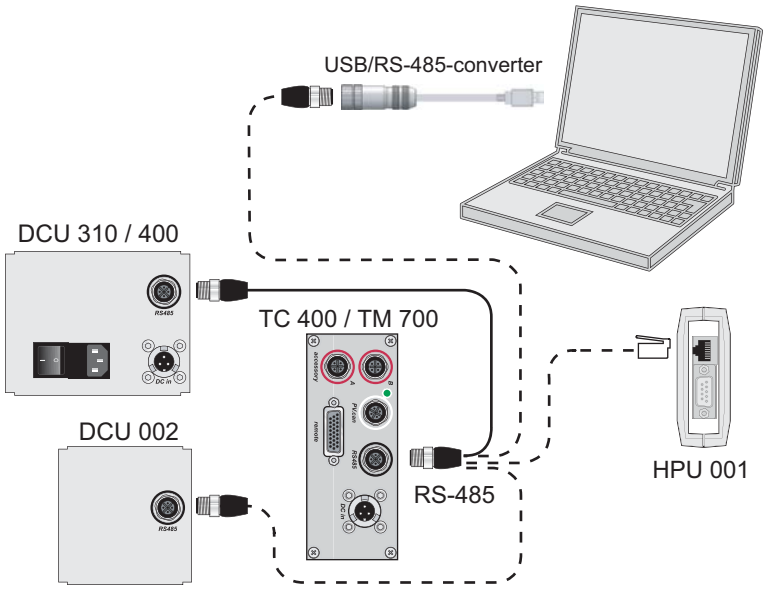
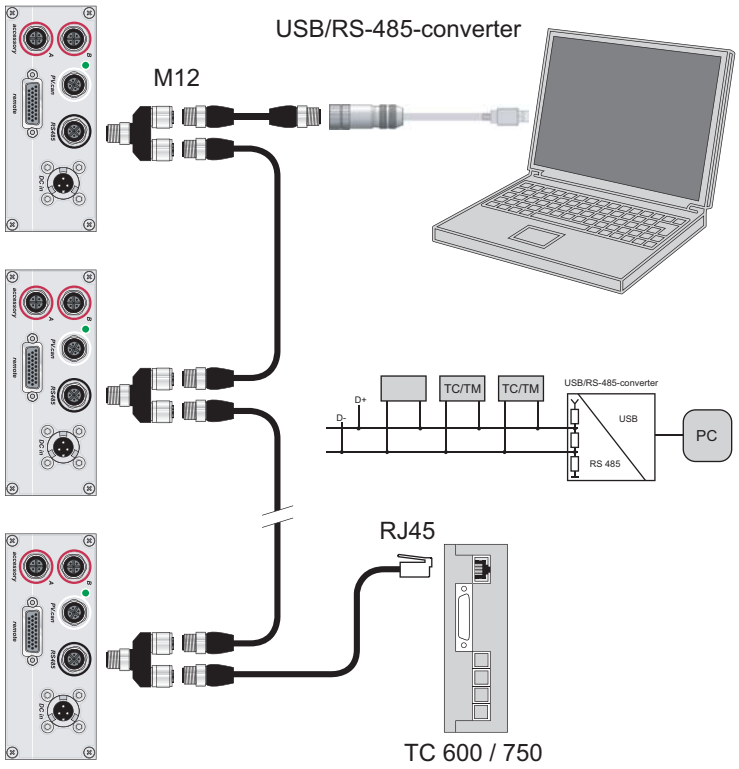



**Fig. 4: Optional connection possibilities for interface RS-485**

## 6.3 Cross-linking via the connection RS-485




**CAUTION**

**Danger of electric shock**

The insulation measures of the bus system are designed only for use with safety extra-low voltage.

➔ Connect only suitable devices to the bus system.

➔ Establish the connections according to the specification of the interface RS-485.

➔ Connect all units with RS-485 D+ and RS-485 D- to the bus.

- The group address of the electronic drive unit is 962.
- All units connected to the bus must have differing RS-485 device addresses **[P:797]**.

# 7 The Pfeiffer Vacuum parameter set

## 7.1 General

All function-relevant variables of a turbopump are anchored in the electronic drive unit as parameters. Each parameter has a three-digit number and a designation. Parameters can be used via Pfeiffer Vacuum display and control units or via RS-485 with the Pfeiffer Vacuum protocol.

**Additional parameters in the control unit**

For the control of connected external components (e.g. vacuum measurement devices) there are additional parameters fixed in the respective Pfeiffer Vacuum display and control unit.

➔ Please consider the respective operating instructions.

### Conventions

Parameters are displayed in square brackets as a three-digit number in bold font. The designation may also be stated if necessary.

Example: **[P:312] Software version**

## 7.2 Parameter overview

### Annotation

| | |
|---|---|
| # | Three figure number of the parameter |
| **Display** | Notification of the parameter in a Pfeiffer Vacuum display and control unit |
| **Designation** | Short description of the parameter |
| **Functions** | Functional description of the parameter |
| **Data type** | Type of formatting of the parameter for the use within the Pfeiffer Vacuum protocol |
| **Access method** | R: read access; W: write access |
| **Unit** | Physical unit of the described characteristic |
| **min / max** | Permissible limits for value input |
| **default** | Factory settings (partially specific of the pump type) |
| 🖫 | Parameter can be stored non volatile in the electronic drive unit and may be reused after resetting of the mains supply. |

### Operation with DCU

**Parameter set and Pfeiffer Vacuum display and control unit**

Pfeiffer Vacuum display and control units DCU show the basic parameter set by default. Furthermore the DCU contains parameters, which are not positioned in the electronic drive unit.

➔ Parameter **[P:794]** = 1 (Display of all available parameters).

| # | Display | Designation | Functions | Data type | Access | Unit | min | max | default | 🖫 |
|---|---|---|---|---|---|---|---|---|---|---|
| 340 | Pressure | Active pressure value | | 7 | R | mbar | 1E-10 | 1E3 | | |
| 350 | Ctr Name | Type of display and control unit | | 4 | R | | | | | |
| 351 | Ctr Software | Software of display and control unit | | 4 | R | | | | | |
| 738 | Gaugetype | Type of pressure gauge | | 4 | RW | | | | | |
| 794 | Param set | Parameterset | 0 = basic parameter set<br>1 = extended parameter set | 7 | RW | | 0 | 1 | 0 | |
| 795 | Servicelin | Insert service line | | 7 | RW | | | | 795 | |

## Control commands

| # | Display | Designation | Functions | Data type | Access | Unit | min | max | default | 🖫 |
|---|---|---|---|---|---|---|---|---|---|---|
| 001 | Heating | Heating | 0 = off<br>1 = on | 0 | RW | | 0 | 1 | 0 | x |
| 002 | Standby | Standby | 0 = off<br>1 = on | 0 | RW | | 0 | 1 | 0 | x |
| 004 | RUTimeCtrl | Run-up time control | 0 = off<br>1 = on | 0 | RW | | 0 | 1 | 1 | x |
| 009 | ErrorAckn | Error acknowledgement | 1 = Error acknowledgement | 0 | W | | 1 | 1 | | |
| 010 | PumpgStatn | Pumping station | 0 = off<br>1 = on and error acknowledgement | 0 | RW | | 0 | 1 | 0 | x |
| 012 | EnableVent | Enable venting | 0 = no<br>1 = yes | 0 | RW | | 0 | 1 | 0 | x |
| 017 | CfgSpdSwPt | Configuration rotation speed switchpoint | 0 = Rotation speed switchpoint 1<br>1 = Rotation speed switchpoint 1&2 | 7 | RW | | 0 | 1 | 0 | x |
| 019 | Cfg DO2 | Configuration output DO2 | 0 = Rot. speed switchpoint attained<br>1 = No error<br>2 = Error<br>3 = Warning<br>4 = Error and/or warning<br>5 = Set speed attained<br>6 = Pump on<br>7 = Pump accelerates<br>8 = Pump decelerates<br>9 = always 0<br>10 = always 1<br>11 = Remote priority active<br>12 = Heating<br>13 = Backing pump<br>14 = Sealing gas<br>15 = Pumping station<br>16 = Pump rotates<br>17 = Pump does not rotate | 7 | RW | | 0 | 17 | 1 | x |
| 023 | MotorPump | Motor pump | 0 = off<br>1 = on | 0 | RW | | 0 | 1 | 0 | x |
| 024 | Cfg DO1 | Configuration output DO1 | 0 = Rot. speed switchpoint attained<br>1 = No error<br>2 = Error<br>3 = Warning<br>4 = Error and/or warning<br>5 = Set speed attained<br>6 = Pump on<br>7 = Pump accelerates<br>8 = Pump decelerates<br>9 = always 0<br>10 = always 1<br>11 = Remote priority active<br>12 = Heating<br>13 = Backing pump<br>14 = Sealing gas<br>15 = Pumping station<br>16 = Pump rotates<br>17 = Pump does not rotate | 7 | RW | | 0 | 17 | 0 | x |
| 025 | OpMode BKP | Operation mode backing pump | 0 = Continous operating<br>1 = Intermittend mode<br>2 = Delayed switch-on | 7 | RW | | 0 | 2 | 0 | x |
| 026 | SpdSetMode | Rotation speed setting mode | 0 = off<br>1 = on | 7 | RW | | 0 | 1 | 0 | x |
| 027 | GasMode | Gas mode | 0 = Heavy gases<br>1 = Light gases<br>2 = Helium | 7 | RW | | 0 | 2 | 0 | x |
| 028 | Cfg Remote | Configuration remote | 0 = Standard<br>4 = Relais inverted | 7 | RW | | 0 | 4 | 0 | x |
| 030 | VentMode | Venting mode | 0 = Delayed venting<br>1 = No venting<br>2 = Direct venting | 7 | RW | | 0 | 2 | 0 | x |
| 035 | Cfg Acc A1 | Configuration accessory connection A1 | 0 = Fan (continous operation)<br>1 = Venting valve, normally closed<br>2 = Heating<br>3 = Backing pump<br>4 = Fan (temperature controlled)<br>5 = Sealing gas<br>6 = always 0<br>7 = always 1<br>8 = Power failure venting unit | 7 | RW | | 0 | 8 | 0 | x |

| # | Display | Designation | Functions | Data type | Access | Unit | min | max | default | 🖫 |
|---|---|---|---|---|---|---|---|---|---|---|
| 036 | Cfg Acc B1 | Configuration accessory connection B1 | 0 = Fan (continous operation)<br>1 = Venting valve, normally closed<br>2 = Heating<br>3 = Backing pump<br>4 = Fan (temperature controlled)<br>5 = Sealing gas<br>6 = always 0<br>7 = always 1<br>8 = Power failure venting unit | 7 | RW | | 0 | 8 | 1 | x |
| 037 | Cfg Acc A2 | Configuration accessory connection A2 | 0 = Fan (continous operation)<br>1 = Venting valve, normally closed<br>2 = Heating<br>3 = Backing pump<br>4 = Fan (temperature controlled)<br>5 = Sealing gas<br>6 = always 0<br>7 = always 1<br>8 = Power failure venting unit | 7 | RW | | 0 | 8 | 3 | x |
| 038 | Cfg Acc B2 | Configuration accessory connection B2 | 0 = Fan (continous operation)<br>1 = Venting valve, normally closed<br>2 = Heating<br>3 = Backing pump<br>4 = Fan (temperature controlled)<br>5 = Sealing gas<br>6 = always 0<br>7 = always 1<br>8 = Power failure venting unit | 7 | RW | | 0 | 8 | 2 | x |
| 045 | Cfg Rel R1 | Configuration Relay 1 | 0 = Rot. speed switch point attained<br>1 = No error<br>2 = Error<br>3 = Warning<br>4 = Error and/or warning<br>5 = Set speed attained<br>6 = Pump on<br>7 = Pump accelerates<br>8 = Pump decelerates<br>9 = always 0<br>10 = always 1<br>11 = Remote priority active<br>12 = Heating<br>13 = Backing pump<br>14 = Sealing gas<br>15 = Pumping station<br>16 = Pump rotates<br>17 = Pump does not rotate | 7 | RW | | 0 | 17 | 0 | x |
| 046 | Cfg Rel R2 | Configuration Relay 2 | 0 = Rot. speed switch point attained<br>1 = No error<br>2 = Error<br>3 = Warning<br>4 = Error and/or warning<br>5 = Set speed attained<br>6 = Pump on<br>7 = Pump accelerates<br>8 = Pump decelerates<br>9 = always 0<br>10 = always 1<br>11 = Remote priority active<br>12 = Heating<br>13 = Backing pump<br>14 = Sealing gas<br>15 = Pumping station<br>16 = Pump rotates<br>17 = Pump does not rotate | 7 | RW | | 0 | 17 | 1 | x |

| # | Display | Designation | Functions | Data type | Access | Unit | min | max | default | 🖫 |
|---|---|---|---|---|---|---|---|---|---|---|
| 047 | Cfg Rel R3 | Configuration Relay 3 | 0 = Rot. speed switch point attained<br>1 = No error<br>2 = Error<br>3 = Warning<br>4 = Error and/or warning<br>5 = Set speed attained<br>6 = Pump on<br>7 = Pump accelerates<br>8 = Pump decelerates<br>9 = always 0<br>10 = always 1<br>11 = Remote priority active<br>12 = Heating<br>13 = Backing pump<br>14 = Sealing gas<br>15 = Pumping station<br>16 = Pump rotates<br>17 = Pump does not rotate | 7 | RW | | 0 | 17 | 3 | x |
| 050 | SealingGas | Sealing gas | 0 = off<br>1 = on | 0 | RW | | 0 | 1 | 0 | x |
| 055 | Cfg AO1 | Configuration output AO1 | 0 = Actual rotation speed<br>1 = Power<br>2 = Current<br>3 = always 0 V<br>4 = always 10 V<br>5 = follows AI1 | 7 | RW | | 0 | 5 | 0 | x |
| 057 | Cfg AI1 | Configuration input AI1 | 0 = Disconnected<br>1 = Set value rot. speed setting mode | 7 | RW | | 0 | 1 | 0 | x |
| 060 | CtrlViaInt | Control via interface | 1 = Remote<br>2 = RS-485<br>4 = PV.can<br>8 = Field bus<br>16 = E74<br>255 = Unlock interface selection | 7 | RW | | 1 | 255 | 1 | x |
| 061 | IntSelLckd | Interface selection locked | 0 = off<br>1 = on | 0 | RW | | 0 | 1 | 0 | x |
| 062 | Cfg DI1 | Configuration input DI1 | 0 = Deactivated<br>1 = Enable venting<br>2 = Heating<br>3 = Sealing gas<br>4 = Run-up time control<br>5 = Rotation speed setting mode<br>Setting ≠**[P:063/064]** | 7 | RW | | 0 | 5 | 1 | x |
| 063 | Cfg DI2 | Configuration input DI2 | 0 = Deactivated<br>1 = Enable venting<br>2 = Heating<br>3 = Sealing gas<br>4 = Run-up time control<br>5 = Rotation speed setting mode<br>Setting ≠**[P:062/064]** | 7 | RW | | 0 | 5 | 2 | x |
| 064 | Cfg DI3 | Konfiguration input DI3 | 0 = Deactivated<br>1 = Enable venting<br>2 = Heating<br>3 = Sealing gas<br>4 = Run-up time control<br>5 = Rotation speed setting mode<br>Setting ≠**[P:062/063]** | 7 | RW | | 0 | 5 | 3 | x |

## Status requests

| # | Display | Designation | Functions | Data type | Access | Unit | min | max | default | 🖫 |
|---|---|---|---|---|---|---|---|---|---|---|
| 300 | RemotePrio | Remote priority | 0 = no<br>1 = yes | 0 | R | | 0 | 1 | | |
| 302 | SpdSwPtAtt | Rotation speed switchpoint attained | 0 = no<br>1 = yes | 0 | R | | 0 | 1 | | |
| 303 | Error code | Error code | | 4 | R | | | | | |
| 304 | OvTempElec | Excess temperature electronic drive unit | 0 = no<br>1 = yes | 0 | R | | 0 | 1 | | |
| 305 | OvTempPump | Excess temperature pump | 0 = no<br>1 = yes | 0 | R | | 0 | 1 | | |
| 306 | SetSpdAtt | Set rotation speed attained | 0 = no<br>1 = yes | 0 | R | | 0 | 1 | | |

| # | Display | Designation | Functions | Data type | Access | Unit | min | max | default | 🖫 |
|---|---|---|---|---|---|---|---|---|---|---|
| 307 | PumpAccel | Pump accelerates | 0 = no<br>1 = yes | 0 | R | | 0 | 1 | | |
| 308 | SetRotSpd | Set rotation speed (Hz) | | 1 | R | Hz | 0 | 999999 | | |
| 309 | ActualSpd | Active rotation speed (Hz) | | 1 | R | Hz | 0 | 999999 | | |
| 310 | DrvCurrent | Drive current | | 2 | R | A | 0 | 9999.99 | | |
| 311 | OpHrsPump | Operating hours pump | | 1 | R | h | 0 | 65535 | | x |
| 312 | Fw version | Firmware version electronic drive unit | | 4 | R | | | | | |
| 313 | DrvVoltage | Drive voltage | | 2 | R | V | 0 | 9999.99 | | |
| 314 | OpHrsElec | Operating hours electronic drive unit | | 1 | R | h | 0 | 65535 | | x |
| 315 | Nominal Spd | Nominal rotation speed (Hz) | | 1 | R | Hz | 0 | 999999 | | |
| 316 | DrvPower | Drive power | | 1 | R | W | 0 | 999999 | | |
| 319 | PumpCylces | Pump cycles | | 1 | R | | 0 | 65535 | | x |
| 324 | TempPwrStg | Temperature power stage | | 1 | R | °C | 0 | 999999 | | |
| 326 | TempElec | Temperature electronic | | 1 | R | °C | 0 | 999999 | | |
| 330 | TempPmpBot | Temperature pump bottom part | | 1 | R | °C | 0 | 999999 | | |
| 336 | AccelDecel | Acceleration / Deceleration | | 1 | R | rpm/s | 0 | 999999 | | |
| 342 | TempBearng | Temperature bearing | | 1 | R | °C | 0 | 999999 | | |
| 346 | TempMotor | Temperature motor | | 1 | R | °C | 0 | 999999 | | |
| 349 | ElecName | Name of electronic drive unit | | 4 | R | | | | | |
| 354 | HW Version | Hardware version electronic drive unit | | 4 | R | | | | | |
| 360 | ErrHist1 | Error code history, pos. 1 | | 4 | R | | | | | x |
| 361 | ErrHist2 | Error code history, pos. 2 | | 4 | R | | | | | x |
| 362 | ErrHist3 | Error code history, pos. 3 | | 4 | R | | | | | x |
| 363 | ErrHist4 | Error code history, pos. 4 | | 4 | R | | | | | x |
| 364 | ErrHist5 | Error code history, pos. 5 | | 4 | R | | | | | x |
| 365 | ErrHist6 | Error code history, pos. 6 | | 4 | R | | | | | x |
| 366 | ErrHist7 | Error code history, pos. 7 | | 4 | R | | | | | x |
| 367 | ErrHist8 | Error code history, pos. 8 | | 4 | R | | | | | x |
| 368 | ErrHist9 | Error code history, pos. 9 | | 4 | R | | | | | x |
| 369 | ErrHist10 | Error code history, pos. 10 | | 4 | R | | | | | x |
| 384 | TempRotor | Temperature rotor | | 1 | R | °C | 0 | 999999 | | |
| 397 | SetRotSpd | Set rotation speed (rpm) | | 1 | R | rpm | 0 | 999999 | | |
| 398 | ActualSpd | Actual rotation speed (rpm) | | 1 | R | rpm | 0 | 999999 | | |
| 399 | NominalSpd | Nominal rotation speed (rpm) | | 1 | R | rpm | 0 | 999999 | | |

### Set value settings

| # | Display | Designation | Functions | Data type | Access method | Unit | min | max | default | 🖫 |
|---|---|---|---|---|---|---|---|---|---|---|
| 700 | RUTimeSVal | Set value run-up time | | 1 | RW | min | 1 | 120 | 8 | x |
| 701 | SpdSwPt1 | Rotation speed switchpoint 1 | | 1 | RW | % | 50 | 97 | 80 | x |
| 707 | SpdSVal | Set value in rot. speed setting mode | | 2 | RW | % | 20 | 100 | 65 | x |
| 708 | PwrSVal | Set value power consumption | | 7 | RW | % | 10 | 100 | 100[1] | x |
| 710 | Swoff BKP | Switching off threshold backing pump in intermittend mode | | 1 | RW | W | 0 | 1000 | 0 | x |
| 711 | SwOn BKP | Switching on threshold backing pump in intermittend mode | | 1 | RW | W | 0 | 1000 | 0 | x |
| 717 | StdbySVal | Set value rotation speed at standby | | 2 | RW | % | 20 | 100 | 66.7 | x |
| 719 | SpdSwPt2 | Rotation speed switchpoint 2 | | 1 | RW | % | 5 | 97 | 20 | x |
| 720 | VentSpd | Venting rot. speed at delayed venting | | 7 | RW | % | 40 | 98 | 50 | x |
| 721 | VentTime | Venting time at delayed venting | | 1 | RW | s | 6 | 3600 | 3600 | x |
| 777 | NomSpdConf | Nominal rotation speed confirmation | | 1 | RW | Hz | 0 | 1500 | 0 | x |
| 797 | RS485Adr | RS-485 device address | | 1 | RW | | 1 | 255 | 1 | x |

1. depending on the pump type

## 7.3 Configuring the connections

The electronic drive unit is pre-configured in the factory. Thereby the turbopump is immediately operational with the necessary functions. The connections of the electronic drive unit can be configured to suit individual requirements using the parameter set.

## Accessory connection

➔ Configuration via parameters **[P:035]**, **[P:036]**, **[P:037]** or **[P:038]**.

| Option | Description |
|---|---|
| 0 = Fan (continous operation) | Control via parameter Pumping station |
| 1 = Venting valve, normally closed | Control via parameter Enable venting, when using a venting valve which is normally closed. |
| 2 = Heating | Control via parameters Heating and Rotation speed switch-pont attained |
| 3 = Backing pump | Control via parameters Pumping station and operation mode backing pump |
| 4 = Fan (temperature controlled) | Control via parameter Pumping station and temperature thresholds |
| 5 = Sealing gas | Control via parameters Pumping station and Sealing gas |
| 6 = always 0 | GND for the control of an external device |
| 7 = always 1 | +24 V DC for the control of an external device |
| 8 = Power failure venting unit | Control via parameter Enable venting, when using a power failure venting unit. |

## Digital inputs on "*remote*"

➔ Configuration via parameters **[P:062]**, **[P:063]** or **[P:064]**.

| Option | Description |
|---|---|
| 0 = deactivated | Connection deactivated |
| 1 = Enable venting | Control is equal to parameter [P:012] |
| 2 = Heating | Control is equal to parameter [P:001] |
| 3 = Sealing gas | Control is equal to parameter [P:050] |
| 4 = Run-up time control | Control is equal to parameter [P:004] |
| 5 = Rotation speed setting mode | Control is equal to parameter [P:026] |

## Digital outputs and relays on "*remote*"

➔ Configuration via parameters **[P:019]** and **[P:024]**, respectively **[P:045]**, **[P:046]**, **[P:047]** and **[P:028]**.

- In the description "active" means:
  - For all digital outputs: V+ active high
  - For all relays: Contact switch-over according to configuration of **[P:028]**

| Option | Description |
|---|---|
| 0 = Rotation speed switchpoint attained | active, if switchpoint attained |
| 1 = No error | active, if failure-free operation |
| 2 = Error | active, if error message is active |
| 3 = Warning | active, if warning message is active |
| 4 = Error and / or warning | active, if error and / or warning is active |
| 5 = Set rotation speed attained | active, if set rotation speed is attained |
| 6 = Pump on | active, if Pumping station and Motor is on; No Error |
| 7 = Pump accelerates | active, if Pumping station is on;<br>Actual rotation speed < Set rotation speed |
| 8 = Pump decelerates | active, if Pumping station is on;<br>Actual rotation speed > Set rotation speed<br>Pumping station is off;<br>Rotation speed > 3 Hz |
| 9 = always 0 | GND for the control of an external device |
| 10 = always 1 | +24 V DC for the control of an external device |
| 11 = Remote priority active | active, if Remote priority is active |
| 12 = Heating | Control is equal to parameter [P:001] |
| 13 = Backing pump | Control is equal to parameter [P:010] and [P:025] |
| 14 = Sealing gas | Control is equal to parameter [P:050] |
| 15 = Pumping station | Control is equal to parameter [P:010] |
| 16 = Pump rotates | active, if rotation speed > 1 Hz |
| 17 = Pump does not rotate | active, if rotation speed < 2 Hz |

### Analog output on "*remote*"

➔ Configuration via parameter **[P:055]**.

| Option | Description |
|---|---|
| 0 = Rotation speed | Rotation speed signal; 0 - 10 V DC = 0 - 100 % x $f_{Nominal}$ |
| 1 = Power | Power signal; 0 - 10 V DC = 0 - 100 % x $P_{max}$ |
| 2 = Current | Current signal; 0 - 10 V DC = 0 - 100 % x $I_{max}$ |
| 3 = always 0 V | always GND |
| 4 = always 10 V | output of continously 10 V DC |
| 5 = follows AI1 | follows the analogue input 1 |

### Analog input on "*remote*"

➔ Configuration via parameter **[P:057]**.

| Option | Description |
|---|---|
| 0 = Switched off | Connection is deactivated |
| 1 = Set value in rotation speed setting mode | Rotation speed setting mode via pin 7 (0 - 10 V) and pin 11 (GND) |

### Control via interface

➔ Configuration via parameters **[P:060]** and **[P:061]**.

| Option [P:060] | Description |
|---|---|
| 1 = remote | Operation via connection "*remote*" |
| 2 = RS-485 | Operation via connection "*RS-485*" |
| 4 = PV.can | For service purposes only |
| 8 = Field bus | Operation via field bus |
| 16 = E74 | Operation via connection "*E74*" |

| Option [P:061] | Description |
|---|---|
| 0 = off | Interface selection via [P:060] |
| 1 = on | Interface selection locked |

## 7.4 Operation with the Pfeiffer Vacuum parameter set

### Factory settings

The electronic drive unit is pre-programmed in the factory. This guarantees proper, reliable turbopump operation without the need for additional configuration.

### Checking the adjustments

➔ Before operating with parameters, check set values and control commands for their suitability for the pumping process.

➔ Remove the remote plug from electronic drive unit if required.

### Gas type dependent operations

Friction causes the rotor to heat up severely under gas load and high rotation speed. To avoid overheating, the electronic drive unit has implemented power-rotation speed-characteristics, whereby the pump can be operated at every rotation speed with the maximum allowable gas load without danger of damage. The maximum power consumption depends on the gas type. Three characteristics are available in order to completely exhaust the pump's capacity for each gas type.

**NOTICE**

**Danger of the pump being destroyed**

Pumping of gases with a higher molecular mass in the wrong gas mode can lead to destruction of the pump.

➔ Ensure the gas mode is correctly set.

➔ Contact Pfeiffer Vacuum before using gases with a greater molecular mass (> 80).

- Gas mode "0" for gases with the molecular mass >39, e.g. argon.
- Gas mode "1" for gases with the molecular mass ≤ 39.
- Gas mode "2" for helium.

- Power characteristics according to the technical data of the turbopump.

➔ Check and set-up the gas mode via **[P:027]**.

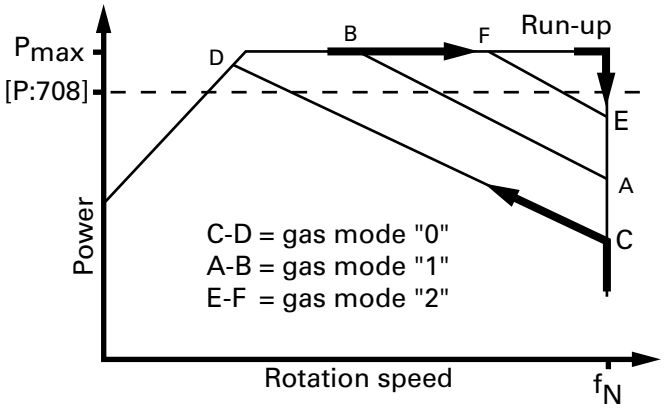



**Fig. 5: Principle of power characteristics lines for gas type dependent operations, e.g. gas mode = 0**

The turbopump runs up with maximum power consumption. When the nominal and/or set rotation speed is reached, the pump automatically switches over to the chosen power characteristic of the selected gas mode. Increasing gas load is initially compensated by a rise in power consumption in order to keep the rotation speed constant. Increasing gas friction, however, causes the turbopump to heat up more severely. When the gastype-dependent maximum power is exceeded, the rotation speed of the turbopump is reduced until an equilibrium between permissible power and gas friction is attained.

➔ To avoid rotation speed fluctuations, Pfeiffer Vacuum recommends setting a somewhat lower frequency in rotation speed setting mode.

## Set value power consumption

➔ Adjust the parameter **[P:708]** to the desired value in %.

If adjusting the set value power consumption below 100 % the run-up time prolongs. To avoid error messages, the parameter **[P:700] RUTimeSVal** should be adjusted accordingly.

## Run-up time

The run-up of the turbopump is time-monitored ex factory. There are various causes of prolonged run-up times, e.g.:

- Too high gas loads
- Leakage in the system
- The set value run-up time is too low

➔ Eliminate any external and application-related causes.

➔ Adjust the run-up time via parameter **[P:700]**.

## Adjusting the rotation speed switchpoint

The rotation speed switchpoint can be used for the message "Pump operational for the process". Overrunning or underrunning the active rotation speed switchpoint activates or deactivates a signal at the pre-configured output on the electronic drive unit and at the status parameter **[P:302]**.

### Rotation speed switchpoint 1

➔ Adjust the parameter **[P:701]** to the desired value in %.

➔ Parameter **[P:017]** = 0

Signal output and status parameter **[P:302]** are based on the set value for rotation speed switchpoint 1 **[P:701]**.

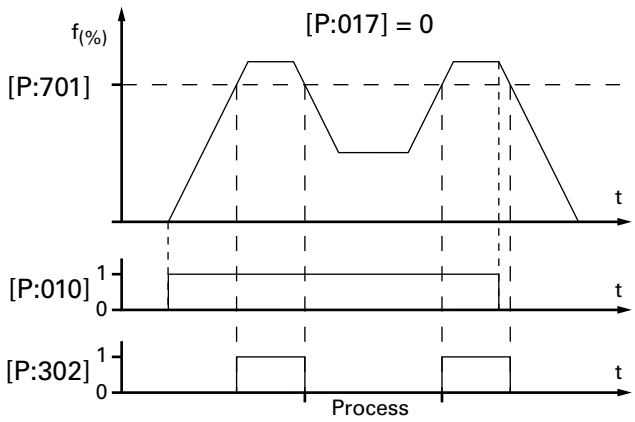



**Fig. 6: Example for the configuration rotation speed switchpoint 1 active**

### Rotation speed switchpoint 1 & 2

➔ Adjust the parameter **[P:701]** to the desired value in %.
➔ Adjust the parameter **[P:719]** to the desired value in %.
➔ Parameter **[P:017]** = 1

When the pumping station **[P:010]** is switched on, the rotation speed switchpoint 1 is the signal generator. When the pumping station is switched off, signal output and status query are based on the rotation speed switchpoint 2. The signal output is governed by the hysteresis between the two switchpoints.

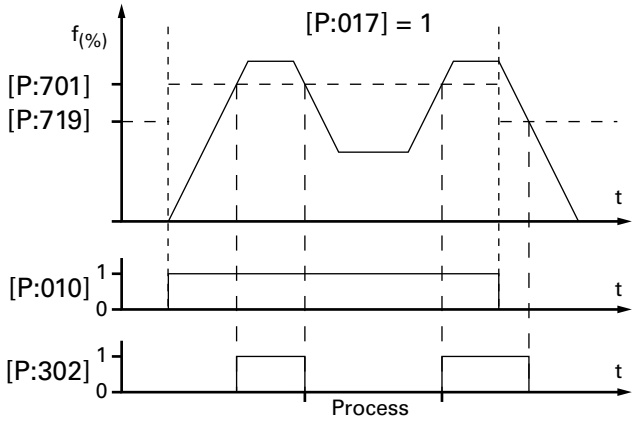



**Fig. 7: Example for the configuration rotation speed switchpoint 1+2 active; [P:701] > [P:719]**

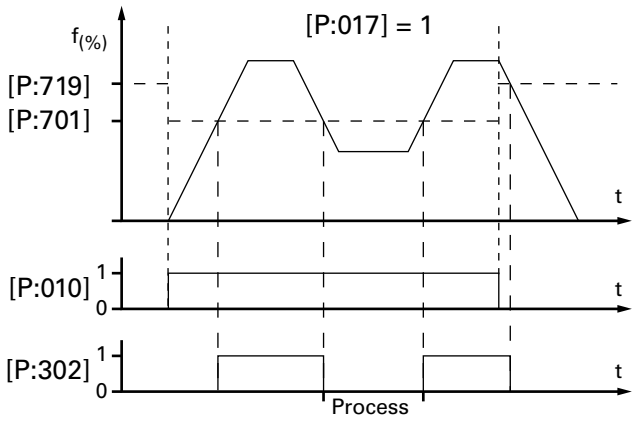



**Fig. 8: Example for the configuration rotation speed switchpoints 1+2 active; [P:701] < [P:719]**

## Rotation speed setting mode

The rotation speed setting mode reduces the rotation speed and hence the throughput of the turbopump. The pumping speed of the turbopump changes proportional to rotation speed. Standby mode is ineffective during rotation speed setting mode. The set rotation speed is adjusted by the set value in rotation speed setting mode **[P:707]**. The rotation speed switchpoint varies with the set rotation speed. Underrunning or overrunning the set value in rotation speed setting mode activates and deactivates the status signal **[P:306] SetSpdAtt** respectively.

➔ Adjust the parameter **[P:707]** to the desired value in %.

➔ Parameter **[P:026]** = 1

➔ Read the parameters **[P:308]/[P:397]**.

**Permissible rotation speed range of the turbopump**

Adjustments in the rotation speed setting mode or in the standby mode are subject to the permissible rotation speed range of the respective turbopump. Underrunning the minimum permissible value causes the warning message **Wrn100**. The electronic drive unit resets the set rotation speed automatically to the next valid value.

➔ Maintain the permissible rotation speed range of the turbopump (please refer to the technical data in the operating instructions for the respective turbopump).

## Standby

Pfeiffer Vacuum recommends standby mode for the turbopump during process and production stops. When standby mode is active, the electronic drive unit reduces the rotation speed of the turbopump. Standby mode is ineffective during rotation speed setting mode. The factory setting for the set value in standby mode is 66.7 % of the nominal rotation speed. Underrunning or overrunning the set speed in standby mode activates or deactivates the status signal **[P:306] SetSpdAtt**.

➔ Adjust the parameter **[P:717]** to the desired value in %.

➔ Parameter **[P:026]** = 0

➔ Parameter **[P:002]** = 1

➔ Read the parameters **[P:308]/[P:397]**.

## Rotation speed set value

The typical nominal rotation speed of a turbopump is factory-set in the electronic drive unit. If the electronic drive unit is replaced or a different pump type is used, the reference set value of the nominal rotation speed must be confirmed. This procedure is part of a redundant safety system for avoiding excess rotation speeds.

| HiPace | Nominal rotation speed confirmation [P:777] |
|---|---|
| 300 | 1000 Hz |
| 400 / 700 / 800 | 820 Hz |

➔ Adjust the parameter **[P:777]** according to the pump type.

Once the nominal rotation speed is attained, the pump will run idle unless additional gas loads are entered. Depending on process or application requirements, the nominal rotation speed can be reduced in rotation speed setting mode or standby mode.

## Operation mode backing pump

Operation of a connected backing pump via the electronic drive unit depends on the backing pump type.

| Operation mode [P:025] | recommended backing pump |
|---|---|
| "0" continous operation | all kinds of backing pumps |
| "1" Intermittend operation | diaphragm pumps only |
| "2" Delayed switching on | all kinds of backing pumps |

➔ Adjust the parameter **[P:025]** to the desired value.

### Continous operation

With "pumping station on", the electronic drive unit sends a signal to the configured accessory connection to switch on the backing pump. This signal can also be used for controlling a fore-vacuum safety valve.

### Intermittend operation (diaphragm pumps only)

Intermittend operation can extend the life expectancy of the membrane of a connected diaphragm pump. Either a diaphragm pump with built-in semiconductor relay or an interconnected relay box with semiconductor relay is required for intermittend operation. The backing pump is switched on and off in dependence of the turbopump's power consumption. A relation to the supplied fore-vacuum pressure is derived from the power consumption. The switching off and switching on thresholds for the backing pump are adjustable. Fluctuations in the power consumption of idling turbopumps and type-dependent varying fore-vacuum pressures of the backing pumps require the switching thresholds to be set separately for the intermittend mode.

Pfeiffer Vacuum recommends the intermittend mode between 5 and 10 hPa. A pressure gauge and a dosing valve are required to set the switching thresholds.

➔ Switch on the vacuum system via the function "pumping station" and await the run-up.
➔ Generate a fore-vacuum pressure of 10 hPa by gas inlet via dosing valve.
➔ Read and note the parameter **[P:316]**.
➔ Adjust the switch on threshold backing pump via parameter **[P:711]** to the determined drive power for a fore-vacuum pressure of 10 hPa.
➔ Reduce the fore-vacuum pressure to 5 hPa.
➔ Read and note the parameter **[P:316]**.
➔ Adjust the switch off threshold backing pump via parameter **[P:710]** to the determined drive power for a fore-vacuum pressure of 5 hPa.

### Delayed switching on

Switching on the turbopump and the backing pump at the same time can result in unwanted gas flows. Depending on process or application requirements, the backing pump can be switched on with a delay. The switch-on delay depends on the rotation speed of the turbopump and is fixed in the electronic drive unit at 6 Hz.

The switch-on delay signal can also be used for switching a fore-vacuum safety valve.

## Operation with accessories

Depending on the configuration, various accessories can be connected to the turbopump and controlled via parameter of the electronic drive unit.

### Heating

➔ Switch on or off the heating via parameter **[P:001]**.

The activation of a connected casing heating depends on rotation speed switchpoint 1 (factory setting: 80 % x $f_{Nominal}$).

### Fan

Two options in the connection configuration enable continuous or temperature controlled operation of a connected air cooling unit *(see p. 20, chap. 7.3)*. Threshold values are type-specific and are anchored in the electronic drive unit.

### Sealing gas valve

➔ Switch on or off a sealing gas valve which is connected to a pre-configured output via parameter **[P:050]**.

## Vent modes

The turbopump can be vented only after the function "pumping station" has been switched off. Signals are sent to configured outputs with a fixed delay of 6 s. There are three options for operation with a venting valve connected.

➔ Enable venting via parameter **[P:012]**.

➔ Select the venting mode via parameter **[P:030]**.

### Delayed venting

Start and venting time after "pumping station off" are configurable and depend on the rotation speed of the turbopump.

➔ Parameter **[P:030]** = 0

➔ Adjust the venting rotation speed in % of the nominal rotation speed via parameter **[P:720]**.

➔ Adjust the venting time in s via parameter **[P:721]**.

If the venting rotation speed is underrun, the venting valve will open for the set venting time. In the event of a power failure, venting will occur if the set venting rotation speed is underrun. In this case, the venting period depends on the residual energy delivered by the moving rotor. When power is restored, the venting process is interrupted.

### No venting

No venting is performed during this operation mode.

➔ Parameter **[P:030]** = 1

### Direct venting

Start and venting time are not configurable. Venting starts with a delay of 6 s after "pumping station off". When the function "pumping station" is switched on renewed, the venting valve closes automatically. In the event of a power failure, venting will occur if an anchored type-specific rotation speed is underrun. When power is restored, the venting process is interrupted.

➔ Parameter **[P:030]** = 2

## Monitoring the thermal load

If threshold values are overrun, output signals from temperature sensors allow the pump to be brought to a safe condition. Depending on pump type, temperature threshold values for warnings and error messages are saved fixed in the electronic drive unit . For information purposes, various status queries are prepared in the parameter set.

## 7.5 Switching on/off the pump

### Switching on

The function "pumping station" comprises turbopump operation with control of all connected accessories (e.g. backing pump).

➔ Switch on the supply voltage with switch S1 on the power supply.
➔ Parameter **[P:023]** = 1
➔ Parameter **[P:010]** = 1

Ongoing (and removed) error messages are reset. After a successfully completed self-test, the electronic drive unit sets the turbopump motor and all connected accessories into operation depending on their configuration.

When the pumping station is activated, the motor of the turbopump can be switched off and on via the function **[P:023]**.

### Switching off

➔ Parameter **[P:010]** = 0

The electronic drive unit switches off the turbopump and activates preset accessory options (e.g. venting, backing pump).

➔ Wait for the complete standstill of the pump.
➔ Cut off the supply voltage with switch S1 on the power supply.

# 8 Pfeiffer Vacuum Protocol for "RS-485"

## 8.1 Telegram frame

The telegram frame of the Pfeiffer Vacuum protocol contains only ASCII code characters [32; 127], the exception being the end character of the message $^{C}_{R}$. Basically, a master 💻 (e.g. a PC) sends a telegram, which is answered by a slave ○ (e.g. electronic drive unit or gauge).

| a2 | a1 | a0 | * | 0 | n2 | n1 | n0 | l1 | l0 | dn | ... | d0 | c2 | c1 | c0 | $^{C}_{R}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | |
|---|---|
| a2 - a0 | Unit address for slave ○<br>– Individual address of the unit ["001";"255"]<br>– Group address "9xx" for all identical units (no response)<br>– global address "000" for all units on the bus (no response) |
| * | Action *(see p. 29, chap. 8.2)* |
| n2 - n0 | Pfeiffer Vacuum parameter numbers |
| l1 - l0 | Data length dn ... d0 |
| dn - d0 | Data in data type concerned *(see p. 30, chap. 8.3)* |
| c2 - c0 | Checksum (sum of ASCII values of cells a2 to d0) modulo 256 |
| $C_R$ | carriage return (ASCII 13) |

## 8.2 Telegrams

**Data request 💻⇨○?**

| a2 | a1 | a0 | 0 | 0 | n2 | n1 | n0 | 0 | 2 | = | ? | c2 | c1 | c0 | $^{C}_{R}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

**Control command 💻⇨○!**

| a2 | a1 | a0 | 1 | 0 | n2 | n1 | n0 | l1 | l0 | dn | ... | d0 | c2 | c1 | c0 | $^{C}_{R}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

**Data response / control command understood ○⇨💻✓**

| a2 | a1 | a0 | 1 | 0 | n2 | n1 | n0 | l1 | l0 | dn | ... | d0 | c2 | c1 | c0 | $^{C}_{R}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

**Error message ○⇨💻×**

| a2 | a1 | a0 | 1 | 0 | n2 | n1 | n0 | 0 | 6 | N | O | _ | D | E | F | c2 | c1 | c0 | $^{C}_{R}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | _ | R | A | N | G | E | | | | |
| | | | | | | | | | | _ | L | O | G | I | C | | | | |

| | |
|---|---|
| NO_DEF | The parameter n2 - n0 does not exist |
| _RANGE | Data dn - d0 are outside the permitted range |
| _LOGIC | Logic access violation |

### Example 1

**Data request**

Actual rotation speed (parameter **[P:309]**, device address slave: "123")

| 💻⇨○? | 1 | 2 | 3 | 0 | 0 | 3 | 0 | 9 | 0 | 2 | = | ? | 1 | 1 | 2 | $^{C}_{R}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ASCII | 49 | 50 | 51 | 48 | 48 | 51 | 48 | 57 | 48 | 50 | 61 | 63 | 49 | 49 | 50 | 13 |

**Data response: 633 Hz**

Actual rotation speed (parameter **[P:309]**, device address slave: "123")

| ○⇨💻✓ | 1 | 2 | 3 | 1 | 0 | 3 | 0 | 9 | 0 | 6 | 0 | 0 | 0 | 6 | 3 | 3 | 0 | 3 | 7 | $^{C}_{R}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ASCII | 49 | 50 | 51 | 49 | 48 | 51 | 48 | 57 | 48 | 54 | 48 | 48 | 48 | 54 | 51 | 51 | 48 | 51 | 55 | 13 |

### Example 2

**Control command**

Switch on pumping station (parameter **[P:010]**, device address slave: "042")

| 💻⇨〇! | 0 | 4 | 2 | 1 | 0 | 0 | 1 | 0 | 0 | 6 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 2 | 0 | $C_R$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ASCII | 48 | 52 | 50 | 49 | 48 | 48 | 49 | 48 | 48 | 54 | 49 | 49 | 49 | 49 | 49 | 49 | 48 | 50 | 48 | 13 |

**Control command understood**

Switch on pumping station (parameter **[P:010]**, device address slave: "042")

| 💻⇨〇! | 0 | 4 | 2 | 1 | 0 | 0 | 1 | 0 | 0 | 6 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 2 | 0 | $C_R$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ASCII | 48 | 52 | 50 | 49 | 48 | 48 | 49 | 48 | 48 | 54 | 49 | 49 | 49 | 49 | 49 | 49 | 48 | 50 | 48 | 13 |

## 8.3 Applied data types

| Data type | Description | Size l1 - l0 | Example |
|---|---|---|---|
| 0 | False / true | 06 | 000000 / 111111 |
| 1 | Positive integer number | 06 | 000000 to 999999 |
| 2 | Positive fixed comma number | 06 | 001571 equal to 15.71 |
| 4 | Symbol chain | 06 | TC_400 |
| 7 | Positive integer number | 03 | 000 to 999 |
| 10 | Exponential value | 06 | 100023 equal to $1.0 \cdot 10^3$ |
| 11 | Symbol chain | 16 | BrezelBier&Wurst |

# 9 Malfunctions

## 9.1 General

Turbopump and electronic drive unit malfunctions always result in a warning or error message. In both cases, the electronic drive unit outputs an error code. Operating messages are generally displayed via the LEDs on the electronic drive unit. If an error occurs, the turbopump and connected devices will be switched off. The selected venting mode will be triggered after the preset delay.

**WARNING**

**Automatic start-up after power failure or malfunction acknowledgement**

The function "pumping station" of the electronic drive unit remains active after power failure or errors that lead to shut down the pump or the system. The turbopump runs up automatically after power ist restoresd or malfunction acknowledgement.

➔ Switch off the function "pumping station" if necessary.

➔ Provide safety measures against interference in the high vacuum flange while the turbopump is running.

## 9.2 Operation display via LED

LEDs in the front panel of the electronic drive unit show basic operating conditions of the turbopump. A differentiated malfunction and warning display is possible only for operation with DCU or HPU.

| LED | Symbol | LED status | Display | Meaning |
|---|---|---|---|---|
| Green | | Off | | currentless |
| | | On, flashing | | "Pumping Station OFF", rotation speed ≤ 60 $min^{-1}$ |
| | | On, invers flashing | | "Pumping Station ON", set rotation speed not attained |
| | | On, constantly | | "Pumping Station ON", set rotation speed attained |
| | | On, blinking | | "Pumping Station OFF", rotation speed > 60 $min^{-1}$ |
| Yellow | | Off | | no warning |
| | | On, constantly | | Warning |
| Red | | Off | | no malfunction |
| | | On, constantly | | Malfunction |

**Fig. 9: Behaviour and meaning of LEDs on the electronic drive unit**

## 9.3 Error codes

| Error code | Problem | Possible cause | Remedy |
|---|---|---|---|
| Err001 | Excess rotation speed | | ⇨ Contact Pfeiffer Vacuum Service<br>⇨ Reset at rotation speed f = 0 only |
| Err002 | Overvoltage | – Wrong mains pack used | ⇨ Check type of mains pack<br>⇨ Check mains pack voltage |
| Err006 | Run-up time error | – Run-up time too short<br>– Gas flow in the vacuum chamber caused by leakage or open valves<br>– Rotation speed switchpoint is underrun after run-up time is expired | ⇨ Adjust run-up time to process<br>⇨ Check the vacuum chamber for leaks or closed valves<br>⇨ Adjust rotation speed switchpoint |
| Err007 | Operating fluid deficiency | – Operating fluid deficiency | ⇨ Check operating fluid<br>⇨ Reset at rotation speed f = 0 only |
| Err008 | Connection electronic drive unit - pump faulty | – Connection to the pump is faulty | ⇨ Check the connection<br>⇨ Reset at rotation speed f = 0 only |

| Error code | Problem | Possible cause | Remedy |
|---|---|---|---|
| Err010 | Internal device fault | | ⇨ Contact Pfeiffer Vacuum Service<br>⇨ Reset at rotation speed f = 0 only |
| Err021 | Electronic drive unit does not recognize pump | | ⇨ Contact Pfeiffer Vacuum Service<br>⇨ Reset at rotation speed f = 0 only |
| Err043 | Internal configuration fault | | ⇨ Contact Pfeiffer Vacuum Service |
| Err044 | Excess temperature electronic | – Cooling deficient | ⇨ Optimize cooling<br>⇨ Check the ambient conditions |
| Err045 | Excess temperature motor | – Cooling deficient | ⇨ Optimize cooling<br>⇨ Check the ambient conditions |
| Err046 | Internal initialization fault | | ⇨ Contact Pfeiffer Vacuum Service |
| Err091 | Internal device fault | | ⇨ Contact Pfeiffer Vacuum Service |
| Err092 | Unknown connection panel | | ⇨ Contact Pfeiffer Vacuum Service |
| Err093 | Temperature analysis motor faulty | | ⇨ Contact Pfeiffer Vacuum Service |
| Err094 | Temperature analysis electronic faulty | | ⇨ Contact Pfeiffer Vacuum Service |
| Err098 | Internal communication fault | | ⇨ Contact Pfeiffer Vacuum Service |
| Err107 | Collective fault power stage | | ⇨ Contact Pfeiffer Vacuum Service<br>⇨ Reset at rotation speed f = 0 only |
| Err108 | Rotation speed measurement faulty | | ⇨ Contact Pfeiffer Vacuum Service<br>⇨ Reset at rotation speed f = 0 only |
| Err109 | Firmware not confirmed | | ⇨ Contact Pfeiffer Vacuum Service |
| Err110 | Operating fluid analysis faulty | | ⇨ Contact Pfeiffer Vacuum Service<br>⇨ Reset at rotation speed f = 0 only |
| Err111 | Communication fault operating fluid pump | | ⇨ Contact Pfeiffer Vacuum Service<br>⇨ Reset at rotation speed f = 0 only |
| Err112 | Collective fault operating fluid fault | | ⇨ Contact Pfeiffer Vacuum Service<br>⇨ Reset at rotation speed f = 0 only |
| Err114 | Temperature analysis power stage faulty | | ⇨ Contact Pfeiffer Vacuum Service |
| Err117 | Excess temperature pump bottom part | – Cooling deficient | ⇨ Optimize cooling<br>⇨ Check the ambient conditions |
| Err118 | Excess temperature power stage | – Cooling deficient | ⇨ Optimize cooling<br>⇨ Check the ambient conditions |
| Err119 | Excess temperature bearing | – Cooling deficient | ⇨ Optimize cooling<br>⇨ Check the ambient conditions |
| Err143 | Excess temperature operating fluid pump | – Cooling deficient | ⇨ Optimize cooling<br>⇨ Check the ambient conditions<br>⇨ Reset at rotation speed f = 0 only |
| Err777 | Nominal rotation speed not confirmed | – Nominal rotation speed not confirmed after replacement of the electronic drive unit | ⇨ Confirm the nominal rotation speed via **[P:777]**<br>⇨ Reset at rotation speed f = 0 only |
| Wrn001 | TMS heating time elapsed | – internal heating-up timer elapsed | ⇨ Check the ambient conditions |
| Wrn003 | TMS heating circuit sensor | – TMS temperature not in the permissible range between +5 °C and 85 °C | ⇨ Check the ambient conditions<br>⇨ Contact Pfeiffer Vacuum Service |
| Wrn007 | Low voltage / mains power failure | – Mains failure | ⇨ Check mains supply |
| Wrn018 | Remote priority conflict | – Pumping station is switched on via **[P:010]**, whereas the E74-input "start/stop" is off (opened) | ⇨ Switch on the pumping station via E74<br>⇨ Switch off **[P:010]** |
| Wrn045 | High temperature motor | – Cooling deficient | ⇨ Optimize cooling<br>⇨ Check the ambient conditions |
| Wrn076 | High temperature electronic | – Cooling deficient | ⇨ Optimize cooling<br>⇨ Check the ambient conditions |
| Wrn097 | Pump information invalid | – Pump data faulty | ⇨ Reset for default values |
| Wrn098 | Pump information incomplete | – Connection to the pump is faulty | ⇨ Contact Pfeiffer Vacuum Service |
| Wrn100 | Rotation speed raised to minimum value | – Permissible adjustments for the rotation speed setting mode or standby are incorrect | ⇨ Check **[P:707]** or **[P:717]**<br>⇨ Find the valid rotation speed range in the technical data of the turbopump |
| Wrn115 | Temperature analysis pump bottom part faulty | | ⇨ Contact Pfeiffer Vacuum Service |
| Wrn116 | Temperature analysis bearing faulty | | ⇨ Contact Pfeiffer Vacuum Service |
| Wrn117 | High temperature pump bottom part | – Cooling deficient | ⇨ Optimize cooling<br>⇨ Check the ambient conditions |
| Wrn118 | High temperature power stage | – Cooling deficient | ⇨ Optimize cooling<br>⇨ Check the ambient conditions |
| Wrn119 | High temperature  bearing | – Cooling deficient | ⇨ Optimize cooling<br>⇨ Check the ambient conditions |

| Error code | Problem | Possible cause | Remedy |
|---|---|---|---|
| Wrn143 | High temperature operating fluid pump | – Cooling deficient | ⇨ Optimize cooling<br>⇨ Check the ambient conditions |
| Wrn168 | High deceleration | – Rate of pressure rise too high; Venting rate to high | ⇨ Check and optimize the venting rate (pump specific) |

# Declaration of conformity

We hereby declare that the product cited below satisfies all relevant provisions according to the following **EC directives**:

- **Electromagnetic Compatibility 2004/108/EC**
- **Low Voltage 2006/95/EEC**

**TC 400**

Harmonised standards and national standards and specifications which have been applied:

DIN EN 61000-3-2 : 2008
DIN EN 61000-3-3 : 2006
DIN EN 61010-1 : 2010
DIN EN 61326-1 : 2006
DIN EN 62061 : 2005
Semi F47-0200
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