OPTIBAR FC 1000 Handbook

Compact flow computer for gas, liquid and steam measurements

The documentation is only complete when used in combination with the relevant documentation for the sensor.

KROHNE

IMPRINT

1.1 Software history

INFORMATION!
In the table below, "x" is a placeholder for possible multi-digit alphanumeric combinations, depending on the available version.

Changes and effect on compatibility

1	Downwards compatible changes and fault repair with no effect on operation (e.g. spelling mistakes on display)	
2-_	Downwards compatible hardware and/or software change of interfaces:	
	H	HART®
	P	PROFIBUS
	F	Foundation Fieldbus
	M	Modbus
	X	all interfaces
3-_	Downwards compatible hardware and/or software change of inputs and outputs:	
	I	Current Output
	F, P	Frequency / pulse output
	S	Status Output
	C	Control input
	CI	Current input
	X	all inputs and outputs
4	Downwards compatible changes with new functions	
5	Incompatible changes, i.e. electronic equipment must be changed.	

Release date	SW version	HW version	Changes and compatibility	Documentation
2023-10-01	3.7.1	1.0.0	4	MA OPTIBAR FC 1000 R01

1.2 Intended use

INFORMATION!
The manufacturer is not liable for any damage resulting from improper use or use for other than the intended purpose.

The OPTIBAR FC 1000 compact computer is used to calculate the flow rate of liquid and gaseous media. The device may only be used for the purposes specified in these instructions. Unless expressly stated otherwise in this manual, all modifications to the device are the responsibility of the user.

CAUTION!

- *Any modification to the device, including drilling, sawing, trimming, welding and soldering of parts, or partially painting over or coating, is prohibited.*
- *Neither is it permitted to use the device as a climbing aid e.g. for installation purposes, as a holder for cables, pipes or other loads.*
- *The mounting or installation of parts is only permitted as described in this document, or insofar as it has been authorised by the manufacturer or a certified service partner.*

1.3 Technical limits

The device was constructed solely for use within the technical limits indicated on the nameplate and in the technical data. Applications outside of these limits are not permitted and could lead to significant risk of accident. For this reason, observe the following limits:

- Do not exceed the indicated permissible operating temperature range.
- The permissible ambient temperatures given may not be exceeded or undershot.

1.4 Certifications

CE marking

The device meets the essential requirements of the EU directives. The CE marking indicates the conformity of the product with the union legislation applying to the product and providing for CE marking.

For full information of the EU directives and standards and the approved certifications, please refer to the EU declaration on the KROHNE website.

1.5 Safety instructions from the manufacturer

1.5.1 Copyright and data protection

The contents of this document have been created with great care. Nevertheless, we provide no guarantee that the contents are correct, complete or up-to-date.

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We hereby expressly prohibit the use of the contact data published as part of our duty to publish an imprint for the purpose of sending us any advertising or informational materials that we have not expressly requested.

1.5.2 Disclaimer

The manufacturer will not be liable for any damage of any kind by using its product, including, but not limited to direct, indirect or incidental and consequential damages.

This disclaimer does not apply in case the manufacturer has acted on purpose or with gross negligence. In the event any applicable law does not allow such limitations on implied warranties or the exclusion of limitation of certain damages, you may, if such law applies to you, not be subject to some or all of the above disclaimer, exclusions or limitations.

Any product purchased from the manufacturer is warranted in accordance with the relevant product documentation and our Terms and Conditions of Sale.

The manufacturer reserves the right to alter the content of its documents, including this disclaimer in any way, at any time, for any reason, without prior notification, and will not be liable in any way for possible consequences of such changes.

1.5.3 Product liability and warranty

The operator shall bear responsibility for the suitability of the device for the specific purpose. The manufacturer accepts no liability for the consequences of misuse by the operator. Improper installation or operation of the devices (systems) will cause the warranty to be void. The respective "Standard Terms and Conditions" which form the basis for the sales contract shall also apply.

1.5.4 Information concerning the documentation

To prevent any injury to the user or damage to the device it is essential that you read the information in this document and observe applicable national standards, safety requirements and accident prevention regulations.

If this document is not in your native language and if you have any problems understanding the text, we advise you to contact your local office for assistance. The manufacturer cannot accept responsibility for any damage or injury caused by misunderstanding of the information in this document.

This document is provided to help you establish operating conditions, which will permit safe and efficient use of this device. Special considerations and precautions are also described in the document, which appear in the form of icons as shown below.

1.5.5 Warnings and symbols used

Safety warnings are indicated by the following symbols.

DANGER!
This warning refers to the immediate danger when working with electricity.

DANGER!
This warning refers to the immediate danger of burns caused by heat or hot surfaces.

DANGER!
This warning refers to the immediate danger when using this device in a hazardous atmosphere.

DANGER!
These warnings must be observed without fail. Even partial disregard of this warning can lead to serious health problems and even death. There is also the risk of seriously damaging the device or parts of the operator's plant.

WARNING!
Disregarding this safety warning, even if only in part, poses the risk of serious health problems. There is also the risk of damaging the device or parts of the operator's plant.

CAUTION!
Disregarding these instructions can result in damage to the device or to parts of the operator's plant.

INFORMATION!
These instructions contain important information for the handling of the device.

LEGAL NOTICE!
This note contains information on statutory directives and standards.

- HANDLING
  This symbol designates all instructions for actions to be carried out by the operator in the specified sequence.

➲ RESULT
This symbol refers to all important consequences of the previous actions.

1.6 Safety instructions for the operator

WARNING!
In general, devices from the manufacturer may only be installed, commissioned, operated and maintained by properly trained and authorized personnel.
This document is provided to help you establish operating conditions, which will permit safe and efficient use of this device.

1.7 Cleaning

The OPTIBAR FC 1000 may only be cleaned with a dry cloth.

2.1 Scope of delivery

INFORMATION!
Inspect the packaging carefully for damages or signs of rough handling. Report damage to the carrier and to the local office of the manufacturer.

INFORMATION!
Do a check of the packing list to make sure that you have all the elements given in the order.

INFORMATION!
Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.

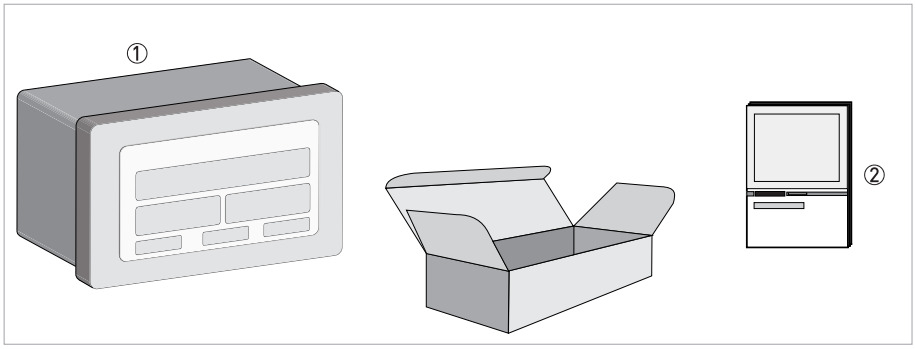

Figure 2-1: Standard scope of delivery

① Flow computer
② Documentation

Optional accessories

- Profibus / Profinet converter
- Automatic Purge Unit APU

INFORMATION!
Assembly materials and tools are not part of the delivery. Use the assembly materials and tools in compliance with the applicable occupational health and safety directives.

2.2 Device description

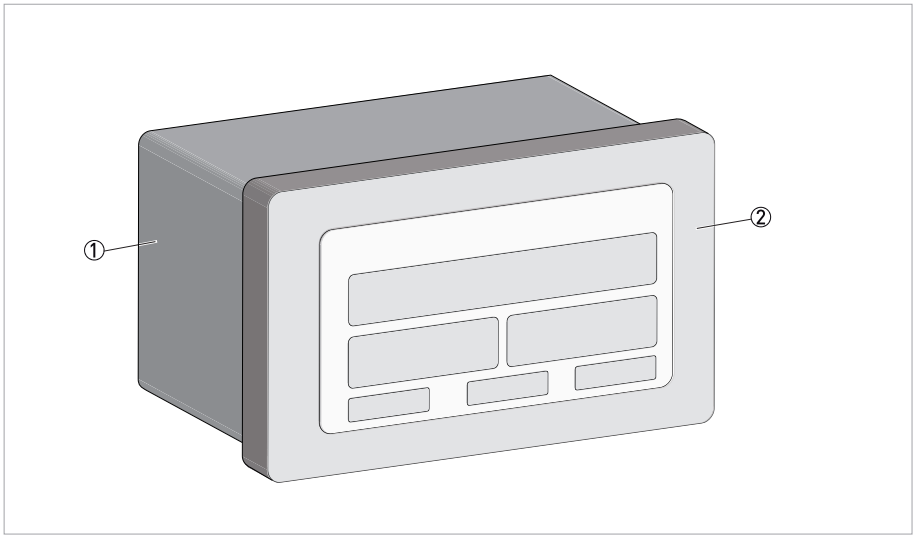

Figure 2-2: Device description

① Housing
② Touch display

The setup of the device is carried out via the touch display. For further information refer to *General operation* on page 28

The device is supplied ready for operation when ordered. The factory setting for the process data corresponds to your order specifications.

2.3 Name plates

INFORMATION!
Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.

The nameplate is used to identify the device. The most important data can be taken from it.

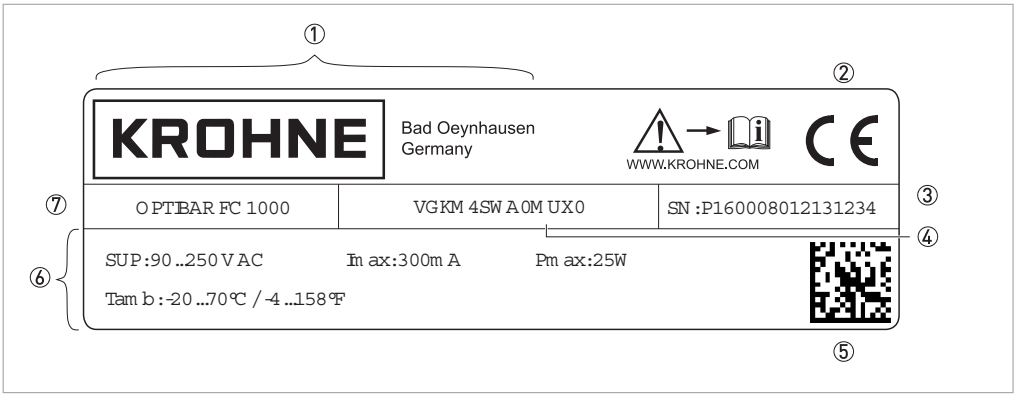

Figure 2-3: Example for a nameplate

① Manufacturer logo and address
② CE marking and marking of notified body (e.g. ATEX, PED,...)
③ Serial number
④ Type code
⑤ Barcode
⑥ Spezifications for process conditions
⑦ Product name

2.4 Use of the OPTIBAR FC 1000

2.4.1 General information

The OPTIBAR FC 1000 is used for flow calculation and evaluation of volume flows of liquid and gaseous media.
Differential pressure or volume flow sensors can be used as primary sensors.

2.4.2 Application with differential pressure sensor

The flow calculation for differential pressure transmitters in the OPTIBAR FC 1000 is based on the following correlation for the mass flow (according to ISO 5167):

$$q_m = \frac{C}{\sqrt{(1 - \beta^4)}} * \varepsilon * \frac{\pi}{4} * d^2 * \sqrt{2 * \Delta p * \rho}$$

Figure 2-4: Correlation for the mass flow

q_m: Mass flow
C: Flow coefficient
β: Diameter ratio
ε: Expansion number
d: Inner diameter of the bottleneck
Δp: Differential pressure
ρ: Density of the medium before the bottleneck

Alternatively, the calculation can also be performed according to AGA-3.

2.4.3 Application with volume flow sensor

The mass flow for a volume flow sensor results from this formula:

$$q_m = q_v * \rho$$

Figure 2-5: Mass flow for volume flow sensor

q_m: Mass flow
q_v: Volume flow
ρ: Density of the medium

Alternatively, an AGA-7 volume flow sensor can be used.

2.4.4 Supported media

The OPTIBAR FC 1000 supports the following media:

Medium / characteristic	Explanation
Gas	Calculation of gas properties according to various equations of state Ideal gas, Redlich-Kwong, Redlich-Kwong-Soave, Peng-Robinson Calculation according to AGA-8 DC/GC, SGERG 88 and AGA-NX19 Additional simplified mode with standard density query
Superheated steam	Calculation of properties according to IAPWS-97 Temperature and pressure measurement required
Saturated steam (p)	Calculation of properties according to IAPWS-97 Pressure measurement required
Saturated steam (T)	Calculation of properties according to IAPWS-97 Temperature measurement required
Water	Calculation of properties according to IAPWS-97
Heat transfer oil	Calculation of the properties depending on the oil temperature using tables of values. Import/export function for a user-defined oil
Simplified liquid	Indication of a constant density

2.4.5 Required sensors

If the OPTIBAR FC 1000 has been ordered parameterized, the parameterization sheet provides information on which sensors are to be connected to which terminals.
For an unparameterized OPTIBAR FC 1000, the following description is used to determine which sensors are required. These sensors are then connected in accordance with section 4.
The differential pressure Δp generated by a differential pressure sensor is measured by a differential pressure transmitter and processed by the OPTIBAR FC 1000.
A volume flow sensor transmits the determined volume flow qV directly to the OPTIBAR FC 1000.
The density is usually determined on the basis of the temperature and pressure of the medium. For the temperature T1 and the pressure p sensors can be used or fixed values can be parameterized.
A sensor is required for each quantity to be measured. The following table shows which connection options are available for the individual measured variables and when the respective sensor is NOT required:

Measurand	Connection options	not necassary for
Differential pressure Δp[1]	Analog inputs Ain1 to Ain4 (if the differential pressure is to be determined via HART®, only Ain1 and Ain2); refer to *Transmitters at the analog inputs* on page 22	Application with volume flow sensor
Volume flow q_v	Analog inputs Ain1 to Ain4; refer to *Transmitters at the analog inputs* on page 22or frequency/pulse input 1; refer to *Switching and frequency inputs* on page 23	Application with differential pressure sensor
Temperature T1	Analog inputs Ain1 to Ain4; refer to *Transmitters at the analog inputs* on page 22 or 1st Pt100; refer to *Connection of the Pt100/RTD* on page 21	Fixed value Saturated steam (p) Simplified liquid
Temperature T2[2]	Analog inputs Ain1 to Ain4; refer to *Transmitters at the analog inputs* on page 22 or 2nd Pt100; see refer to *Connection of the Pt100/RTD* on page 21	Fixed value No heat quantity application
Pressure p	Analog inputs Ain1 to Ain4; refer to *Transmitters at the analog inputs* on page 22	Fixed value Saturated steam (T) Liquids[3]

Table 2-1: Connection options available for individual measured variables

[1] Two transmitters may also be used for differential pressure: One covers the lower range and the other the upper range (split-range application).

[2] A second temperature (T2) is required for heat quantity calculations. The determination of the first temperature (T1) always takes place at the position of the actual flow measurement. The determination of the second temperature (T2) takes place at the position in the pipe course where a heat supply or heat dissipation takes place. The heat quantity is output by the OPTIBAR FC 1000 as an absolute value (regardless of whether cooling or heating is used). The second temperature can also be parameterized as a fixed value. The default value is then 0 °C.

[3] For water, a pressure sensor can optionally be used, otherwise the density is determined with a parameterizable design pressure.

2.4.6 Functional enhancement

The OPTIBAR FC 1000 can control certain external components and thus extend the functionality. For further information refer to *Functional extensions* on page 64.

3.1 General notes on installation

INFORMATION!
Inspect the packaging carefully for damages or signs of rough handling. Report damage to the carrier and to the local office of the manufacturer.

INFORMATION!
Do a check of the packing list to make sure that you have all the elements given in the order.

INFORMATION!
Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.

3.2 Ingress protection for housing

The housing of the device fulfills the requirements for ingress protection in accordance with IEC 60529. For further information refer to *Technical data* on page 74.

CAUTION!
The first digit stands for the protection of the inner electronic components against the ingress of foreign bodies including dust. The first digit "6" means that the housing is dust-proof. The second digit designates the protection of the inner electronic components against the ingress of water. The second digit "6" means that the housing is waterproof and also resistant against a strong jet of water. The number "7" means that the housing is waterproof even submersed under water for a given pressure and time. The number "8" means that the housing is permanently waterproof even under water.

3.3 Packaging

Your device was protected by packaging during transport. Its capacity to handle normal leads during transport is assured by test following ISO 22248. The packing of standard devices consists of environmentally friendly materials.

3.4 Storage

CAUTION!
Observe the storage information found on the packaging. Labels on the original packaging must always remain legible and may not be damaged.

- Store the device in a dry, dust-free location.
- Avoid extended direct exposure to the sun.
- Store the device in the original packaging supplied.
- Do not expose to aggressive media.
- Avoid mechanical shocks.
- Storage temperature: -40...+85°C / -40...+185°F
- Relative air humidity: 0...95%; non-condensing

3.5 Transport

- Use original packaging for transport and ensure that the packaging does not get crushed or damaged by sharp objects or other boxes.
- Do not throw or drop the device.
- Avoid temperatures below -40°C / -40°F and above +85°C / +185°C.
- When transporting by ship, use seaworthy outer packing.

3.6 Installation specifications

INFORMATION!
Observe the relevant directives, ordinances, standards and accident prevention regulations (e.g. VDE/VDI 3512, DIN 19210, VBG, Elex V, etc.).

3.7 Mounting

CAUTION!
- *Prior to installing the transmitter, it is essential to verify whether the version of the device on hand completely fulfils the technical and safety requirements of the measuring point. This applies in particular to the temperature, explosion protection and operating voltage.*
- *The device must not be heated by radiated heat (e.g. exposure to the sun) to an electronics housing surface temperature above the maximum permissible ambient temperature. If it is necessary to prevent damage from heat sources, a heat protection (e.g. sun shade) has to be installed.*

3.7.1 Panel mounting case

This version of the OPTIBAR FC 1000 is mounted by default in a panel cut-out.

For mounting the two brackets at the side must be removed (when installed) by pressing them forward. The unit is then inserted into the front of the control panel. Afterwards, reinstall the brackets and tighten the screw to fix the device in place. Ensure that the supplied gasket is firmly seated between the display and the control panel.

3.7.2 Wall mounting case

This version of the OPTIBAR FC 1000 is intended to be mounted on a wall by using the provided four mounting holes.

To open the housing for access to the mounting holes, open the cover profile on the left side of the device and loose the two locking screws. After that, the cover can be opened.

INFORMATION!
The protection class of the housing in only guaranteed if the locking screws are retightened after closing the cover.

4.1 Safety instructions

DANGER!
All work on the electrical connections may only be carried out with the power disconnected.
Take note of the voltage data on the nameplate!

DANGER!
Observe the national regulations for electrical installations!

WARNING!
Observe without fail the local occupational health and safety regulations.
Any work done on the electrical components of the measuring device may only be carried out by properly trained specialists.

INFORMATION!
Look at the device nameplate to ensure that the device is delivered according to your order.
Check for the correct supply voltage printed on the nameplate.

4.2 Notes for electrical cables

DANGER!
The device must be grounded to a spot in accordance with regulations in order to protect personnel against electric shocks.

DANGER!
Cables may only be connected when the power is switched off! Since the transmitter has no switch-off elements, overcurrent protection devices, lightning protection and/or energy isolating devices need to be provided by the customer.

4.3 Connections at the OPTIBAR FC 1000

The terminals / connections at the OPTIBAR FC 1000 can be divided into multiple areas. These are shown in the following figure.

The terminals for the electrical connections are pluggable. The power supply terminal is additionally secured with screws.

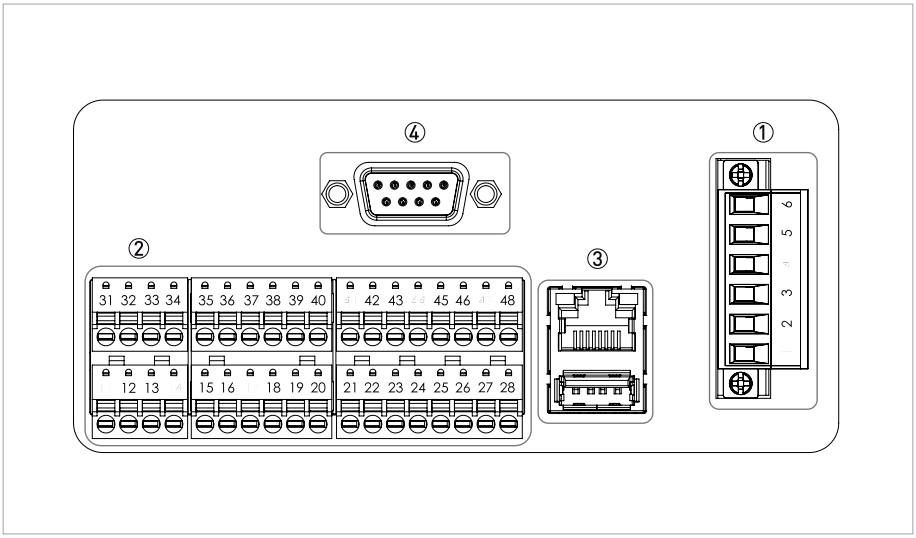

Figure 4-1: Connections at OPTIBAR FC 1000

① Power supply terminal with relay
② Main terminal strip
③ 3 Ethernet connection / USB socket
④ 4 D-sub connector (optional for panel mounting case, not available for wall mounting case)

4.4 Terminal assignment

4.4.1 Power supply terminal with relay

Pin	AC connection	DC connection
1	L	Unused
2	PE	GND
3	N	L+
4	Relay NC	Relay NC
5	Relay COM	Relay COM
6	RelayNO	Relay NO

Table 4-1: Pin assignment of power supply terminal and relay

INFORMATION!
The nameplate indicates whether it is an OPTIBAR FC 1000 for AC operation (AC voltage) or DC operation (DC voltage). Only the information on the nameplate of the device applies.

The auxiliary voltage is connected via the power supply terminal. For parametrization of the relay R, please refer to *Outputs* on page 50.

4.4.2 Connection of the Pt100/RTD

First Pt100/RTD		Second Pt100/RTD	
Pin	**Description**	**Pin**	**Description**
11	Port A	31	Port A
12	Port a	32	Port a
13	Port B	33	Port B
14	Port b (optional)	34	Port b (optional)

Table 4-2: Pin assignment of first and second Pt100/RTD

The Pt100 temperature resistors (RTDs) can be connected in 3- or 4-wire connection.

Both possibilities are illustrated in the figure below. The terminal assignments for the second Pt100/RTD are given in brackets.

If the temperature sensor is equipped with a transmitter, the connection is made as described in the next chapter.

For the parameterization of the temperature inputs refer to *Transmitter settings: Continued for any basic setting* on page 47.

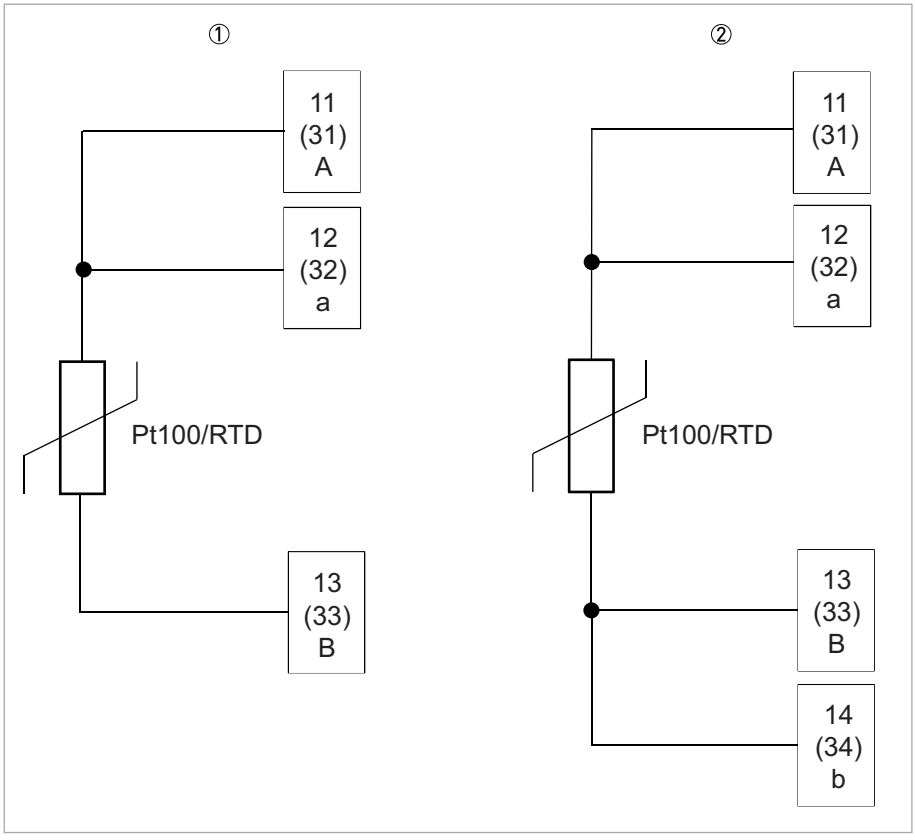

Figure 4-2: 3- and 4-wire connection of Pt100/RTD

① 3-wire connection of Pt100/RTD
② 4-wire connection of Pt100/RTD

4.4.3 Transmitters at the analog inputs

Passive transmitters are wired with their plus terminal to the signal input contact of the respective analog input. The minus terminal is connected to the respective GND contact. The following figure shows an example of a pressure transmitter at the third analog input. “AE” stands for the auxiliary energy with which the transmitter is supplied.

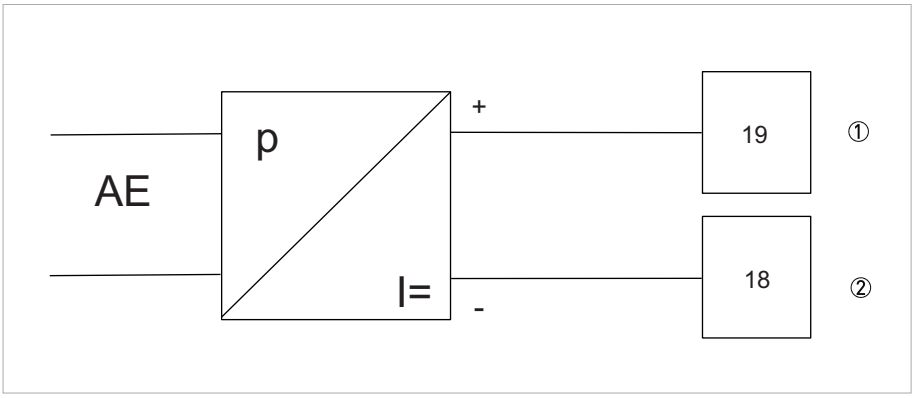

Figure 4-3: Connection of an passive transmitter

① Signal input
② GND

Active transmitters are wired with their plus terminal to the +24 V supply output of the respective analog input. The minus terminal is connected to the respective signal input. The following figure shows an example of a differential pressure transmitter at the first analog input.

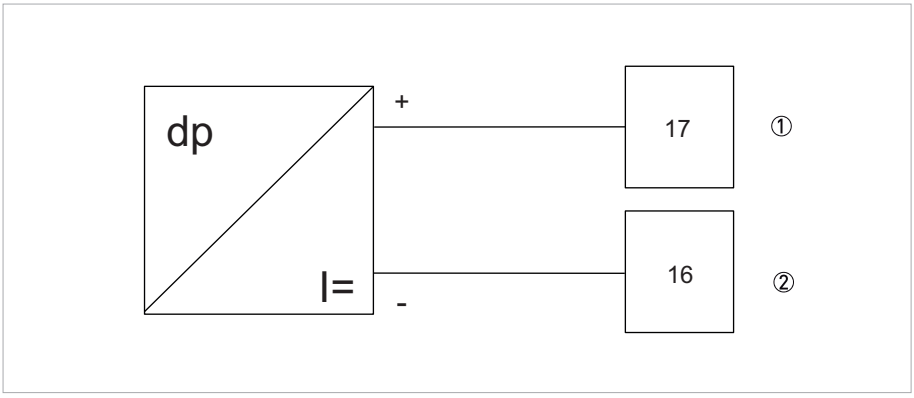

Figure 4-4: Connection of an active transmitter

① +24 V
② Signal input

Pins of 1. - 4. analog input (Ain1 / 2 / 3 / 4); HART capable	**Description**
15 / 18 / 35 / 38	Transmitter GND (VDC-)
16 / 19 / 36 / 39	for passive Transmitter Signal (VDC +)
17 / 20 / 37 / 40	for active Transmitter Signal (24 VDC + Supply)

Table 4-3: Pin assignment for 1. - 4. analog input

For the assignment of the inputs to the measured variables refer to *Inputs* on page 44. For the parameterization of the transmitter settings see chapters on page 45, on page 46 and on page 47.

If the temperature is determined with a Pt100 (without transmitter), the connection is made according to the chapter before.

4.4.4 Switching and frequency inputs

Pins of 1. and 2. switch / frequency input	**Description**
21 / 41	Connection +
22 / 42	Connection -

Table 4-4: Pin assignment for switching and frequency inputs

These inputs are used, for example, to connect a volumetric flow sensor (first input; refer to *Transmitter settings for volume flow transmitters* on page 46) if it has a frequency output or an AGA-7 sensor (refer to *Transmitter settings for AGA-7 sensors* on page 46). They are also used when connecting functional extensions.

4.4.5 Connection of analog outputs

Pins of 1. and 2. analog output	**Description**
23 / 43	Connection +
24 / 44	Connection -

Table 4-5: Pin assignment for analog outputs

Process variables can be output as 0/4...20 mA signals via the analog outputs. For the parameterization of the outputs refer to *Outputs* on page 50.

4.4.6 Electronic relays

Pins of 1. (NO) and 2. (NC) electronic relay	**Description**
25 / 27	Connection + (COM)
26 / 28	Connection - (NC)

Table 4-6: Pin assignment for electronic relays

The OPTIBAR FC 1000 offers two electronic relays/switches. These are used, for example, for the output of status signals or as frequency/pulse outputs. For the parameterization of the electronic relays the figure below shows a connection recommendation for the first electronic relay. The resistance R should be 5 to 10 kΩ. The second electronic relay is connected in the same way.

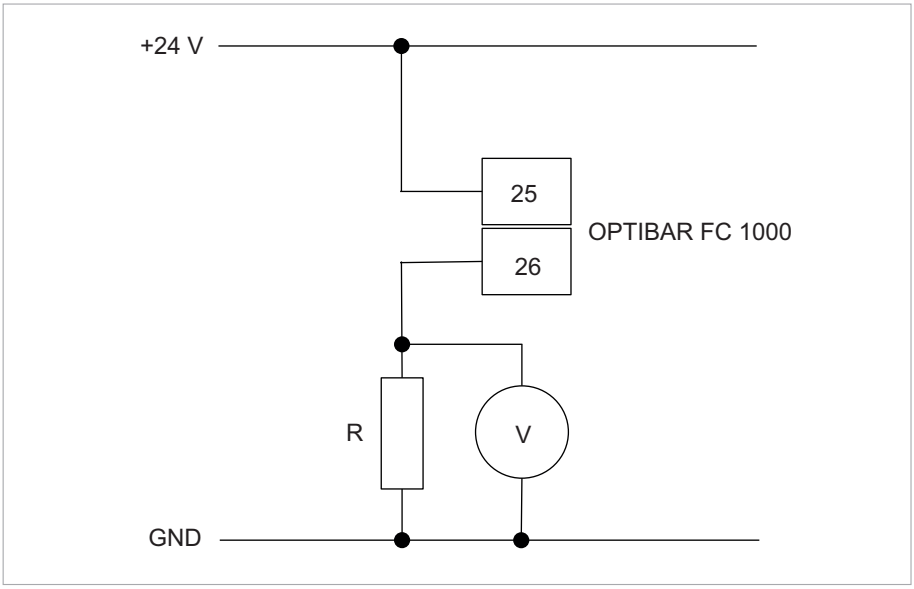

Figure 4-5: Connection recommendation first relay

4.4.7 Modbus / M-bus (serial 1)

Pin	Description
45	Connection +
46	Connection -
47	GND connection

Table 4-7: Pin assignment for electronic relays

The OPTIBAR FC 1000 offers an interface for Modbus/M-Bus. The interface assignment must be selected when ordering ("first Interface", refer to *Order information* on page 90). For the parameterization of the interface refer to *Description of digital interfaces* on page 80.

4.4.8 Ethernet interface

The OPTIBAR FC 1000 offers an Ethernet interface. This allows access to the web server of the OPTIBAR FC 1000 and provides Modbus TCP. A standard Ethernet cable is required for the connection. For the parameterization of the interface refer to *Description of digital interfaces* on page 80.

4.4.9 D-Sub connector

Pin (at D-sub connector)	**Description**
5	GND connection
8	Connection + (COM)
9	Connection - (NC)

Table 4-8: Pin assignment for D-sub connector

A standard serial cable with 1:1 wiring is required for the optional D-Sub connection ("second Interface", refer to *Order information* on page 90). For the parameterization of the interface refer to *Description of digital interfaces* on page 80.

4.4.10 Interface converter for Profibus / Profinet

An interface converter for the first or second serial interface of the OPTIBAR FC 1000 is used for communication via Profibus DP Slave or Profinet.

When using the first serial interface (option P/S for "Interface (Terminals)", refer to *Order information* on page 90), a corresponding D-Sub connector with screw terminals is supplied to create a connecting cable.

When using the second serial interface (option P/S for "Interface (Sub-D)" refer to *Order information* on page 90), a corresponding connecting cable (length approx. 2 m) is supplied.

Technical Data of the interface converter

Technical specification	
Power supply	24 V DC ±10 %
Current consumption	max. 300 mA, typical 100 mA
Dimensions (mm)	27 W × 120 H × 75 D
Degree of protection	IP20
Mounting	DIN rail TH 35 (Top hat rail IEC/EN 60715 35 × 7.5 mm²)
Operating temperature	0 ... 55 °C
Storage temperature	–40 ... 85 °C
Relative air humidity	0 ... 95 %; non-condensing
Installation altitude	up to 2000 m

Table 4-9: Technical data interface converter

Electrical connection of the interface converter

The interface converter is connected to the power supply and the OPTIBAR FC 1000. See the following figure.

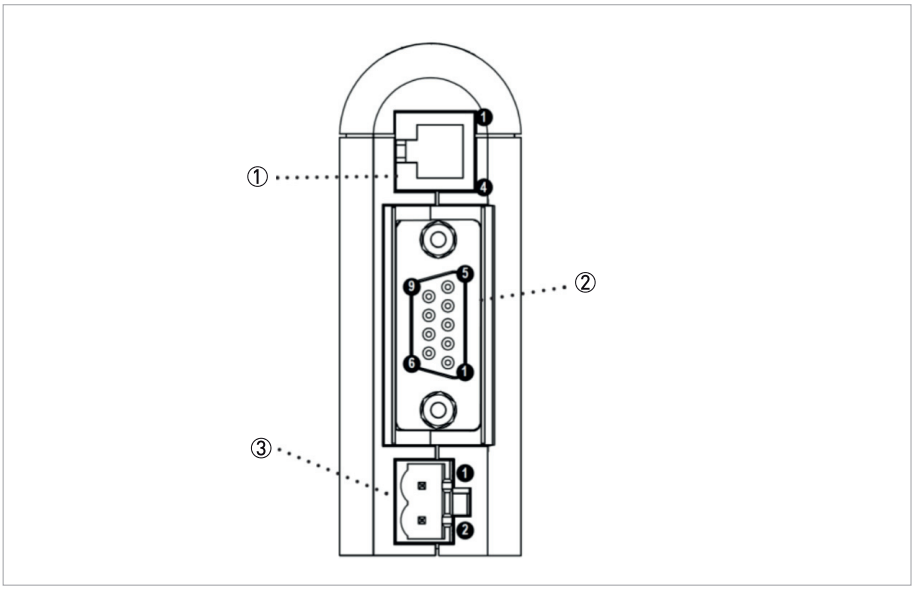

Figure 4-6: Electrical connection interface converter

① Maintenance connection (unused)
② D-Sub socket for connection to the OPTIBAR FC 1000 (via the supplied connecting cable or the D-Sub connector)
Pin assignment: 5 =GND connection; 8 = Connection +; 9 = Connection –
③ Power supply terminal
Pin assignment: 1 = +24 V DC; 2 = GND

The connection between the interface converter and the control station is made via the socket located on the front: D-Sub socket for the Profibus version and RJ45 socket for the Profinet version.

4.4.11 Automatic purging unit (APU)

General wiring

For the connection of the optional air purging unit (APU), the connection is as shown in the figure below. The remaining electrical connections are the same as in the previous sections.

INFORMATION!
The general wiring shown here is only an example. The order documentation of the purging unit (APU) usually includes a wiring diagram which represents the complete system. This wiring diagram then has sole validity.

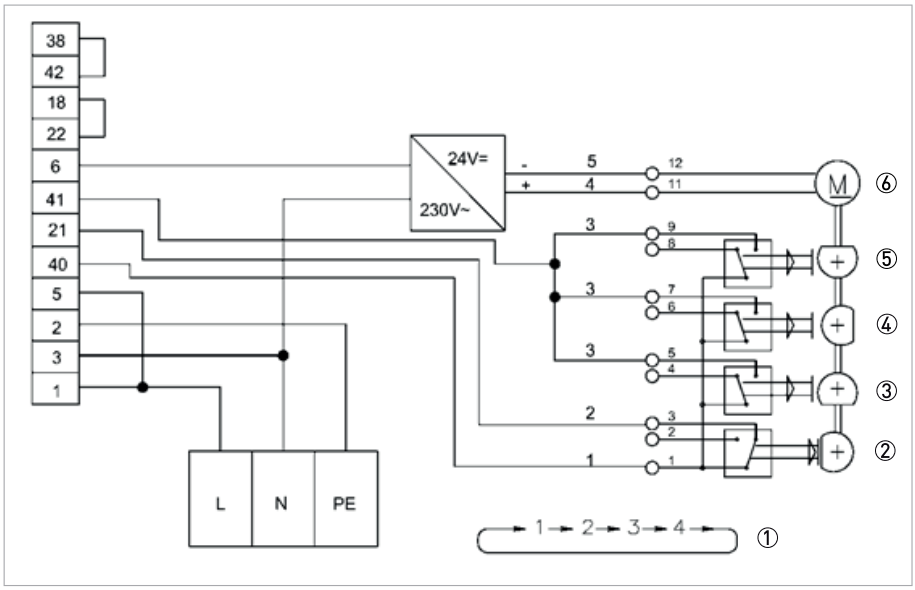

Figure 4-7: Connections of air purging unit

① Sequence of positions reached by the multiway valve
② Normal mode
③ Zero point control
④ Purging chamber 1
⑤ Purging chamber 2
⑥ Drive with endswitches for multiway valve

External triggering

If an external triggering of the purging cycle is desired, the connection for this is realized as shown in the figure below. The resistor R must be between 5 and 10 kΩ.

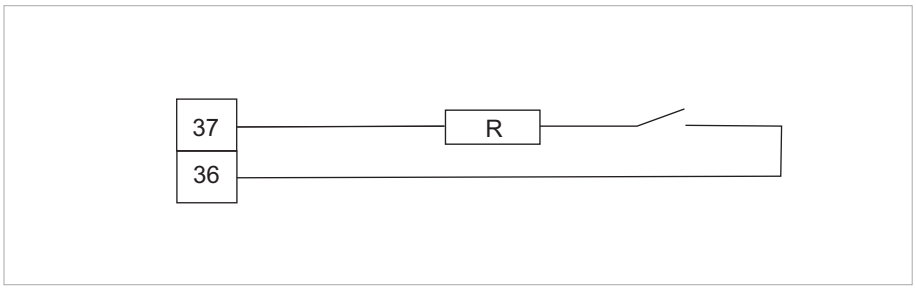

Figure 4-8: Connection external triggering of purging cycle

The two terminals 36 and 37 are used as standard. The triggering is then parameterized for the second analog input Ain2. Alternatively, another analog input can also be used. The terminals for transmitter supply and signal input of the respective analog input must then be used (refer to *Transmitters at the analog inputs* on page 22) and the parameterization must be changed (refer to *Inputs* on page 44).

4.5 Connection of an automatic zero point correction (functional extension)

The connection of the optional automatic zero-point correction device is described in the corresponding mounting instruction of the automatic zero-correction unit.

5.1 Commissioning

The device may only be started up after it has been completely installed and checked by appropriately qualified personnel. Switch on the operating voltage for start-up.

Prior to applying the operating voltage check that

1. the pressure transmitter is completely installed
2. the signal and, if necessary, supply lines are properly connected

If not all electrical connections have been made during commissioning, the OPTIBAR FC 1000 will issue corresponding error messages, refer to *Output warning and errors* on page 58.

INFORMATION!
Changes to the settings are not saved automatically. Thus, it is possible to use a new parameterization for test purposes and to return to the old parameterization by restarting or pressing "Load config" (refer to Service menu on page 53). The changes are permanently accepted via the service menu ("Save config."; refer to *Service menu on page 53*).

5.2 General operation

In the basic state, the user has five different display screens (process screens) at his disposal. There are process screens with one, two, three, five and six fields for displaying one result each (display tiles; see following figure).

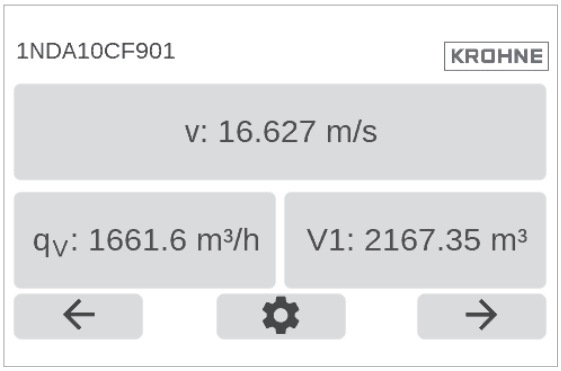

Figure 5-1: Display tiles

The OPTIBAR FC 1000 is operated via a touch display. Depending on the context, buttons are shown at the bottom of the display.

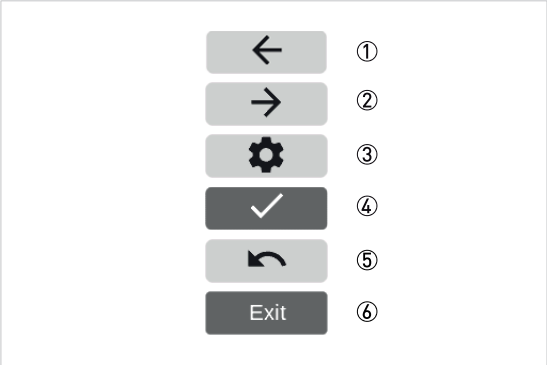

Figure 5-2: Possible display buttons

① Show the previous screen
② Show the next screen
③ Call up the parameterization/special functions menu (refer to *Menu selection and handling* on page 31).
④ Accept a setting and switch to the higher-level menu
⑤ Do not accept changed settings and switch to the higher-level menu
⑥ Exit a menu level

5.3 User rights management

All operations that go beyond switching the process screens (and displaying error messages, refer to *Display indication* on page 58) require the entry of a code.

INFORMATION!
The codes can be changed (refer to Access menu on page 56).

There are three levels with preset codes. A higher level includes the rights of the lower level(s).

Level	Code	Access options
1	8941	Operation: Reset counter, trigger zero-point control or purging cycle, display parameterization
2	5624	Simple settings: Change process settings, adjust display tiles, set time, save/load configuration, load factory configuration
3	9376	Advanced settings: Calibration, change of the basic setup within the scope of the activated functionality of the OPTIBAR FC 1000

Table 5-1: Levels with preset codes

As soon as it is necessary, the code is requested (see figure below). An automatic logout occurs 10 minutes after the last user input.

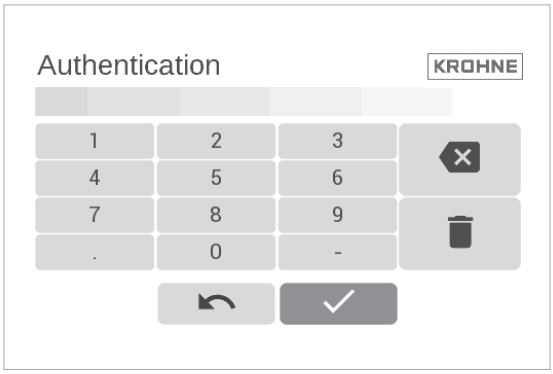

Figure 5-3: Authentication

5.4 Adaption of the display tiles

The displayed value of a display tile can be changed by pressing on the corresponding tile. For each tile various properties can be adapted (see figure below).

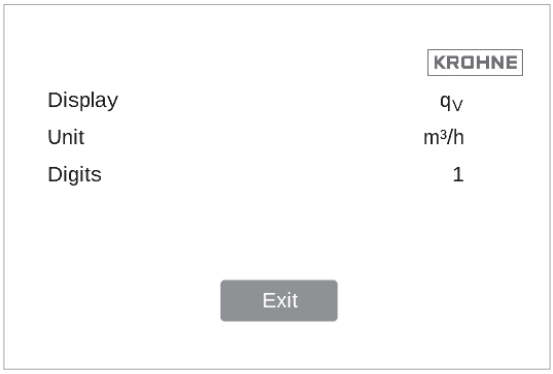

Figure 5-4: Tile properties

Pressing a property line opens another subpage with the query of the respective sizes (for the value "Display" there is a query of the category before, see following figure). In the example, "Volume flow qV" was selected from the "Process values" category as the display value. A press on the category "Clear" creates an empty tile.

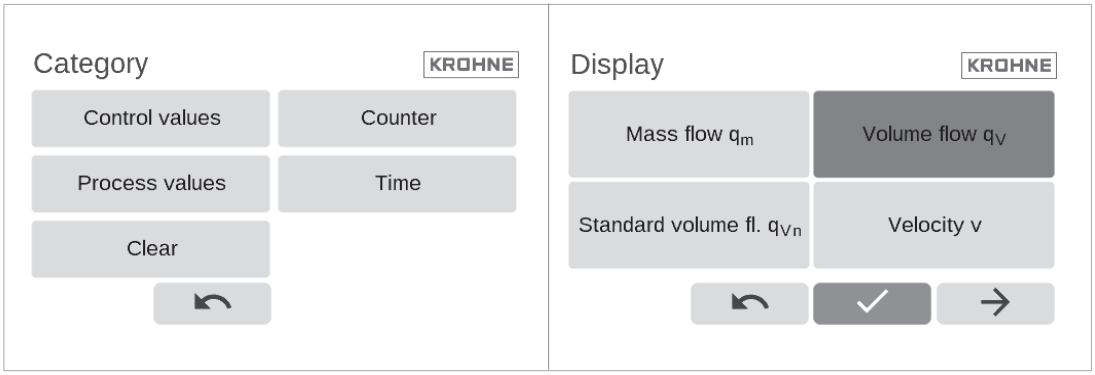

Figure 5-5: Subpage category and display

Currently selected values are highlighted in blue. Pressing another value selects it. The following figure shows the query of the units of measurement and the decimal places.

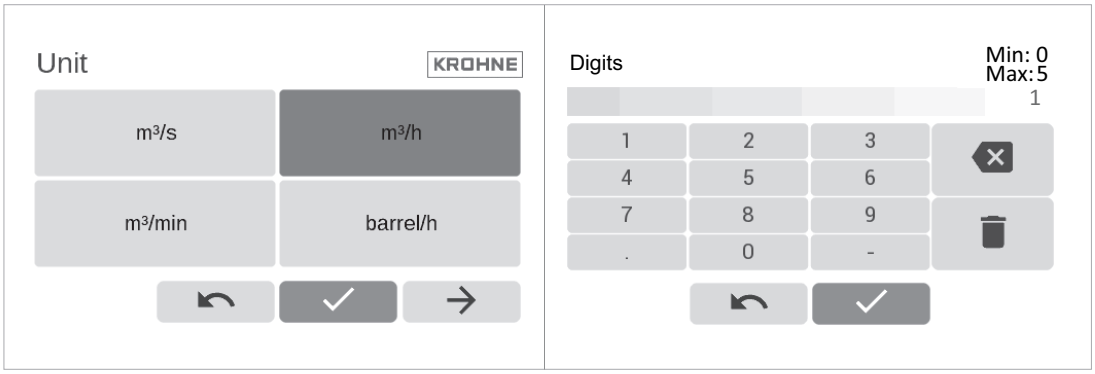

Figure 5-6: Query of the units of measurement and decimal places

5.5 Menu selection and handling

After pressing the gear symbol, the OPTIBAR FC 1000 menu selection will show up. From here, you can branch to the corresponding submenus (see following figure). There, functional extensions can be invoked (refer to *Functional extensions* on page 64) and the OPTIBAR FC 1000 parameters can be displayed or changed (refer to *Parameterization* on page 33).

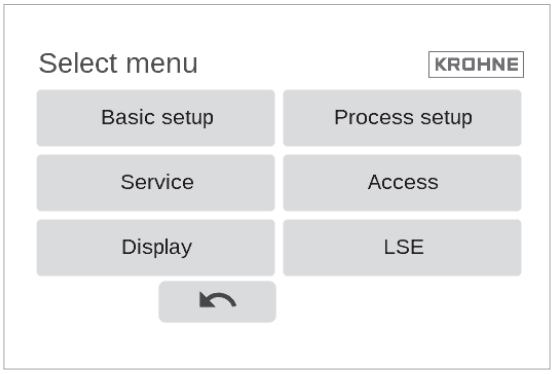

Figure 5-7: Menu selection

The submenus are arranged in a tree structure. On the right side of the display there are buttons for control:

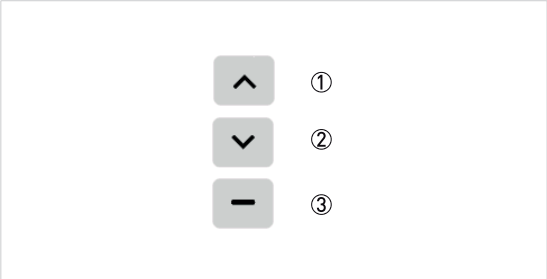

Figure 5-8: Control buttons

① Scroll up
② Scroll down
③ Collapse the expanded tree structure

Values that have a [+] or [-] on the right in the tree structure are used to expand or collapse the tree structure branches. When the tree structure is unfolded, the display content is moved so that the branch to be unfolded is at the top. The values in the branches are given two leading points for each lower level (see following figure).

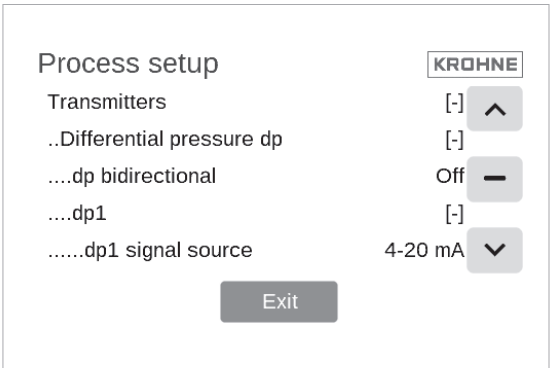

Figure 5-9: Expanded tree structure

To adjust a value, click on the corresponding line. The value is then toggled (if there are only two options for the setting in question), a selection page opens with several selection tiles or an input mask for direct value input appears (analogous to the adaptation of the process value display; refer to *Adaption of the display tiles* on page 30).

There are also lines that trigger a function (e.g. a purging process).

INFORMATION!
If the text of a branch of the tree structure is grayed out, the corresponding parameter cannot be changed. This occurs when another option causes this parameter not to be changeable. If the text on a selection tile is grayed out, the corresponding option cannot be selected. Either the function is deactivated by another option or the respective function is not activated (for activation of functions refer to Activation menu on page 55).

6.1 Parameterization

The parameters can be displayed and adjusted from the menu selection (refer to *Menu selection and handling* on page 31). The general operation of the submenus is also described in the chapter mentioned before.

In order to parameterize the OPTIBAR FC 1000, it is recommended to proceed from "top to bottom". All relevant data are entered in the menus one after the other.

The OPTIBAR FC 1000 menu is structured in such a way that settings made further up in the tree struc-ture can influence menu items further down. If, for example, "Steam" was defined for the selection of the medium, no gas components are queried afterwards (as would happen if a gas were selected).

In this analogy, the basic settings lies above the process settings. Changed basic settings can therefore influence the process settings.

An exception to this rule relates to the selection of the units to be displayed (refer to *Units* on page 50). All unit-related values are converted internally to SI units and then stored. You can therefore adjust the units to be displayed at any time.

INFORMATION!
If basic settings (e.g. the medium type) are changed, the other settings must be checked from "top to bottom".

6.1.1 Basic setup

The basic settings are used for the basic determination of, for instance, the medium to be measured and the flow sensor.

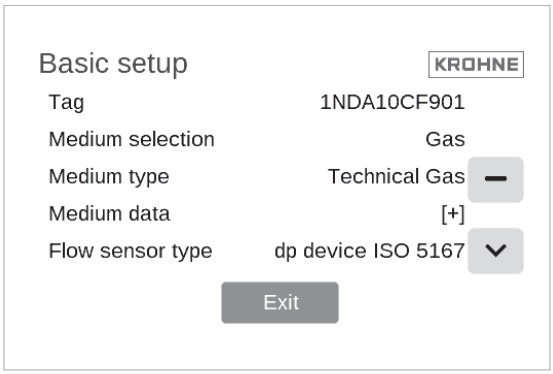

Figure 6-1: Basic setup

The individual basic settings vary depending on the basic settings already made. A case distinction may therefore be made in the description of the following subitems. The following values can be parameterized in the basic settings (see previous figure).

6.1.2 Tag and medium selection

Value	Option	Remark
Tag	free text	The text entered here appears at the top of the result displays
Medium selection	Gas Steam Liquid	The medium to be measured can be selected

Table 6-1: Tag and medium selection

6.1.3 Type of medium

Medium type for basic setting: Medium selection “Gas”

Value	Option	Remark
Medium type	Technical gas AGA-8 DC AGA-8 GC SGERG 88 AGA-NX19	The type of gas can be selected

Table 6-2: Medium selection "Gas"

Medium type for basic setting: Medium selection “Steam”

Value	Option	Remark
Medium type	Superheated steam Saturated steam (p) Saturated steam (T)	The type of steam can be selected

Table 6-3: Medium selection "Steam"

Medium type for basic setting: Medium selection “Liquid”

Value	Option	Remark
Medium type	Water Heat transfer oil Simplified liquid	The type of liquid can be selected

Table 6-4: Medium selection "Liquid"

6.1.4 Medium data for gases

Medium data for basic setting: Medium selection “Gas”

Value	Option	Remark
Medium data	**fold-out function**	
..Reference pressure	numerical value	The reference pressure for the desired standard conditions
..Reference temperature	numerical value	The reference pressure for the desired standard conditions

Table 6-5: Medium data for selection "Gas"

INFORMATION!
The output of the standard volume flow q_{Vn} always refers to the standard conditions entered here.

Medium data for basic setting: Medium selection “Gas”; Medium type “Technical gas”.

Value	Option	Remark
Medium data	**fold-out function**	
..Simple mode	On Off	Toggles between standard density query and gas component query. (If a standard density is used, only “Simplified prim. device” and “Simplified pitot tube” of the ISO 5167 devices can be used.)
..Standard density	numerical value	The standard density of the gas mixture (for simple mode: On). The standard density refers to the standard conditions entered here (Table Medium data for basic setting: Medium selection “Gas”)
..Dew point temperature	numerical value	The dew point temperature of the humid gas mixture (for simple mode: Off)
..Eq. of state	Ideal Gas Redlich-Kwong Redlich-Kwong-Soave Peng-Robinson	Selection of the equation of state to calculate the properties of the gas mixture (for simple mode: Off)
..Gas components	**fold-out function**	**(for simplified mode: Off)**
..Selection from list	Custom comp. List with gases	If you select “Custom comp.”, you can create your own gas mixture. Alternatively, a predefined gas (mixture) can be selected from the list.
..Edit mode	On Off	In the edit mode all selectable gas components are displayed (also such with “0 %”). (only if “Custom comp.” is selected)
..Normalize	function release	The gas components are normalized in such a way that the sum of all components is 100%. (only if “Custom comp.” is selected)
..Components	**fold-out function**	
..Component x	percentage	The percentage values of the individual gas components.

Table 6-6: Medium data for selection "Gas" and medium type "Technical gas"

Medium data for basic setting: Medium selection “Gas”; Medium type “AGA-8 DC”

Value	Option	Remark
Medium data	**fold-out function**	
..AGA-8 DC components	**fold-out function**	
..Component x	percentage	The percentage values of the individual gas components

Table 6-7: Medium data for selection "Gas" and medium type “AGA-8 DC”

Medium data for basic setting: Medium selection “Gas”; Medium type “AGA-8 GC”

Value	Option	Remark
Medium data	**fold-out function**	
..AGA-8 GC parameters	**fold-out function**	
..Method	1 2	Calculation method 1 or 2
..Relative density	numerical value	The relative density
.. CO_2 concentration	percentage	The concentration of CO_2 in mol %
..Calorific value	numerical value	The calorific value of the gas (method 1 only)
.. N_2 concentration	percentage	The concentration of N_2 in mol % (method 2 only)

Table 6-8: Medium data for selection "Gas" and medium type “AGA-8 GC"

Medium data for basic setting: Medium selection “Gas”; Medium type “SGERG-88"

Value	Option	Remark
Medium data	**fold-out function**	
..SGERG-88 parameters	**fold-out function**	
..CH concentration	percentage	The concentration of CH in mol %
.. N_2 concentration	percentage	The concentration of N_2 in mol %
.. CO_2 concentration	percentage	The concentration of CO_2 in mol %
..CO concentration	percentage	The concentration of CO in mol %
..Calorific value	numerical value	The calorific value of the gas

Table 6-9: Medium data for selection "Gas" and medium type “SGERG-88"

Medium data for basic setting: Medium selection “Gas”; Medium type “AGA-NX19"

Value	Option	Remark
Medium data	**fold-out function**	
..Standard density	numerical value	The standard density of the gas. The standard density refers to the standard conditions entered here (Table Medium data for basic setting: Medium selection "Gas")
..AGA-NX19 parameters	**fold-out function**	
.. CO_2 concentration	percentage	The concentration of CO_2 in mol %
.. N_2 concentration	percentage	The concentration of N_2 in mol %
..Calorific value	numerical value	The calorific value of the gas

Table 6-10: Medium data for selection "Gas" and medium type "AGA-NX19"

6.1.5 Medium data for steam

Medium data for basic setting: Medium selection "Steam"; Medium type "Superheated steam"

Value	Option	Remark
Medium data	**fold-out function**	
..Water/steam error limit	numerical value	If the temperature for the current pressure value falls below the minimum temperature for the steam state, the OPTIBAR FC 1000 continues to calculate in the "Saturated steam (p)" mode. It can be parameterized how far the minimum temperature may be undercut. A water alarm is triggered if the value falls below the limit (refer to *Error messages on the display* on page 72).

Table 6-11: Medium data for steam

6.1.6 Medium data for liquids

Medium data for basic setting: Medium selection "Liquid"; Medium type "Heat transfer oil"

Value	Option	Remark
Medium data	**fold-out function**	
..Oil selection	List of heat transfer oils Custom oil	A predefined heat transfer oil can be selected from the list. Alternatively, you can select "Custom oil" (user-defined oil).
..Name	display value	The name of the custom oil is displayed. (Only for "Custom oil")

Table 6-12: Medium data for heat transfer oil

INFORMATION!
The data of a user-defined oil are imported/exported via the USB menu (refer to USB menu on page 54).

Medium data for basic setting: Medium selection “Liquid”; Medium type “Simplified liquid”

Value	Option	Remark
Medium data	**fold-out function**	A predefined heat transfer oil can be selected from the list. Alternatively, you can select “Custom oil” (user-defined oil).
..Density	numerical value	The density of the liquid

Table 6-13: Medium data for simplified liquid

6.1.7 Flow sensor

Value	Option	Remark
Flow sensor type	dp device ISO 5167 Volume flow AGA-3 AGA-7	The flow sensor type can be selected

Table 6-14: Flow sensor types

6.1.8 Measurement design for dp devices according to ISO 5167

Measurement design (ISO 5167) for basic setting: Flow sensor type “dp device ISO 5167”

Value	Option	Remark
Measurement design (ISO 5167)	**fold-out function**	
..Device type	Pitot type flow meter Orifice corner tappings Orifice D-D/2 Orifice flange tappings ISA1932 nozzle Long radius nozzle Venturi nozzle CVT machined CVT rough welded CVT cast Cone flowmeter Simplified prim. device	Selection of the differential pressure sensor

Value	Option	Remark
..Material	Carbon steel (1.0345) 1.4301 / 304L 1.4404 / AISI 316L 1.4539 / 904L 1.4541 1.4571 / AISI 316Ti 1.4828 1.4841 1.4878 1.4903 (P91) 1.4948 16Mo3 (1.5415) 1.7335 (13CrMo44) 1.7380 (10CrMo9-10) Hastelloy C22 (2.4602) Inconel 600 (2.4816) Monel P91/92/1.492x No thermal expan-sion	Selection of the material used for the differential pressure sensor (relevant for the thermal expansion of the differential pressure sensor)
..Throttle opening d	numerical value	The throttle opening of the differential pressure sensor (for all primary elements except "Pitot type flow meter"; for a cone flowmeter, d describes the diameter of the cone in the plane of the beta edge; at 20 °C)
..Flow coefficient C	numerical value	Flow coefficient C (only for primary element "Simplified prim. device"; C is calculated for the other differential pressure sensors)
..Metering factor k	numerical value	The k-factor of the pitot tube (only for primary ele-ments "Pitot type flow meter"; at 20 °C)
..Expansion factor eps	numerical value	The expansion factor ε to consider the compressibil-ity of the fluid (only for the primary element "Simpli-fied prim. device"; ε is calculated for the other dif-ferential pressure sensors).
..Pipe	**fold-out function**	
..Material	Carbon steel (1.0345) 1.4301 / 304L 1.4404 / AISI 316L 1.4539 / 904L 1.4541 1.4571 / AISI 316Ti 1.4828 1.4841 1.4878 1.4903 (P91) 1.4948 16Mo3 (1.5415) 1.7335 (13CrMo44) 1.7380 (10CrMo9-10) Hastelloy C22 (2.4602) Inconel 600 (2.4816) Monel P91/92/1.492x No thermal expansion	Selection of the material used for the pipe (relevant for the thermal expansion of the pipe)
..Shape	Round Rectangular	Selection of the tube shape
..Inner diameter D	numerical value	The inside diameter of the pipe (only for round shape; at 20 °C)

Value	Option	Remark
..Duct width	numerical value	Width of the duct (only for rectangular shape; at 20 °C)
..Duct height	numerical value	Height of the duct (only for rectangular shape; at 20 °C)
..Damping value [%]	numerical value	The damping in percent (the last valid flow rate value is calculated with x percent weighted with the current flow rate value; related to a cycle time of 0.5 s)
..Small flowrate cutoff	**fold-out function**	
..Reference	q_m; q_V; q_{Vn}; v	Reference value for minimum quantity suppression
..Minimum flowrate	numerical value	The minimum quantity below which the flow value is set to 0. The value of the reference is always used as an absolute value (relevant for bidirectional measurement).
..Sampling points Reynolds number	numerical value	Value pairs from Reynolds number and correction factor can be entered in table form. The table is automatically sorted in ascending order by Reynolds number. For Reynolds numbers that are smaller than the smallest value in the table, the correction factor of the smallest value is used. The correction factor is interpolated linearly between two Reynolds numbers. For Reynolds numbers larger than the largest value in the table, the correction factor of the largest value is used. (If no Reynolds number can be calculated for the current medium (e.g. for a gas with standard densi-ty), a fixed correction factor can be specified by means of a single grid point for Reynolds number 0.

Table 6-15: Measurement design for flow sensor type "dp device ISO 5167"

6.1.9 Measurement design for dp devices according to AGA-3

Measurement design (ISO 5167) for basic setting: Flow sensor type "AGA-3"

Value	Option	Remark
Measurement design (AGA-3)	**fold-out function**	
..Tapping type	Flange tapping Corner tapping	The tapping type of the AGA-3 orifice
..Orifice material	Carbon steel 1.4404 / AISI 316L Monel Custom	Selection of the material used for the orifice (relevant for the thermal expansion of the orifice) If "Custom" is selected, the thermal expansion coefficient α is queried (see next item)

Value	Option	Remark
..Alpha Orifice	numerical value	The thermal expansion coefficient α, which characterizes the thermal expansion of the orifice plate (only for orifice material "Custom")
..Throttle opening d	numerical value	The throttle opening of the orifice (at 20 °C)
..Pipe material	Carbon steel 316L Monel Custom	Selection of the material used for the pipe (relevant for the thermal expansion of the orifice) If "Custom" is selected, the thermal expansion coefficient α is queried (see next item)
..Alpha pipe	numerical value	The thermal expansion coefficient α, which characterizes the thermal expansion of the pipe (only for pipe material "Custom")
..Inner diameter D	numerical value	The inside diameter of the pipe (at 20 °C)
..Base pressure	numerical value	The AGA-3 base pressure
..Base temperature	numerical value	The AGA-3 base temperature
..Damping value [%]	numerical value	The damping in percent (the last valid flow rate value is calculated with x percent weighted with the current flow rate value; related to a cycle time of 0.5 s)
..Small flowrate cutoff	**fold-out function**	
..Reference	q_m; q_V; q_{Vn}; v	Reference value for minimum quantity suppression
..Minimum flowrate	numerical value	The minimum quantity below which the flow value is set to 0. The value of the reference is always used as an absolute value (relevant for bidirectional measurement).
..Sampling points Reynolds number	numerical value	Value pairs from Reynolds number and correction factor can be entered in table form. The table is automatically sorted in ascending order by Reynolds number. For Reynolds numbers that are smaller than the smallest value in the table, the correction factor of the smallest value is used. The correction factor is interpolated linearly between two Reynolds numbers. For Reynolds numbers larger than the largest value in the table, the correction factor of the largest value is used. If no Reynolds number can be calculated for the current medium (e.g. for a gas with standard density), a fixed correction factor can be specified by means of a single grid point for Reynolds number 0.

Table 6-16: Measurement design for flow sensor type "dp device AGA-3"

6.1.10 Measurement design for volume flow sensor and AGA-7 sensor

Measurement design (flow rate) for basic setting: Flow sensor type "Volume flow" or "AGA-7"

Value	Option	Remark
Measurement design (Volume flow) or Measurement design (AGA-7)	**fold-out function**	
..Base pressure	numerical value	The AGA-7 base pressure (AGA-7 only)
..Base temperature	numerical value	The AGA-7 base temperature (AGA-7 only)
..Use pipe data	On Off	Should the pipe data be considered? If "Off" is set, the flow velocity is not calculated.
..Pipe	**fold-out function**	**(only available for "Use pipe data": On)**
..Material	Carbon steel (1.0345) 1.4301 / 304L 1.4404 / AISI 316L 1.4539 / 904L 1.4541 1.4571 / AISI 316Ti 1.4828 1.4841 1.4878 1.4903 (P91) 1.4948 16Mo3 (1.5415) 1.7335 (13CrMo44) 1.7380 (10CrMo9-10) Hastelloy C22 (2.4602) Inconel 600 (2.4816) Monel P91/92/1.492x No thermal expansion	Selection of the material used for the pipe (relevant for the thermal expansion of the pipe)
..Shape	round rectangular	Selection of the tube shape
..Inner diameter D	numerical value	The inside diameter of the pipe (only for round shape; at 20 °C)
..Duct width	numerical value	Width of the duct (only for rectangular shape; at 20 °C)
..Duct height	numerical value	Height of the duct (only for rectangular shape; at 20 °C)
..Damping value [%]	numerical value	The damping in percent (the last valid flow rate val-ue is calculated with x percent weighted with the current flow rate value; related to a cycle time of 0.5 s)
..Small flowrate cutoff	**fold-out function**	
..Reference	q_m; q_V; q_{Vn}; v	Reference value for minimum quantity suppression
..Minimum flowrate	numerical value	The minimum quantity below which the flow value is set to 0

Table 6-17: Measurement design for volume flow sensor, standard volume flow sensor, mass flow sensor and AGA-7 sensor

6.1.11 Functional enhancement and interfaces

Value	Option	Remark
Functional enhancement	Zero APU None	Selection of the functional enhancement to be controlled
Interfaces	**fold-out function**	
..Serial 1	Deactivated Modbus Slave Modbus Master M-Bus Slave	Selection of the assignment of the interface "Serial 1" (refer to *Modbus / M-bus (serial 1)* on page 24) Modbus or M-Bus are an order option (refer to *Modbus / M-bus (serial 1)* on page 24) the mode must be selected to match the hardware configuration.
..Serial 2	Deactivated Modbus Slave Modbus Master	Selection of the assignment of the interface "Serial 2" (refer to *D-Sub connector* on page 25)

Table 6-18: Functional enhancement and interfaces

6.1.12 Process setup

Once the basic settings have been defined (refer to *Basic setup* on page 33), the process settings can be used to acquire the parameters for the inputs, transmitters, units, outputs and interfaces.

The individual process settings vary depending on the selected basic or already made process settings. A case distinction may therefore be made in the description of the following sub-items.

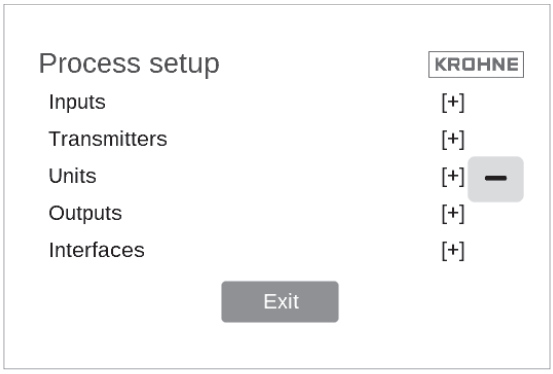

Figure 6-2: Process setup

The following values can be parameterized in the process setup (see previous figure).

6.1.13 Inputs

Value	Option	Remark
Inputs	**fold-out function**	
..Analog input AinX	dp1 dp2 q_V T1 T2 p APU/Zero ext. Deactivated	For each of the four analog inputs Ain1 to Ain4 it may be selected which measurand is to be determined. Ain1 and Ain2 are HART® compatible

Table 6-19: Inputs

6.1.14 Transmitter settings for dp devices according to ISO 5167 and AGA-3

Transmitters for basic setting: Flow sensor "dp device ISO 5167" or "AGA-3"

Value	Option	Remark
Transmitters	**fold-out function**	
..Differential pressure dp	**fold-out function**	
..dp bidirectional[1]	On; Off	Activate/deactivate bidirectional measurement
..dp1	**fold-out function**	
..dp1 signal source	HART 4-20 mA 0-20 mA Constant[2]	The signal source used for the first differential pressure value
..dp1 square rooting	by flow computer by transmitter	Indication of where the root extraction of the differential pressure signal takes place
..dp1.min	numerical value[3]	The differential pressure at 0/4 mA
..dp1.max	numerical value[3]	The differential pressure at 20 mA
..dp1.offset	numerical value	Input option for a constant deviation (e.g. due to the installation situation)
..dp2 (lower range for split-range)	**fold-out function**	
..dp2 signal source	HART 4-20 mA 0-20 mA constant[2] deactivated	The signal source used for the second differential pressure value Only relevant for split-range applications
..dp2 square rooting	by flow computer by transmitter	Indication of where the root extraction of the differential pressure signal takes place
..dp2.min	numeric value[3]	The differential pressure at 0/4 mA
..dp2.max	numeric value[3]	The differential pressure at 20 mA
..dp2.offset	numerical value	Input option for a constant deviation (e.g. due to the installation situation)

Table 6-20: Transmitters

[1]It must be ensured that the flow sensor is suitable for bidirectional measurement. In the case of bidirectional measurement with an analog electric current signal and split-range operation, it must be ensured that the respective lower and upper limits are set symmetrically.

[2]If "Constant" is selected, this value is queried in the form "Value x.const". The further specifications for this value (min/max etc.) are then no longer queried.

[3]With a HART® connection to the transmitter, the lower/upper limits are determined automatically at every restart of the FC 1000. If HART® communication is lost, they serve as a fallback option (see 7.4). In a measurement with split-range operation, the switchover from dp2 to dp1 occurs at 97 % of dp2.max. The hysteresis is 1 %.

6.1.15 Transmitter settings for volume flow transmitters

Transmitters for basic setting: Flow sensor "Volume flow"

Value	Option	Remark
Transmitters	**fold-out function**	
..Volume flow q_V	**fold-out function**	
..q_V signal source	4-20 mA 0-20 mA Frequency Constant[1]	The signal source used for the volumetric flow sensor

Table 6-21: Transmitters for basic setting: Flow sensor "Volume flow"

Transmitters for basic setting: Flow sensor "Volume flow"; signal source "0/4-20 mA".

Value	Option	Remark
..qV.min	numerical value	The flow value at 0/4 mA
..qV.max	numerical value	The flow value at 20 mA

Table 6-22: Transmitters for basic setting: Flow sensor "Volume flow"; signal source "0/4-20 mA".

Transmitters for basic setting: Flow sensor "Volume flow"; signal source "frequency".

Value	Option	Remark
..qV.min	numerical value	The flow rate value at the lower end of the measuring range
..qV.min frequency	numerical value	The frequency at the lower end of the measuring range
..qV.max	numerical value	The flow value at the upper end of the measuring range
..qV.max frequency	numerical value	The frequency at the upper end of the measuring range

Table 6-23: Transmitters for basic setting: Flow sensor "Volume flow"; signal source "frequency".

6.1.16 Transmitter settings for AGA-7 sensors

Transmitters for basic setting: Flow sensor "AGA-7"

Value	Option	Remark
Transmitters	**fold-out function**	
.. Volume flow q_V .. (AGA-7)	**fold-out function**	
..Pulse value	numerical value	The value to correspond to a pulse. For example 1 pulse = 5 m^3

Value	Option	Remark
..Calibration data	numerical value	Value pairs of volume flow (qV) and corresponding deviation can be entered in table form. The table is automatically sorted in ascending order by q_V. For flow values smaller than the smallest value in the table, the deviation of the smallest value is taken. The deviation between two flow values is interpolated linearly. For flow values greater than the largest value in the table, the deviation of the largest value is taken.
..q_Vr.min	numerical value	The minimum rated volume flow rate
..q_Vr.max	numerical value	The maximum rated volume flow rate

Table 6-24: Transmitters for basic setting: Flow sensor "AGA-7"

6.1.17 Transmitter settings: Continued for any basic setting

Transmitters (Continued for any Basic setup)

Value	Option	Remark
..Temperature T1	**fold-out function**	
..T1 type	Pt100 3-wire Pt100 4-wire 4-20 mA 0-20 mA HART Constant[1]	The signal source used for the first temperature value In the "Saturated steam (p)" application, the first temperature is not queried.
..T1.min	numerical value	The temperature at 0/4 mA (not available when selecting a Pt100)
..T1.max	numerical value	The temperature at 20 mA (not available when selecting a Pt100)
..T1.offset	numerical value	Input possibility for a constant deviation
..T1 use fallback	On Off	A fallback value can be parameterized for the event of a wire break or short circuit.
..T1.fallback	numerical value	The fallback value
..T1 use std. coe./R0	On Off	For t ≥ 0 °C, different coefficients and a different value for the resistance at 0 °C can be specified[2] (when selecting a Pt100)
..Coefficient A	numerical value	Coefficient A [$°C^{-1}$]
..Coefficient B	numerical value	Coefficient B [$°C^{-2}$]
..Temperature T2	**fold-out function**	

Value	Option	Remark
..T2 type	Pt100 3-wire Pt100 4-wire 4-20 mA 0-20 mA Constant[1]	The signal source used for the second temperature value If a second temperature measurement is not necessary, any fixed value can be set.
..T2.min	numerical value	The temperature at 0/4 mA (not available when selecting a Pt100)
..T2.max	numerical value	The temperature at 20 mA (not available when selecting a Pt100)
..T2.offset	numerical value	Input possibility for a constant deviation
..T2 using fallback	On Off	A fallback value can be parameterized for the event of a wire break or short circuit.
..T2.fallback	numerical value	The fallback value
..T2 use std. coe./R0	On Off	For t ≥ 0 °C, different coefficients and a different value for the resistance at 0 °C can be specified[2] (when selecting a Pt100)
....A	numerical value	Coefficient A [$°C^{-1}$]
....B	numerical value	Coefficient B [$°C^{-2}$]
....R0	numerical value	Resistance at 0 °C [Ω]
..Pressure p	**fold-out function**	
....p type	Absolute 4-20 mA Relative 4-20 mA Absolute 0-20 mA Relative 0-20 mA Absolut HART Constant[1] Deactivated	The signal source used for the pressure value For the medium “Saturated steam (T)”, the pressure is not queried. The pressure sensor can be deactivated for a medium belonging to the category “Liquid”. For the medium “Water”, a design pressure is requested in this case (see next entry). For the medium “Heat transfer oil”, the pressure value is generally only used for display, it is not required for any calculation.
..p.design (abs)	numerical value	The design pressure for the density calculation (only with medium “Water” and deactivated pressure sensor; this pressure is used by default for density determination, if the saturated steam temperature is reached, a higher pressure is calculated internally, thus no steam alarm can occur, refer to *Display indication* on page 58
....p tapping	Pipe Plus chamber Minus chamber	Type of the pressure tapping; serves to correct the pressure value (only with primary element “Pitot type flow meter”)

Value	Option	Remark
..p position	Downstream (after dp device) Upstream (before dp device)	Mounting position of the pressure transmitter; serves to correct the pressure value "Upstream" uses the measured static pressure to calculate the media properties. "Downstream" adds the pressure loss[3] caused by the primary element to the measured static pressure to calculate the media properties. For bidirectional measurement, the position refers to the flow direction 1 ("positive flow"). (always visible with differential pressure transmitters; with pitot type flow meter, if the tapping is set to "pipe").
..p.min[4]	numerical value	The pressure at 0/4 mA
..p.max[4]	numerical value	The pressure at 20 mA
..p.offset	numerical value	Input possibility for a constant deviation
..p use fallback	On Off	A fallback value can be parameterized for the event of a wire break or short circuit.
..p.fallback[4]	numerical value	The fallback value
..p.environment[5]	numerical value	Ambient pressure (only for relative pressure measurement)

Table 6-25: Transmitters (Continued for any Basic setup)

[1]If "Constant" is selected, this value is queried in the form "Value x.const". The further specifications for this value (min/max etc.) are then no longer queried.

[2]The temperature determination for the Pt100 measurement for $t \geq 0$ °C is carried out according to: $Rt = R0 \times (1 + At + Bt^2)$ with the standard coefficients and the standard resistance at 0 °C: $A = 3.9083 \times 10^{-3}°C^{-1}$, $B = -5.775 \times 10^{-7}°C^{-2}$ and $R0 = 100\Omega$

[3] The pressure loss can only be determined approximately.

[4] When selecting the pressure transmitter types "Absolute 4-20 mA" or "Absolute 0-20 mA", absolute pressures are expected as input values. When selecting the pressure transmitter types "Relative 4-20 mA" or "Relative 0-20 mA", relative (gauge) pressures are expected as input values.

[5] The ambient pressure is queried as absolute pressure.

6.1.18 Units

Value	Option	Remark
Units	**fold-out function**	
..Process variable x	list of corresponding units	The unit to be displayed can be selected for the pro-cess variables used in the OPTIBAR FC 1000

Table 6-26: Units

6.1.19 Outputs

Value	Option	Remark
Outputs	**fold-out function**	
.. Analog Aout1[1]	**fold-out function**	
..Aout1 assignm.	q_{qm}; q_V; q_{Vn}; T1; T2; p_{abs}; p_{rel}; dQ; v; Current Ain1; Current Ain2; Current Din1; Current Din2 ; Deactivated	The process variable to be output via analog output 1 If "Current AinX" is selected, the electric current measured at AinX is output 1:1 at Aout1. The behav-iour for the digitally received electric current DinX via HART is equivalent to this. refer to *Sequence of a purging cycle* on page 64or refer to *Sequence of a zero-point calibration* on page 70
..Aout1 signal type	4-20 mA 0-20 mA	Selection of the characteristic of the first analog output
..Aout1.min	numerical value	The output value at 0/4 mA
..Aout1.max	numerical value	The output value at 20 mA
..Aout1.fallback	numerical value	The electric current value output in the event of a fault (refer to *Signaling of errors via the outputs* on page 61)
..Switching output S1[2]	**fold-out function**	
..S1 behavior	Counting pulse3[3] MIN switch MAX switch Frequency output[3] Collective alarm Motor control switch[4] APU operating indicator APU error Next APU Zero error Zero operating indicator Deactivated	Selection of the switching behavior for the electronic relay 1 Depending on the selection made, further parameters are queried (see following tables) For item "Collective alarm" refer to *Signaling of errors via the outputs* on page 61 For the items "Motor switch", "APU operating indicator", "APU error" and "Next APU" refer to *Signaling to the control station/another APU* on page 68. For the items "Zero error" and "Zero operating indicator", refer to *Signaling to the control system* on page 73.

Table 6-27: Outputs

Outputs for S1 behavior: Counting pulse[3]

Value	Option	Remark
..S1 assignment	m1; m2; m abs; Q1; Q2; Q abs; V1; V2; V abs; V_n1; V_n2; V_n abs	Selection of the value to be output via the counting pulse. For flow direction 1 ("positive flow") or 2 ("negative flow"; only relevant with bidirectional transmitter). When selecting a quantity with "abs", pulses are output with both positive and negative flow.
..S1 pulse value	numerical value	The value to correspond to a pulse. For example: 1 pulse = 5 m^3
..S1 pulse width [ms]	numerical value	The duration that a pulse takes and at the same time the minimum duration between two pulses

Table 6-28: Outputs for S1 behavior: Counting pulse[3]

Outputs for S1 behavior: frequency output[3]

Value	Option	Remark
..S1 assignment	q_V 1; q_V 2; q_V abs; q_{Vn} 1; q_{Vn} 2; q_{Vn} 2 abs; q_m 1; q_m 2; q_m abs; dQ 1; dQ 2; dQ abs	Selection of the quantity to be output via a frequency. For flow direction 1 ("positive flow") or 2 ("negative flow"; only relevant with bidirectional transmitter). When selecting a quantity with "abs", a frequency is output with both positive and negative flow.
..S1 max. value	numerical value	The maximum value of the quantity to be output.
..S1 f.max [Hz][5]	numerical value	The maximum frequency (this corresponds to the maximum value of the quantity to be output)

Table 6-29: Outputs for S1 behavior: frequency output[3]

Outputs for S1 behavior: MIN/MAX switch

Value	Option	Remark
..S1 assignment	q_m; q_v; q_{Vn}; T1; T2; p_{abs}; p_{rel}; dQ; v	Selection of the measured value to be monitored
..S1 switching value	numerical value	If the MIN switch is selected, S1 is switched if the measured value is lower than or equal to the switching value (" ≤ "). If the MAX switch is selected, switching takes place if the measured value is greater than or equal to the switching value (" ≥ ").
..S1 hysteresis	numerical value	Indication of the hysteresis for the switching value

Table 6-30: Outputs for S1 behavior: MIN/MAX switch

Outputs for S1 behavior: all except counting pulse and frequency output

Value	Option	Remark
..S1 normally[6]	Open Closed	Determination of the switching state for the normal state.

Table 6-31: Outputs for S1 behavior: all except counting pulse and frequency output

[1] The settings for analog output Aout2 are analogous to Aout1.

[2] The settings for switching output S2 and relay R must be made analogous to S1.

[3] No counting pulse or frequency output can be parameterized for relay R.

[4] If the "APU" functional enhancement is selected, relay R is permanently set to the "Motor control switch" behavior.

[5] A maximum switching frequency of 150 Hz applies to switching output 1 and switching output 2. This must not be exceeded by the process.

[6] For relay R there is no setting of the normal state. The following applies to an FC 1000 disconnected from the supply voltage independently of the parameterization: S1 is open (NO) and S2 is closed (NC) (refer to *Electronic relays* on page 23).

6.1.20 Interfaces

Value	Option	Remark
Interfaces	**fold-out function**	
..Ethernet	**fold-out function**	
..IP address	free text	Input option for the IP address
..Subnet mask	free text	Input option for the subnet mask
..MAC address	free text	Input option for the MAC address
..Default gateway	free text	Input option for the standard gateway
..DHCP	On Off	Will activate/deactivate DHCP. If DHCP is switched on, the Ethernet configuration (IP address, subnet mask and standard gateway) is obtained automatically.
..Serial 1[1]	**fold-out function**	
..Serial 1 parity	None Even Odd	Selection of parity for the 1st serial interface
..Serial 1 bit count	7 bit; 8 bit	Selection of the number of bits
..Serial 1 baud rate	4800; 9600; 19200; 38400; 57600; 115200	Selection of baud rate
..Serial 1 address	numerical value	Address selection
..Serial 1 stop bits	1 bit; 2 bit	Selection of the number of stop bits

Table 6-32: Interfaces

INFORMATION!
For the output capabilities of the digital interfaces refer to Description of digital interfaces on page 80.
When connecting the interface converter (refer to Interface converter for Profibus / Profinet on page 25), the following values must be parameterized for the second serial interface:

Parameter	Input
..Serial 1[1] parity	None
..Serial 1 bit count	8 bit
..Serial 1 baud rate	38400
..Serial 1 address	1
..Serial 1 stop bits	1 bit

Table 6-33: values to be parameterized for the second serial interface

[1] The setting options for the second serial interface are the same as for the 1st. The serial interfaces are only available if they are enabled in the basic setup (refer to *Basic setup* on page 33).

6.1.21 Service menu

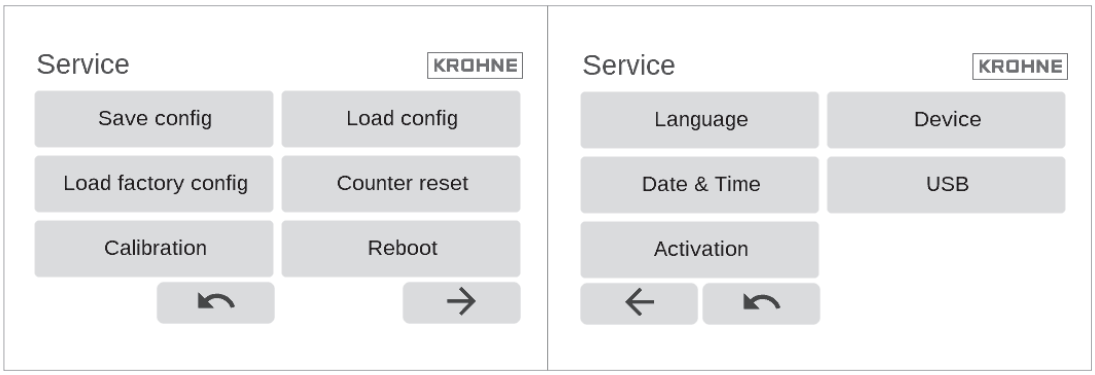

Figure 6-3: Service menu

The following entries can be made in the service menu (see previous figure):

Value	Option
Save config	The current settings are stored permanently after a confirmation.
Load config	The last configuration is loaded after confirmation (unsaved changes are reset).
Save factory config	The factory configuration is loaded after confirmation (the delivery status of the parameterization is restored).
Counter reset	The counter readings are reset after a confirmation.
Calibration	Calling up the calibration menu.
Reboot	After a confirmation, the OPTIBAR FC 1000 is restarted.

Value	Option
Language	The language is switched between English and German.
Device	The serial number, the hardware ID and the software version are displayed.
Date & Time	The date and time can be adjusted.
USB	The USB menu is displayed.
Activation	The activation menu is called up.

Table 6-34: Entries for service menu

6.1.22 Restart incl. update function

A new firmware file can be provided by KROHNE Pressure Solutions GmbH. This file "a.bin" is then copied to a USB flash drive formatted with FAT32.

Each time the OPTIBAR FC 1000 is restarted, it checks whether a USB flash drive with a new firmware is available at the USB port. If a new firmware was found, the message "Found USB ... trying to flash new firmware" appears. Then the OPTIBAR FC 1000 restarts.

The OPTIBAR FC 1000 is designed in such a way that the settings and counter readings are retained during an update, but it is still strongly recommended to save the settings and counter readings of the OPTIBAR FC 1000 before the update process (refer to *USB menu* on page 54).

6.1.23 Calibration menu

The OPTIBAR FC 1000 is delivered calibrated as standard. In this menu it is possible to calibrate the inputs and outputs.

6.1.24 USB menu

In this menu, the settings and counter readings of the OPTIBAR FC 1000 can be exported to a USB flash drive (FAT32 formatted) and imported from there. The logging on a USB flash drive can also be parameterized. During logging, a filled red circle appears in the upper right corner of the display.

Value	Option	Remark
Parameters	**fold-out function**	
..Import parameters	function release	Import parameters from USB flash drive
..Export parameters	function release	Export parameters to the USB flash drive
Calibration	**fold-out function**	
..Import calibration	function release	Import calibration from USB flash drive
..Export calibration	function release	Export the calibration to the USB flash drive
Counter values	**fold-out function**	
..Import counter values	function release	Import counter values from USB flash drive
..Export counter values	function release	Export counter values to the USB flash drive

Value	Option	Remark
Heat transfer oil	**fold-out function**	
..Import heat transfer oil	function release	Imports custom oil from USB flash drive
..Export heat transfer oil	function release	Exports the custom oil to the USB flash drive
Logging	**fold-out function**	
..Active	On Off	Switches logging on or off
..Interval	numerical value	Specification of the storage interval

Table 6-35: USB menu

INFORMATION!
The settings and counter readings are stored on the USB flash drive as JSON files in the root directory.
The assignment is as follows:

File name	Content
PARAMS.JSO	Parameters
CALIB.JSO	Calibration
COUNTER.JSO	Counter values

INFORMATION!
The values for the heat transfer oil are stored in a CSV file "custom_oil.csv" in the root directory. This file has the following form:
Name of the oil
*T [K], rho [kg/m³], eta [Pa*s], cp [J/(kg*K)]]*
273.15,842.7,0.02842,2007
283.15,836.1,0.01751,2043
Any liquid for which the above mentioned substance data are available in tabular form can be imported as an "oil".
The logging function creates CSV files in a subfolder called "Recorder". A new file is created for each day. The files contain columns for all process and control values, including those that may not be required by the current OPTIBAR FC 1000 application. Such values can then be output with "0" or "nan".

6.1.25 Activation menu

The OPTIBAR FC 1000 can be ordered with various options. The ordering code (see section 11) reflects these options. Functions from the "Operating mode", "Functional extension" and "2nd interface" areas can be enabled via the activation menu. The code for the activation of the respective values can be obtained from KROHNE Pressure Solutions GmbH.

The code for an option is entered via the menu according to the following table. If the options are not enabled, the digit "0" is displayed. The code is displayed for functions that have already been activated.

Value	Option	Remark
Operating mode	**fold-out function**	
..TG	numerical value	
..NG	numerical value	Also includes TG
Function extension	**fold-out function**	
..AZ	numerical value	
..LA	numerical value	
Second interface	**fold-out function**	
..MS	numerical value	Also necessary for P or S (connection of the interface converter; this option is automatically enabled when P or S is ordered for second interface)
..DA	numerical value	
..MN	numerical value	

Table 6-36: Activation menu

6.1.26 Access menu

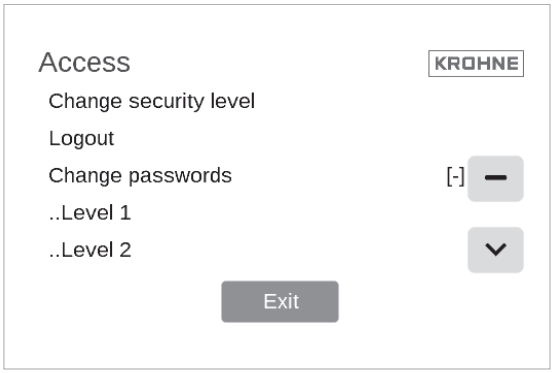

Figure 6-4: Access menu

In the access menu (see previous) you can change to another access level (refer to *User rights management* on page 29). The codes can also be changed.

Value	Option	Remark
Change security level	code request	After entering the corresponding code, the system changes to the desired access level.
Logout	function release	The user is logged out. The system returns to the process screen.
Change codes	**fold-out function**	
..Level 1	code request	Enter a new code for level 1*
..Level 2	code request	Enter a new code for level 2*
..Level 3	code request	Enter a new code for level 3*

Table 6-37: Access menu

* The code can be changed for the current access level and all lower levels.

6.1.27 Display setup menu

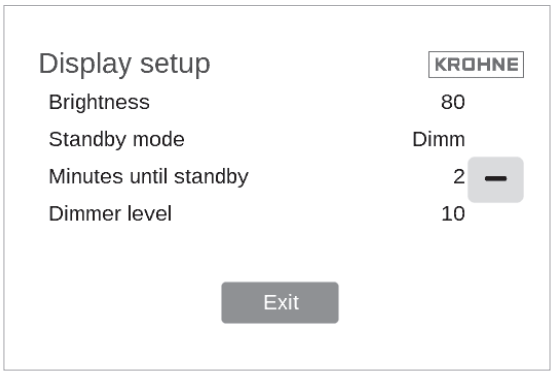

Figure 6-5: Display setup menu

The brightness of the display can be adjusted in the display setup menu (see previous figure).

Value	Option	Remark
Brightnessl	numerical value	Setting range from 0 (= dark) to 100 (= light)
Standby mode	Deactivated Dim Turn off	A standby mode for the display can be parameterized: After the corresponding waiting time, the display is dimmed or switched off.
Minutes until standby	numerical value	The duration until dimming / switching off
Dimming level	numerical value	The brightness in the dimmed state: Setting range from 0 (= dark) to 100 (= light)

Table 6-38: Display setup menu

INFORMATION!
When the OPTIBAR FC 1000 display is in standby mode (i.e., the display is dimmed or turned off), a brief touch anywhere on the display will cause it to light up again at the default brightness, and subse-quent touch input will be processed normally.
If the OPTIBAR FC 1000 responds poorly to touch input or performs other functions than expected, it may be necessary to calibrate the touchscreen.

7.1 Output warning and errors

DANGER!
Observe the national regulations for electrical installations!

DANGER!
All work on the electrical connections may only be carried out with the power disconnected. Take note of the voltage data on the nameplate!

WARNING!
Installation, assembly, start-up and maintenance may only be performed by personnel trained in ***explosion protection****. Additional regional standards, safety directives and laws must be observed at all times.*

WARNING!
Observe without fail the local occupational health and safety regulations.
Any work done on the electrical components of the measuring device may only be carried out by properly trained specialists.

7.1.1 General information

The OPTIBAR FC 1000 signals states deviating from the standard state in its display, via the electron-ic/mechanical relays, the digital interfaces and/or the analog outputs.

7.1.2 Display indication

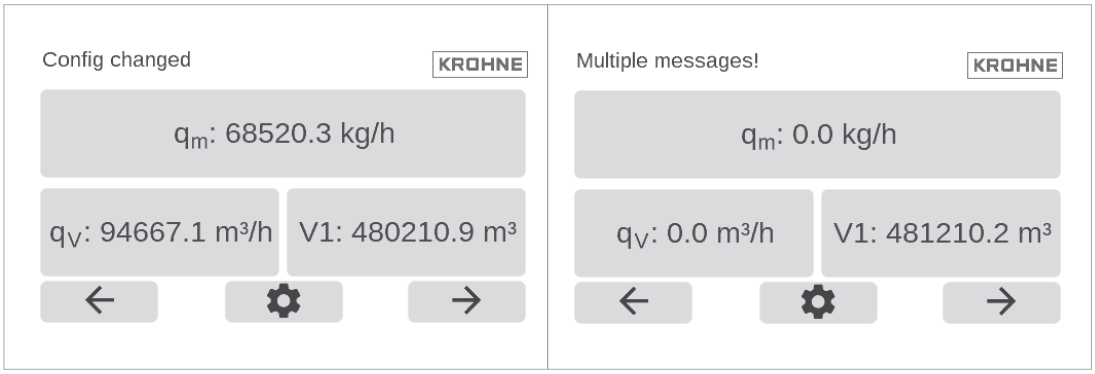

Figure 7-1: Warnings and error messages

As shown in the figure above warnings or error messages appear above the display tiles. If there is only one message, it is displayed directly (in the example: “Config changed”). If several occur, the message “Multiple messages!” appears. Pressing the message text opens an overview page with the time at which the warnings or errors occurred (see figure below). Warnings are displayed in yellow and errors in red.

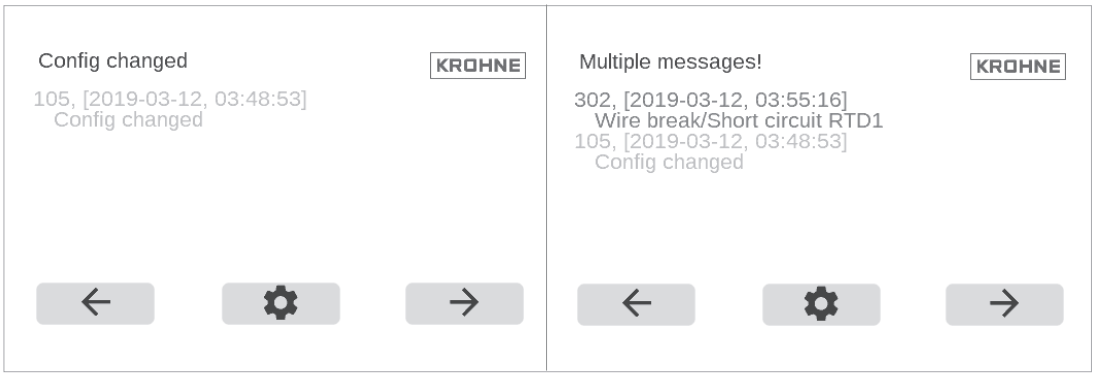

Figure 7-2: Warning and message information

INFORMATION!
If the reason for the corresponding message is no longer given, the corresponding message also disappears.

Warning on the display

The OPTIBAR FC 1000 outputs warnings in the display. The following table lists the possible warnings:

Warning	Explanation
Config changed	There are unsaved changes. If these are to be accepted, they must be saved (refer to *Service menu* on page 53).
Small flow rate	The parameterized minimum flow rate has not been reached. The flow rate is set to 0.
AinX: Current too low/high	At signal input AinX, the electric current value is outside the regular measuring range (lower than normal under range or higher than normal over range), but not yet in an error range. It should be checked whether the limits of the transmitter can be adjusted. Electric current ranges for warnings at signal input 4 ... 20 mA: 3.65 mA < AinX < 3.85 mA and 20.45 mA < AinX < 20.95 mA Electric current range for warning at signal input 0 ... 20 mA: 20.45 mA < AinX < 20.95 mA Note: A hysteresis of ±0.02 mA applies.
Saturated steam mode	Relevant for the medium “superheated steam”. If the temperature falls below the minimum temperature for the steam state (for the respective current pressure value), the OPTIBAR FC 1000 continues to calculate in “Saturated steam (p)” mode (refer to *Medium data for steam* on page 37).
Values are frozen	The manual freezing of all values via the service menu is active. In this case, the FC 1000 no longer calculates any values. Furthermore, no warnings or error messages are removed during this time. This will only be done again when the freeze has been removed (refer to *Service menu* on page 53).

Table 7-1: Possible display warnings

Error messages on the display

The OPTIBAR FC 1000 outputs error messages in the display. The following table lists the possible error messages:

Error	Explanation
Wire break/short circuit RTDX	There is an error at Pt100 input X. Check the wiring. If no fallback value1 is parameterized, the calculation is stopped.
No X source	No input has been assigned for one of the measurands "X". "X" can stand for: "dp1", "dp2", "qV", "T1", "T2" or "p" If no fallback value[1] is parameterized or no fallback value can be parameterized for the relevant measurand, the calculation is stopped. An input must be parameterized for the respective measured variable (refer to *Inputs* on page 44).
AinX: Wire break	No transmitter is detected at the relevant signal input AinX or the electric current from the transmitter is too low (AinX ≤ 3.65 mA[2]). The wiring must be checked. If no fallback value5 is parameterized, the calculation is stopped. This error cannot be detected with sig-nal input 0 ... 20 mA.
AinX: Short circuit	The transmitter at signal input AinX emits an electric current that is too high (AinX ≥ 20.95 mA[2]) or there is a short circuit. Check the wiring and/or the transmitter. If no fallback value[1] is parameterized, the calculation is stopped.
AinX: No HART comm.	HART® communication cannot be established with the transmitter at signal input AinX. In this case, the measured values are determined via the electric current signal. Here it is assumed that the electric current signal is present as a 4...20 mA signal. If the transmitter is not HART®-capable, the signal source of the analog input should be changed accordingly (refer to *Transmitter settings for dp devices according to ISO 5167 and AGA-3* on page 45).
Differential pressure greater than pressure	Relevant for flow sensor type "dp device ISO 5167" and "AGA-3": If the determined differential pressure is greater than the absolute pressure, no more calculation can take place. The parameterization and the connections of the transmitters must be checked.
ISO 5167 calculation aborted	Relevant for flow sensor type "dp device ISO 5167": If no convergence is achieved in the calculation according to ISO 5167, no further calculation can take place. The parameterization and the connections of the transmitters must be checked.
Invalid p or T value	Relevant for medium "water" or "steam": If the values for pressure or temperature are outside a range defined according to IAPWS-97, no further calculation can be performed. The parameterization and the connections of the transmitters must be checked.
Water alarm	Relevant for medium "superheated steam": If the current pressure/temperature combination results in the aggregate state water, a water alarm is issued and the calculation is stopped (refer to *Medium data for steam* on page 37).
Steam alarm	Relevant for medium "water": If the current pressure/temperature combination results in the aggregate state steam, a steam alarm is output, and the calculation is stopped.

Table 7-2: Possible error messages

[1] For the pressure and temperature inputs, fallback values can be parameterized. This fallback value is then used in the event of a wire break, defect or short circuit of the sensor concerned (refer to *Transmitter settings: Continued for any basic setting* on page 47).

[2] A hysteresis of ±0.02 mA applies.

INFORMATION!
If the calculation is stopped, "nan" is displayed for all calculated values.
Error messages concerning the functional extensions are listed separately when these extensions are described.

7.1.3 Signaling of errors via the outputs

Errors are also signaled via the outputs.

Output	Explanation
Fallback current at analog output X	If a flow calculation is not possible (refer to *Display indication* on page 58) and a flow value is to be output at analog output X, this outputs a parameterizable fallback value (refer to *Outputs* on page 50).
Signal at electronic relay (switching output) 1 or 2 or at mechanical relay	Parameterization of the collective alarm for one of the switching outputs or the relay (refer to *Outputs* on page 50). The collective alarm is triggered if there is an error (refer to *Display indication* on page 58).

Table 7-3: Error signaling via outputs

INFORMATION!
Additional signals may occur with the functional extensions, these are listed in the description of the extensions.

7.2 Software update

Please refer to *Restart incl. update function* on page 54.

7.3 Spare parts availability

The manufacturer adheres to the basic principle that functionally adequate spare parts for each device or each important accessory part will be kept available for a period of 3 years after delivery of the last production run for the device. This regulation only applies to spare parts which are subject to wear and tear under normal operating conditions.

7.4 Availability of trainings

The manufacturer offers a range of services to support the customer after expiration of the warranty. These include repair, maintenance, technical support and training.

INFORMATION!
For more precise information, please contact your local sales office.

7.5 Repairs

Repairs must be carried out exclusively by the manufacturer or the manufacturer authorised specialist companies.

7.6 Returning the device to the manufacturer

7.6.1 General information

This device has been carefully manufactured and tested. If installed and operated in accordance with these operating instructions, it will rarely present any problems.

WARNING!
Should you nevertheless need to return a device for inspection or repair, please pay strict attention to the following points:

- *Due to statutory regulations on environmental protection and safeguarding the health and safety of the personnel, the manufacturer may only handle, test and repair returned devices that have been in contact with products without risk to personnel and environment.*
- *This means that the manufacturer can only service this device if it is accompanied by the following certificate (see next section) confirming that the device is safe to handle.*

WARNING!
If the device has been operated with toxic, caustic, radioactive, flammable or water-endangering products, you are kindly requested:

- *to check and ensure, if necessary by rinsing or neutralising, that all cavities are free from such dangerous substances,*
- *to enclose a certificate with the device confirming that it is safe to handle and stating the product used.*

7.7 Disposal

LEGAL NOTICE!
Disposal must be carried out in accordance with legislation applicable in your country.

Separate collection of WEEE (Waste Electrical and Electronic Equipment):

According to the directive 2012/19/EU or UK Regulation 2013 No. 3113, the monitoring and control instruments marked with the WEEE symbol and reaching their end-of-life **must not be disposed of with other waste**.
The user must dispose of the WEEE to a designated collection point for the recycling of WEEE or send them back to our local organisation or authorised representative.

7.8 Display calibration

If the OPTIBAR FC 1000 responds poorly to touch input or performs other functions than expected, it may be necessary to calibrate the touchscreen.

Each time the OPTIBAR FC 1000 is restarted, the company logo "KROHNE" is displayed full-screen. Pressing this logo starts the calibration mode of the display.

A dot will appear on the display (see following figure), which must be pressed with the finger. The dot then disappears and a second dot appears. When the second dot is pressed, a third dot will appear and, after pressing it, the calibration of the display is completed. After that, the OPTIBAR FC 1000 will show the normal process display.

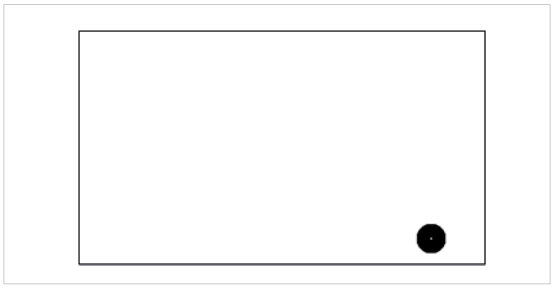

Figure 7-3: Display calibration

8.1 Use and adaption

Functional extensions can be used and adapted starting from the menu selection (refer to *Menu selection and handling* on page 31).

8.2 Automatic Air purging unit

8.2.1 Background

The OPTIBAR FC 1000 can control the optional automatic air purge unit (APU). Details on this unit can be found in the separate instructions.

8.2.2 Display

If the APU functionality is activated in the basic setup (refer to *Functional enhancement* on page 16), there is an additional screen (see following figure). This screen displays the status of the APU and offers two additional tiles for the display of process values. In the home or normal position, which corresponds to the measuring mode, the remaining time until the next purge is displayed in the status area (if the timer mode is deactivated, the message "Waiting for external triggering" appears).

Figure 8-1: Display with information about the APU

8.2.3 Sequence of a purging cycle

INFORMATION!
During a purging cycle, the differential pressure transmitter is not connected to the process. Pressure and temperature measurement can also be influenced by the purging process. Therefore, no current flow rate can be determined during the cycle. The input values for differential pressure, pressure and temperature are thus frozen during the entire purging cycle. The display values and the outputs also retain their last state. Counters continue to count constantly, and pulse/frequency outputs continue to output the last valid values constantly. It is possible to send a status signal to the control station during the purging cycle (refer to Signaling to the control station/another APU on page 68).

If only the electric current value output by the dp transmitter is required in the control station, it can also be output directly via Aout1 (refer to *Outputs* on page 50). The previously measured current value is then frozen during a purging cycle.

After a parameterized duration (in timer mode) or following an external triggering, a purging cycle is carried out. The following table illustrates a purging cycle:

Output at OPTIBAR FC 1000	Explanation
Going to zero-point check	The rotary actuator of the APU is switched on to move to the zero-point control position.
Zero-point check	The zero-point control position has been reached. The zero-point is checked/corrected.
Going to chamber 1	The rotary actuator of the APU is switched on to approach the first chamber.
Purging chamber 1	The position for purging the first chamber has been reached. The first chamber is purged.
Going to chamber 2	The rotary actuator of the APU is switched on to approach the second chamber.
Purging chamber 2	The position for purging the second chamber has been reached. The second chamber is purged.
Going to the home position	The rotary actuator of the APU is switched on to approach the home position.
Waiting for settling	The home position has been reached. The transmitter is granted time to settle back to the process conditions.

Table 8-1: Illustration of a purging cycle

INFORMATION!
While the APU is moving to a position, the message "Motor timeout: 36 s / 40 s" also appears. The "40 s" in this example indicate the maximum time that may elapse until the next position is reached. The "36 s" indicate the current remaining time. If this remaining time has expired – i.e. the APU has not approached a defined position within 40 s – the APU is defective. The message "Error: Destination not reached! Check motor!" will appear.

DANGER!
The drive may only be inspected when it is disconnected from the supply voltage.

INFORMATION!
While the APU is in one of the states "Zero-point check", "Purging chamber 1", "Purging chamber 2" or "Waiting for settling", a "Remaining time: 17s / 20s" is also displayed. The "20s" in this example indicate the parameterized duration of the respective process. The "17 s" indicate the current remaining time. If automatic zero-point correction is activated (see notes on page 65), no remaining time is displayed in the "zero-point check" state because the correction is carried out depending on the parameterization and the behavior of the transmitter.

8.2.4 Parameterization and manual control

The APU menu (see following figure) can be called up from the menu selection (refer to *Menu selection and handling* on page 31). The general operation of the submenus is also described there.

Figure 8-2: APU menu

INFORMATION!
The APU can be operated in two modes: With or without automatic zero-point correction. If there are differences in the output or operation between the two variants, a distinction is made between the two in the following tables.

INFORMATION!
After installation, an initial zero-point calibration must be carried out (see the explanation of the command "Move to zero-point position" in the following table).

Value	Option	Remark
Commands	fold-out function	
..Start purging	function release	Starts a purging cycle
..Move to zero-point position	function release	The APU is moved to the zero-point control position. The current value or differential pressure output by the transmitter is then displayed. A zero-point calibration can be carried out on the differential pressure transmitter after installation and afterwards if required.
..Set zero-point	function release	Will set the zero-point. This command is only active if the APU is in zero-point control position (see previous point). "HART" must be selected as the differential pressure transmitter signal source (refer to *Transmitter settings for dp devices according to ISO 5167 and AGA-3* on page 45). The zero point is set independently of the displayed value (i.e. the previously set zero-point of the transmitter).
..Move to home position	function release	The APU is moved back from the zero-point control position to the home position.
Timer	fold-out function	
..Timer active	On Off	Activates or deactivates timer operation
..Timer duration [min]	numerical value	Indication of the waiting time between two purging cycles. Only visible when timer operation is active
Zero-point check	fold-out function	
..Auto zero-point	On Off	Activates or deactivates the automatic zero-point correction. If the function is active, HART must be selected as the signal source for the differential pressure transmitter (refer to *Transmitter settings for dp devices according to ISO 5167 and AGA-3* on page 45).

Table 8-2: Explanation of command "Move to zero-point position"

Menu entries for: “Auto zero-point”: On

Value	Option	Remark
..Zero-point max. dev. before	numerical value	Indication of the maximum permissible zero-point deviation BEFORE the zero-point calibration. If the deviation of the zero point (in comparison to the last calibration) is too large, there may be a defect in the differential pressure transmitter. The zero-point calibration is not carried out if the deviation is too large.
..Zero-point max. dev. after	numerical value	Indication of the maximum permissible zero-point deviation AFTER the zero-point calibration. If the deviation of the zero point is too large, there may be a defect in the differential pressure transmitter. In this case an error message is shown after the purging cycle is completed.

Table 8-3: Menu entries for: “Auto zero-point”: On

Menu entries for: “Auto zero-point”: Off

Value	Option	Remark
...Zero-point check duration [s]	numerical value	Indication of the duration of the zero-point check. The transmitter must be given the opportunity to settle to zero. This duration depends mainly on the damping of the transmitter.
..Zero-point I.min	numerical value	The minimum permissible current output value of the transmitter at zero-point condition
..Zero-point I.max	numerical value	The maximum permissible current output value of the transmitter at zero-point condition

Table 8-4: Menu entries for: “Auto zero-point”: Off

Continuation for any setting of “Auto zero-point”

Value	Option	Remark
Purging duration [s]	numerical value	Duration of the purging of each chamber
Settling duration [s]	numerical value	Indication of the duration of settling in the measuring (home) position. The transmitter must be given the opportunity to settle to the measured value. This duration depends mainly on the damping of the transmitter.
Motor timeout [s]	numerical value	The maximum time the motor may turn until it has reached the target position.

Table 8-5: Continuation for any setting of “Auto zero-point”

8.2.5 Error messages in the display

For further information refer to *Display indication* on page 58.

Error	Explanation
Zero-point failure	For "Auto zero-point: On": The error is output if the automatic zero-point correction could not be carried out. Possible causes: After installation, no initial zero point calibration was carried out (refer to *Parameterization and manual control* on page 65); the value for the max. zero-point deviation is parameterized too small or there is a defect. For "Auto zero-point: Off": The error is output if a deviation of the current value that is too large was detected during the zero-point check. To correct the error, a manual zero-point calibration must be carried out on the differential pressure transmitter. The rotary actuator of the APU is switched on to move to the zero-point control position.
Autom. zero-point needs HART	Automatic zero-point correction can only be performed if the differential pressure transmitter is connected to a HART®-compatible analog input (Ain1 or Ain2) (refer to *Transmitters at the analog inputs* on page 22) and HART has been selected as the signal source for the differential pressure transmitter (refer to *Transmitter settings for dp devices according to ISO 5167 and AGA-3* on page 45).
Drive failure	The target position could not be reached. The calculation is stopped. The drive/wiring of the APU must be checked.
Wire break APU	A target position could not be reached. The APU is in the home position again. The drive/wiring of the APU must be checked.

Table 8-6: Error messages

DANGER!
The drive/wiring may only be inspected when it is disconnected from the supply voltage.

8.2.6 Signaling to the control station/another APU

The errors listed on page 67 will result in the output signals, refer to *Signaling of errors via the outputs* on page 61.

The OPTIBAR FC 1000 can output additional signals to the control system and to another APU (with OPTIBAR FC 1000) via the switching outputs S1/S2 and the relay R. The drive of the APU is also controlled. For the parameterization of the switching outputs and the relay refer to *Outputs* on page 50.

Signal name	Explanation
Motor control switch	This signal is used to control the drive of the APU. By default, the relay R is used for this purpose.
APU operating indicator	During a purging cycle and during manual control, this signal indicates that the measured values are frozen.
APU error	This signal is output if there is an error concerning the APU (refer to *Error messages in the display* on page 67).
Next APU	If two (or more) APU are to be used at one measuring point, one APU controls one further APU at a time. This ensures that current measured values are always available for at least one flow measurement at an APU position, since never more than one APU performs a purging cycle at the same time.

Table 8-7: Signal explanation

8.3 Automatic zero-point correction

8.3.1 Background

The OPTIBAR FC 1000 can control an optional automatic zero-point calibration unit.

The OPTIBAR FC 1000 continuously monitors the cell temperature of the differential pressure transmitter. If a change in this value is detected which is outside an adjustable limit value, an automatic zero-point calibration is carried out. Pressure changes in the system are monitored analogously. If no in-admissible deviations from cell temperature or system pressure are detected within an adjustable time interval, a calibration is also carried out after the interval has elapsed in order to prevent a long-term drift. The value for the static pressure transmitted by the differential pressure transmitter is used to determine the system pressure (if the transmitter measures this value and makes it available via the HART® interface), otherwise the pressure transmitter is used. If no pressure transmitter is present and the differential pressure transmitter does not transmit a pressure value, no monitoring of the pressure value takes place.

In the OPTIBAR FC 1000, the automatic zero-point calibration is shortened to "Zero" for display reasons.

The OPTIBAR FC 1000 can control two differential pressure transmitters ("split-range operation"), in which case the automatic zero-point calibration is carried out for both transmitters. For the sake of simplicity, the following sections always refer to only one transmitter, but the information also refers to operation with two transmitters.

"HART" must be selected as the signal source of the differential pressure transmitter (refer to *Transmitter settings for dp devices according to ISO 5167 and AGA-3* on page 45).

8.3.2 Display

If the zero functionality is activated in the basic settings (refer to *Functional enhancement* on page 16), there is an additional display page (see following figure). This screen displays the status of the zero-point calibration and provides two additional tiles for displaying process values. One of these tiles is occupied by the digitally read differential pressure of the first differential pressure transmitter ("Ddp1"). If two differential pressure transmitters are present, the second tile is occupied by the digitally read differential pressure of the second differential pressure transmitter ("Ddp2"). The values "Ddp1" and "Ddp2" always represent the values currently measured by the transmitters, for the flow calculation the differential pressure "dp" is used, which is derived from these quantities and which is frozen during a zero-point calibration. In the normal status, which corresponds to the measuring mode, the remaining time until the next zero-point calibration is displayed in the status area (if the timer mode is deactivated, the message "Waiting for external triggering" appears).

Figure 8-3: Display with information about the automatic zero-calibration unit

8.3.3 Sequence of a zero-point calibration

INFORMATION!
During a zero-point calibration, the differential pressure transmitter is not connected to the process. Therefore, no current flow rate can be determined during the calibration. The input values for differential pressure, pressure and temperature are frozen during the entire calibration process. Thus, the display values and the outputs also retain their last state. Counters continue to count constantly and pulse/frequency outputs continue to output the last valid values constantly. It is possible to send a status signal to the control station during calibration (refer to Signaling to the control station/another APU on page 68).

If only the current value output by the dp transmitter is required in the control station (measured by the OPTIBAR FC 1000 at Ain1), it can also be output directly via Aout1 (refer to *Outputs* on page 50). The previously measured current value is then frozen during calibration.

After a parameterized duration (in timer mode), with relevant changes in cell temperature or system pressure or following an external triggering, a zero-point calibration is carried out. The following table illustrates a sequence:

Output at OPTIBAR FC 1000	Explanation
Establishing zero-point condition	The automatic zero-point calibration unit physically establishes the zero-point condition: The transmitter is disconnected from the process and then the two chambers of the transmitter are connected.
Zero-point calibration	The transmitter is given time to settle to zero. If the transmitter delivers a constant measured value close to the old zero-point, this value is set as the new zero-point.
Establishing measurement condition	The automatic zero-point calibration unit physically establishes the measurement condition: The connection between the two chambers of the transmitter is disconnected and then the transmitter is reconnected to the process.
Waiting for settling	The transmitter is granted time to settle back into the process conditions.

Table 8-8: Zero point calibration sequence

8.3.4 Parameterization and manual control

The Zero menu (see following figure) can be called from the menu selection (refer to *Menu selection and handling* on page 31). For the general operation of the submenus also refer to *Menu selection and handling* on page 31.

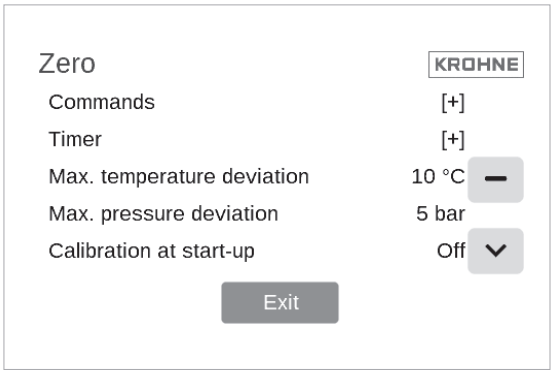

Figure 8-4: The zero menu

INFORMATION!
After installation, an initial zero-point calibration must be carried out (see explanation of the "Set zero-point" command in the following table).

Value	Option	Remark
Commands	fold-out function	
..Start zero-point calibration	function release	Starts a zero-point calibration
..Establish zero-point condition	function release	The automatic zero-point calibration unit establishes the zero-point condition: the transmitter is disconnected from the process and the two chambers of the transmitter are connected. The differential pressure output by the transmitter is then displayed.
..Set zero-point	function release	Set the zero-point. This command is only active if the zero-point condition was previously established. The zero point is set independently of the displayed value (i.e. the previously set zero-point of the transmitter).
..Establish measurement condition	function release	The automatic zero-point calibration unit restores the measurement condition: the connection between the two chambers is disconnected and the connection to the process is restored. After a settling time, the measurement is enabled again.
..Execute ventilation	function release	The valves in the automatic zero-point calibration unit are switched several times to remove any air bubbles. Only available for hardware type "solenoid valves"; only for medium steam or liquid
Timer	fold-out function	
..Timer active	On Off	Activates or deactivates timer operation
..Timer duration [min]	numerical value	Indication of the waiting time between two zero-point calibrations. Only visible when timer operation is active
Max. temperature deviation	numerical value	The value for the maximum permissible tempera-ture deviation of the transmitter's measuring cell in comparison to the last zero-point calibration.
Max. pressure deviation	numerical value	The value for the maximum permissible pressure deviation of the transmitter's measuring cell compared to the last zero-point calibration. Only visible when system pressure can be measured.
Calibration at start-up	On Off	Indicates whether a zero-point calibration should be carried out after the power supply has been restored (e.g. after system maintenance).

Value	Option	Remark
Ventilation	fold-out function	Sub-item only available for hardware type "solenoid valves"; only for medium steam or liquid
..Ventilation cycles	numerical value	The number of times the valves are to be switched for venting
..Ventilation at startup-up	On Off	Indicates whether venting should be performed after the power supply has been restored (e.g. after system maintenance).
Default settings	fold-out function	
..Settling duration [s]	numerical value	Indication of the duration of the settling time in the measuring position. The transmitter must be given the opportunity to settle to the measured value. This duration depends mainly on the damping of the transmitter.
..Max. dp deviation	numerical value	Indication of the maximum permissible zero-point deviation BEFORE zero-point calibration. If the deviation of the zero-point (compared to the last calibration) is too large, there may be a defect in the differential pressure transmitter. The zero-point calibration is not carried out if the deviation is too large.
..Hardware type	Rotary actuator Solenoid valves	The type of the automatic zero-point calibration unit used: version with rotary actuator or version with solenoid valves
..Damping during calibration [s]	numerical value	During the actual calibration, the damping of the transmitter is set to this value. This is how averaging takes place. This is useful, for example, when the system is subject to vibrations.
..Max. fluctuation during calibration	numerical value	The maximum fluctuation of the zero-point during the zero-point calibration.
..Check cycles	numerical value	Number of cycles for which the zero-point must not fluctuate by more than the max. allowed value. Cycles corresponds to approx. 250 ms.
..Timeout [s]	numerical value	The maximum time granted to the transmitter to reach a stable zero point.

Table 8-9: Explanation of command "Set zero-point"

8.3.5 Error messages on the display

For the explanation also refer to *Display indication* on page 58.

Error	Explanation
Zero-point error	The error is output if the automatic zero-point calibration could not be carried out. Possible causes: No initial calibration was carried out after installation (refer to *Parameterization and manual control* on page 70); the value for the "Max. dp deviation" or the "Max. fluctuation during calibration" is parameterized too small or there is a defect.
Automatic calibration only with HART	Automatic calibration can only be performed if the differential pressure transmitter is connected to a HART®-compatible analog input (Ain1 or Ain2) (refer to *Transmitters at the analog inputs* on page 22) and HART has been selected as the signal source for the differential pressure transmitter (refer to *Transmitter settings for dp devices according to ISO 5167 and AGA-3* on page 45).
Measurement condition not established	The measurement condition (connection of the transmitter to the process; no connection between the chambers of the transmitter) is not established. There may be a wiring error or a defect. The calculation is stopped.
No connection to Zero	The OPTIBAR FC 1000 cannot communicate with the automatic zero-point calibration unit. There may be a wiring error or a defect.

Table 8-10: Explanation of error messages

DANGER!
The wiring may only be checked when it is disconnected from the supply voltage.

8.3.6 Signaling to the control system

The errors listed on page 72 will result in the output signals described on page 61.

The OPTIBAR FC 1000 can output additional signals to the control system via the switching outputs S1/S2 and the relay R. The parameterization of the switching outputs and the relay is explained on page 50.

Signal name	Explanation
Zero error	This signal is output if one of the errors on page 72is present.
Zero operating indicator	During a zero-point calibration or during a manual zero-point check, it is signaled that the measured values are frozen.

Table 8-11: Signaling to the control system

9.1 Technical data

INFORMATION!

- *The following data is provided for general applications. If you require data that is more relevant to your specific application, please contact us or your local sales office.*
- *Additional information (certificates, special tools, software,...) and complete product documentation can be downloaded free of charge from the website (Downloadcenter).*

9.1.1 Connections and interfaces

Electrical connection

AC power supply	100 ... 240 V AC ±10 %; 50 ... 60 Hz ±5 %
DC power supply (optional)	18 ... 30 V DC ±10 %
Power consumption	max. 20 VA

Inputs

Analog inputs	
Number	4 (2 of which have HART® capability[1])
Measuring range	0/4 ... 20 mA
Percentage error	0.1 % of measured value or 0.05 % of upper range value
Burden	22 Ω (262 Ω for the HART®-enabled inputs)
Pt100 / RTD inputs	
Number	2
Connection type	3- or 4-wire connection
Measuring range	–200 ... +750 °C
Divergence	typ. ±0.005 K
Feed current	250 µA
Pulse / frequency inputs	
Number	2
Switching threshold	0 signal: 0 ... 2 V; 1 signal: 3 ... 24 V
Frequency range	0 ... 10 kHz; EN 1434 Cl. IB, IC, ID, IE

Outputs

Analog outputs	
Number	2
Output range	0/4 ... 20 mA; output voltage 15 V
Percentage error	0.1 % of the output value or 0.05 % of the upper range value
Burden	max. 500 Ω
Switching outputs	
Number	3
1 × mechanical relay (normally open/normally closed)	230 V AC; 6 A
1 × electronic relay (normally open)	40 V AC/60 V DC; 120 mA max. switching frequency: 150 Hz
1 × electronic relay (normally closed)	40 V AC/60 V DC; 120 mA max. switching frequency: 150 Hz
Digital interfaces	
USB port	logging function and updates
Ethernet interface	Modbus Slave TCP and web interface that displays the measured data
First digital interface	Modbus Slave RTU or Modbus Master RTU or M-Bus (ordering option); (optional connection of an external converter to Profibus DP Slave or Profinet Slave)
Second digital interface (optional)	Modbus Slave RTU or Modbus Master RTU (optional connection of an external converter to Profibus DP Slave or Profinet Slave)

Table 9-1: Technical data: connections and interfaces

[1] Compatible differential pressure transmitters for use with the HART® interface:
KROHNE OPTIBAR DP 7060
KROHNE OPTIBAR DP 3050
Siemens SITRANS P DS III, P320, P420
Endress+Hauser Deltabar S PMD 75
ABB 266MST
VEGA VegaDif 65, VegaDif 85
Yokogawa DPharp EJX 110A
Rosemount 3051C
others on request

9.1.2 User interface

Touch display

Dimension	95 W × 53.5 H (in mm^2)
Aspect Ratio/Resolution	16:9; 480 pixels × 272 pixels
Technology	TFT color display with capacitive touch screen

Table 9-2: Technical data: user interface

9.1.3 Housing and dimensions

Panel mounting housing

Material

Display front	Plastic
Electronics housing	Stainless steel

Dimensions

Display front	144 mm × 83 mm × 14 mm
Electronics housing	135 mm × 65 mm × 119 mm
Panel breakout	136.5 ± 1 mm × 70 ± 3 mm
Degree of protection	
Display front	IP54
Electronics housing	IP20
Environmental conditions	
Operating temperature	–20 ... 55 °C
Storage temperature	–40 ... 85 °C
Relative air humidity	0 ... 95 %; non-condensing
Installation height	Up to 2000 m

Table 9-3: Technical data: panel mounting housing

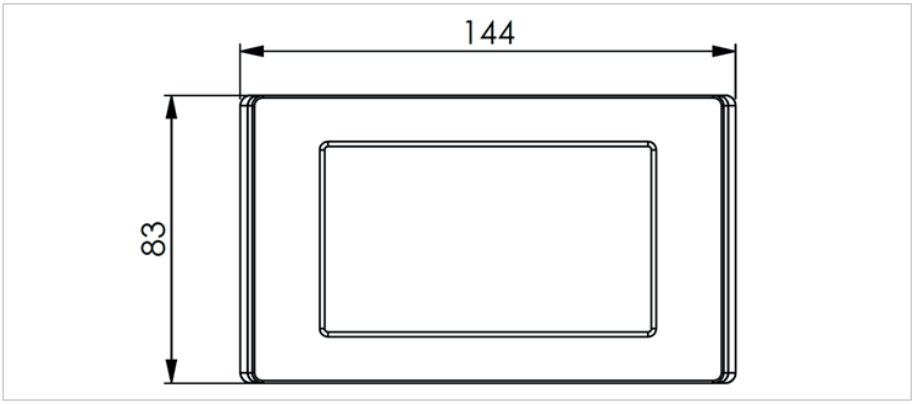

Figure 9-1: Front view

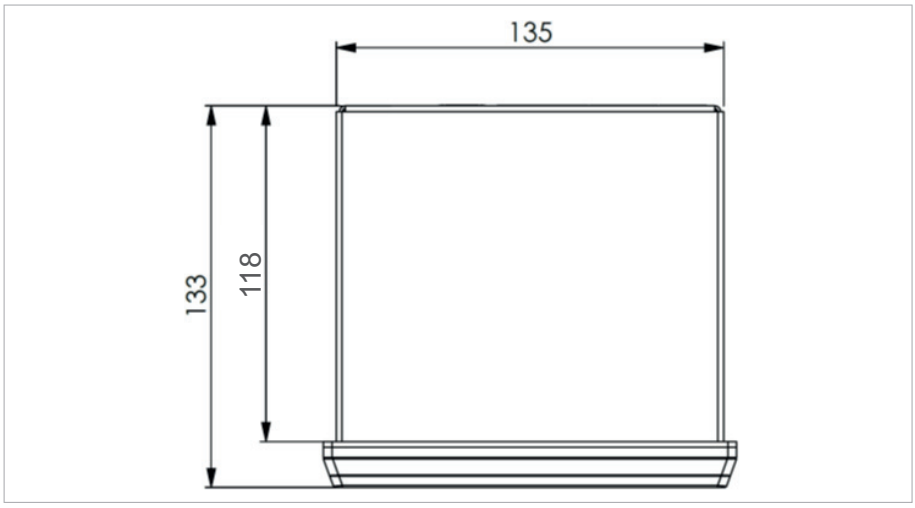

Figure 9-2: Top view

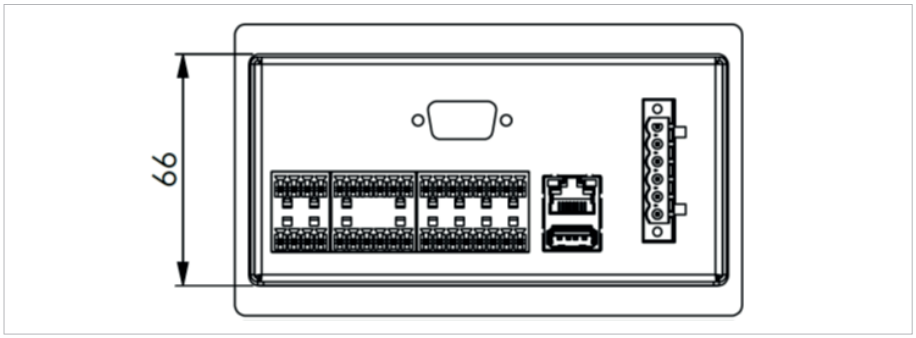

Figure 9-3: Back view

Wall mounting housing

Material

Display front	Glass
Housing	Aluminum

Dimensions

Housing	299 mm × 173 mm × 60.2 mm
Degree of protection	
Housing	IP65
Environmental conditions	
Operating temperature	–20 ... 55 °C
Storage temperature	–40 ... 85 °C
Installation height	Up to 2000 m

Table 9-4: Technical data: wall mounting housing

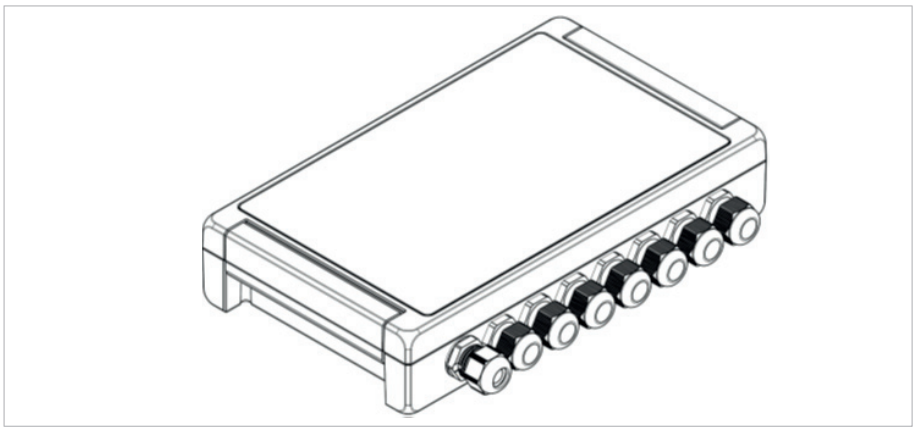

Figure 9-4: Housing for wall mounting with cable glands

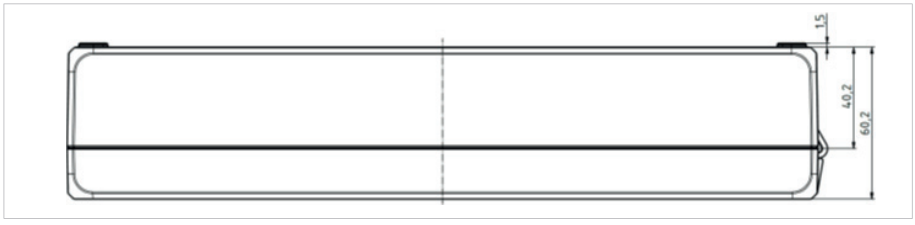

Figure 9-5: Top view

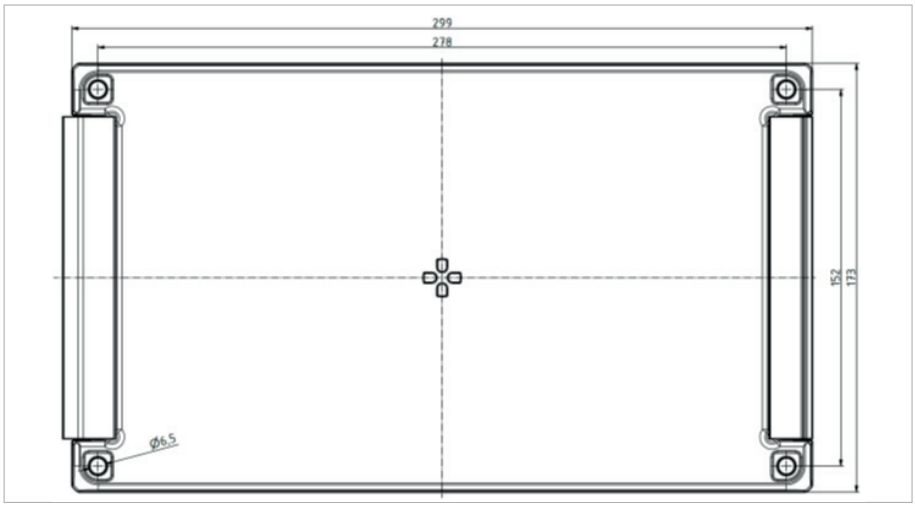

Figure 9-6: Bottom view with mounting holes

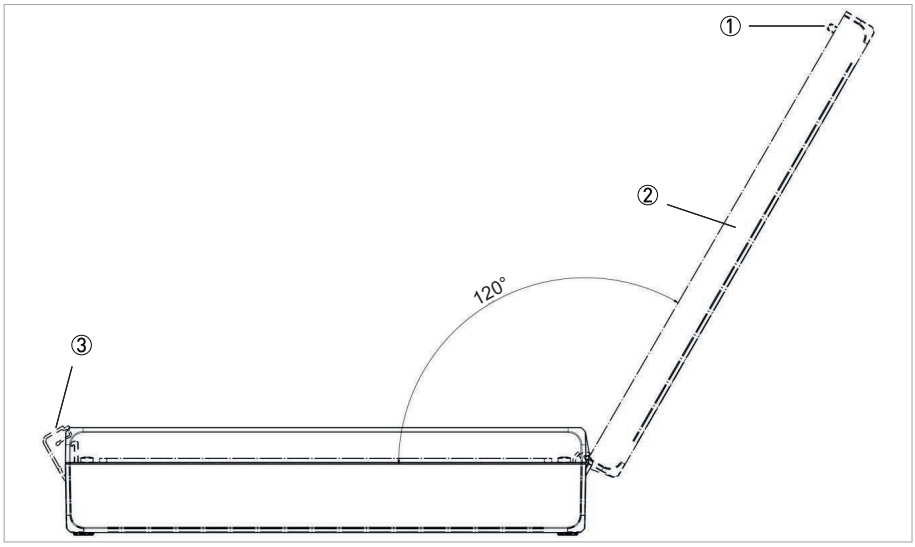

Figure 9-7: Housing with opened cover

① Locking screw
② Open cover
③ Open cover profile

10.1 Web server

Requirements: The OPTIBAR FC 1000 has been connected to the network (refer to *Ethernet interface* on page 24) and the interface parameters have been set accordingly (refer to *Interfaces* on page 52).

Via a web browser, an overview screen with process data, meter readings, etc. can be called up after entering the IP address of the OPTIBAR FC 1000. Remote configuration of the OPTIBAR FC 1000 is not provided for security reasons. There is only read access.

10.2 Modbus

Requirements: The OPTIBAR FC 1000 has been connected to the network (for Modbus TCP refer to *Ethernet interface* on page 24; for Modbus RTU refer to *Modbus / M-bus (serial 1)* on page 24) and the interface has been parameterized accordingly (refer to *Interfaces* on page 52).

The following sections show the assignment tables required for communication.

10.2.1 Input registers

INFORMATION!
The counters each consist of an integer portion and a decimal portion. The values are transferred as follows: Big endian, high byte first, high word first.

Module	ID	Start address	End address	Hint	Bits	Type
Firmware version	18	18	19	MMmmrr	32	int
Heat totalizer 1	20	20	23	Q1	64	int
Heat totalizer fraction 1	24	24	25	Q1 fract	32	IEEE754 FLOAT
Heat totalizer 2	26	26	29	Q2	64	int
Heat totalizer fraction 2	30	30	31	Q2 fract	32	IEEE754 FLOAT
Unit heat totalizer	32	32	32	1105=[kWh] fix.	16	int
Standard volume totalizer 1	33	33	36	V_n1	64	int
Standard volume totalizer fraction 1	37	37	38	V_n1 fract	32	IEEE754 FLOAT
Standard volume totalizer 2	39	39	42	V_n2	64	int
Standard volume totalizer fraction 2	43	43	44	V_n2 fract	32	IEEE754 FLOAT
Unit standard volume	45	45	45	400=[Nm^3] fix.	16	int
Actual volume totalizer 1	46	46	49	V1	64	int
Actual volume totalizer fraction 1	50	50	51	V1 fract	32	IEEE754 FLOAT
Actual volume totalizer 2	52	52	55	V2	64	int

Module	ID	Start address	End address	Hint	Bits	Type
Actual volume totalizer fraction 2	56	56	57	V2 fract	32	IEEE754 FLOAT
Unit actual volume	58	58	58	300=[m^3] fix.	16	int
Standard volume flow	59	59	60	q_{Vn}	32	IEEE754 FLOAT
Unit standard volume flow	61	61	61	201=[Nm^3/h] fix.	16	int
Actual flow	62	62	63	q_v	32	IEEE754 FLOAT
Unit actual flow rate	64	64	64	101=[m^3/h] fix.	16	int
Mass totalizer line 1	65	65	68	m1	64	int
Mass totalizer fraction 1	69	69	70	m1 fract	32	IEEE754 FLOAT
Mass totalizer 2	71	71	74	m2	64	int
Mass totalizer fraction 2	75	75	76	m2 fract	32	IEEE754 FLOAT
Unit mass totalizer	77	77	77	901=[kg] fix.	16	int
Mass flow	78	78	79	q_m	32	IEEE754 FLOAT
Unit mass flow	80	80	80	804=[kg/h] fix.	16	int
Temperature 1	81	81	82	T1	32	IEEE754 FLOAT
Unit temperature 1	83	83	83	501=[°C] fix.	16	int
Temperature 2	84	84	85	T2	32	IEEE754 FLOAT
Unit temperature 2	86	86	86	501=[°C] fix.	16	int
Temperature difference	87	87	88	ABS(T2 – T1)	32	IEEE754 FLOAT
Unit temperature difference	89	89	89	2700=[K] fix.	16	int
Differential pressure	90	90	91	dp	32	IEEE754 FLOAT
Unit differential pressure	92	92	92	703=[mbar] fix.	16	int
Absolute pressure	93	93	94	p	32	IEEE754 FLOAT
Unit absolute pressure	95	95	95	604=[bar] fix.	16	int
Specific density 1	96	96	97	rho1	32	IEEE754 FLOAT
Unit specific density 1	98	98	98	1800=[kg/m^3] fix.	16	int
Specific density 2	99	99	100	rho2	32	IEEE754 FLOAT
Unit specific density 2	101	101	101	1800=[kg/m^3] fix.	16	int

Module	ID	Start address	End address	Hint	Bits	Type
Flow velocity	102	102	103	v	32	IEEE754 FLOAT
Unit flow velocity	104	104	104	2200=[m/s] fix.	16	int
Compressibility	105	105	106	Z	32	IEEE754 FLOAT
Super-compressibility	107	107	108	Zn	32	IEEE754 FLOAT
Enthalpy 1	109	109	110	h1	32	IEEE754 FLOAT
Unit enthalpy 1	111	111	111	2800=[kJ/kg] fix.	16	int
Enthalpy 2	112	112	113	h2	32	IEEE754 FLOAT
Unit enthalpy 2	114	114	114	2800=[kJ/kg] fix.	16	int
Heat power	115	115	116	dQ	32	IEEE754 FLOAT
Unit heat power	117	117	117	1001=[kW] fix.	16	int
Offset:	**0**	**Shorts:**	**118**		**236**	

Table 10-1: Input registers

10.2.2 Input status

Module	ID	Adress (Bit)	Type
STATUS OK	0	0	bool
STATUS WARNING	1	1	bool
STATUS FAILURE	2	2	bool
APU purging in process	3	3	bool
Zero calibration in progress	4	4	bool
Service request	5	5	bool
QAL combination	6	6	bool
OFFSET	0	7	0

Table 10-2: Input status

10.2.3 Units

Parameter	Value	Unit
q_V (actual flow rate)	101	m^3/h
q_{Vn} (standard volume flow)	201	Nm^3/h
V (volume)	300	m^3
V_n (standard volume)	400	Nm^3
T (temperature)	501	°C
p (pressure)	604	bar

Parameter	Value	Unit
dp (differential pressure)	703	mbar
q_m (mass flow)	804	kg/h
m (mass)	901	kg
dQ (actual heat power)	1001	kW
Q (heat totalized)	1105	kWh
rho (density)	1800	kg/m^3
v (velocity)	2200	m/s
t_{diff} (temperature difference)	2700	K
h (specific enthalpy)	2800	kJ/kg

Table 10-3: Units

10.3 M-bus

Requirements: The OPTIBAR FC 1000 has been connected to the network (refer to *Modbus / M-bus (serial 1)* on page 24) and the interface parameters have been set accordingly (refer to *Interfaces* on page 52).

The following table shows the data sets for M-Bus

Data set	Variable	Description	Unit
1	q_m	mass flow	kg/h
2	q_v	volume flow	m^3/h
3	q_{vn}	standard volume flow	m^3/h
4	dQ	heat power	kW
5	p	absolute pressure	bar
6	T1	temperature 1	°C
7	T2	temperature 2	°C
8	dp	differential pressure	mbar
9	m1	mass 1	t
10	m2	mass 2	t
11	Q1	heat quantity 1	kWh
12	Q2	heat quantity 2	kWh
13	V_n1	standard volume 1	m^3
14	V_n2	standard volume 2	m^3
15	V1	volume 1	m^3
16	V2	volume 2	m^3

Table 10-4: Data sets for M-bus

10.4 Profibus / Profinet

Requirements: The OPTIBAR FC 1000 has been connected to the interface converter (refer to *Interface converter for Profibus / Profinet* on page 25) and the second serial interface has been parameterized accordingly (refer to *Interfaces* on page 52).

The table on page 87 shows the assignment of the modules for Profibus/Profinet.

10.4.1 Status messages and parameterization of the Profibus converter

The Profibus converter has 6 LEDs for status indication. It also has two rotary switches for setting the Profibus station address (see following Figure).

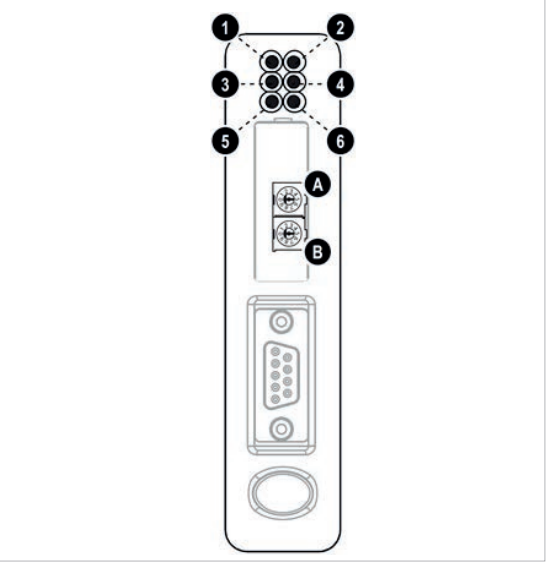

Figure 10-1: Profibus module with status LEDs and rotary switches
1-6 status LEDs

A+B rotary switches

The following table describes the status displays:

LED	Indication	Meaning
1 (Online)	green Off	Online Not online
2 (Offline)	Red Off	Offline Not offline
3 (Not used)	-	-
4 (Fieldbus Diagnostics)	Off Red flashing (1 Hz) Red flashing (2 Hz) Red flashing (4 Hz)	No diagnostics present Configuration error User parameter data error Initialization error
5 (Subnet Status)	Flashing green Green Red	Running, but one or more transaction errors Running Transaction error/timeout or subnet stopped
6 (Device Status)	Off Alternating red/green Green Flashing green Red Flashing red	Power off Invalid or missing configuration Initializing Running Bootloader mode Defective

Table 10-5: Status displays of Profibus converter

INFORMATION!
Rotary switches A and B are located behind a cover that can be carefully opened with a flat screwdriver.

The station address is set via the two rotary switches A and B according to the following relationship: Station address = 10 × B + A

An example for address 42 is shown in the following Figure: Station address = 10 × 4 + 2 = 42

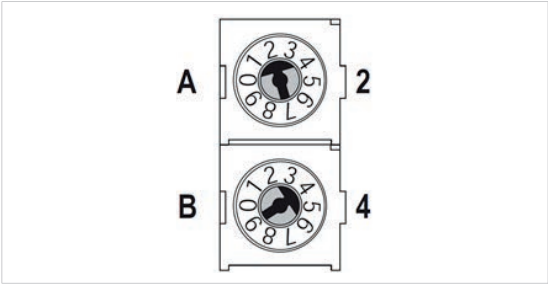

Figure 10-2: Example configuration: Address 42

DANGER!
The station address may only be changed when the converter is disconnected from the supply voltage.

10.4.2 Status messages of the Profinet converter

The Profinet converter has 6 LEDs for status indication (see following Figure).

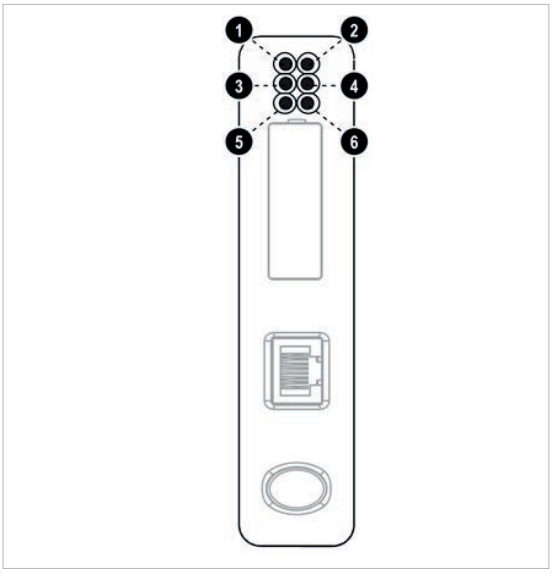

Figure 10-3: Profinet module with status LEDs
1-6 status LEDs

The following table describes the status displays:

LED	Indication	Meaning
1 (Communication status)	Off Green Flashing Green	Not online Online, connection with IO established, IO controller in run state Online, connection with IO established, IO controller in stop state
2 (module status)	Off Green 1 Sequential Green Blink 2 Sequential Green Blinks 1 Sequential Red Blink 3 Sequential Red Blinks 4 Sequential Red Blinks	No power / Not initialized Initialized, no errors Diagnostic data available Used by engineering tool to identify the module Configuration error No station name or no IP address assigned Internal error
3 (Link, activity)	Off Green Flashing Green	No link Connected to an Ethernet network Packets are received or transmitted
4 (Not used)	-	-
5 (Subnet Status)	Flashing green Green Red	Running, but one or more transaction errors Running Transaction error/timeout or subnet stopped
6 (Device Status)	Off Alternating red/green Green Flashing green Red Flashing red	Power off Invalid or missing configuration Initializing Running Bootloader mode Defective

Table 10-6: Status displays of Profinet converter

10.4.3 Integration of General Station Description files

In order to integrate the OPTIBAR FC 1000 into the control system, General Station Description files (GSD files) are provided.

For Profibus: “HMSB1803.gsd” and “Master.gcf”.

For Profinet: “GSDML-V2.3-HMS-ABC_PROFINET_IO-20141127.xml”

10.4.4 Assignment of modules

INFORMATION!
The counters each consist of an integer portion and a decimal portion.

Module	ID	Start address	End address	Hint	Bits	Type
Firmware version	0	0	3	MMmmrr	32	int
Heat totalizer 1	4	4	11	Q1	64	int
Heat totalizer fraction 1	12	12	15	Q1 fract	32	IEEE754 FLOAT
Heat totalizer 2	16	16	23	Q2	64	int
Heat totalizer fraction 2	24	24	27	Q2 fract	32	IEEE754 FLOAT
Unit heat	28	28	29	1105=[kWh] fix.	16	int
Standard volume totalizer 1	30	30	37	V_n1	64	int
Standard volume totalizer fraction 1	38	38	41	V_n1 fract	32	IEEE754 FLOAT
Standard volume totalizer 2	42	42	49	V_n2	64	int
Standard volume totalizer fraction 2	50	50	53	V_n2 fract	32	IEEE754 FLOAT
Unit standard volume	54	54	55	400=[Nm^3] fix.	16	int
Actual volume totalizer 1	56	56	63	V1	64	int
Actual volume totalizer fraction 1	64	64	67	V1 fract	32	IEEE754 FLOAT
Actual volume totalizer 2	68	68	75	V2	64	int
Actual volume totalizer fraction 2	76	76	79	V2 fract	32	IEEE754 FLOAT
Unit actual volume	80	80	81	300=[m^3] fix.	16	int
Standard volume flow	82	82	85	q_{Vn}	32	IEEE754 FLOAT
Unit standard volume flow	86	86	87	201=[Nm^3/h] fix.	16	int
Actual flow	88	88	91	q_v	32	IEEE754 FLOAT
Unit actual flow rate	92	92	93	101=[m^3/h] fix.	16	int
Mass totalizer line 1	94	94	101	m1	64	int
Mass totalizer fraction 1	102	102	105	m1 fract	32	IEEE754 FLOAT
Mass totalizer 2	106	106	113	m2	64	int
Mass totalizer fraction 2	114	114	117	m2 fract	32	IEEE754 FLOAT

Module	ID	Start address	End address	Hint	Bits	Type
Unit mass	118	118	119	901=[kg] fix.	16	int
Mass flow	120	120	123	q_m	32	IEEE754 FLOAT
Unit mass flow	124	124	125	803=[kg/h] fix.	16	int
Temperature 1	126	126	129	T1	32	IEEE754 FLOAT
Unit Temperature 1	130	130	131	501=[°C] fix.	16	int
Temperature 2	132	132	135	T2	32	IEEE754 FLOAT
Unit Temperature 2	136	136	137	501=[°C] fix.	16	int
Temperature difference	138	138	141	ABS(T2 – T1)	32	IEEE754 FLOAT
Unit temperature difference	142	142	143	2700=[K] fix.	16	int
Differential pressure	144	144	147	dp	32	IEEE754 FLOAT
Unit differential pressure	148	148	149	703=[mbar] fix.	16	int
Absolute pressure	150	150	153	p	32	IEEE754 FLOAT
Unit absolute pressure	154	154	155	604=[bar] fix.	16	int
Density 1	156	156	159	rho1	32	IEEE754 FLOAT
Unit density 1	160	160	161	1800=[kg/m^3] fix.	16	int
Density 2	162	162	165	rho2	32	IEEE754 FLOAT
Unit density 2	166	166	167	1800=[kg/m^3] fix.	16	int
Flow velocity	168	168	171	v	32	IEEE754 FLOAT
Unit flow velocity	172	172	173	2200=[m/s] fix.	16	int
Compressibility	174	174	177	Z	32	IEEE754 FLOAT
Super-compressibility	178	178	181	Zn	32	IEEE754 FLOAT
Specific enthalpy 1	182	182	185	h1	32	IEEE754 FLOAT
Unit specific enthalpy 1	186	186	187	2800=[kJ/kg] fix.	16	int
Specific enthalpy 2	188	188	191	h2	32	IEEE754 FLOAT
Unit specific enthalpy 2	192	192	193	2800=[kJ/kg] fix.	16	int
Heat power	194	194	197	dQ	32	IEEE754 FLOAT

Module	ID	Start address	End address	Hint	Bits	Type
Unit heat power	198	198	199	1001=[kW] fix.	16	int
STATUS OK	200	200	200		1	bool
STATUS WARNING	200	200	200		1	bool
STATUS FAILURE	200	200	200		1	bool
APU purging in process	200	200	200		1	bool
Zero calibration in progress	200	200	200		1	bool
Service request	200	200	200		1	bool
QAL combination	200	200	200		1	bool
Offset:	0	Shorts:	201		201	

Table 10-7: Assignment of modules

10.4.5 Units

Parameter	Value	Unit
q_V (actual flow rate)	101	m^3/h
q_{Vn} (standard volume flow)	201	Nm^3/h
V (volume)	300	m^3
V_n (standard volume)	400	Nm^3
T (temperature)	501	°C
p (pressure)	604	bar
dp (differential pressure)	703	mbar
q_m (mass flow)	804	kg/h
m (mass)	901	kg
dQ (actual heat power)	1001	kW
Q (heat totalized)	1105	kWh
rho (density)	1800	kg/m^3
v (velocity)	2200	m/s
t_{diff} (temperature difference)	2700	K
h (specific enthalpy)	2800	kJ/kg

Table 10-8: Units

11.1 Order code

Instrument code		Type								
VGKM	4	Housing								
		S	Panel mounting; 4.3"-TFT-Touchdisplay							
		B	Wall mounting; 4.3"-TFT-Touchdisplay							
			Operation mode							
			W	Heat flow computer for steam, water, heat transfer fluid and ideal gas						
			G	additional to W: technical gases (real gas calculation)						
			E	additional to G: natural gas (SGERG-88, AGA8 (DC92/G1/G2), NX-19, ISO 20765-1)						
				Power supply						
				A	100-250 VAC (50-60 Hz)					
				D	18-30 VDC					
					Extensions					
					0	Without				
						Interface (Terminals)				
						M	Modbus Slave RTU			
						B	M-bus			
						P	Profibus DP Slave			
						N	Profinet Slave			
							Interface (Sub-D)			
							0	Without		
							M	Modbus Slave RTU		
							B	Modbus master RTU		
							P	Profibus DP Slave		
							N	Profinet Slave		
								Device parameterization		
								X	without; factory setting	
								C	with parameterization acc. application data	
								D	like X; additional 5-point factory calibration certificate	
								E	like C; additional 5-point factory calibration certificate	
									Marking	
									0	Tag on the display
									T	Tag plate (30 x 19mm)
VGKM	4									

INFORMATION!

Certain options can be enabled via the "Activation" menu, (refer to Activation menu on page 55).

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