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Particle Flow Meter PFM 92 C



Operation manual

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1 General remarks

1.1 General advices

The product described by this manual has left the factory in a safety-related proper and checked state. In order to keep this state and to achieve a perfect and safe product operation it is only allowed to be used in the way described by the manufacturer. Moreover the perfect and safe operation of this device requires a correct transportation, storage and installation as well as a careful operation and maintenance.

This manual contains the necessary information for the determined use of the described product. It is directed towards technically-qualified staff which have been specially educated or have knowledge about measuring and control technology - called automation technology further on.

The knowledge and the technically correct realisation of the safety hints and warnings contained in this manual are the precondition for safe installation and putting into operation as well as for safety during operation and maintenance of the product described. Only professional staff have the required knowledge to interpret as well as to realise correctly the general safety hints and warnings in the respective individual case.

This manual is within the scope of delivery even if a separated order respectively delivery had been planned due to logistic reasons. In order to preserve clarity neither all details for all types of the described product are contained, nor each possible case of installation, operation, maintenance and use in systems can be considered. If you need further information or if problems arise which are not treated explicitly in this manual please contact the respective agency of Dr. Födisch Umweltmesstechnik AG being responsible for you.

1.2 Advices for handling the manual

In the manual it is described how you can mount, set up, control and maintain the measuring equipment. Please pay especially attention to texts of **warning and advices**.

1.3 Warning advices

Safety hints and warnings serve the avoidance of dangers for life and health of users or staff respectively damages to property. In the manual they are marked by here defined signal words. Moreover they are marked by symbols at the place of their appearance. The used signal words mean in this manual and on the product itself the following:

**WARNING**

means, that death, heavy injuries and / or substantial damages to property **can** occur, if necessary precautions are not taken.

Thereby the following risks are differentiated:

**WARNING**

Danger by electric current

**WARNING**

Danger by hot surface

**ATTENTION**

Means that an event or state which is not desired can occur, if the corresponding advice is not observed.

**HINT**

Is an important information about the product itself, its handling or that chapter of manual where special attention shall be paid to.

1.4 Approved use

The product described in this manual has been developed, manufactured, tested and documented taking into account the appropriate safety standards. No danger therefore exists in the normal case with respect to damage to property or the health of persons if the handling guidelines and safety information described for configuring, assembly, approved use and maintenance are observed. This device has been designed such that safe isolation is guaranteed between the primary and secondary circuits. Low voltages which are connected must also be generated using safe isolation. Correct and safe operation of this analyser is additionally dependent on proper transport, storage, installation and assembly, as well as careful operation and maintenance.



WARNING



Danger of injury by electric current!

This device is operated by electricity. Following removal of the housing or guard, or after opening the system cabinet, certain parts of the device/system are accessible which may carry dangerous voltages. Therefore only suitably qualified personnel shall work on this device. This must be thoroughly acquainted with all sources of danger and the maintenance measures as described in this manual.

1.5 Qualified personnel

Severe personal injury and/or extensive damage to property may occur following unqualified work on the device/system or the failure to observe the warnings described in the instructions or on the device/system cabinet. Therefore only suitably qualified personnel may work on this device/system. Qualified persons in the sense of the safety information of these instructions or on the product itself are persons who

- ⇒ are either familiar as project engineers with the safety concepts of automation technology
- ⇒ or have been trained as operators in the use of automation technology equipment and are acquainted with the contents of these instructions which refer to operation
- ⇒ or have been appropriately trained as commissioning and/or maintenance personnel for such automation technology equipment or are authorised to energise, ground and tag circuits and devices/systems in accordance with established safety practices.

1.6 Warranty Information

Your attention is drawn to the fact that the contents of these instructions are not part of a previous or existing agreement, commitment or statutory right and do not change them. All commitments are contained in the respective sales contract which also contains the complete and solely applicable warranty conditions. These warranty conditions in the contract are neither extended nor limited by the contents of this manual.

Changes in design or construction of the filter controller are not allowed. Any intervention lead to a termination of the warranty.

1.7 Supply and delivery

The respective scope of delivery according to the valid contract is listed on the shipping documents accompanying the delivery. When opening the packaging, please check that the delivery is complete and undamaged. Please keep the packaging material in order to return the device, if necessary.

1.7.1 Scope of supply

The Particle Flow Meter PFM 92 C consists in standard version of the following components:

- ⇒ 1 probe
- ⇒ 1 1"-weld-in sleeve with screwing
- ⇒ 1 operation manual



HINT

Depending on the order configuration deviations in the technical design are possible.

1.8 Standards and regulations

The harmonised European standards have been applied to the specification and production of this device as far as possible. If no harmonised European standards have been used, the standards and regulations for the Federal Republic of Germany apply.

1.9 Declaration of conformity

CE-Symbol

The Particle Flow Meter PFM 92 C complies with the requirements of the EU guidelines listed below.

EG-low voltage directive

The Particle Flow Meter PFM 92 C complies with the requirements of the EU low voltage directive 2006/95/EG dated 12. Dezember 2006.

EMC-Guideline

The Particle Flow Meter PFM 92 C complies with the requirements of the EU guideline 89/336/EEC "Electromagnetic Compatibility" in the product family norm EN 61326.

The Particle Flow Meter PFM 92 C is designed for the use in industrial applications.



Requirements for:		
Emitted interference		Interference immunity
EN 50081-1		EN 61000-6-2
Emitted interference	Interference field intensity according to	EN 55022 (CISPR 22)
Emitted interference	Interference voltage according to	EN 55022 (CISPR 22)
Interference immunity	ESD according to	EN 61000-4-2
Interference immunity	HF radiated according to	EN 61000-4-3
Interference immunity	Burst according to	EN 61000-4-4
Interference immunity	Surge according to	EN 61000-4-5
Interference immunity	HF streamed into according to	EN 61000-4-6
Interference immunity	Power loss	EN 61000-4-11

Declaration of conformity

In line with the above-mentioned EU guidelines, the EU declarations of conformity are available at the following address for inspection by appropriate authorities:

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2 Safety advices

2.1 General safety advices



WARNING

Risk of injury due to non-observance of safety advices!

Operate the measuring device PFM 92 C only in perfect state and under strict observance of the safety hints!

- ⇒ Before the PFM 92 C is allowed to be used, the complete manual must have been read and understood.
- ⇒ The PFM 92 C as a whole as well as the single components are only allowed to be operated in the original state. If elements are changed the manufacturer's original parts shall be used.
- ⇒ Elements are device-typically configured and, therefore, cannot be changed among various PFMs.
- ⇒ Changes in design or configuration of the PFM 92 C are not allowed.
- ⇒ The filter controller PFM 92 C is only allowed to be connected to the supply voltage written on the type plate (Standard: 24 VDC).
- ⇒ The PFM 92 C is only allowed to be operated at a power supply with ground contact. The protective effect must not be revoked by an extension cable without protective conductor. Each interruption of the protective conductor inside or outside the device is dangerous and not permitted.
- ⇒ The PFM 92 C has to be secured by 2 A on input side..
- ⇒ Before opening any component of the device the dust measuring device PFM 92 C has to be made free of voltage by pulling the power connector.
- ⇒ Neither it is allowed to use the PFM 92 C in potential explosive rooms nor to measure in explosive gaseous mixtures.
- ⇒ Cables and gas pipes should be assembled in a way that a danger of accident by stumbling or getting caught on the pipes can be excluded.
- ⇒ Parts of the probe can get into contact with hot measuring gas and can, therefore, be heated up. Therefore please never touch these parts without temperature-resistant gloves or under voltage.
- ⇒ Changes in the configuration of the PFM 92 C , that means the mis-adjustment of parameters which usually are not at the user's disposal, can endanger the safety and functioning of the filter controller and are done at one's own risk! Therefore changes in configuration shall be executed by authorised service technicians or by manufacturer's staff.
- ⇒ Coverings of PFM 92 C are only allowed to be removed in the state free of voltage.
- ⇒ It should be possible to switch off the PFM 92 C by a switch being close to the device.



WARNING

Risk of injury due to lack of expertise!

Installation, operation, maintenance and all kind of repair have to be done solely by skilled staff referring to the corresponding regulations. (Zentralverband der Elektrotechnik- und Elektroindustrie e.V.).

3 Structure and function

3.1 Structure

The filter controller PFM 92 C consists of the following components:

- ⇒ 1 in-situ probe
- ⇒ 1 weld-in sleeve

3.1.1 Probe

The probe PFM 92 C consists of a probe rod and a probe head. The probe rod is assembled in a sleeve and an insulator which insulates it electrically from the case.

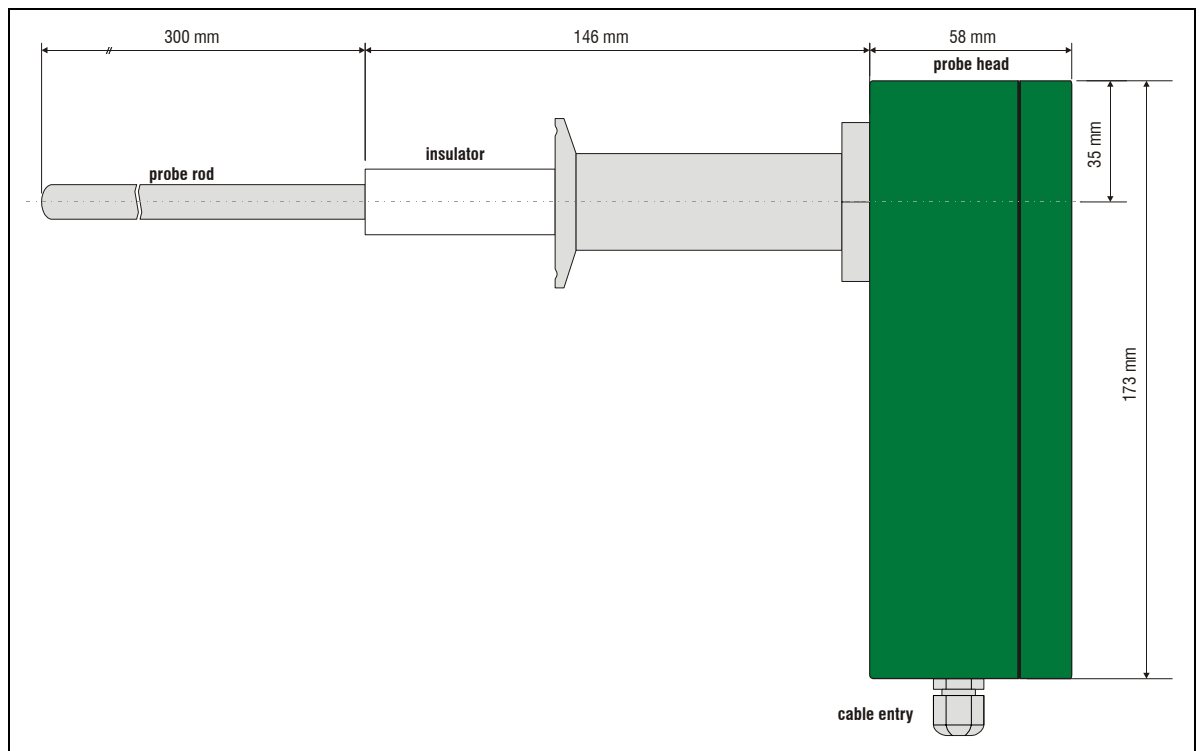


Fig. 3.1: Side view PFM 92 C

3.2 Function

The filter controller PFM 92 C is a highly sensitive system for continuous, triboelectric in-situ filter monitoring. The qualitative monitoring of the exhaust gas is done hereby.

The measuring gas is measured triboelectrically in the exhaust gas flow by means of the probe rod of the PFM 92 C (see 3.2.1 *Measuring principle* Page 12).

The signal resulting from the derived current is a degree for the exhaust gas' dust content.

The micro controller integrated in the control unit produces a dust proportional signal which is provided as 4 ... 20 mA – signal.

3.2.1 Measuring principle

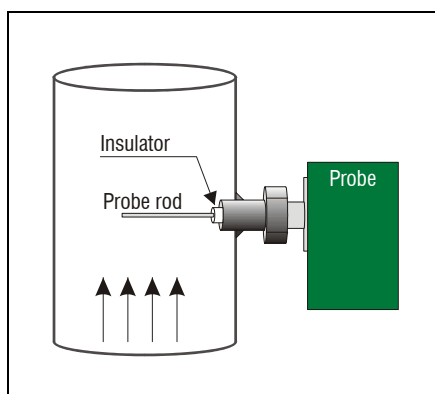


Fig. 3.2: Measuring principle

Triboelectricity:

If 2 bodies get into contact with each other by friction or touch, a charge transfer will occur. The charge difference arises by the exchange of electrons between atoms on the surfaces. So a boundary layer with a positive and negative surface charge within a very low molecular distance from each other is formed.

This charge difference, also called charge fluctuation, is the basis for triboelectric dust meters which use the charge exchange between measuring probe and nearby streaming or direct impacting dust particles.

The triboelectric signal depends on the mechanical and electric properties of the dusts.

$$S \sim C_{i.B.}$$

⇒ $C_{i.B.}$	⇒ = dust concentration [mg/m ³]
⇒ S	⇒ = triboelectric measuring signal
⇒	at constant velocity!

4 Installation

4.1 Selection of the measuring point



WARNING

Risk of measuring failures.

The point of installation of the weld-in sleeve must be grounded. Therefore the weld-in sleeve has to be integrated into the local potential equalisation!

The place of installation of the probe has to meet the requirements of local valid guidelines (e.g. EN 13284-1, in Germany: VDI 2066 page 1). In case of doubts it is recommended to let have determined the measuring point by a responsible measuring institute (in Germany according to §§ 26/28 BImSchG). We recommend to realise at least 5 times the diameter of the exhaust gas channel as entry and exit section.

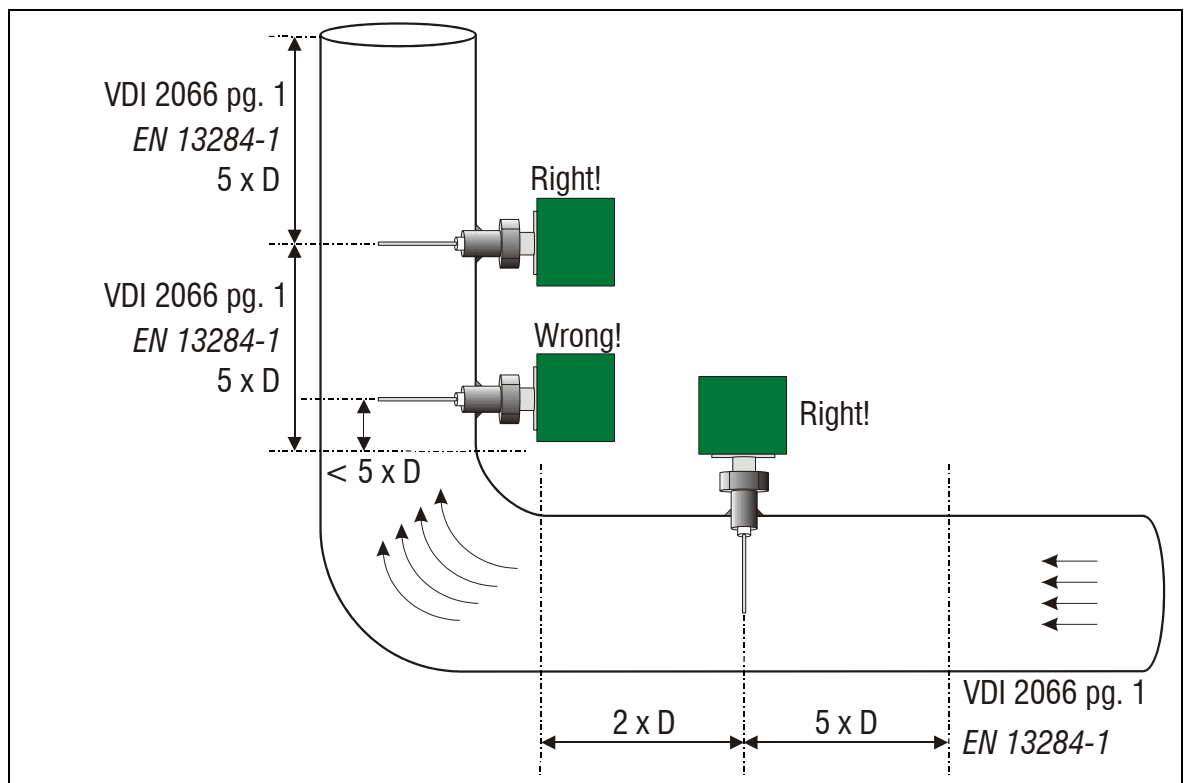


Fig. 4.1: Entry and exit section

Basically it has to be considered that the dust and smoke gas distribution must prevail as homogeneously as possible at the measuring point in order to get a representative measurement of the dust content across the channel cross – section.



WARNING

Risk of measuring failures.

The probe profile should be protected against rain falling down!

4.2 Installation of the weld-in sleeve

The weld-in sleeve of the PFM 92 C is installed according to *Fig. 4.2: Weld-in sleeve*. The installation position of the probe is horizontal or vertical from top.

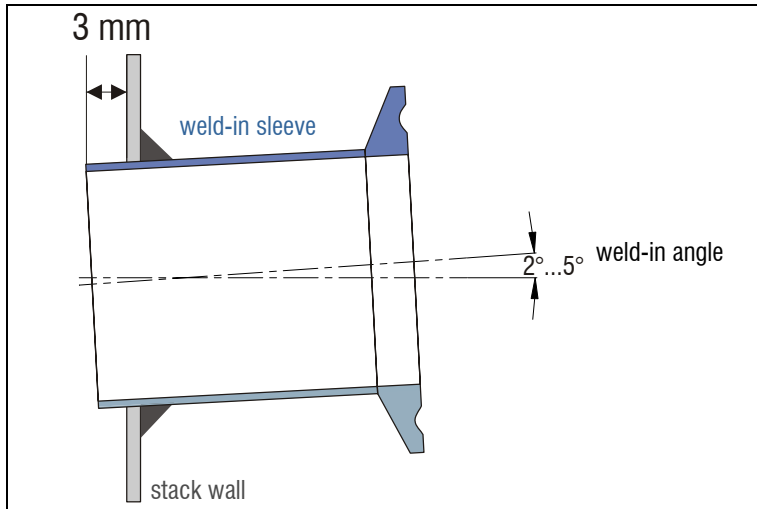


Fig. 4.2: Weld-in sleeve

4.3 Assembly of the probe

At first the gasket has to be fitted into the sleeve. Then the probe is pushed up against it and fixed with the quick clamp.

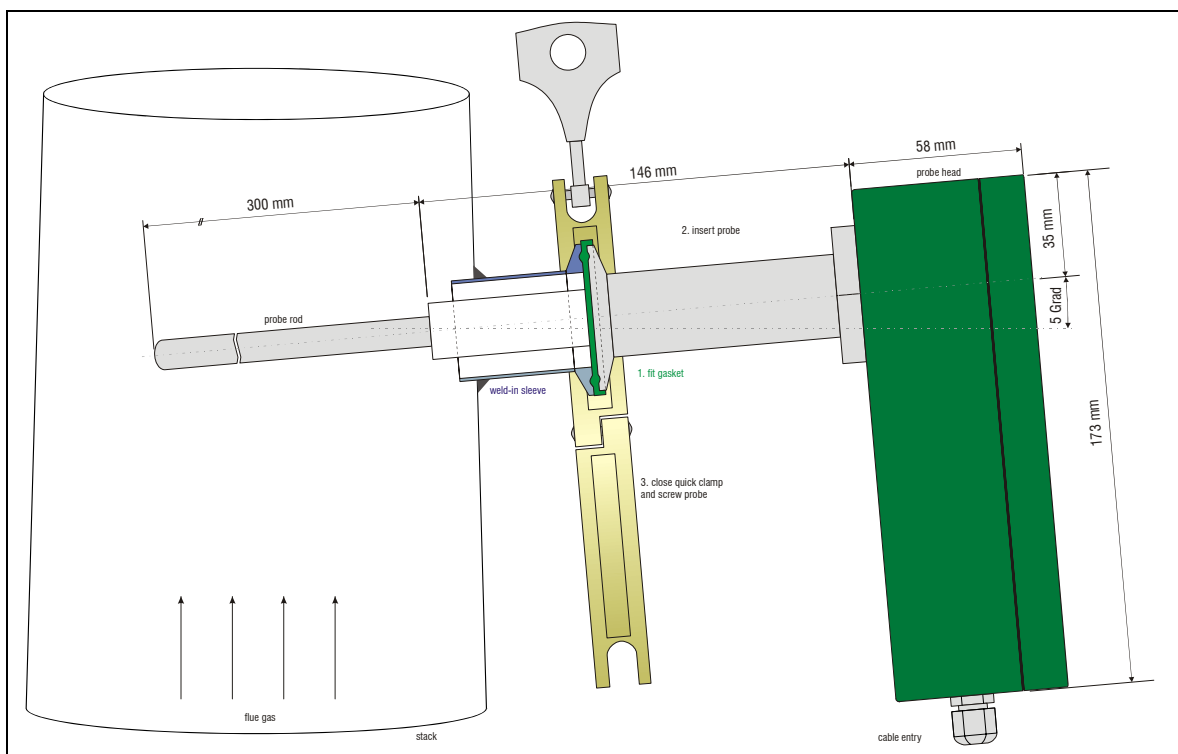


Fig. 4.3: Installation rule

4.4 Electric connection



WARNING

Risk of injury if safety advices are not observed!

The measuring device PFM 92 C must not be opened in potentially explosive dust atmosphere!

The electric connections of the PFM 92 C are inside the probe head. The terminals are arranged in a terminal strip which can be seen after removal of the cover. To get there 4 screws have to be unscrewed and the cover has to be removed.



Fig. 4.4: Probe head

The terminals are designed as plug terminals. For connecting the cable no special tool is required.

4.4.1 Operational voltage (24 VDC)

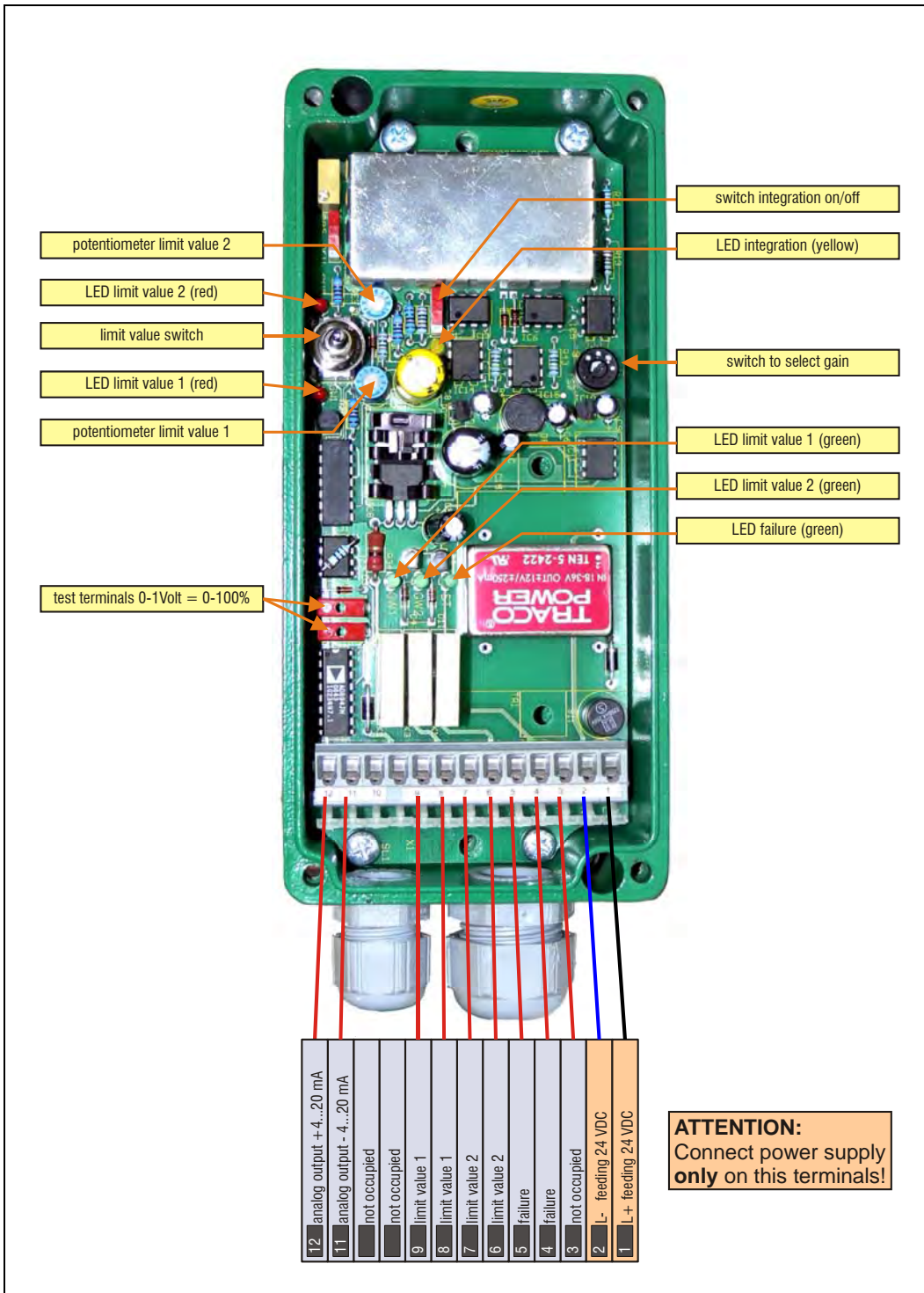


Fig. 4.5: Electric connection 24 VDC



WARNING

The operational voltage 24 VDC is connected to the terminals 1 and 2!

4.4.2 Operational voltage (110/230 VAC)

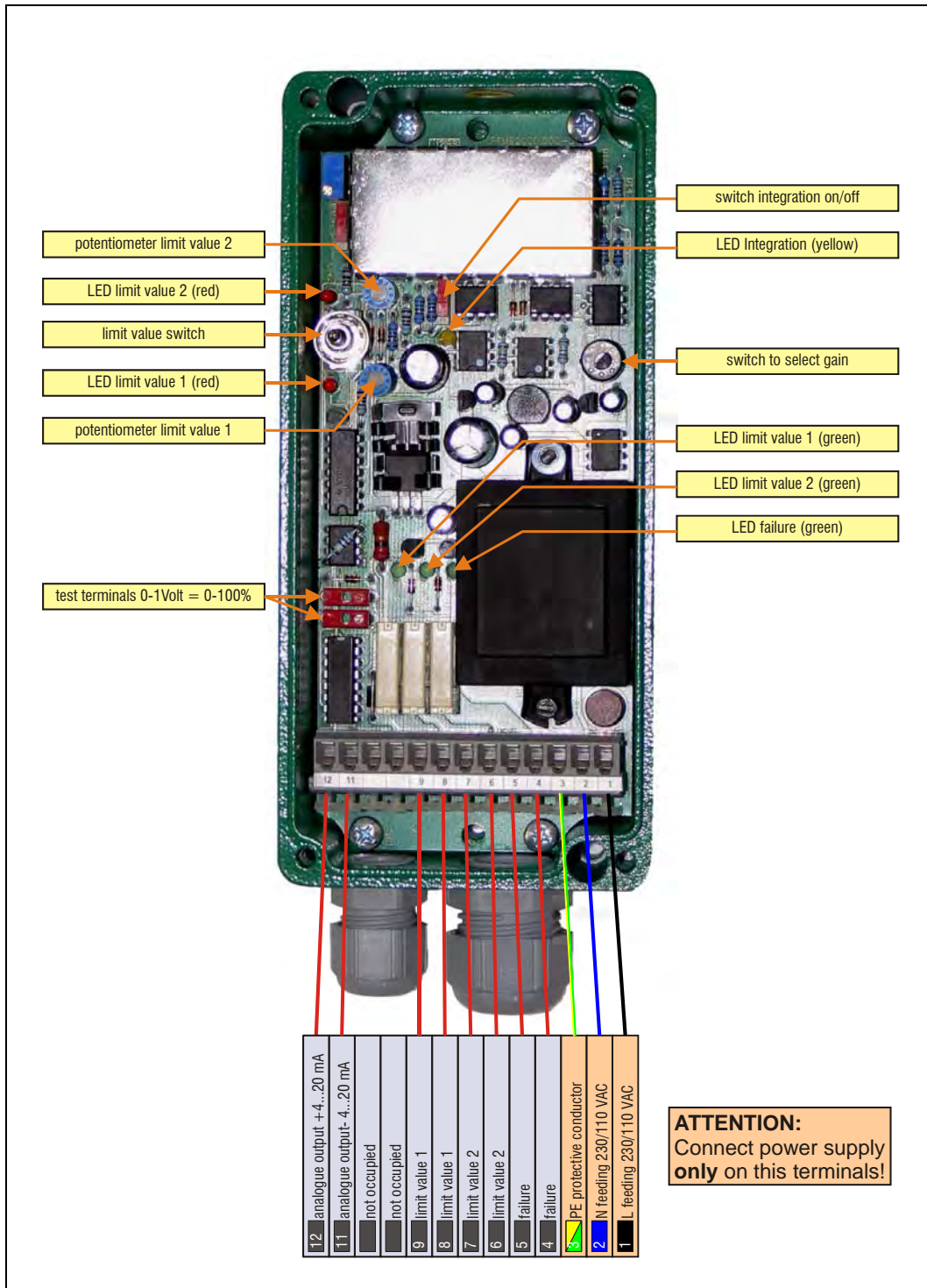


Fig. 4.6: Electric connection 110/230 VAC



WARNING

The operational voltage 110/230 VAC is connected to the terminals 1, 2 and 3!

4.4.3 Status signals

The status signals are made as potential-free contacts. These contacts are only allowed to be loaded with low voltage 24 V, max. 0,1 A.. The following status signals are provided at the PFM 92 C:

Signals	Contact position
⇒ Failure ⇒ 9 Failure elimination page 27	⇒ Normally closed (NCC), in case of <i>failure</i> opened
⇒ Limit value 1	⇒ Normally closed (NCC), in case of <i>limit value violation</i> opened
⇒ Limit value 2	⇒ Normally closed (NCC), in case of <i>limit value violation</i> opened

Table 4.1: Status signals

4.4.4 Analogue output

The analogue output of the PFM 92 C is made as 4 ... 20 mA output. An external analogue separator has to be used for the galvanic isolation of the output signal. The following signal can be provided by the PFM 92 C:

⇒ Analogue output -> dust in [%]



WARNING

Risk of device demolition (loss of warranty)!

The analogue output of the PFM 92 C is active! It must not be supplied with voltage under any circumstances!



5 Set up

1. Switch on pre-fuse
2. Check provided measuring values for plausibility
3. Adjust measuring range / amplification , if necessary (*see 6.2 Adjust amplification Page 20*)
4. Adjust operation mode, if necessary (*see 6.3 Selection of operation mode Page 21*)
5. Adjust limit values (*see 6.4 Adjust limit values Page 23*)

6 Operation and handling

After all electric connections have been made, the device is ready for operation within ca. 10 to 15 min. All control elements of the PFM 92 C are on the signal board – a selector switch for the amplification [S2], a switch for the selection of the operation mode integration [S1] and a tip button [S3] for adjustment of the limit values as well as diverse LED – displays (see Fig. 4.5).



WARNING

Risk by non-observance of the safety advices!

The measuring device PFM 92 C must not be opened in potentially explosive dust atmosphere!

6.1 Measuring signal

The PFM 92 C does not have a display. The measuring signal is only provided via a 4 ... 20 mA analogue signal output. The signal output supplies a dust-equivalent signal.

Status messages are provided via status contacts and additionally via LED on the board of the PFM 92 C (see Fig. 4.5).

- ⇒ display *Failure* (at in operation: **green**)
- ⇒ display of *limit value violations* (at below the value: **green**)
- ⇒ display of *integration* (at *Integration*: **yellow**)
- ⇒ display of *limit value adjustment* activated (at activated: **red**)

Table 6.1: Status displays

6.2 Adjust amplification

In order to adjust the sensitivity of the PFM 92 C the amplification of the electronic has to be adjusted manually. The corresponding amplification selector is on the board of the filter controller [S2] (see Fig. 4.5). The following procedure is recommended:

1. Turn amplification selector [S2] first on stage 3 and switch [S1] for the operation mode *Integration* at *on* (LED [L1] flashes **yellow**).

For the standard operation of the filter plant the output signal between the cleaning cycles should have a value between ca. 3 % and 25 % (ca. 4,5 mA ... 8 mA).

Dust signal in [%]	Current output in [mA]
0	4,00
3	4,48
25	8,00
50	12,00
75	16,00
100	20,00

Table 6.2: Conversion of dust signal in mA

If necessary, the measuring range of the filter controller can be changed on the amplification stages 2, 1 or 0.



HINT

If the measuring signal is not within the amplification range 3 (that means the signal is > 100 % or 20 mA), a filter defect has to be assumed!

The sensitivities of the possible amplifications have the following relation:

Amplification/Gain	Sensitivity
0	0,33
1	1
2	3,3
3	10

Table 6.3: Amplification

After the selection of the correct measuring range the device will have been adjusted to the local conditions and is ready for operation.

The zero point is adjusted at factory.

6.3 Selection of operation mode

The PFM 92 C has 2 operation modes. In operation mode *Integral On* (LED [L1] Integration flashes yellow) the measuring signal is averaged with a time constant of ca. 30 s. A malfunction of the filter plant results in a substantial increase of the output signal. In order to check the filter plant thoroughly the integration can be switched off (*Integral Off*).

Now the tendency of the momentary dust content in the clean gas can be followed up at the recorder or any other registration unit. A strong increase of dust emissions in the moment of cleaning (ca. 2 ... 3 s) is typical for filters with pulse-jet cleaning. This effect can be used for the clear localisation of defective filter elements. A beginning wear of the filter plant is recognisable by an increase of the basic signal but also by substantially increased cleaning peaks..

In *Fig 6.1* a filter diagram is shown as example. It is a bag filter with 13 bag rows. The dust emissions of the rows 1 - 6, 12 and 13 are low, whereas at the bag rows 7- 11 a strongly increased dust penetration can be identified. The filter bags of these rows should be exchanged.

In *Fig. 6.2*, however, a sound filter diagram is shown.

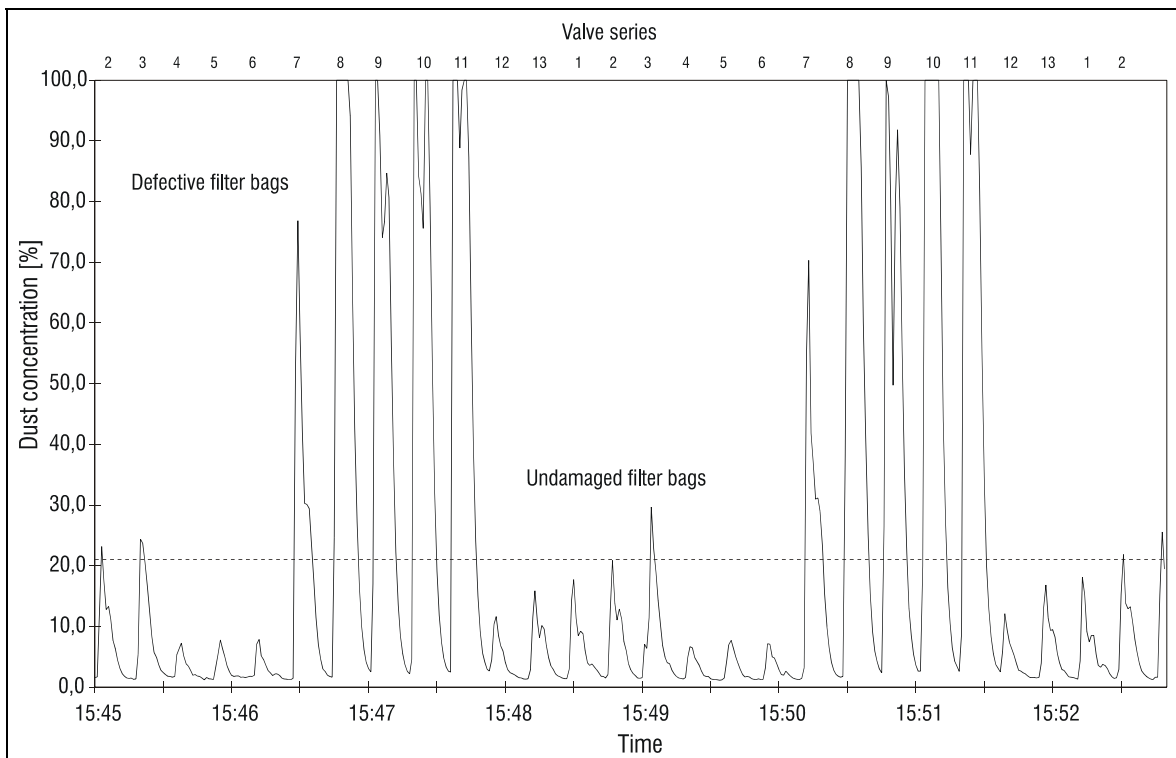


Fig 6.1: Filter diagram with defective filter bags

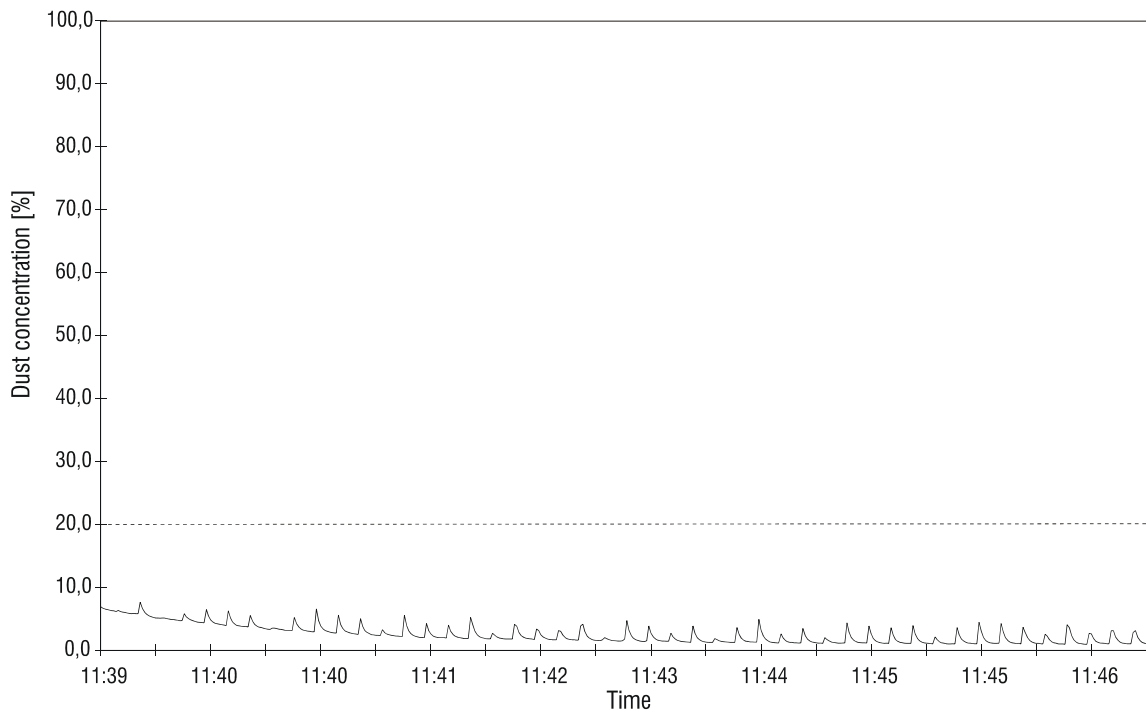


Fig. 6.2: Filter diagram with sound filter bags

6.4 Adjust limit values

By means of the button *Limit* [L3] two separate alarm limit values can be adjusted in the range 4 ... 20 mA (= 0 ... 100 % of the signal level). The use of this alarm makes only sense for the operation mode *Integral On*. Otherwise strong cleaning peaks could activate an alarm as well. In order to adjust the alarm limit value the button *Limit* [L3] has to be pressed rightwards for the first limit value or leftwards for the second limit value. If the button was used, the corresponding LED [L5] or [L6] flash red. The threshold value of the related limit value is now supplied to the analogue signal output. The threshold can be adjusted by means of a screw-driver at the potentiometers [P1] and [P2] being diagonally left and right above the button.

In order to signal the switch threshold there are 2 possibilities:

- ⇒ 4 ... 20 mA analogue signal output or
- ⇒ test signal output (0 ... 1 V) on the board (2 mm – test terminals)

The dust contents correspond to the signals as shown in table 1:

Dust signal in [%]	Current output in [mA]	Test signal in [V]
0	4,00	0,00
3	4,48	0,03
25	8,00	0,25
50	12,00	0,50
75	16,00	0,75
100	20,00	1,00

Table 6.4: Test signal

The LED-displays **GW1** [L2] and **GW2** [L3] usually flash (below the limit value) green. If one of these threshold values is violated, its corresponding LED goes out and the respective limit value contact is opened.



WARNING

Risk by non-observance of the safety advices!

The measuring device PFM 92 C must not be opened in potentially explosive dust atmosphere!

7 Shut down



WARNING

Danger of burn!

The probe rod can be heated up extremely by the measuring gas! Don't touch the probe rod. Wear protective gloves during works at the probe.

⇒ Switch off pre-fuse

7.1 Dis-assembly

The probe is de-installed according to *Fig. 7.1: Disassembly*. Thereby the power supply has to be interrupted first. Then the screw is unscrewed and the probe can be taken out.

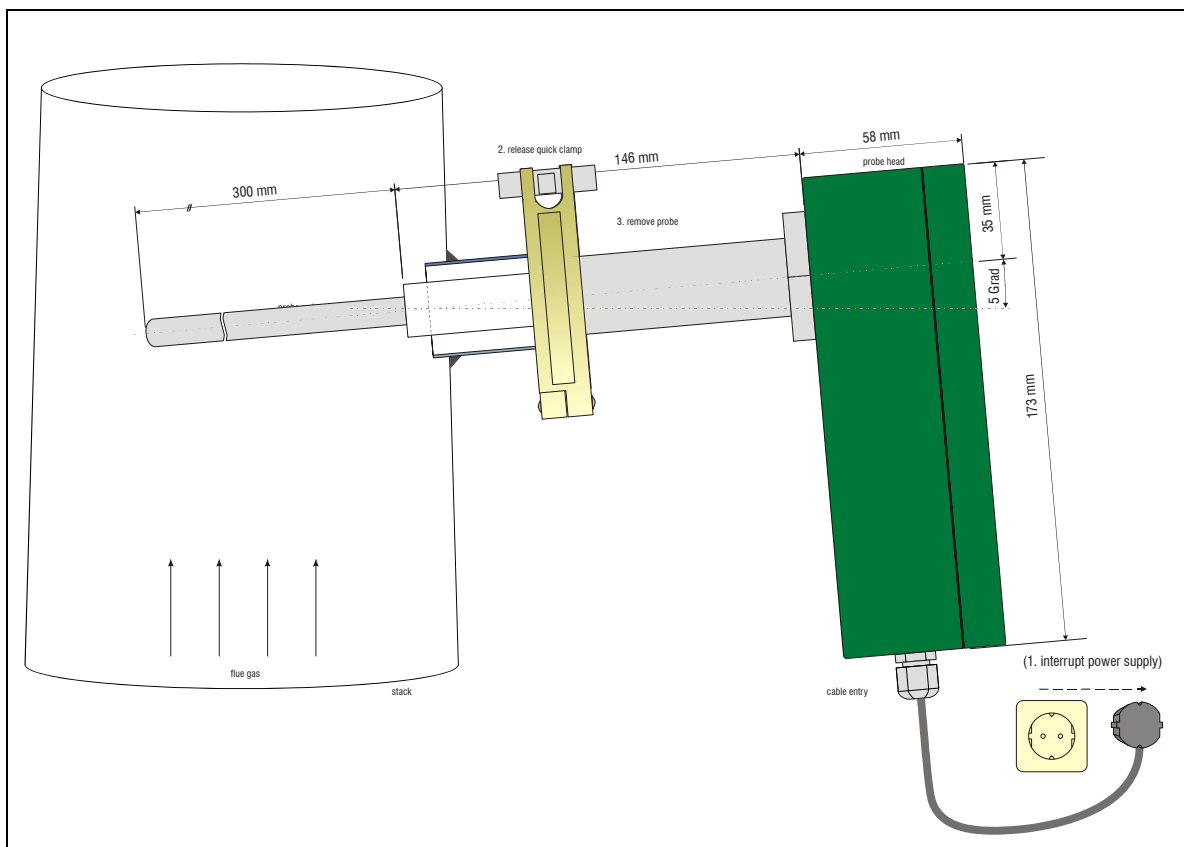


Fig. 7.1: Disassembly



7.2 Disposal



HINT

The disposal of the PFM 92 C has to be done according to locally valid environmental protection regulations.

In case of disposal the PFM 02 has to be treated as hazardous waste.

8 Maintenance

8.1 Maintenance



HINT

Warranty claims can only be granted if maintenance works have been done in accordance with the instructions.

The maintenance works aim at:

- ⇒ Preserving the measuring exactness of PFM 92 C,
- ⇒ Granting the operating safety,
- ⇒ Increasing the lifetime of the measuring device.

Moreover maintenance works are a basis for guarantee items.

8.1.1 Maintenance works

Minimum period	Activity
6 months	⇒ Cleaning of probe
6 months	⇒ Check sealing, replace if necessary

Table 8.1: Maintenance works

8.2 Cleaning

The dust measuring device PFM 92 C has to be cleaned at least every 6 months. The frequency of cleaning works to be done depends on the chosen measuring position respectively the measuring media (especially the dust content) and on the environmental and climatic conditions.

For all cleaning works at PFM 92 C it is valid:



WARNING

Danger of burn!

The probe rod can be heated up extremely by the measuring gas. Before the PFM 92 C is de-installed and cleaned, it must be switched off and the probe rod has to be cooled down.



9 Failure elimination



HINT

If failures or errors occur, which cannot be eliminated by the measures described hereinafter, contact the Dr. Födisch Umweltmesstechnik AG (see cover inside).

The PFM 92 C supplies status signals for monitoring, signalling failure states and failure search. They are provided at the status contacts as potential-free contact.

9.1 Failure

The operating state Failure (via status contact) occurs under the following points:

Failure message	Meaning	Activity
⇒ Voltage break down	⇒ Voltage supply is interrupted	⇒ Re-connect voltage supply

Table 9.1: Failure messages

10 Technical data

Feeding	230 / 110 VAC, 50 – 60 Hz, 24 VDC, 5 VA
Degree of protection	1
Ready for operation	after 5 to 15 minutes
Probe	
Dimensions (W x H x D)	ca. 78 x 173 x 500 mm
Immersion depth	300 mm (standard -> see order data!)
Weight	ca. 1,8 kg
Kind of protection	IP 64
Ambient temperature	-20 °C ... +50 °C
Ambient humidity	n.a. (no explicit sensitivity)
Measuring ranges	
Dust (qualitative)	0 ... 100 %
Electric connections	
Analogue signal (output)	4 ... 20 mA not galvanically isolated potential separation optionally possible
Load	max. 500 Ω
Status signals	max. 24 V / 0,1 A
⇒ Failure	contact normally closed (in case of failure open)
⇒ Limit value 1	contact normally closed (in case of limit value violation open)
⇒ Limit value 2	contact normally closed (in case of limit value violation open)

Table 10.1: Technical data



11 Spare parts & consumables

In order to purchase spare parts and consumables please contact Dr. Födisch Umweltmesstechnik AG (see cover inside)



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A	
Amplification 20	
ATTENTION 6	
B	
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C	
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