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Umweltmesstechnik AG

Particle flow meter

PFM 20

Operating manual

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Contents

1 General

1.1 Notes on the operating manual

This operating manual contains the information required to enable you to use the product described as intended. It represents a fixed component of the delivery contents, even if, for logistical reasons, it is ordered or delivered separately. For reasons of clarity, it does not contain all details of all variants of the described product, and cannot take into account every conceivable scenario that may occur when using the product.

Read the operating manual carefully and in its entirety. Pay attention to the safety information and handling instructions contained in this operating manual, as well as the markings and labels on the device and its packaging. Store the operating manual in a safe place for later use.

Should you require additional information, or if problems occur that are not addressed extensively enough in this operating manual, please contact Dr. Födisch Umweltmesstechnik AG (contact details on the inside cover page).

For information on using any optional additional devices, please see the respective supplier's documentation. The respective manufacturer is responsible for the content of such documentation.

1.2 Intended use

The product described in this operating manual has been designed, manufactured, tested and documented under consideration of applicable safety standards, and left the factory in perfect, tested condition as far as safety is concerned.

The product does not ordinarily present dangers, provided that the described actions and safety information for configuration, installation, intended use and servicing are observed. Other prerequisites for trouble-free, safe operation include proper transport, correct storage, positioning and installation, as well as careful operation and servicing.

The PFM 20 is a highly sensitive system for continuous triboelectric in situ-filter monitoring. It enables waste gas to be monitored. The device can be used both as a filter monitoring device or particle flow meter.

The PFM 20 is a Group 1, Class A device in accordance with DIN EN 61326-1. It is therefore intended for use in industrial environments. Connection to low voltage supply networks used for residential buildings can in rare cases lead to line-conducted or radiated interference with devices.

In order to maintain the device's perfect condition and to achieve correct, safe operation, it must only be used as described by the manufacturer. Any use other than as described in this operating manual is regarded as improper use, and can lead to bodily injury or material damage.

In the event of improper use, the warranty becomes null and void.

1.3 Warranty

Dr. Födisch Umweltmesstechnik AG would like to point out that the content of this operating manual does not represent part of an earlier or existing agreement, assurance or a legal relationship, nor does it modify any of the above. All obligations result from the respective contract of sale, which also includes the complete, solely applicable warranty conditions. These contractual warranty conditions are neither expanded nor restricted by the information contained in this operating manual.

Conversions of, or modifications to, the product are not permitted. Any kind of interference with the device, as well as any type of improper use, lead to the guarantee becoming null and void. The manufacturer assumes no liability whatsoever.

1.4 Standards and regulations

As far as possible, harmonised European standards were used when creating the specification for this product and manufacturing it. In the event that no harmonised European standards could be applied, standards and regulations applicable for the Federal Republic of Germany apply.

1.5 Declaration of Conformity

The PFM 20 particle flow meter bears a CE mark. We thereby declare that the device complies with fundamental health and safety requirements, both in its design and construction and in the implementation that we have placed on the market.

NOTE!
Upon request, the Declaration of Conformity is available from Dr. Födisch Umweltmesstechnik AG (contact details on the inside cover page).

2 Safety

The device must only be operated when in perfect working order, and under strict observance of the safety information.

Work on the device must only be carried out by qualified personnel (see section 2.2 ‘Personnel requirements’), page 10). Personal protective equipment that complies with currently applicable regulations on the prevention of accidents must be worn.

Safety information for any optional additional devices can be found in the respective supplier’s documentation. The respective manufacturer is responsible for the content of such documentation.

2.1 Safety information

Safety information is intended to prevent users’ and servicing personnel’s life and health being endangered, as well as to prevent material damage. In this operating manual, it is denoted by use of the signal words defined below. Furthermore, specific safety information can be denoted by additional symbols.

2.1.1 General safety information

DANGER
Information labelled with the signal word ‘DANGER’ represents potential hazards which, if the safety precautions are not observed, lead to bodily injury in the form of death or the most severe injuries.

WARNING
Information labelled with the signal word ‘WARNING’ represents potential hazards which, if the safety precautions are not observed, can lead to bodily injury in the form of light to moderate injuries.

CAUTION
Information labelled with the signal word ‘CAUTION’ represents potential hazards which, if the safety precautions are not observed, can lead to material damage.

NOTE
This symbol denotes helpful information and tips relating to using the product, and which also helps prevent faults.

2.1.2 Specific safety information

DANGER
Electrical voltage!
Parts of the device can carry dangerous voltage.
Danger of electrical shock.
Work on the device must only be carried out by qualified personnel.

DANGER
Risk of explosion!
This can result in bodily injury to persons in the immediate area and material damage to the device and others in its vicinity.
The device must not be operated in explosive atmospheres. It is not permitted to use the device to measure explosive gas mixtures.

DANGER
Toxic substances!
Poisonous gases can severely impair health or lead to death. They can result in irritation to the eyes, skin or respiratory organs.
Take all necessary safety precautions (eg personal protective equipment), in order to guarantee safe use in the area around the flue.

WARNING
Caustic substances!
In the event of contact, irritant or caustic gases or substances can lead to chemical burns to body tissue and severe damage to the eyes.
If such substances come into contact with the skin or eyes, the affected areas must be washed immediately!
Objects that have come into contact with irritant or caustic gases must be thoroughly cleaned.

WARNING
Hot surface!
Individual device components can develop high temperatures.
This can result in burns to the skin!
In order to prevent any possible injuries, safety gloves must be worn.

2.1.3 Personal protective equipment

WEAR PROTECTIVE CLOTHING
In order to protect against injuries caused by all manner of dangers, protective clothing must be worn.

WEAR FOOT PROTECTION
In order to prevent any possible injuries, foot protection (eg safety boots) must be worn.

WEAR SAFETY GLOVES
In order to prevent any possible injuries when touching device components, safety gloves must be worn.

WEAR HEAD PROTECTION
In order to prevent any possible injuries from falling objects or impact, a safety helmet must be worn.

WEAR BREATHING PROTECTION
In order to protect against any possible risk of suffocation or damage to respiratory organs by toxic gases, breathing protection must be worn.

WEAR EYE PROTECTION
In order to protect against any possible eye irritation from caustic gases or substances, eye protection must be worn.

WEAR EAR PROTECTION
In order to protect against any possible damage to hearing from high noise levels, ear protection must be worn.

2.2 Personnel requirements

This operating manual is intended for technically qualified personnel who have been specially trained in, or have relevant knowledge of, the field of measurement and control technology, hereafter referred to as automation technology.

Qualified personnel mean people who

- In their role as configuration personnel, are familiar with the automation technology's safety concepts
- As operating personnel, have been trained in the use of automation technology equipment, and who are familiar with the content of this operating manual that relates to operation
- As commissioning personnel and/or servicing personnel, have received education and training that entitles them to repair such automation technology equipment, and who are authorised to put electrical circuits and electrical equipment/systems into operation, to earth them and to label them, in accordance with safety-related standards

Familiarity with the safety information contained in this operating manual, as well as being able to implement it flawlessly, represents a requirement for being able to install the device and safely put it into operation, as well as for safe operation and maintenance. Personnel must be familiar with the general risks and hazards, and must also know and observe the relevant safety precautions.

Unqualified interventions in the device, or non-observance of the information contained in the operating manual or on labels or signage applied to the product, can lead to bodily injury and/or material damage.

All works on the device must only be carried out by qualified personnel, observing the relevant regulations in place in the country of use (for example, in Germany, those of the ZVEI [Central Association of the Electrical Engineering and Electrical Industry]).

2.3 Power supply

DANGER
Electrical voltage! Danger of electrical shock.
Even when the device is switched off, high voltages can be present inside the device.
Work on the device must only be carried out by qualified personnel. The following conditions must be observed.

- The power supply must be installed and fused in accordance with applicable statutory safety regulations.
- When supplying the device with power, observe the information on fine-wire fusing contained in the technical documentation.
- The device must only be connected to the supply voltage specified on the type plate.
- Electrically protective separation between the primary and secondary circuits is fundamentally guaranteed. Any low voltages that are connected must also be created so they are electrically protected.
- The device must always be earthed.
- Cables must be installed so there is no danger of people stumbling on them or getting caught up in them.
- Covers:
  - The device must not be operated if covers or other parts have been removed, as this would mean that live components are exposed during operation.
  - Unless otherwise expressly stated, no works must be performed in the device's interior.
  - Before opening the device, you must ensure it has been disconnected from the power supply by actuating the preliminary fuse.
  - If works must be carried out when the device is open (alignment, servicing etc), these works must only be performed by appropriately qualified personnel who are aware of the hazardous areas and who know how to prevent the danger by taking appropriate safety precautions.

Electrical safety

If the electrical safety of the device can no longer be guaranteed, the device must be taken out of operation and secured against unauthorised or accidental switch-on.

The device's electrical safety can no longer be guaranteed if:

- It shows visible signs of external damage
- It no longer works correctly
- It was stored for a longer period in conditions that are not permitted, or which are otherwise unfavourable
- It was subjected to impermissible loads during transport

2.4 Modules

The device, including its individual modules, must only be operated as supplied. When replacing individual elements, it is only permitted to use the manufacturer's original replacement parts. Modules have been configured to be device-specific, and are therefore not interchangeable between different devices.

2.5 Electronic modules

Electrostatic discharges can cause damage to the electronic modules. Take the following precautions:

- Keep electronic modules away from statically charged surfaces (PVC plastics, plastic bags etc).
- Wear a special ESD safety wristband or use an earthed, antistatic working surface.

2.6 Configuration settings

Modifications to the configuration can endanger safety and device functioning. Configuration settings can only be made by authorised service technicians or by the manufacturer's service personnel.

3 Function

The PFM 20 has been designed for permanently monitoring dust emissions. Used as a filter monitoring device, it is an effective aid for the early detection and pinpointing of damage to filtering separators. Configured as a particle flow meter, it can be used to continuously monitor clean gas and dust content from filtering separators. The device can help prevent visible and invisible waste gas plumes. The monitoring device also enables targeted maintenance measures, and helps prevent loss of product.

The PFM 20 works on the basis of the triboelectric measuring principle. The probe rod records the gas being measured in the exhaust gas flow. The particles of dust that flow around it and hit it cause a charge exchange between the particles and the probe rod. A signal results from the derived current, and which depends on the dust's mechanical and electrical properties. This signal, proportional to the dust, and which is created by the microcontroller integrated into the device, represents the measurement value of the dust content of the waste gas.

3.1 Filter monitoring

When the device is used for filter monitoring, the raw signal [mV] is output via analogue output 2 (4…20 mA), as well as via the Modbus interface. The output measurement range is freely configurable (for the parameters, see section 9.5.2, page 42).

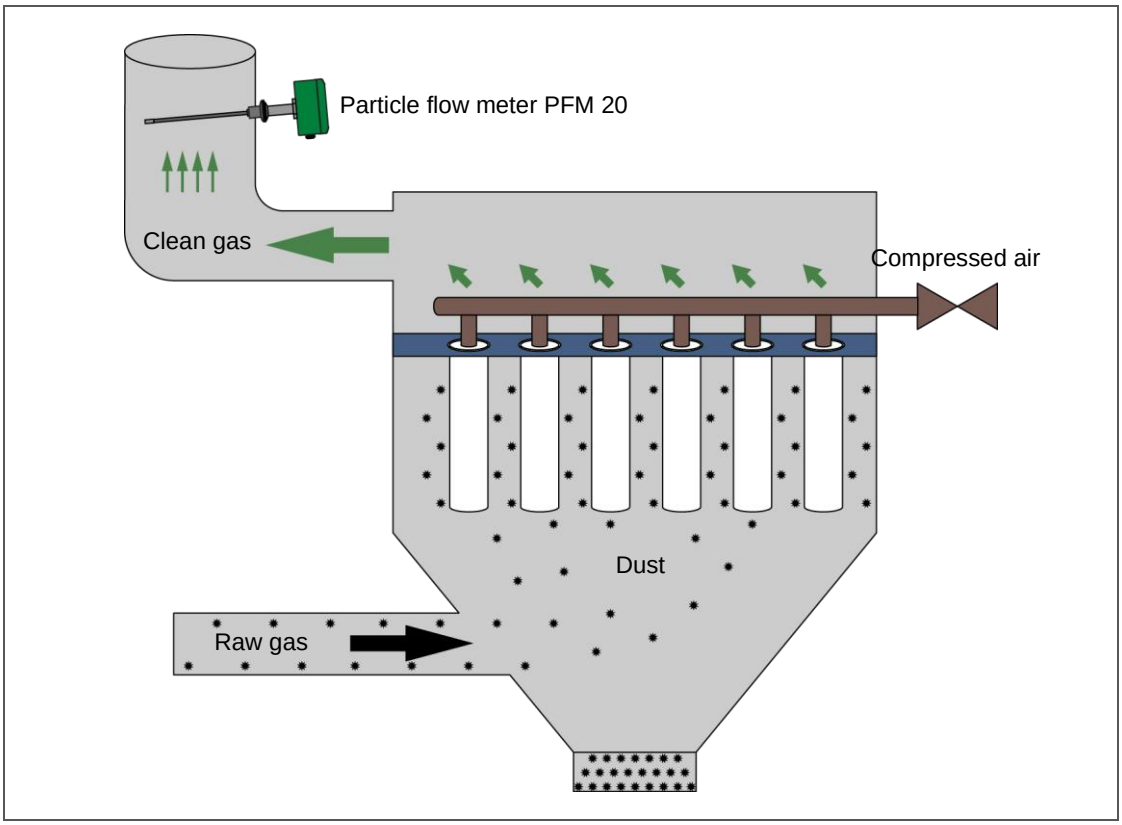

Fig 1: Example installation for filter monitoring

The filtering separator is cleaned by for example compressed air pulses. A characteristic of this is significantly higher dust emissions for the duration of the cleaning process (approx 2–3 seconds). The increasing basic signal and increased signal peaks during cleaning enable you to detect when the filtration system is beginning to display signs of wear, making it possible to clearly identify defective filter elements. The output signal required for diagnosis can be determined using integration (for parameters, see section 9.5.2, page 42).

The image below shows an example of an error-free filter graph. The second example registers heavily increased dust passage for certain filter hoses. In this case, the affected filter hoses must be replaced.

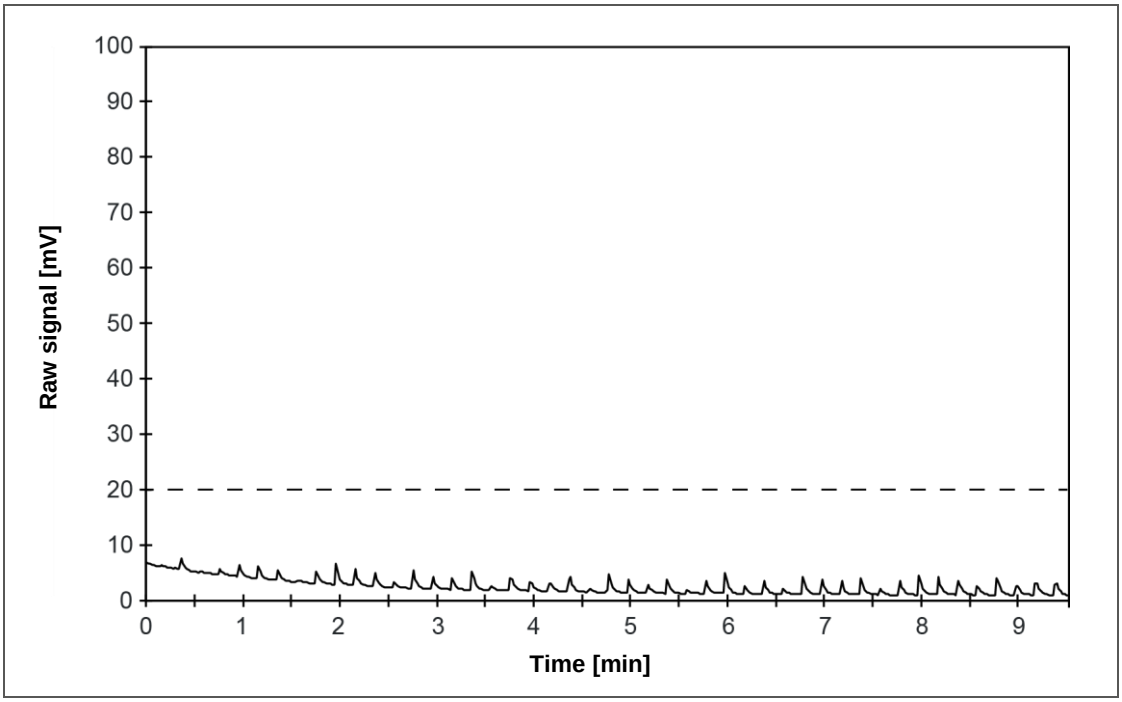

Fig 2: Filter diagram with error-free filter hoses

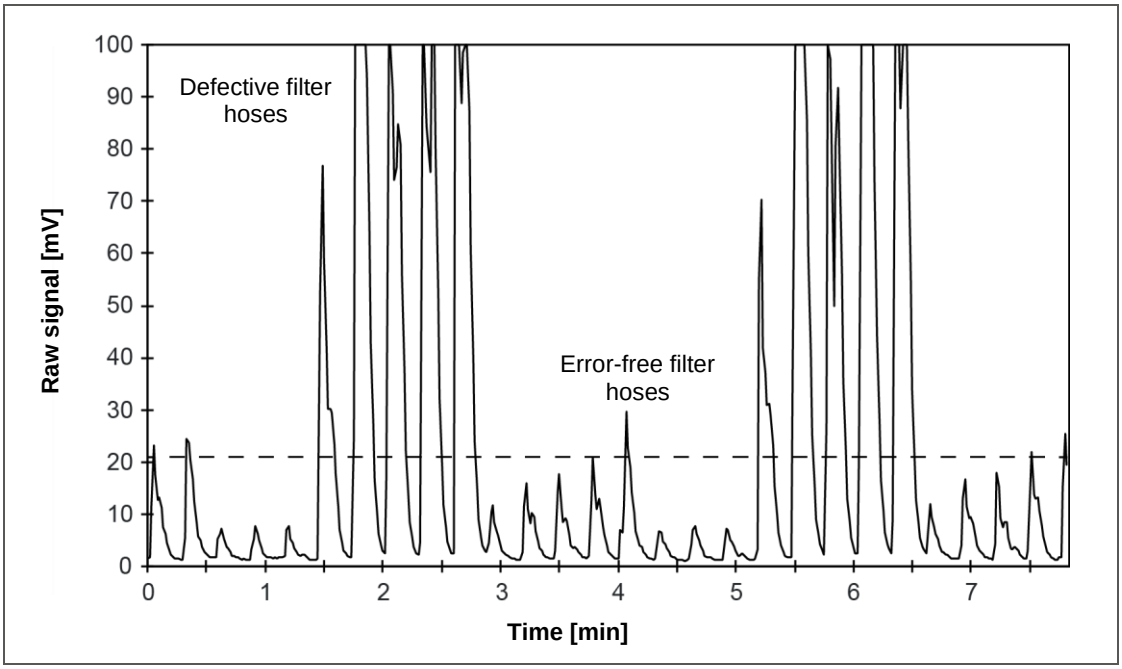

Fig 3: Filter diagram with defective filter hoses

3.2 Dust concentration measurement

Configured as a particle flow meter, the dust concentration [mg/m³] is output via analogue output 1 (4…20 mA), as well as via the Modbus interface. The output measurement range is freely configurable (for the parameters, see section 9.5.2, page 42).

The dust concentration [mg/m³] is calculated as follows:

$$C_{iB} = A \cdot S + D$$

C_{iB}	Dust concentration [mg/m³]
A, D	Constants from the dust calibration
S	Raw signal [mV]

NOTE
At the measurement point, dust calibration is necessary (see section 8.4, page 31).

Speed compensation (optional)

The triboelectric signal depends on the dust's mechanical and electrical properties. The speed has the greatest influence on the triboelectric charge transfer. In order to determine the actual dust concentration, speed compensation for the triboelectric signal is therefore necessary.

The speed of the measuring gas can be measured using an external device. The PFM 20's additional analogue input continuously records this speed value and offsets it from the measured raw signal, resulting in a precise determination of the dust concentration.

When the speed is constant, the following equation applies:

$$S \sim C_{iB}$$

S	Raw signal [mV]
C_{iB}	Dust concentration [mg/m³]

Taking into consideration the speed compensation, the mathematical correlation is as follows:

$$C_{iB} = A \cdot S \cdot v^{Exp} + D$$

$$Exp = B \cdot v^2 + C \cdot v + E$$

$C_{i.B.}$	Dust concentration [mg/m³]
A, D; B, C, E	Constants from the dust calibration
S	Raw signal [mV]
v	Measuring gas speed [m/s]
Exp	The speed's exponent

NOTE
- Speed compensation only occurs when the deviation from the external speed measurement is greater than 10%.
- At the measurement point, dust calibration is necessary (see section 8.4, page 31).

4 Construction

The PFM 20 particle flow meter comprises an in-situ probe with probe head and probe rod. The probe rod has a high temperature coating, for insulation purposes. It is surrounded by a guide sleeve and an insulator, and therefore electrically insulated from the housing. The probe head contains the signal module and evaluation electronics.

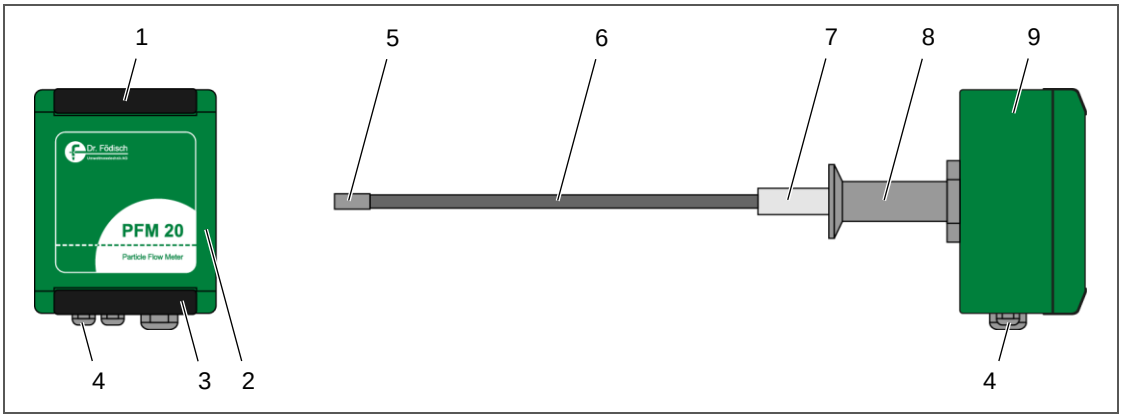

Fig 4: Construction

1 Locking clip (with Allen connection)
2 Housing cover
3 Housing cover fastening
4 Cable glands (x3)
5 Connection for linearity test, contamination monitor
6 Probe rod with high temperature coating
7 Insulator
8 Guide sleeve
9 Probe head

4.1 Dimensions

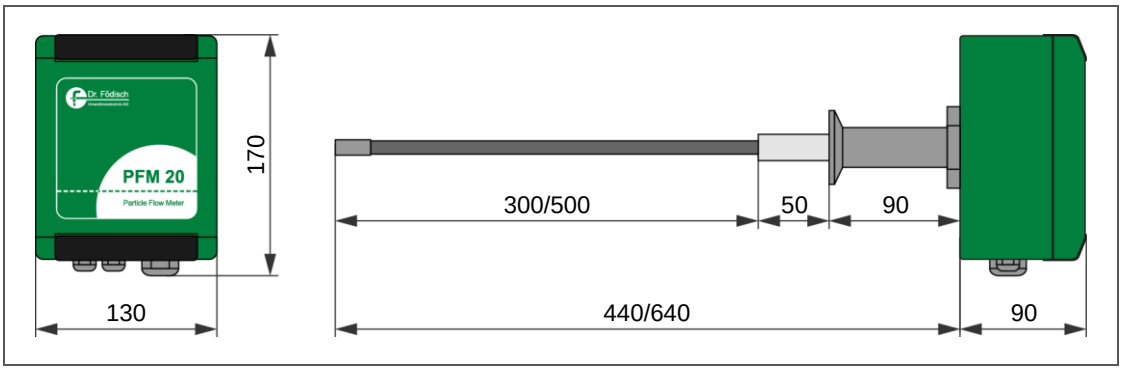

Fig 5: Dimensions, stated in mm

The probe length of PFM20 can be customized to 1000 mm or above, if the local regulation requires it.

4.2 Terminal assignment

The PFM 20's electrical connections are found in the probe head. The terminals on the signal module are caged spring terminals. As well as the analogue outputs (4…20 mA) for outputting the raw signal [mV] or dust concentration [mg/m³], they also have digital outputs for outputting messages (fault, maintenance, limit value 1 and limit value 2/optional maintenance required), as well as connections for transmitting the signal to external interfaces.

4.2.1 Signal module connections

NOTE

- The operating mode switch for switching between measurement mode and maintenance (1, Fig 6, page 19) is labelled '1'. Set it to top position (ON) for measurement mode. (Switch 2 does not have a function.)
- During normal operation, the green LED 'Operation' flashes. The blue LED 'Test' must not light up during measurement operation.

NOTE

For information on using the available additional options (display/operating panel, wi-fi), please read the separate description.

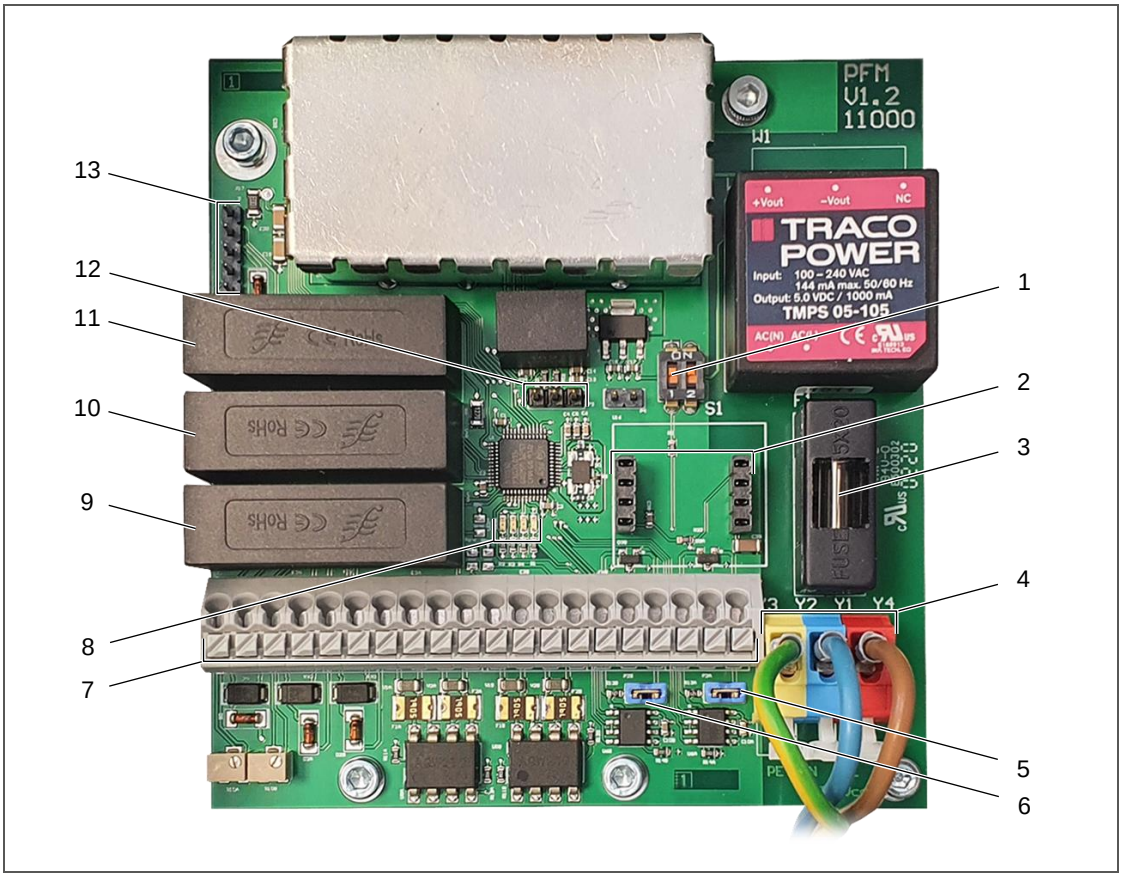

Fig 6: Signal module connections – power supply 110…230 V AC

1 Operating mode switch (‘1’)
2 Wi-fi port (for version with wi-fi module)
3 Fuse
4 Terminal strip for power supply connection
5 Terminating resistor (jumper) for Modbus*
6 Terminating resistor (jumper) for display/operating panel (optional)
7 Terminal strip for signal connections
8 LEDs for displaying operating statuses (For meanings, see section 9.1, page 36)
9 Module for analogue output 1
10 Module for analogue output 2
11 Module for analogue input for external speed
12 PC interface(USB)
13 Service port for resetting to factory settings

** in accordance with VDI guideline VDI 4201 sheet 3*

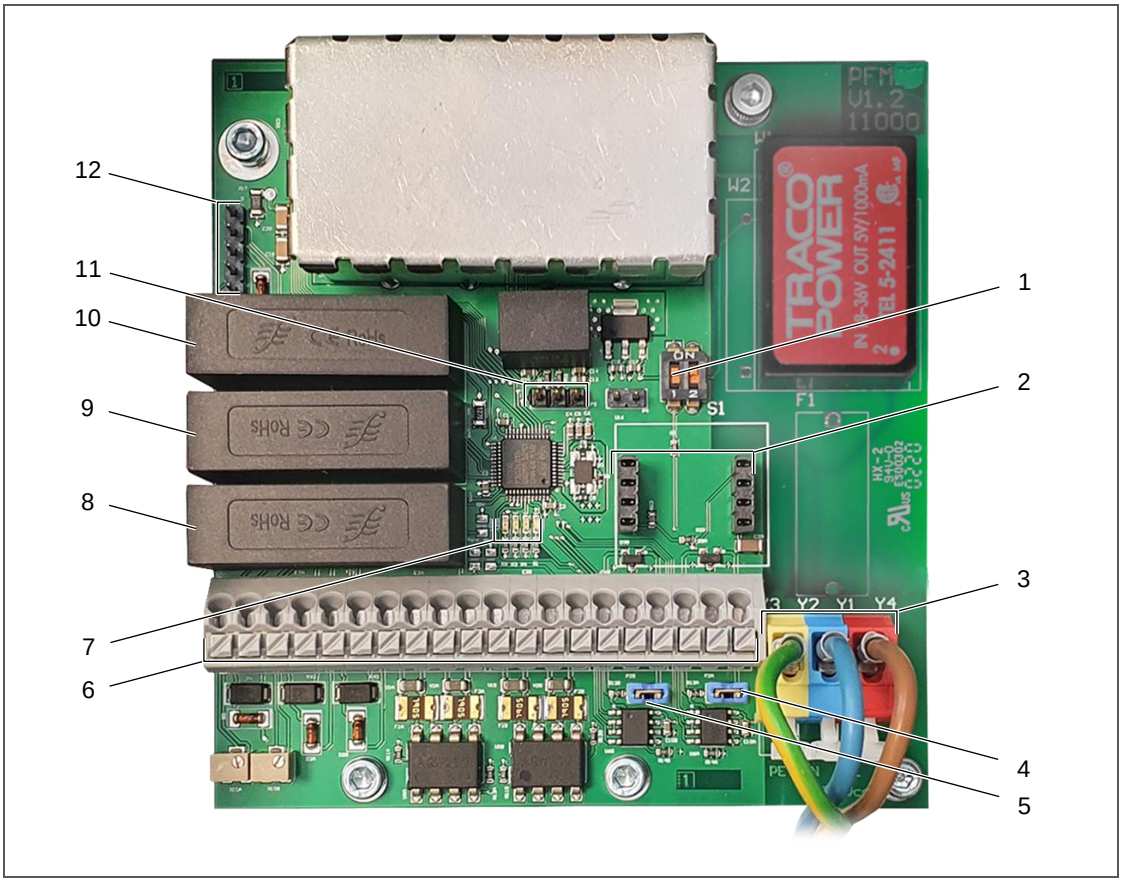

Fig 7: Signal module connections – power supply 24 V DC (optional)

1 Operating mode switch (‘1’)
2 Wi-fi port (for version with wi-fi module)
3 Terminal strip for voltage supply connection
4 Terminating resistor (jumper) for Modbus*
5 Terminating resistor (jumper) for display/operating panel (optional)
6 Terminal strip for signal connections
7 LEDs for displaying operating statuses (For meanings, see section 9.1, page 36)
8 Module for analogue output 1
9 Module for analogue output 2
10 Module for analogue input for external speed
11 PC interface(USB)
12 Service port for resetting to factory settings

** in accordance with VDI guideline VDI 4201 sheet 3*

Terminal strip for signal connections

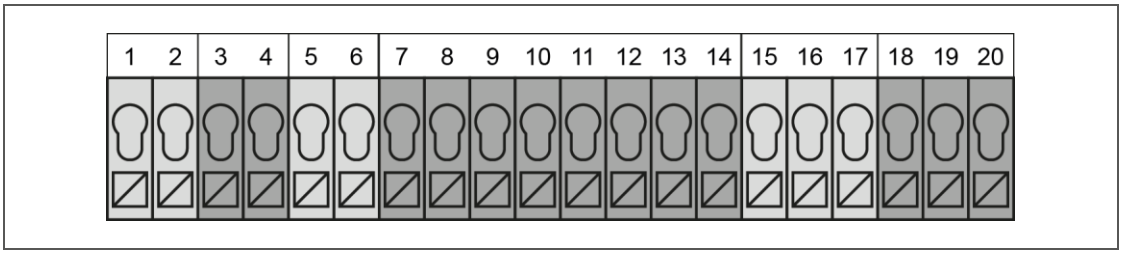

Fig 8: Terminal strip for signal connections

Pin	Type	
1	+	Analogue input (4…20 mA) for external speed v [m/s]
2	–	
3	+	Analogue output 1 (4…20 mA) for dust concentration C_{iB} [mg/m³]
4	–	
5	+	Analogue output 2 (4…20 mA) for raw signal [mV]
6	–	
7		Digital output fault (switch contact, normally closed or open)
8		
9		Digital output maintenance (switch contact, normally closed or open)
10		
11		Digital output limit value 1 (switch contact, normally closed or open)
12		
13		Digital output limit value 2/Maintenance required (optional) [1] (switch contact, normally closed or open)
14		
15	B	Connection for optional display/operating panel
16	PE	
17	A	
18	B	Modbus interface [2] (eg for emissions calculator)
19	PE	
20	A	

[1] Configurable (for the parameters, see section 9.5.2, page 42)
[2] In accordance with VDI guideline VDI 4201 sheet 3

Table 1: Terminal strip for signal connections – pin assignment

Power supply connection

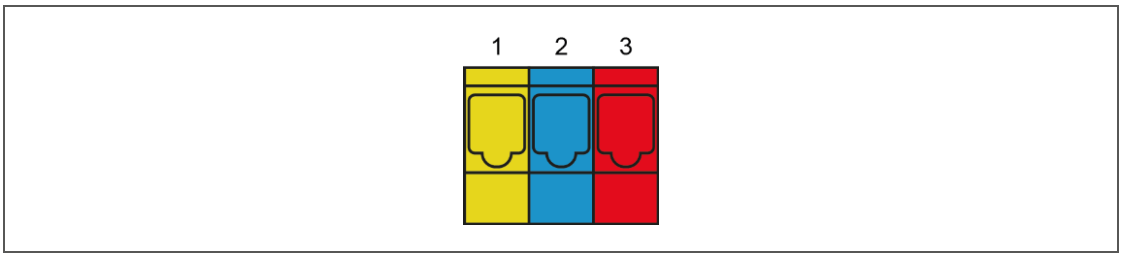

Fig 9: Power supply connection

Power supply 110…230 V AC
1 PE protective conductor
2 Neutral conductor N
3 Conductor L

Power supply 24 V DC (optional)
1 PE protective conductor
2 GND
3 24 V DC

PC interface (USB)

NOTE
The connection of an external PC is only necessary for setting parameters and for servicing/maintenance and troubleshooting purposes.
To do so, insert the USB cable's connector into the signal module's PC interface (12, Fig 6, page 19).

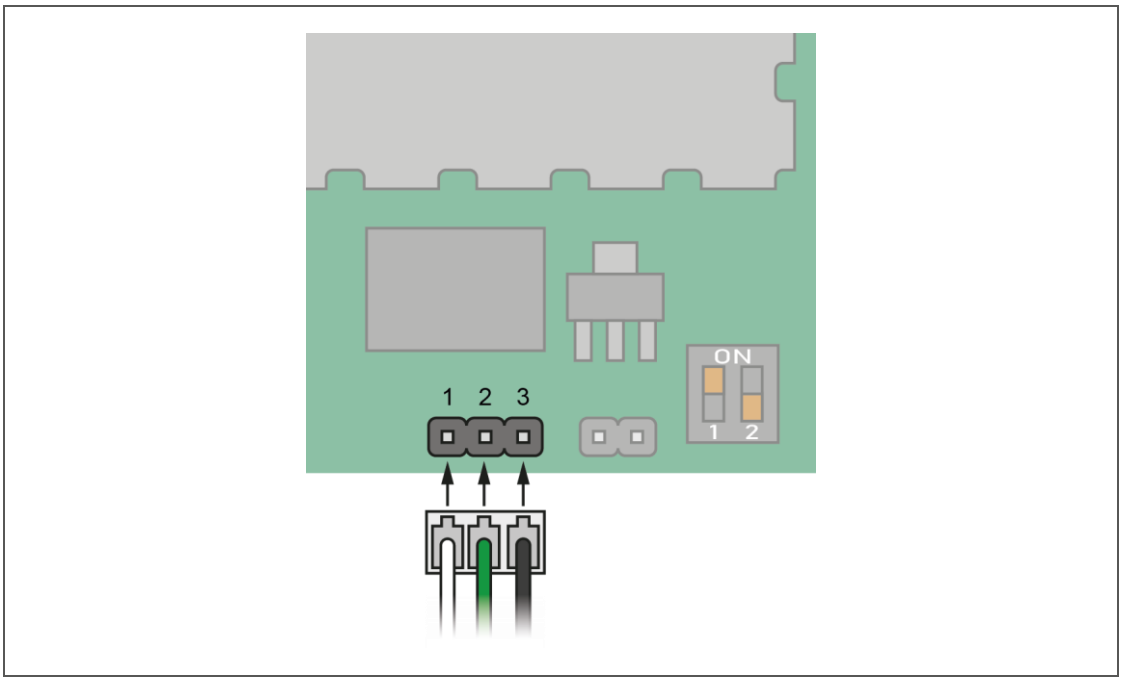

Fig 10: PC interface connection (USB)

1 Data signal + (white)
2 Data signal – (green)
3 Earth GND (black)

5 Transport and delivery contents

5.1 Transport

The device is inside a transport box. The probe rod is additionally packaged in a protective sleeve.

CAUTION
Strong vibrations during transport (eg falling) can damage sensitive components.
Choose suitable means of transport.

1. Inspect the device and also the packaging material for signs of damage during transport.
2. Document any damage you notice.

5.2 Delivery contents

The respective delivery contents are based on the valid contract of sale, which is stated on the dispatch papers inserted into the delivery.

The delivery contents include:

- 1 particle flow meter PFM 20
- 1 welding sleeve
- 1 seal
- 1 tri-clamp connector
- 1 operating manual
- 1 USB cable for PC interface
- 1 PC software for setting parameters

NOTE
Depending on the configuration of your order, the technical design of your product may differ.

1. Inspect the delivery contents for completeness and intactness.
2. Remove the packaging material.
3. Retain the packaging material for possible reuse.

6 Installation

6.1 Environmental conditions

CAUTION
The device must not be operated in explosive atmospheres.

For correct operation of the device, the following environmental conditions apply:

- Ambient temperature: -20…+50°C
- Relative humidity: Not especially sensitive
- The site should be free of vibrations

6.2 Installation site requirements

The device's installation site must meet the requirements of the regulations in place at the location of use (eg EN 13284-1 – for instance, in Germany, this is VDI 2066 page 1; see Fig 11):

- Inflow section: min 5x length of the duct diameter
- Outflow section: min 2x length of the duct diameter
- Measuring section preferably in the vertical duct

In case of doubt, the installation site can be determined by a relevant measuring institute (in Germany, see sections 26/28 of the Federal Pollution Control Act, BIMSchG, or otherwise refer to the equivalent in your country of use).

NOTE
Dr. Födisch Umweltmesstechnik AG recommends inflow and outflow sections that correspond with 5x the length of the duct diameter (see Fig 11).

NOTE
To obtain a representative recording of the dust load throughout the duct cross-section, the distribution of dust gas and flue gas at the measuring point must be homogeneous.

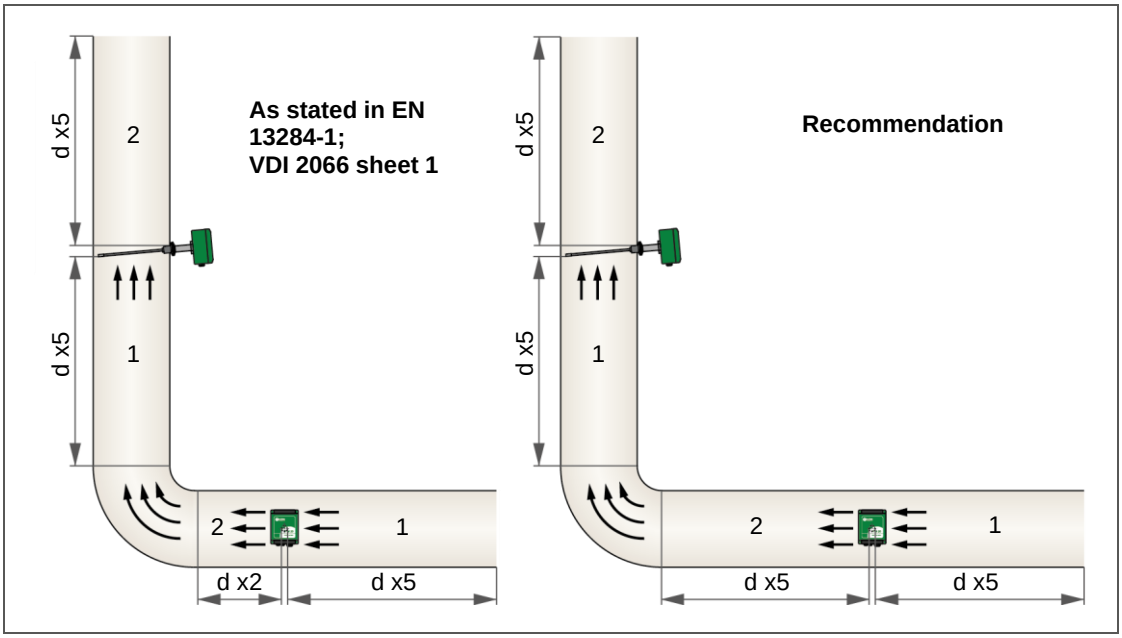

Fig 11: Inflow and outflow section at the measuring point

1 Inflow section 2 Outflow section

6.3 Installing the welding sleeve

CAUTION
Incorrect installation of the welding sleeve can lead to measurement errors.
The welding sleeve must be earthed. It must therefore be integrated into the on-site potential equalisation.

The device can be fitted into the horizontal or vertical duct. The device itself can be positioned laterally or at angles up to vertically from above. If installing the welding sleeve to the side, observe the correct installation angle (see Fig 12).

CAUTION
Incorrect installation can lead to the condensation that builds up accumulating on the duct wall during operation.
To prevent deposits building up, the installation angle must be between 2° and 5°, so that when the device is later fitted into the duct, the probe rod points downwards. The welding sleeve must protrude into the duct by at least 3mm.

1. Install the measuring point, observing the necessary inflow and outflow sections (see section 6.2, page 24).
2. Affix the welding sleeve (2, Fig 12) to the provided opening in the duct wall (1).

CAUTION
Incorrect installation of the welding sleeve can lead to measurement errors.
If used with non-metallic ducts, the welding sleeve must be connected with conductive material and earthed.

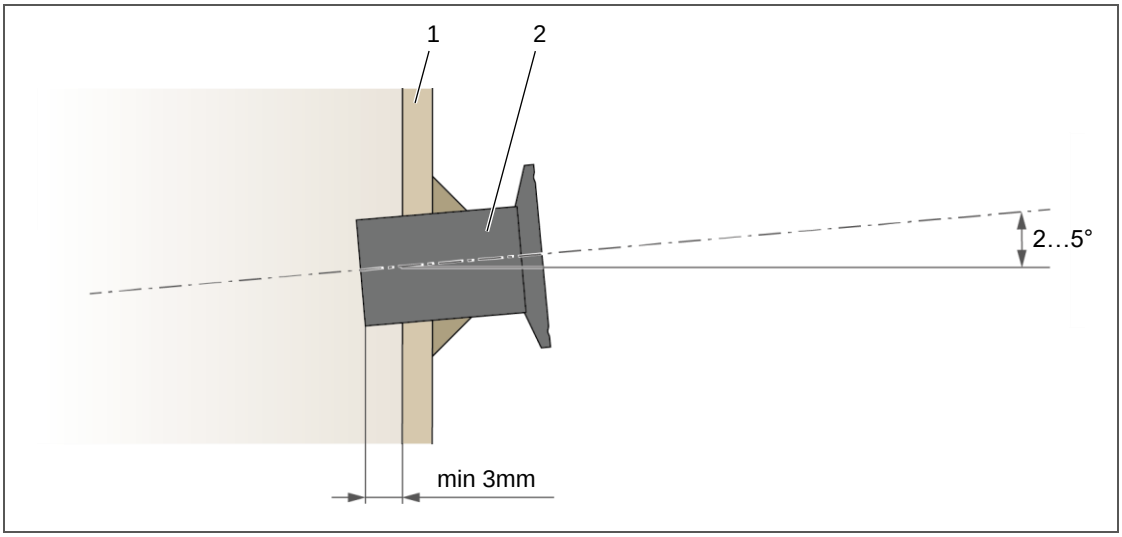

Fig 12: Installing the welding sleeve (side view)

1 Duct wall
2 Welding sleeve

6.4 Fitting the device into the duct

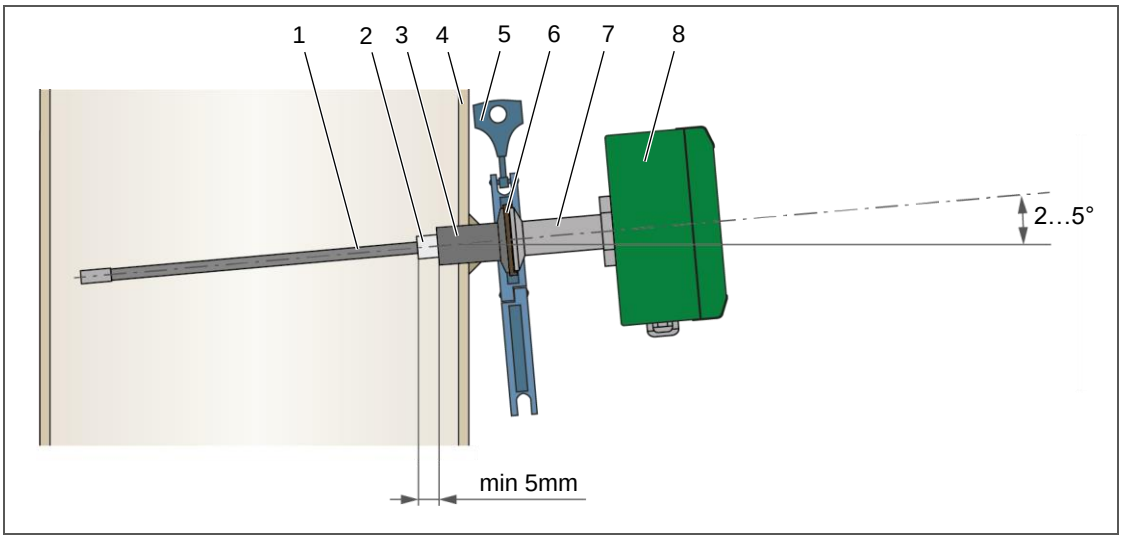

Fig 13: Fitting into the duct (side view)

1 Probe rod
2 Insulator
3 Welding sleeve
4 Duct wall
5 Tri-clamp connector (opened)
6 Seal
7 Guide sleeve
8 Probe head

1. Insert the seal (6, Fig 13) onto the welding sleeve (3).
2. Feed the device's probe rod (1) through the welding sleeve and into the duct, until the guide sleeve (7) lies on the seal (6).

CAUTION
Incorrect installation of the device can lead to measurement errors.
The insulator (2) must protrude into the flow by at least 5mm. It must also be protected against moisture.

3. Rotate the probe head (8) to the correct position, so that the cable glands point downwards.
4. Place the tri-clamp connector (5) on the sleeve and seal and affix it.

6.5 Electrical connection

DANGER
Electrical voltage!
Danger of electrical shock.
Ensure the external power supply's preliminary fuse is disconnected.

1. Open the housing cover (2, Fig 4, page 17). To do so, release the locking clip (1) on the top of the device, as well as the Allen connection behind the locking clip.
2. Feed all required cables through the cable glands (4) and into the device.
3. Connect the external power supply's cables to the power supply connection (4, Fig 6, page 19) on the signal module.
4. Connect the cables for the analogue and digital outputs, as well as those of the Modbus interface and any external devices (optional) to the terminal strip (7).
5. Tighten all cable glands firmly, so that all cables are securely fixed in place.
6. Close the housing cover and affix it into place by means of the Allen connection and locking clip.
7. In the case of the PFM 20 with the wi-fi option, screw the wi-fi antenna to the bottom of the device.

7 Commissioning

DANGER
Electrical voltage!
Parts of the device can carry dangerous voltage.
Danger of electrical shock.
Work on the device must only be carried out by qualified personnel.

1. Connect the external power supply's preliminary fuse.
   › During normal operation, the green LED 'Operation' flashes.
   › The blue LED 'Test' must not light up during measurement operation.
2. Check the measured values for plausibility.
3. Check the analogue output's output measurement range, the integration time and the preconfigured limit values (for parameters, see section 9.5.2, page 42).
   If required, adjust the parameters as necessary.

NOTE
The PFM 20 software must be installed on the PC.

NOTE
For information on using the available additional options (display/operating panel, wi-fi), please read the separate description.

8 Calibration

NOTE

- Upon delivery, the device has already been calibrated.
- However, dust calibration is at the customer's discretion.

8.1 Functional test

The functional test comprises the following points:

- Visual inspection of the measurement system
- Zero point and reference point check, including testing for long-term discrepancies
- Linearity test
- Checking the data transfer (analogue and status signals, Modbus transmission)

8.2 Zero point and reference point check

As a highly sensitive measuring device, the PFM 20 is subject to the fine vibrations of the components and materials used. In order to be able to determine any possible errors on the device, a zero point and reference point check is necessary before the device is put into operation for the first time, and after servicing and conversion works.

8.2.1 Automatic zero point and reference point check

Starting with the most recent switch-on, the PFM 20 continuously checks the electronic system's zero point and reference point (interval: 4 hours). During the check, the zero point is 4 mA and the reference point is 15.2 mA.

NOTE

During the cyclical zero point and reference point check, the device is in maintenance mode.

If the zero point or reference point deviates by 2% (0.32 mA) or more, a 'Maintenance required' message is issued. If the deviation is 3% (0.48 mA) or greater, a fault message is issued.

8.2.2 Manual zero point and reference point check

1. Open the housing cover (2, Fig 4, page 17). To do so, release the locking clip (1) on the top of the device, as well as the Allen connection behind the locking clip.
2. For manual maintenance of the device, set the operating mode switch (1, Fig 6, page 19) on the signal module to bottom position.
   › The blue LED ‘Test’ lights up. The status ‘Maintenance’ is also accordingly issued.
3. Wait around 2 to 9 seconds and then switch the device back to measurement mode, by setting the operating mode switch back to top (ON) position.
4. The device performs a zero point and reference point check. Wait until this is complete.
5. Check the values for plausibility.
6. Close the housing cover and affix it into place by means of the Allen connection and locking clip.

8.3 Linearity test

To perform a linearity test, set the operating mode switch on the signal module to bottom position.

During a linearity test, the blue LED ‘Test’ lights up. The status ‘Maintenance’ is also accordingly issued.

NOTE
To perform a linearity test, the PFM 20 must be fitted in the specially produced linearity module (optional).
For information on using the linearity module, please read the separate description.

8.4 Dust calibration

As a result of the different technological factors at the respective measurement points, the recording of the measured values is subject to various influencing factors. Variable influencing factors include among others the type of dust, the gas speed and the temperature. The dust being measured varies for instance in particle size, density, particle shape, charge and other dust and gas properties. Therefore, every application a PFM is used for results in a different characteristic line in respect of the dust concentration. It is therefore necessary to calibrate the device's signals with gravimetric comparisons in accordance with DIN EN 13284-1. The results of the calibration, ie the parameters, can be input directly into the device's software. The output signal is in proportion to the dust concentration.

The basis of the triboelectric dust measurement is the measurement of the dust particles' charge intensity. As well as various physical effects, the intensity is also determined by the system itself. The fabric filter, for example, plays an important role in this regard.

NOTE
The filtering unit's differential pressure control must be actively working. The dust concentration must therefore not be increased by additional external metering. Alternatively, try the following:

- Increase the frequency of the cleaning pulses
- Use bypasses over the filters
- Use defective filter hoses

NOTE
(For the calculation basis for measuring the dust concentration, see section 3.2, page 16)

8.4.1 Performing the dust calibration

NOTE

Before starting calibration, ensure that all the parameters have been properly set (see section 9.5.2, page 42)

- The analogue signal's output measurement range (dust concentration/raw signal)
- Speed compensation must have been deactivated. To do so, set the substitute value to 0.
- The calibration constants must be defined as follows:
  A = 1, B = 0, C = 0, D = 0, E = 0

1. Check the measured values for plausibility.
2. If required, adjust the analogue output's output measurement range.

CAUTION

If the output measurement range is too small, this results in erroneous calibration.
The current measurement values must be smaller than 90% of the measurement range.

3. Perform the gravimetric comparison measurement.

CAUTION

Incorrect calibration can lead to measurement errors during operation.

- If, during the gravimetric comparison measurement, a maintenance required notification or fault is issued, the dust calibration must be repeated.
- If, during calibration, an automatic zero point and reference point check occurs (see section 8.2.1, page 29), there is no data for the comparison measurement. The dust calibration must be repeated.

4. Use the recorded analogue signal C_{iB} to calculate the median values over the entire time the gravimetric comparison measurements were carried out. If speed compensation is required, calculate the median values for external speed measurement analogously.
5. If speed compensation is required, calculate the calibration constants B, C and E.
6. Calculate the calibration constants A and D.
7. Set the calibration constants A and D.
8. If speed compensation is required, set the calibration constants B, C and E and set the substitute value for speed compensation to the median speed of the measurement gas.
9. Adjust the analogue output's output measurement range. If speed compensation is required, also set the external speed measurement's input measurement range.

8.4.2 Determining the exponent

To start the analysis, the exponent parameters must be determined:

$$Exp = \frac{ln\left(\frac{C_{grav}}{S}\right)}{ln(v)}$$

C_{grav}	The gravimetric comparison measurement's dust concentration [mg/m³]
In	Natural logarithm
S	Raw signal [mV]
v	Measuring gas speed [m/s]
Exp	Exponent of the speed

Depending on the measurement point, the exponent can have a quadratic function, a linear function or be a constant. This can be seen in the resulting curve progression:

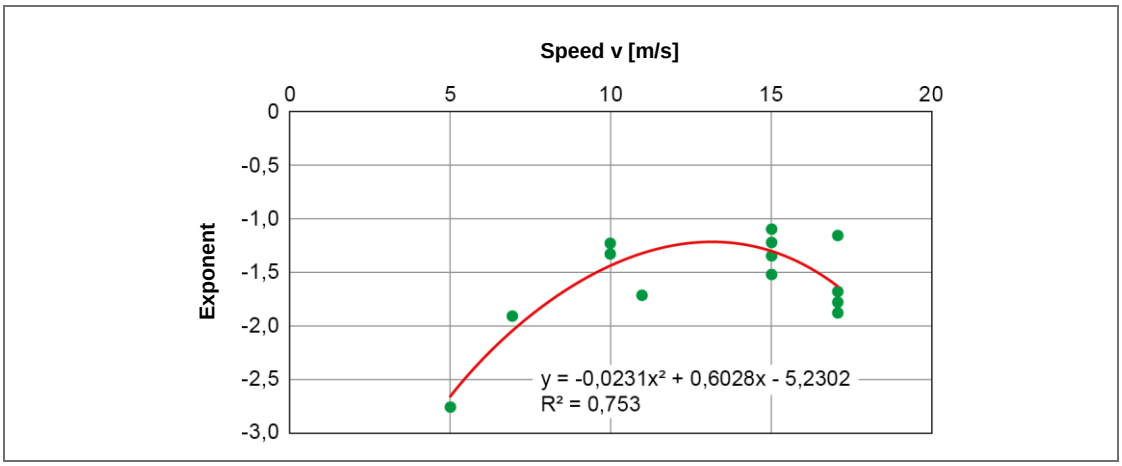

Fig 14: Exponent – quadratic function

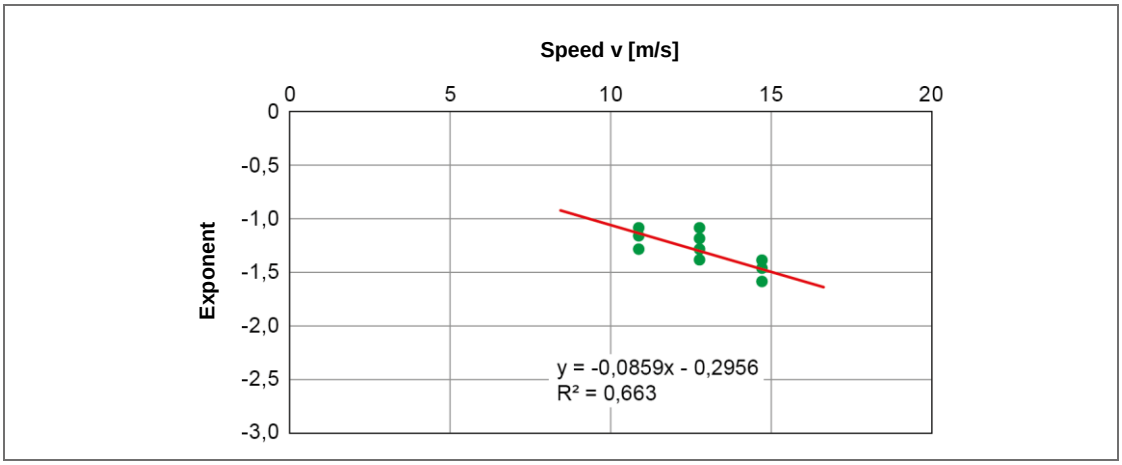

Fig 15: Exponent – linear function

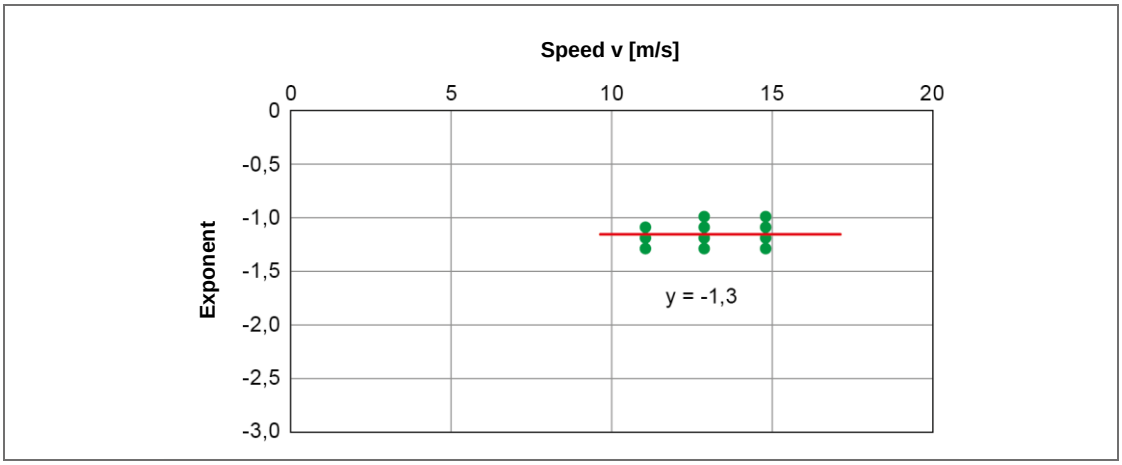

Fig 16: Exponent – constant

From the resulting function you can read off parameters B, C and E.

You can then use an auxiliary variable to determine parameters A and D.

$$S' = S \cdot v^{Exp}$$

S’	Auxiliary variable [mV]
S	Raw signal [mV]
v	Measuring gas speed [m/s]
Exp	The speed’s exponent

8.4.3 Determining the dust concentration

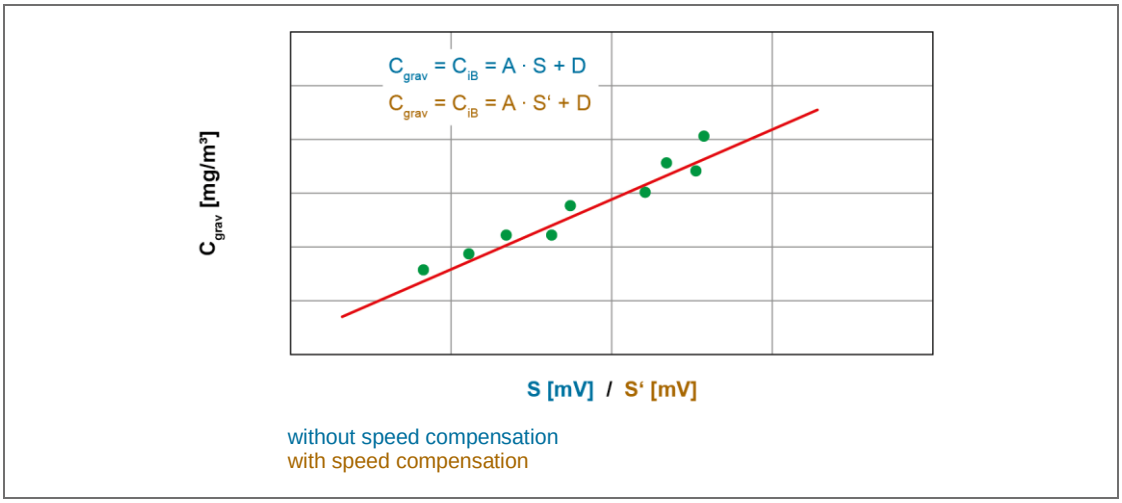

Fig 17: The gravimetric comparison measurement’s dust concentration [mg/m³]

Parameters A and D can be read from the curve progression of the dust concentration from the gravimetric comparison measurement.

9 Operation

CAUTION

Incorrect operation can lead to incorrect measurement results, faults in the measurement procedure or material damage.
A precise knowledge of the device's method of working is a fundamental requirement for safe operation. The device must only be operated by qualified personnel (see section 2.2 'Personnel requirements'), page 10).

Signal module

The PFM 20's signal module offers the following display and operating elements:

- Four differently coloured LEDs for displaying operating statuses
- An operating mode switch for switching between measurement mode and maintenance
- Terminating resistors
- Service port for starting using the factory settings

NOTE

Observe the functions of the PFM 20's display and operating elements (see sections 9.1 to 9.4, from page 36) and ensure they are correctly configured.

External operation

The raw signal [mV] or the dust concentration [mg/m³] and any messages that occur (fault, maintenance, limit value 1 and limit value 2/optional maintenance required) are output via the analogue or digital outputs, and can be displayed on an external device. There are the following options for visualisation and operation:

- PC with the PFM 20 software
- Dr. Födisch Umweltmesstechnik AG display/operating panel (optional)
- Wi-fi (optional)

NOTE

- Using the optional Dr. Födisch Umweltmesstechnik AG display/operating panel, you can monitor and operate up to four devices simultaneously.
- For information on using the available additional options (display/operating panel, wi-fi), please read the separate description.

9.1 Meaning of the LEDs

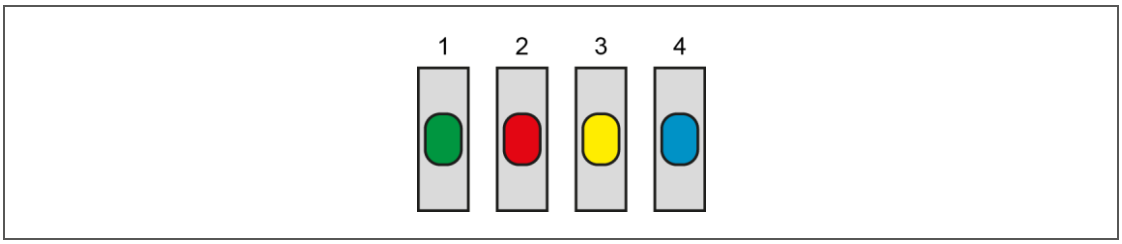

Fig 18: LED assignment

1 LED ‘Operation’
2 LED ‘Error’
3 LED ‘Wi-fi’
4 LED ‘Test’

LED ‘Operation’ (green)

During normal operation, the green LED ‘Operation’ flashes.

LED ‘Error’ (red)

The red LED ‘Error’ indicates faults or maintenance activities:

- The LED is lit up: There is a device fault.
  › Check the cause of the error/fault and remedy it (see section 11, page 49).
- The LED flashes: The device is in maintenance mode (for example linearity test, zero point and reference point check)

LED ‘Wi-fi’ (yellow)

NOTE
In the standard version without a wi-fi module, this LED does not have a function.

If the wi-fi module (optional) is integrated, the yellow LED ‘Wi-fi’ flashes as soon as a connection to the online system has been established. The flashing interval indicates the following statuses:

- The LED is continuously lit up:
  The device is connected to the online system.
- The LED is on for 2 seconds and off for 1 second:
  Use as access point (AP) / The PFM 20 is working as a wi-fi base station (standard):
  The IP address is ‘192.168.15.1’ as standard.
- The LED is on for 1 second and off for 2 seconds:
  Use as station (ST) / The PFM 20 is connected to an existing wi-fi base station:
  The device receives an IP address from the wi-fi base station. This must be established with the aid of an IP scanner.

LED ‘Test’ (blue)

The blue LED ‘Test’ lights up if the device has been set to manual maintenance by setting the operating mode switch on the signal module (‘1’ – see section 9.2, page 37) to bottom position. The status ‘Maintenance’ is also accordingly issued.

9.2 Operating mode switch

NOTE
The operating mode switch for switching between measurement mode and maintenance (1, Fig 6, page 19) is labelled ‘1’. (Switch 2 does not have a function.)

Measurement mode

For measurement mode, set the operating mode switch on the signal module to top position (ON).

During normal operation, the green LED ‘Operation’ flashes.

Manual maintenance

For manual maintenance, set the operating mode switch on the signal module to bottom position.

During manual maintenance, the blue LED ‘Test’ lights up. The status ‘Maintenance’ is also accordingly issued.

9.3 Terminating resistors

As standard, a jumper is inserted into the pins of the terminating resistors (5 and 6, Fig 6, page 19).

NOTE
How the jumper is set on the respective terminating resistor depends on the number of devices in the RS485 line. This applies both to the devices in the Modbus or in the optional operating/display panel.
The terminating resistor must be set as the final device in the RS485 line. Otherwise, it must be removed.

9.4 Service port for starting using the factory settings

By setting a jumper over pins 3 and 4 on the respective service port (13, Fig 6, page 19) and restarting the device, the factory settings can be loaded.

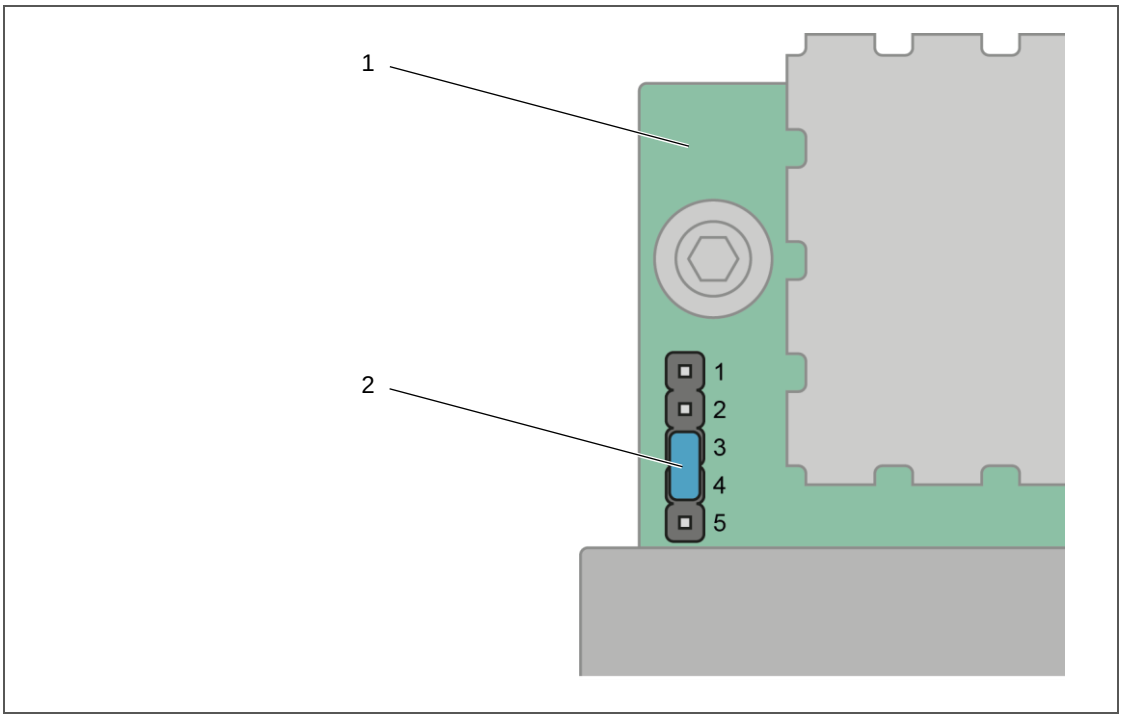

Fig 19: Service port on the signal module

1 Signal module

2 Service port for factory settings

When restarting with the jumper set, the following standard settings are read:

- PFM 20:
  - Password: 1234
- Modbus (in accordance with VDI guideline VDI 4201 sheet 3):
  - Baud rate: 19200
  - Address: 10
- Display/operating panel (optional):
  - Baud rate: 19200
  - Address: 10
- Wi-fi (optional):
  - Operating mode: Access point (wi-fi base station)
  - IP address: 192.168.15.1
  - Password: 12345678

After removing the jumper, the previous settings apply again. Parameters that were modified while the jumper was set are applied.

9.5 PC software

NOTE
The PFM 20 software must be installed on the PC.

After opening the file ‘PFM20_HID.exe’, the PC software is shown. Use the menu to open all relevant screens, and view or configure results and parameters.

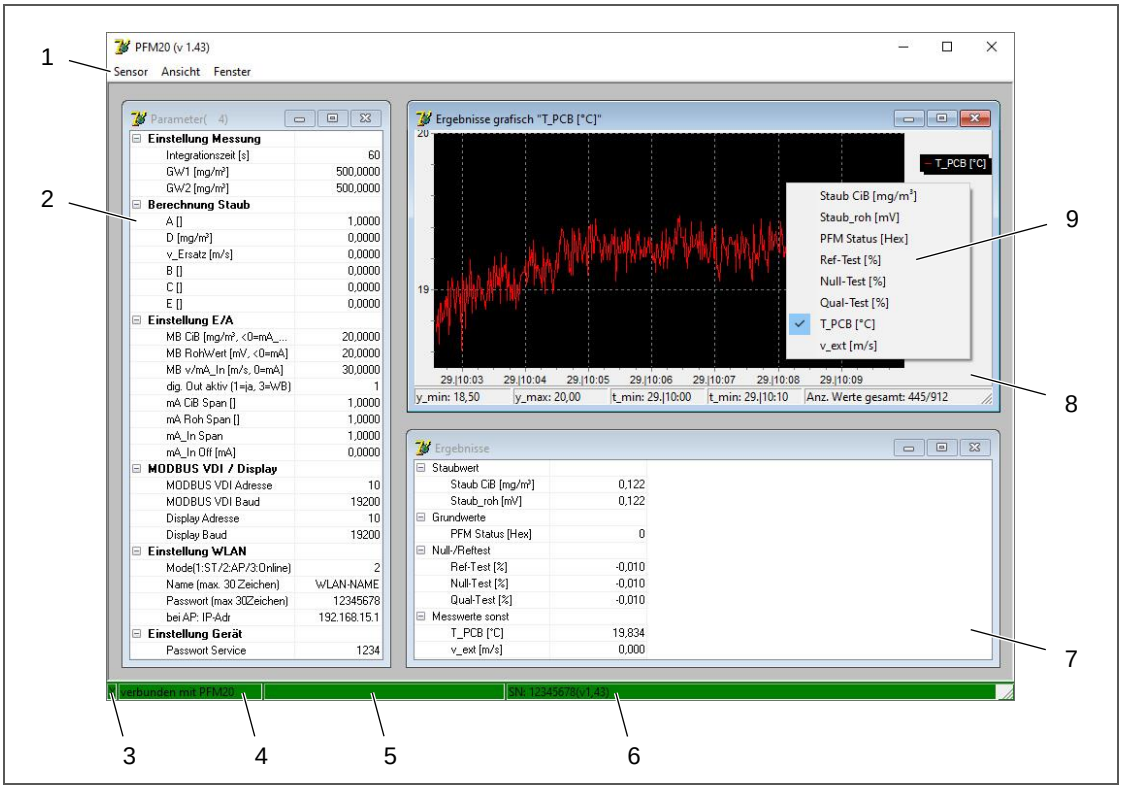

Fig 20: PC software

1 Menu
2 ‘Parameters’ window
3 Indicator for data receipt (alternates between x-X)
4 Connection status to the PFM 20
5 PFM 20 device status
6 PFM 20 serial number and software version
7 ‘Results’ window
8 ‘Graphical results’ window
9 Contextual menu for graphical results

9.5.1 Menu

Sensor

Read parameters

The sensor's parameters are read and shown in the 'Parameters' (2, Fig 20, page 39) window.

Write parameters

NOTE
It is only possible to write parameters after successfully entering the password (see the 'View – Access rights' menu).

The values entered in the 'Parameters' (2, Fig 20, page 39) window are transmitted to the sensor.

Save parameters as file

This menu item enables you to save all read parameters and results in a text file. This file also includes the PFM 20's serial number and software version, as well as the date and time settings of the PC used.

View

Access rights

A further window opens, for entering the password. After entering the password for access to the PFM 20, advanced modification is possible.

NOTE
It is only possible to write, display and configure parameters after successfully entering the password.

German -> English

Selecting this menu item directly switches the software's language.

Parameters

NOTE
It is only possible to show and configure parameters after successfully entering the password (see the 'View – Access rights' menu).

If selecting this menu item, the 'Parameters' (2, Fig 20, page 39) window opens. All required parameters can be displayed and configured (for a description, see section 9.5.2, page 42).

In the event that parameters were modified, the input fields are shown in yellow until the next time a parameter is written. The number of times a parameter has been written is shown in brackets in the window title.

All read parameters and results can be saved in a text file (see the menu ‘Sensor – Save parameters as file’).

NOTE
If the connection to the PFM 20 is interrupted, the parameters must be re-read.

Results

If selecting this menu item, the ‘Results’ (7, Fig 20, page 39) window opens. This shows all results of the measurement (for a description, see section 9.5.3, page 44).

All read parameters and results can be saved in a text file (see the menu ‘Sensor – Save parameters as file’).

Graphical results

If selecting this menu item, the ‘Graphical results’ (7, Fig 20, page 39) window opens. To modify the graphic, right-click:

- Click within the graphic (black background):
  A contextual menu opens, showing all results that can be displayed. After selecting the desired results, the relevant curve progression is shown on the graphic. All selected results are indicated in the contextual menu by a tick.
- Click on the left-hand edge of the graphic:
  A contextual menu for modifying the Y axis opens. Use this to define minimum and maximum values for the display range (measurement unit). Alternatively, you can reset the display to the automatically determined range.
- Click on the bottom edge of the graphic:
  A contextual menu for modifying the X axis opens. Use this to define minimum and maximum values for the display range (date and time). Alternatively, you can reset the display to the automatically determined range.

Window

Close all

All opened windows can be simultaneously closed using this function.

Parameters/Results/Graphical results

The menu item ‘Window’ shows all open windows. Select the relevant name to bring that window to the front.

9.5.2 Parameters

NOTE
The menu ‘View – Parameters’ opens the respective window in the PC software (see Fig 20, page 39).

NOTE
It is only possible to show and configure parameters after successfully entering the password (for access rights, see section 9.5.1, page 40).

Description	Meaning	Standard value
Measurement settings		
Integration time [s]	Integration time (smoothing)	60
LV1 [mg/m³]	Limit value 1	500.0000
LV2 [mg/m³]	Limit value 2	500.0000
Dust calculation		
A [ ]	Calibration constant (freely configurable)	1.0000
D [mg/m']	Calibration constant (freely configurable)	0.0000
v_Substitute [m/s]	Substitute value for speed compensation (used if the external speed measurement input signal fails) Note: If the substitute value is 0, no speed compensation occurs.	30.0000
B [ ]	Calibration constant (freely configurable)	0.0000
C [ ]	Calibration constant (freely configurable)	0.0000
E [ ]	Calibration constant (freely configurable)	0.0000
Input/output settings		
MB CiB [mg/m³, <0=mA]	The dust concentration’s output measurement range Note: If the input value is negative, a fixed mA value is shown. The status ‘Maintenance’ is also accordingly issued.	1000.0000
MR raw value [mV, <0=mA]	The raw signal’s measurement range Note: If the input value is negative, a fixed mA value is shown. The status ‘Maintenance’ is also accordingly issued.	20.0000

Description	Meaning	Standard value
MB v/mA_In [m/s, 0=mA]	The external speed measurement's input measurement range Note: If the input value is 0, the measured mA value is output for the external speed. The status 'Maintenance' is also accordingly issued.	30.0000
Digital out active (1=yes, 3=Maintenance required)	Switching the digital outputs 0 = NO, 1 = NC Note: If, instead of limit value 2, the maintenance required digital output (optional) is used, the following applies: 2 = NO, 3 = NC	1
mA CiB span [ ]	Correction value for mA output mA1 / CiB	1.0000
mA raw span [ ]	Correction value for mA output mA1 / raw signal	1.0000
mA_In span	Correction value for the external speed measurement's input signal	1.0000
mA_In Off [ma]	Offset value for the external speed measurement's input signal	0.0000
MODBUS VDI / display		
MODBUS VDI address	The device's Modbus address	*- the last two characters of the serial number -*
MODBUS VDI baud	The RS485 interface's baud rate	19200
Display address	The device's Modbus address for connecting to optional display/ operating panel	*- the last two characters of the serial number -*
Display baud	The RS485 interface's baud rate for connecting to optional display/ operating panel	19200
Wi-fi settings		
Mode (1:ST / 2:AP / 3:Online)	Wi-fi operating mode 1 = Station (ST), 2 = Access point (AP), 3 = Online system	2
Name (max 30 characters)	Wi-fi name Note: The wi-fi name cannot contain special characters.	
Password (max 30 characters)	Wi-fi password	12345678
For AP: IP address	IP address (only when used as access point)	192.168.15.1
Device settings		
Password service	Password for accessing the PFM 20	1234

Table 2: PC software – parameters

9.5.3 Results

NOTE
The menu ‘View – Results’ opens the respective window in the PC software (see Fig 20, page 39).
Alternatively, use the menu ‘View – Graphical results’ to open a window that shows a graphical representation of the curve progression.

Description	Meaning
Dust value	
Dust CiB [mg/m³]	The dust concentration’s measured value
Dust raw [mV]	The raw signal’s measurement value
Base values	
PFM status [hex]	The PFM 20’s device status (see section 9.5.4, page 45)
Zero point/reference point test	
Reference point test [%]	Reference point value from the last zero point and reference point check (setpoint = 70%)
Zero point test [%]	Zero point value from the last zero point and reference point check (setpoint = 0%)
Quality test [%]	The sensor’s contamination value from the last zero point and reference point check Note: If the contamination value is 50% or more, a maintenance required message is issued. If the contamination value is 80% or more, a fault message is issued.
Measurement values miscellaneous	
T_PCB [°]	Internal device temperature
v_ext [m/s]	The external speed measurement’s measured value Note: If the input measurement range (parameter ‘MB v/mA_In’) is defined as 0, the measured mA value is output for the external speed.

Table 3: PC software – results

9.5.4 PFM 20 device status

The PFM 20's device status is shown as fixed bit positions, and as a hexadecimal value on the bottom edge of the PC software (5, Fig 20, page39), as well as in the results view (see section 9.5.3, page 44).

Bit value (hexadecimal value)	Status	Meaning
0002	Maintenance required	*Sum status*
0004	Fault	*Sum status*
0008	Maintenance	*Sum status*
0010	Maintenance required	Sensor's triboelectric input signal is too great, either temporarily or permanently
0020	Maintenance required	Output measurement range is too small (the measurement value to be output is greater than the configured measurement range, either temporarily or permanently)
0400	Fault	Probe rod (triboelectric connection) not correctly internally connected to the electronics assembly
0800	Maintenance required/Fault	Internal device temperature too high or too low (< -22°C or > + 73°C / < -32°C or > + 93°C)
1000	Maintenance required/Fault	Zero point deviation outside the permitted tolerance (> 2% / > 3%)
2000	Maintenance required/Fault	Probe rod dirty (contamination value > 50% / > 80%)
4000	Maintenance required/Fault	Reference point deviation outside the permitted tolerance (> 2% / > 3%)

Table 4: Device status

NOTE
For information on troubleshooting and fault rectification, see section 11, page 49

NOTE
All other set bits in the status indicate internal errors or statuses in the PFM 20. If status types occur that do not correspond with those listed here, please contact Dr. Födisch Umweltmesstechnik AG (contact details on the inside cover page).

10 Servicing/Maintenance

NOTE
Compliance with the maintenance works is a prerequisite for the fulfilment of warranty services.
Work on the device must only be carried out by qualified personnel.
All servicing and maintenance works carried out must be documented in accordance with applicable regulations.

The servicing works have the following objectives:

- Maintaining accuracy of the measurements
- Maintaining operational safety
- Increasing service life

The following servicing/maintenance works must be performed:

Module	Action	Maintenance interval
- General -	Plausibility test	1 month
	Zero point and reference point control, checking the contamination value	1 month
	Linearity test	1 year
Device components	Cleaning	6 months
Probe rod (high temperature coating)	Visual inspection	6 months
Seal	Inspection/replacement	6 months

Table 5: Servicing and maintenance works

NOTE
How often cleaning works must be undertaken depends on the chosen measurement point and the measured medium, in particular the dust concentration, as well as environmental and climatic conditions.

10.1 Plausibility test

1. Check the measured values for plausibility.
2. Check the analogue output's output measurement range, the integration time and the preconfigured limit values (for parameters, see section 9.5.2, page 42).
   If required, adjust the parameters as necessary.

NOTE
For information on using the available additional options (display/operating panel, wi-fi), please read the separate description.

10.2 Linearity test

NOTE
To perform a linearity test, the PFM 20 must be fitted in the specially produced linearity module (optional). (See section 8.3, page 30).

10.3 Zero point and reference point check with checking of the contamination value

In order to be able to determine any possible errors on the device, a zero point and reference point check is necessary before the device is put into operation for the first time, and after servicing and conversion works.

1. Check that the PFM 20 has been installed correctly.
2. Check the internal device temperature (Results, see section 9.5.3, page 44).
3. Perform a manual zero point and reference point check (see section 8.2.2, page 30).
4. Check the contamination value from the last zero point and reference point check (Results, see section 9.5.3, page 44).

10.4 Cleaning and replacing the seal

NOTE
Impurities on the probe rod are detected during operation. Depending on the degree of contamination, a maintenance required message or fault message is issued.
Check the contamination value from the last zero point and reference point check (Results, see section 9.5.3, page 44).

1. Clean the probe rod with a clean, lint-free cloth.
2. Disconnect the external power supply's preliminary fuse and secure it against being switched on again.

WARNING
Hot surface!
Individual device components can develop high temperatures.
Risk of burns!
Before working on the device, ensure it has cooled down.

3. Wait until the device has cooled down.

DANGER
Open ducts with harmful gases, high temperatures or high pressure can lead to severe health problems, injuries or death.
Only dismantle the device when the system is at a standstill.

4. Release the tri-clamp connector (5, Fig 13, page 26) and remove it.
5. Remove the device from the duct.
6. Clean the insulator (2) and the probe rod (1) with a clean, lint-free cloth.

CAUTION
Damage to the probe rod's high temperature coating can lead to measurement errors.
Regularly inspect the probe rod for signs of damage.

7. Clean the welding sleeve and tri-clamp connector.
8. Replace the seal (6) on the welding sleeve with a new one.
9. Set the new seal (6) onto the welding sleeve (3).
10. Feed the device's probe rod (1) through the welding sleeve and into the duct, until the guide sleeve (7) lies on the seal (6).
11. Rotate the probe head (8) to the correct position, so that the cable glands point downwards.
12. Place the tri-clamp connector (5) on the sleeve and seal and affix it.
13. Connect the external power supply's preliminary fuse.
    › The device is ready for operation.

11 Troubleshooting and fault rectification

CAUTION
Troubleshooting must be carried out by qualified personnel.

The PFM 20 outputs status signals to assist with monitoring and for indicating error statuses. These are supplied as a potential-free contact for the status contacts, and can be displayed on an external device (see section 9, page 35). The statuses can be divided into three status types: ‘Fault’, ‘Maintenance required’ and ‘Maintenance’.

In certain cases, current faults and the ‘Maintenance’ status are also indicated by LEDs on the signal module (see section 9.1, page 36).

NOTE
The PFM 20’s device status is shown as fixed bit positions, and output as a hexadecimal value (see section 9.5.4, page 45).

1. Check the LEDs on the signal module.
   - › If the red ‘Error’ LED is lit up, this indicates a fault has been issued.
   - › If the red ‘Error’ LED flashes, the status ‘Maintenance’ has been issued.
   - › In certain cases, the LEDs do not indicate any specific message.
2. Check the device status that has been output (see section 9.5.4, page 45).
3. Compare the status that has been output with the following tables:
   - › Fault (see section 11.1, page 50)
     The respective cause should be rectified immediately.
   - › Maintenance required (see section 11.2, page 51)
     To prevent faults as early as possible, we recommend checking the status that has been output and where necessary undertaking the appropriate corrective measures.
   - › Maintenance (see section 11.3, page 53)
     The respective cause should be checked, and if required, rectified.
4. Carry out the required actions to rectify the fault.
5. Check the LEDs and the status that has been issued once again.
   - › If there are still any errors or faults, these are output and where necessary indicated by the LEDs.

NOTE
If status types occur that are not shown in the following tables, or if errors or faults occur that cannot be resolved by consulting the operating manual, please contact Dr. Födisch Umweltmesstechnik AG (contact details on the inside cover page).

11.1 Fault

NOTE
If a fault occurs, the red ‘Error’ LED lights up.
A precise analysis of the PFM 20’s device status is possible by means of the hexadecimal values that are output (see section 9.5.4, page 45).

Fault (Bit value sum status 0004)		
Output	**Cause**	**Action**
Bit value 0400 / red LED lit up	Probe rod (triboelectric connection) not correctly internally connected to the electronics assembly	• Send the device to Dr. Födisch Umweltmesstechnik AG for repair.
Bit value 0800 / red LED lit up	Internal device temperature too high or low (< -32°C or > + 93°C)	• Check the internal device temperature (Results, see section 9.5.3, page 44). • Adapt the insulation to the duct or the external environment.
Bit value 1000 / red LED lit up	Zero point outside the permitted tolerance (> 3%)	• Clean the probe rod (see section 10.4, page 48). • Perform a manual zero point and reference point check (see section 8.2.2, page 30).
Bit value 2000 / red LED lit up	Probe rod dirty (Contamination value > 80%)	• Clean the probe rod (see section 10.4, page 48). • Check the contamination value. To do so, perform a manual zero point and reference point check (see section 8.2.2, page 30).
Bit value 4000 / red LED lit up	Reference point outside the permitted tolerance (> 3%)	• Clean the probe rod (see section 10.4, page 48). • Perform a manual zero point and reference point check (see section 8.2.2, page 30).
No bit value / red LED lit up	Other	• Send the device to Dr. Födisch Umweltmesstechnik AG for repair.
No bit value / green LED continuously lit up	Software error	• Restart the device. • In the event of a device defect, send the device to Dr. Födisch Umweltmesstechnik AG for repair.

Fault (Bit value sum status 0004)		
Output	**Cause**	**Action**
No bit value / No specific LED indication / green flashes as standard (Current value constantly at 4 mA or 20 mA)	device defective	• Check the output measurement range settings (parameters, see section 9.5.2, page 42). Correct these if necessary. • In the event of a device defect, send the device to Dr. Födisch Umweltmesstechnik AG for repair.
No bit value / all LEDs off (Current value < 4.0 mA / no current value output)	No power supply; damaged cable; device defective	• Check the power supply connections are firmly attached. • Inspect the power supply cable for kinks, tears and breakages. If necessary, replace the damaged cable. • In the event of a device defect, send the device to Dr. Födisch Umweltmesstechnik AG for repair.

11.2 Maintenance required

NOTE!
If, instead of limit value 2, the maintenance required digital output (optional) is used, the respective switching of the digital outputs must be set (parameters, see section 9.5.2, page 42).

NOTE!
If a maintenance required status is output, this is not specifically indicated by the LEDs. The green LED flashes as standard.
An analysis of the PFM 20 F's device status is solely possible by means of the hexadecimal values that are output (see section 9.5.4, page 45).

Maintenance required (Bit value sum status 0002)		
Output	**Cause**	**Action**
Bit value 0010	Sensor's triboelectric input signal is too great, either temporarily or permanently	• Clean the probe rod (see section 10.4, page 48). • Check that the PFM 20 has been installed correctly. • Check the installation location and duct conditions.
Bit value 0020 (Current value constantly at 4 mA or 20 mA)	Measurement range is too small (the measurement value to be output is greater than the configured measurement range, either temporarily or permanently)	• Check the output measurement range settings (parameters, see section 9.5.2, page 42). Correct these if necessary.

Maintenance required (Bit value sum status 0002)		
Output	**Cause**	**Action**
Bit value 0800	Internal device temperature too high or low (< -22°C or > +73°C)	• Check the internal device temperature (Results, see section 9.5.3, page 44). • Adapt the insulation to the duct or the external environment.
Bit value 1000	Zero point outside the permitted tolerance (> 2%)	• Clean the probe rod (see section 10.4, page 48). • Perform a manual zero point and reference point check (see section 8.2.2, page 30).
Bit value 2000	Probe rod dirty (Contamination value > 50%)	• Clean the probe rod (see section 10.4, page 48). • Check the contamination value. To do so, perform a manual zero point and reference point check (see section 8.2.2, page 30).
Bit value 4000	Reference point outside the permitted tolerance (> 2%)	• Clean the probe rod (see section 10.4, page 48). • Perform a manual zero point and reference point check (see section 8.2.2, page 30).

11.3 Maintenance

NOTE
If the ‘maintenance’ status is issued, the red ‘Error’ LED flashes.
A precise analysis of the PFM 20’s device status is possible by means of the hexadecimal values that are output (see section 9.5.4, page 45).

Maintenance (Bit value sum status 0008)		
Output	**Cause**	**Action**
Bit value 0008 / red LED flashes	Device in maintenance mode (eg zero point and reference point check active)	• Wait until the maintenance work has been completed or correct the parameter settings for the analogue output/input.
Bit value 0008 / red LED flashes and blue LED lit up	Device set to manual maintenance	• Complete the manual maintenance and use the operating mode switch to switch the device to measurement mode.

12 Decommissioning and disposal

12.1 Decommissioning

DANGER
Electrical voltage!
Parts of the device can carry dangerous voltage.
Danger of electrical shock.
Work on the device must only be carried out by qualified personnel.

1. Disconnect the external power supply's preliminary fuse and secure it against being switched on again.

12.2 Dismantling

DANGER
Open ducts with harmful gases, high temperatures or high pressure can lead to severe health problems, injuries or death.
The welding sleeve and probe must only be removed when the system is at a standstill.

WARNING
Hot surface!
Individual device components can develop high temperatures.
Risk of burns!
Before working on the device, ensure it has cooled down.

1. Release the tri-clamp connector (5, Fig 13, page 26) and remove it.
2. Remove the device from the duct.
3. Disconnect the electrical connections from the device:
   a) Open the housing cover (2, Fig 4, page 17). To do so, release the locking clip (1) on the top of the device, as well as the Allen connection behind the locking clip.
   b) Release the cable glands' screws (4).
   c) Disconnect the external power supply's cable, as well as all cables from the analogue and digital outputs, interfaces and optional devices from the signal module.
   d) Feed all required cables through the cable glands and out of the device.
   e) Close the housing cover and affix it into place by means of the Allen connection and locking clip.
4. Remove the seal (6, Fig 13, page 26) from the welding sleeve (3).
5. If required, remove the welding sleeve from the duct.
6. Stow all cables away safely, and ensure the device and its components are stored correctly.

12.3 Storage

For correct storage of the device, the following environmental conditions apply:

- Ambient temperature: 0 … +50°C
- Relative humidity: max 90° (non-condensing)
- Storage indoors (outdoor storage not permitted)
- Protection against moisture

12.4 Disposal

NOTE
Disposal must be in accordance with the environmental regulations that apply in the country of use. The device must be disposed of as special waste.

13 Technical data

Particle flow monitor PFM 20	
Housing	Compact device with aluminium housing; IP 65
Probe	Triboelectric probe comprising probe rod and probe head; Probe rod: high temperature coating, electrically insulated from the housing, length: 300/500mm (standard); Penetration depth: approx 300/500mm The probe length of PFM20 can be customized to 1000 mm or above, if the local regulation requires it.
Dimensions	approx 130mm x 170mm x 530/730mm (W x H x D)
Weight	approx 2.0kg
Display/operation	LEDs and switches on the signal module
Ambient temperature	-20…+50°C
Relative humidity	Not especially sensitive
Measured gas	• Temperature: max 280°C • Dew point difference: min +5 K
Flow speed	min 5 m/s
Measurement range dust	• Raw signal: 0…250 mV • Dust concentration: 0…250 mg/m³
Operational readiness	approx 1 min after connecting the power supply
Calibration	By means of gravimetric comparison measurements (not required for tendency measurements and filter analyses)
Analogue outputs	2 analogue outputs 4…20 mA, 2-wire transmitter, galvanically isolated from device earth, output load max 500 Ω; Outputs for: • Dust concentration C_{iB} [mg/m³] • Raw signal [mV]
Analogue input	1 analogue input 4…20 mA for external speed v [m/s], galvanically isolated from device earth
Digital outputs	4 potential-free contacts for fault, maintenance, limit value 1 and limit value 2 / optional maintenance required; 24 V, 100 mA
Interfaces	• PC interface (USB, for setting parameters) • Modbus, in accordance with VDI guideline VDI 4201 sheet 3 • Modbus for optional display/operating panel
Process connection	Welding sleeve with tri-clamp connector
Cable gland/clamping area	• 1x M16 x 1.5 • 2x M12 x 1.5
Power supply	• 110…230 V AC, fuse time delay 1 A, 10 W; Preliminary fuse: min time delay 1.2 A • 24 V DC (optional), 10 W; preliminary fuse: 500 mA slow blow
Optional	• Display/operating panel • Wi-fi module • Linearity module

Table 6: Technical data

14 Spare parts and wear parts

To order spare parts and wear parts, please contact Dr. Födisch Umweltmesstechnik AG (contact details on the inside cover page).

Component/Module	Quantity	Part number
Adaptor nozzle tri-clamp, 1" external thread	1	10004307
Seal	1	10004299
Welding sleeve	1	10004300
Clamping ring (tri-clamp connector)	1	10004301
Signal module 110…230 V AC	1	10007557
Signal module 24 V DC	1	10007559

Table 7: Spare parts and wear parts

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