Embracing Challenge

Oxygen Analyzer Series PMA®

PMA 50 EX
(Effective starting Serial No. 1803436)

Instruction Manual
Version 1.02.01

Dear customer,

Thank you for buying our product. In this instruction manual you will find all necessary information about this M&C product. The information in the instruction manual is fast and easy to find, so you can start using your **M&C** product right after you have read the manual.
If you have any question regarding the product or the application, please don't hesitate to contact M&C or your M&C authorized distributor. You will find all the addresses in the appendix of this manual.
For additional information about our products and our company, please go to **M&C**'s website **www.mc-techgroup.com**. There you will find the data sheets and manuals of our products in German and English.

Version: 1.02.01

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1 GENERAL INFORMATION

The product described in this instruction manual has been examined before delivery and left our works in perfect condition related to safety regulations. In order to keep this condition and to guarantee a safe operation, it is important to heed the notes and prescriptions made in this instruction manual. Furthermore, attention must be paid to appropriate transportation, correct storage, as well as professional installation and maintenance work.
All necessary information a skilled staff will need for appropriate use of this product are given in this instruction manual.

2 DECLARATION OF CONFORMITY

CE - Certification

The product described in this instruction manual complies with the following EU directives:

ATEX-Directive

The product described in this manual is produced in accordance with the EU directive for devices and protection systems for appropriate use in hazardous areas 2014/34/EU appendix II.

RoHS Directive

The requirements of the RoHS2 ('Restriction of Hazardous Substances 2') directive 2011/65/EU and its annexes are met.

EMV-Instruction

The requirements of the EU directive 2014/30/EU "Electromagnetic compatibility" are met.

Low Voltage Directive

The requirement of the EU directive 2014/35/EU "Low Voltage Directive" are met.
The compliance with this EU directive has been examined according to DIN EN 61010.

Declaration of conformity

The EU Declaration of conformity can be downloaded from the **M&C** homepage or directly requested from **M&C**.

The SIL –declaration of conformity can be requested directly at M&C.

3 ELECTRICAL STANDARDS

The electrical standard of electrical equipment corresponds to the safety regulations concerning the EN61010 and to the safety requirements of the European standards:

- EN 61010
- EN 61508
- EN 60079-0:2012+A11:2013
- EN 60079-1:2014
- EN 60079-7:2015

for operation of the equipment in hazardous areas group II category 2. Attention must be paid to the Certificate of Conformity IBExU 16 ATEX 1192 (see appendix).

4 SAFETY INSTRUCTIONS

Note the following basic safety procedures when using this equipment:

- Read these operating instructions carefully before start-up and use of the equipment! The information and warnings given in these operating instructions must be heeded.
- Attention must be paid to the requirements of the certificate of conformity (see appendix): IBExU 16 ATEX 1192.
- Work on electrical equipment is only to be carried out by trained specialists as per the regulations currently in force.
- Attention must be paid to the requirements of **VDE 0100** when setting high-power electrical units with nominal voltages of up to 1000 V, together with the associated standards and stipulations.
- For use in hazardous area observe the relevant national and international instructions and regulations.
- Check the details on the type plate to ensure that the equipment is connected up to the correct mains voltage.
- Protection against touching dangerously high electrical voltages. Before opening the equipment, it must be switched and hold no voltages. This also applies to any external control circuits that are connected.
- The equipment is only to be set within the permitted range of temperatures and pressures.
- Check that the location is weather-protected. It should not be subjected to either direct sun, rain or moisture.
- Installation, maintenance, monitoring and any repairs may only be done by authorised personnel with respect to the relevant stipulations.

4.1 PROPER USE

The oxygen analyzer PMA50 EX is suitable for analyzing gas mixtures classified in Zone 1 with an oxygen content of up to 21% by volume. The PMA50 EX is suitable for the continuous measurement of oxygen in particle-free and dry sample gases with a maximum dew point of 5 °C [41 °F].
Only install and operate the analyzer under the operating parameters and conditions described in chapter 5 "Information and safety instructions for using the Analyzer in hazardous areas" and chapter 10 "Technical Data" of this instruction manual.
Refrain from all uses other than for this purpose. Improper use can lead to serious injuries, for more details see the safety instructions at the appropriate place.

5 INFORMATION AND SAFETY INSTRUCTIONS FOR USING THE ANALYZER IN HAZARDOUS AREAS

The Oxygen Analyzer **PMA 50 Ex** is suitable for use in hazardous area group II category 2.

The explosion proof protection is:
Ⓔx II 2G Ex d b eb IIC T4 Gb IBExU 16 ATEX 1192 , IECEx IBE 16.0041

The oxygen analyzer PMA50 EX is suitable for analyzing gas mixtures classified in Zone 1 with an oxygen content of up to 21% by volume.
Higher oxygen concentrations are not covered by the ATEX directive.

The analyzer has been certified through **IBExU**, authorized company for official approval of electric equipment in the Netherlands. Detailed information and a copy of the certificate are attached to this instruction manual.

Installation and operation of the analyzer has to be done corresponding to the conditions in the Ex-certificate (see appendix). Only in this case, the reliability of operation in hazardous area can be guaranteed.

All changes of the standard analyzer with parts which are not specified or approved by **M&C** as well as repair and service with not specified parts mean a loss of the Ex-certificate.

In case of doubt, please turn directly to **M&C** respectively to your **M&C** franchised dealer.

5.1 ANALYZING GASES FROM EX ZONE Ⓔx II 1G EX IIC T4

T wo protective devices must always be used for category 1G.

In both, the measuring gas inlet and outlet of the analyzer PMA50 EX, a M&C breathing and draining device MC95A EX II 2G Ex db IIC Gb is mounted.

When using explosive gas mixtures, which require zone 0, a suitable protection system must be provided in both the inlet and outlet against flame flashback.

The entire body has to be made of stainless steel.
Alternatively, other suitable protective devices against flame flashback can be used.

6 WARRANTY

If the equipment fails, please contact **M&C** directly or else go through your **M&C** authorised dealer.
We offer a one year warranty as of the day of delivery as per our normal terms and conditions of sale, and assuming technically correct operation of the unit. Consumables are hereby excluded. The terms of the warranty cover repair at the factory at no cost or the replacement at no cost of the equipment free ex user location.

Reshipments must be sent in a sufficient and proper protective packaging.

7 USED TERMS AND SIGNAL INDICATIONS

Danger

This means that death, severe physical injuries and/or important material damage **will occur** in case the respective safety measures are not fulfilled.

Warning

This means that death, severe physical injuries and/or important material damage **may occur** in case the respective safety measures are not fulfilled.

Caution

This means that minor physical injuries **may occur** in case the respective safety measures are not fulfilled.

Caution

Without the warning triangle means that a material damage may occur in case the respective safety measures are not met.

Attention

This means that an unintentional situation or an unintentional status may occur in case the respective note is not respected.

Note

These are important information about the product or parts of the instruction manual which require user's attention.

Qualified personnel

'Qualified personnel' are experts who are familiar with the installation, commissioning, maintenance, and operation of these types of products.
The following knowledge is at least required for the work:

- Instructed person in EX-protection
- Trained person in the electrotechnical field
- Detailed knowledge of the manual and the applicable safety regulations

'Ex' indicates important information about the product or about the corresponding parts in the instruction manual, relating to usage in potentially explosive atmospheres.

High voltages!
Protect yourself and others against damage which might be caused by high voltages.

Toxic!
Acute toxicity (oral, dermal, inhalation)! Toxic when in contact with skin, swallowed or inhaled.

Corrosive!
These substances destroy living tissue and equipment upon contact.
Do not breathe vapors; avoid contact with skin and eyes.

Hot surface!
Contact may cause burn! Do not touch!

Wear protective gloves!
Working with chemicals, sharp objects or extremely high temperatures requires wearing protective gloves.

Wear safety glasses!
Protect your eyes while working with chemicals or sharp objects. Wear safety glasses to avoid getting something in your eyes.

Wear protective clothes!
Working with chemicals, sharp objects or extremely high temperatures requires wearing protective clothes.

Use foot protection

Use safety helmet and full protective goggles

8 INTRODUCTION

8.1 SERIAL NUMBER

The type plate with the serial number is fixed on the left side of the analyzer's housing.
Please indicate always this serial number in case of questions or when purchasing spare parts.

8.2 POWER SUPPLY

The internal power supply of the oxygen analyzer **PMA50 EX** is 115 V or 230 V AC, 40 - 60 Hz. Detailed information can be found on the type plates. Variations of the power supply of -15 % to +10 % do not effect the function of the analyzer.

9 APPLICATION

The Oxygen Analyzer **PMA 50 EX** is suitable for the continuous measurement of oxygen in particle-free and dry sample gases with a maximum dew point of 5 °C [41 °F].

The features of the analyzer are safe operation, accuracy and low maintenance.

The measurement is based on the physical principle of the paramagnetic oxygen measuring cell and is one of the most exact quantitative methods of oxygen determination within the range of 0-100 vol% oxygen.

There is a direct flow against the measuring cell which has got a low volume of only 2 ml (small stagnant volume). Further characteristics are robustness, extremely small drift, fast response time (T_{90} < 5 sec.) and negligible cross sensitivities to other sample gas components.

Fluctuations of the sample gas flow in a range from 10 to 60 Nl/h nitrogen (N_2) cause a change of the oxygen reading which is smaller than 0.1 vol% O_2.

Measurements in flue gas and in inerting plants are among many other measurement tasks which are typical applications for the **PMA 50 EX**.

10 TECHNICAL DATA

Part Number	**05A1000**	**PMA 50 EX**, power supply **230 V**, pressure range **0.6 to 1.1 bar abs.**
	05A1000a	**PMA 50 EX**, power supply **115 V**, pressure range **0.6 to 1.1 bar abs.**
	05A2500	**PMA 50 EX/P/PD-1-50**, power **230 V**, (not with SIL-certification) pressure compensation 0.6 to 1.5 bar abs. with purging the enclosure via two breathing and draining devices in the in- and outlet 1/4" NPT female
	05A2500a	**PMA 50 EX/P/PD-1-50**, power **115 V**, (not with SIL-certification) pressure compensation 0.6 to 1.5 bar abs. with purging the enclosure via two breathing and draining devices in the in- and outlet 1/4" female
	05A2505	**PMA 50 EX/P/PD**, power **230 V**, (not with SIL-certification) pressure compensation 0.6 to 1.1 bar abs.
	05A2505a	**PMA 50 EX/P/PD**, power **115 V**, (not with SIL-certification) pressure compensation 0.6 to 1.1 bar abs.
Power supply		230 V AC (standard) or 115 V AC (a) -15 % to +10 %, 40-60 Hz, 35.5 VA
Electrical connections		Via Ex e connection box 3 x cable gland cable diameter : 7 mm–13 mm (M20), 14 mm–18 mm (M25) terminals 0.5 to 2.5 mm^2, Tightening torque 0.6 Nm (power, signals, range position and remote choice, status signal)
Measuring ranges **Be sure to observe chapter 5** ⟨Ex⟩		Selectable for 0-1, 0-3, 0-10, 0-30 and 0-100 vol% O_2 linear choice via turning selection switch at PMA 50 EX or remote switching
External range indication		Potential free contact for all measuring ranges. Switching capacity 48 V DC, 200 mA DC, Minimum contact rating 5 V/1 mA
Remote range selection		Measuring ranges selectable via potential free contacts max. 30 V DC, 3 mA DC. The function is displayed at the PMA 50 EX via LED.
Combined analog/digital indicator		Analog meter with a scale of 0-30 and 0-100 % for each selected range digital meter 4 ½ digit 9 mm high LCD-indicator for 0-100 % O_2 reading, selectivity 0.01 vol% O_2
Output signals		0/4-20 mA burden 270 Ω for every measuring range, electrically isolated; output voltage max. 15 V (ex works). Switchable max. burden 800 Ω, output voltage max. 30 V. Output current limiting adjustable 20 mA to 22 mA **20.5 mA ex works** 0-10 V DC, burden >100 KΩ for range 0-100 % isolated.
Response time for 90% FSD		< 5 seconds at 60 Nl/h air
Accuracy after calibration		± 1 % of the span value of measuring range after calibration or ± 0.02 %O_2 depending on which value is the higher one
Reproducibility		Analog output = < 1 % of measuring range / digital indication = ± 0.01 vol% O_2
Influence of ambient temperature		No influence up to 50 °C [122 °F]
Influence of barometric pressure		The oxygen reading varies in direct proportion to changes of the barometric pressure. No influence from 0.6-1.5 bar abs. at PMA 50 EX/P/PD(-1-50) with process pressure compensation
Influence of sample gas flow		Fluctuations of the sample gas flow in a range from 10 to 60 Nl/h nitrogen (N_2) cause a change of the oxygen reading which is smaller than 0.1 vol% O_2
Sample gas inlet pressure		Max. 1.1 bar abs.standard or in case of purging up to 1.5 bar abs. (Minimum inlet pressure is required for necessary gas flow, PMA50 EX has no integrated pump)
Sample gas outlet pressure		Outlet of analyzer must discharge freely into atmosphere. or 0.6 to 1.5 bar abs. at version PMA 50 EX/P/PD(-1-50) with process pressure compensation
Flow rate of sample gas		Min. 10 to max. 60 Nl/h adjustable externally via flowmeter (PMA50 EX has no integrated flow meter)

Temperature of sample gas	-10 up to +50 °C [14 up to 122 °F] dry gas
O_2-Transmitter temperature	Fixed at +55 °C [131 °F] (factory-set)
Temperature cut-off	At 72 °C [161.6 °F] via thermal fuse, non-reversible
Ambient temperature	0 to +50 °C [32 to 122 °F]
Storage temperature	-20 to +60 °C [-4 to 140 °F] at relative air moisture of 0-90 % r.h.
Medium touched material	Platinum, glass, PTFE, PVDF, stainless steel 316Ti, Epoxy
Connections measuring gas	1/4" NPT female
Flow failure	Thermo-conductive flow sensor downstream mounted after measuring cell
Status signal outlet	Change-over contact, switching capacity 250 V AC, 2A AC, 48 V DC, 200 mA DC minimum contact rating 50 mW for temperature <+45 °C [113 °F]/> +60 °C [140 °F], defect light beam, measuring cell not coupled, flow failure < 5 Nl/h, power supply error control, mains voltage breakdown, failure measuring range selection
Classification/Protection	Ⓔx II 2G Ex db eb IIC T4 Gb IP54 EN 60529
Housing/color	EX-d e wall mounted explosion-proof housing/white
Dimensions (H x W x D)	475 (535 mm with breathing and draining device) x 355 x 200 mm [≈ 18.7" (535 mm [≈ 21.1"] with breathing and draining device) x 14" x 7.9"]
Weight	Approx. 22 kg [≈ 48.5 lbs]
Certificate No.	IBExU 16 ATEX 1192 IECEx IBE 16.0041

10.1 OPTIONS

Part number	Options
05A9005	Extra charge for one breathing and draining device for PMA50 EX enclosure, for sample gas pressures up to max. 1.5 bar abs. and non-corrosive gases
05A9000	Purging the enclosure via two breathing and draining devices in the gas inlet and outlet, for sample gas pressures up to max. 1.5 bar abs and/or corrosive gases, connection 1/4" NPT female, purge gas inlet pressure max. 1.1 bar abs., flow rate 10-60 Nl/h
90A0009	Measuring cell type PMC-1LB, solvent resistant.
90A0006	Measuring cell PMC-1G with glass solder. O-ring made of Chemraz®

Please note: Nl/h and Nl/min refer to the German standard DIN 1343 and are based on these standard conditions: 0 °C [32 °F], 1013 mbar.

Chemraz® is a registered trademark for perfluoroelastomer by Greene Tweed, USA.

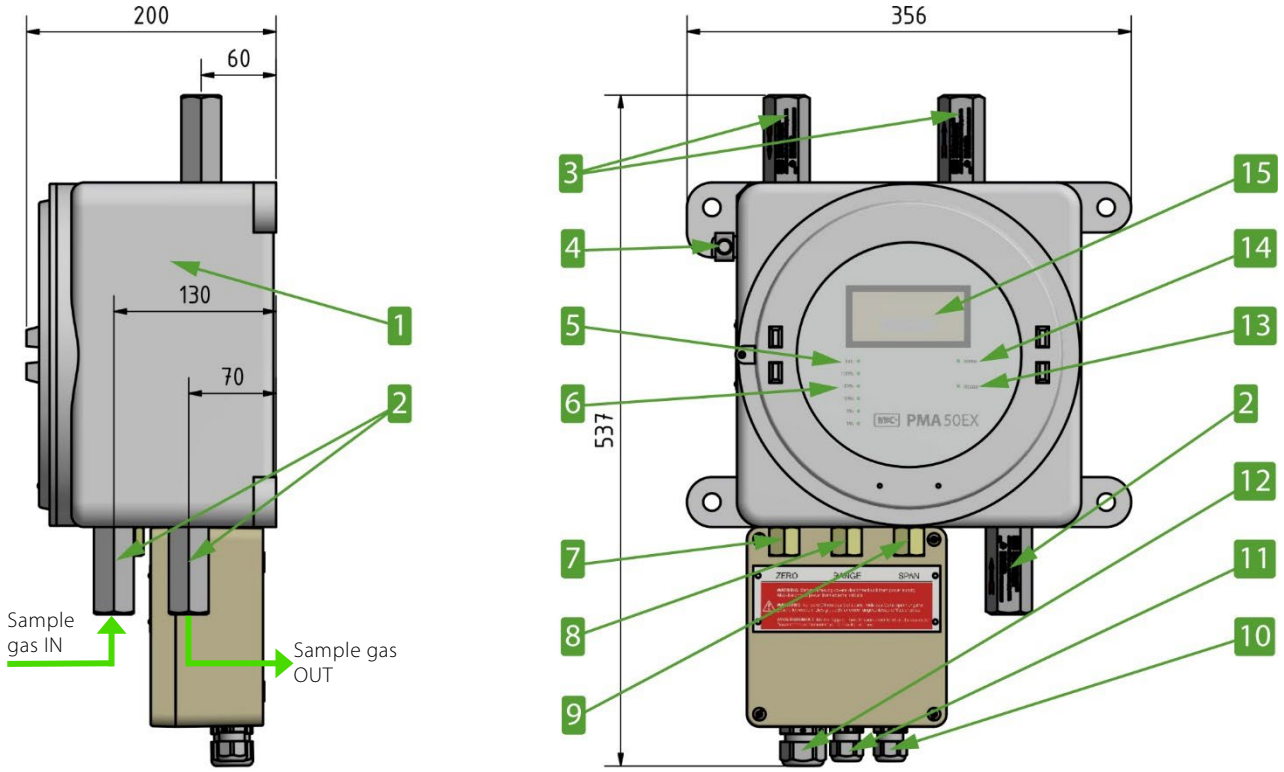
11 DESCRIPTION

The main part of the **PMA50 EX** is the paramagnetic oxygen measuring cell.
This measuring principle is one of the most precise quantitative methods for determination of the oxygen contents in the range of 0-100 vol% O_2.

The Oxygen Analyzer **PMA50 EX** is destined for stationary operation. The mounting into an **Ex db eb IIC T4** housing 1 with breathing and draining devices in the sample gas inlet and outlet 4, allows the analyzer to be installed in an explosive atmosphere of equipment group II, category 2, and allows the analysis of explosive gases of equipment group II, category 2.

The analyzer is thermostatted and regulated to a transmitter temperature of +55 °C [131 °F]. The temperature controller is designed in such a way that the low voltage section and the 230 V power section are separated via an opto-coupler with zero voltage switch.
The large heating elements mounted on the transmitter surface guarantee a fast and even temperature distribution.
The non-reversible overtemperature fuse prevents the transmitter from overheating above 72 °C [161.6 °F].
For better heat storage and insulation, the transmitter is equipped with an insulating cover.

Figure 1 shows the Oxygen Analyzer **PMA50 EX** in front view and side view.



1 Enclosure
2 Sample gas inlet, outlet
3 Breathing and draining devices type MC95A
4 Equipotential bonding terminal
5 Measuring range: internal, external-LED
6 Measuring range-LED
7 Zero adjustment
8 Measuring range selector
9 Full scale adjustment
10 Cable gland M20
11 Cable gland M20
12 Cable gland M25
13 Heating control-LED
14 Status-LED collective status
15 Measured value display

Figure 1 PMA50 EX oxygen analyzer

A window in the housing of the analyzer enables the control of the analog/digital measured value display 15, the heating control LED 13 and status LED 14, as well as the measuring range LEDs 5 and 6.

All operating elements are accessible from the outside and guarantee simple and user-friendly handling during calibration as well as measuring range switching.
The operating elements are:

- Full scale adjustment 9,
- Measuring range selector 8 and
- Zero adjustment 7.

The oxygen display 15 of the **PMA50 EX** consists of a two-scale analog display instrument. Here the oxygen value is displayed in a range of 0-100 vol% with a resolution of 0.1 vol%. A digital display is integrated in the analog display. Here the oxygen value is displayed in a range of 0-100 vol% with a resolution of 0.1 vol%.

The measuring range can be switched via selector switch 8. The selected measuring range is indicated externally by a corresponding LED 6 on the front panel of the **PMA50 EX** and by potential-free contacts (see Figure 6).
The measuring range can also be selected externally (see Figure 6). An external selection overrides the selector switch 8. LED 5 on the front panel of the analyzer in conjunction with the corresponding measuring range LED 6 signals the external measuring range control.

The function of the analyzer heating is indicated by LED 13. When the LED flashes, the operating temperature is reached.

The **PMA50 EX** has a collective status output as standard. This is a potential-free changeover contact in'Safety-First' circuit. The switching capacity is 200 mA at 48 A DC or 2 A at 250 V AC. The status is indicated by the status LED 14.
The following status messages are displayed:

- Light source defective,
- measuring cell not coupled,
- flow failure < 5 Nl/h,
- power supply error control,
- mains voltage breakdown,
- transmitter temperature < +45 °C [113 °F]/> +60 °C [140 °F],
- failure measuring range selection.

11.1 PMA 50 EX/P/PD-1-50 WITH PRESSURE COMPENSATION AND ENCLOSURE PURGING (WITHOUT SIL-CERTIFICATION)

In case of barometric or process -related pressure variations, the **PMA 50 EX** can be equipped with a special pressure compensation. The pressure can be compensated in a range of 0.6 to 1.5 bar abs. This can eliminate measurement errors due to pressure fluctuations.

In addition, the analyzer is equipped with an enclosure purging via breathing and draining devices in the inlet and outlet. The enclosure purging is necessary in case of corrosive sample gas and / or pressure above 1.1 bar abs. In the event of a leak in the analyzer, no pressure can build up in the housing and the analyzer cannot be damaged by corrosion if the sample gas is additionally corrosive. The required purge gas quantity is 10 - 60 Nl/h according to the set sample gas quantity, and the purge gas inlet pressure is max. 1.1 bar abs.

The enclosure purging has to flow off atmospherically free!

11.2 PMA 50 EX/P/PD WITH PRESSURE COMPENSATION (WITHOUT SIL-CERTIFICATION)

In case of barometric or process-related pressure variations, the **PMA50 EX** can be equipped with a special pressure compensation. The pressure can be compensated in a range of 0.6 to 1.1 bar abs. This can eliminate measurement errors due to pressure fluctuations.

11.3 OPTION ZERO SUPPRESSION (WITHOUT SIL-CERTIFICATION)

A zero suppression is possible for devices with pressure compensation within a range of 1 to 97 vol% O_2 in increments of 1 %. The suppressed measuring range can, depending on the suppression, be located at the position of one of the standard measuring ranges. The factory-set suppression can be switched on or off via a switch at terminal points 22 or 23 in the connection box of the analyzer (see Figure 6). After switching off, the original standard measuring range is active again.

11.4 OPTION ENCLOSURE PURGING OR ENCLOSURE VENTILATION

When measuring corrosive gases, it is recommended to equip the analyzer with the possibility of purging the enclosure. This reduces the risk of the analyzer being destroyed by corrosion in the event of leaking gas paths. Please select the option Art. No. 05A9000 (2 x breathing and draining devices). The required purge gas quantity is 10 - 60 Nl/h according to the set sample gas quantity, and the purge gas inlet pressure is max. 1.1 bar abs.

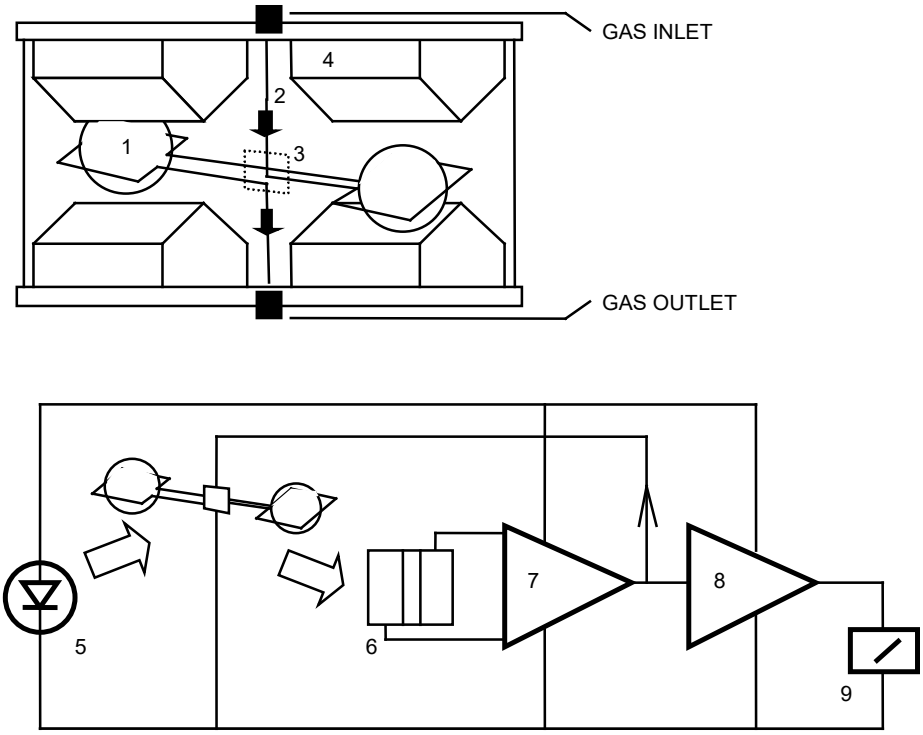
For increased inlet pressures from 1.1 bar to max. 1.5 bar abs. **one** breathing and draining device is also required in accordance with the Ex certificate (see appendix). To do this, select the option with item no. 05A9005. For increased inlet pressure from 1.1 bar to max. 1.5 bar abs. **and** corrosive sample gas, the analyzer needs to be equipped with the option Art.-No.: 05A9000.
The required purge gas quantity is 10 - 60 Nl/h according to the set sample gas quantity and the purge gas inlet pressure is max. 1.1 bar abs.

For excess pressure operation (> 1.1 bar abs.) an enclosure ventilation according to the ex-certificate is necessary. For additionally corrosive sample gas an enclosure purging is necessary. Both have to flow off atmospherically free!

12 MEASURING PRINCIPLE

Oxygen is a gas with a significant paramagnetic susceptibility. The molecules of oxygen are attracted much more strongly by a magnetic field than the molecules of other gases. The measuring principle shown in the following is benefitting from these characteristics of the oxygen. The great advantage of the paramagnetic measuring principle is the highly reduced cross sensitivity of the measurement to other components in the sample gas.

Figure 2 shows the diagram of the measuring cell as well as the optical system for the detection of the dumbbell's movement.



1 Nitrogen-filled spheres
2 Tightening strap out of platinum
3 Small mirror
4 Wedge-shaped pole pieces
5 Projektions-LED
6 Photo cell
7 Measuring amplifier
8 Measuring amplifier
9 Display

Figure 2 Drawing of the measuring cell and optical signal processing

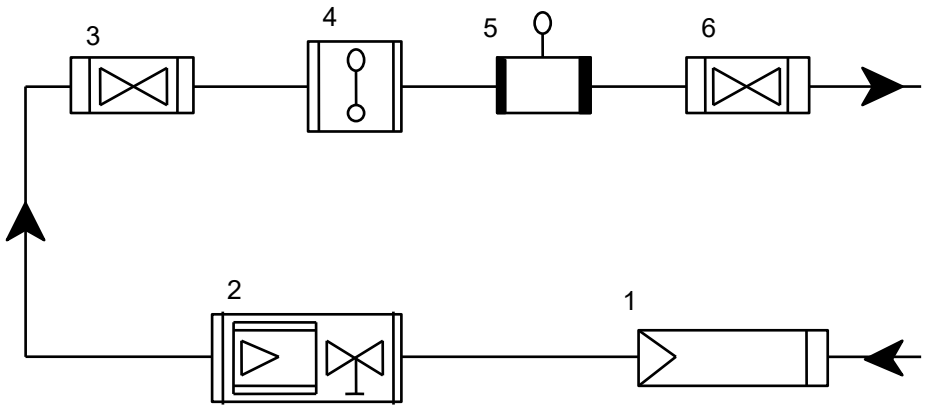
The measuring cell consists of two hollow spheres **1** filled with nitrogen, which are formed into a dumbbell. In the center of rotation of the dumbbell is a small mirror **3**, which surrounds a wire loop, which is required for the compensation procedure. The above system is fixed rotationally symmetrically in a glass tube with a platinum strap **2** and is screwed into two pole pieces **4**.

Two permanent magnets generate an inhomogeneous magnetic field. When oxygen flows in, the oxygen molecules are drawn into the magnetic field. The field lines on the wedge-shaped pole pieces **4** are compressed and the nitrogen-filled diamagnetic hollow spheres are forced out of the magnetic field. This causes the dumbbell to rotate. The rotation motion is detected by an optical system consisting of mirror **3**, projection LED **5** and photocell **6**.

When the dumbbell is pushed out of the magnetic field, the voltage of the photocell changes immediately. The measuring amplifiers **7** and **8** generate a corresponding current which generates an electromagnetic counter-torque via the wire loop on the dumbbell. The counter torque returns the dumbbell to its zero position.
Each change in the oxygen concentration causes a linear proportional change in the compensation current and can therefore be read directly as oxygen value in % O_2 on the display **9**.
Due to its very small stagnant volume (2 cm^3) and the direct flow to the **M&C** measuring cell, an extremely fast response time (T_{90}-time) of one second for a high gas flow can be realized.

13 GAS FLOW DIAGRAM

Figure 3 shows the gas flow diagram of the Oxygen Analyzer **PMA50 EX**.



1 : External fine filter
2 : External flow meter
3 : breathing and draining device
4 : Measuring cell
5 : Flow alarm sensor
6 : breathing and draining device

Figure 3 Gas flow diagram

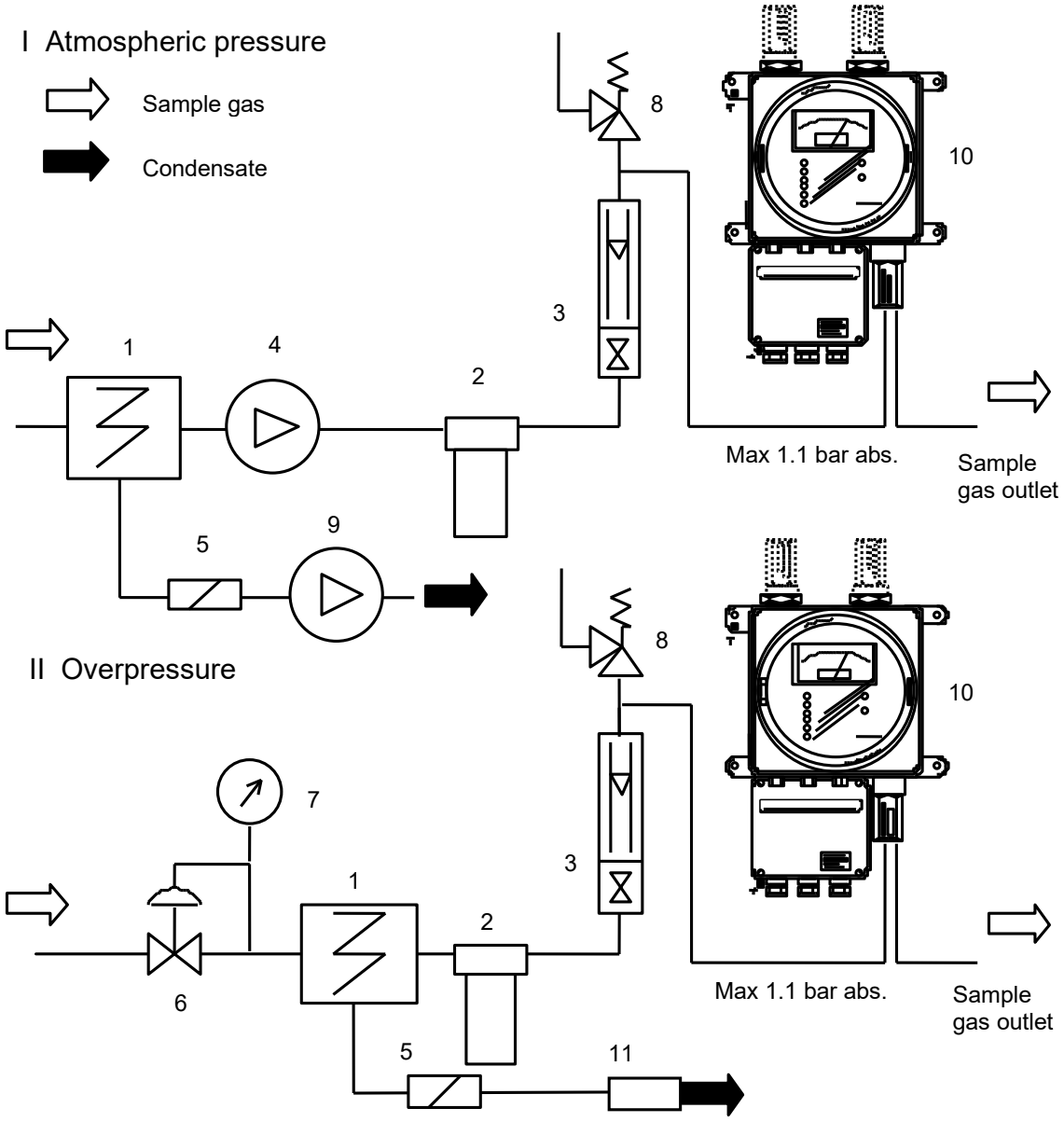
The measuring cell **4** must absolutely be protected against dust particles. Therefore, the upstream external gas conditioning system should be equipped with a fine filter **1** of at least 2 µm filter porosity (eg. type **FP-2T**).

The maximum gas flow of 60 Nl/h can adjusted by an externally mounted flow meter **2** with a needle valve.

The sample gas enters the measuring cell **4** via the inlet breathing and draining device **3**.

A flow sensor **5** in the outlet of the measuring cell is controlling the gas flow through the cell according to the measuring principle of thermal conductivity. If the minimum gas flow is not reached, an alarm is automatically triggered and is available as a status message at the collective status output. The status is also indicated by a color change of LED 14 (see Figure 1) on the front panel of the analyzer (red/green).

Figure 4 shows the structure of the conditioning system according to the above-mentioned specification.



1 Gas cooler
2 Fine filter
3 Flow meter 6-60 Nl/h
4 Sample gas pump
5 Filter
6 Pressure reduction
7 Pressure display
8 Overflow valve
9 Condensate pump
10 Analyzer PMA50 EX
11 Condensate removal

Figure 4 Gas conditioning

14 RECEIPT OF GOODS

The analyzer **PMA50 EX** is a completely pre-installed unit.

- Please take the analyzer and possible special accessories carefully out of the packaging material immediately after arrival, and compare the goods with the items listed on the packing list;
- Check the goods for any damage caused during delivery and, if necessary, notify your transport insurance company without delay of any damage discovered.

Note

The oxygen analyzer PMA50 EX must be stored in a weather-protected and frost-free area!

15 INSTALLATION

The **PMA50 EX** analyzer is designed for stationary wall mounting. All electrical connecting options are located inside the connection box below the analyzer housing.

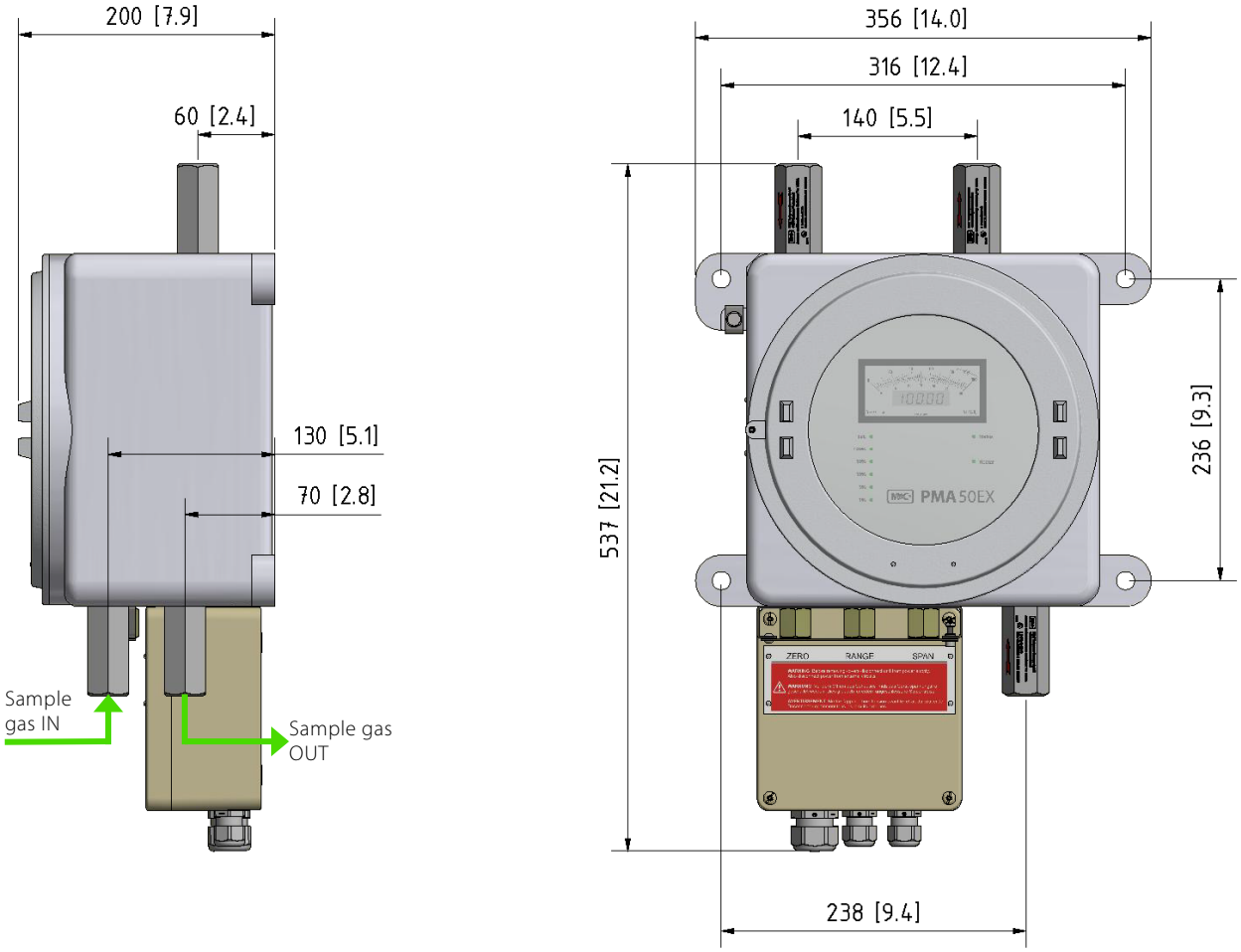


Figure 5 Dimensions for installation

The correct installation, as well as an optimized upstream sample gas treatment guarantee a long functionality and a minimum of maintenance.

When using the analyzer outdoors, it must be protected against the effects of the weather.

If possible, the installation should be done in constant climatic ambient conditions.

A vibration-free location is ideal for installation. If this is not possible, antivibration mounts must be used to decouple the housing.

The analyzer must not be installed in direct proximity of heat sources.

Warning

The sample gas must be dry (dew point 5 °C [41 °F]), free from dust and the sample gas temperature must not exceed 50 °C [122 °F]. Otherwise an upstream sample gas cooler with automatic condensate removal is necessary.
A preceding fine filter of at least 2 µm is absolutely necessary.
The sample gas has to flow off atmospherically freely at the sample gas outlet, because a pressure rise at the sample gas outlet and therefore in the measuring cell falsifies the oxygen measurement.
The maximum inlet pressure is 1.1 bar abs. For the standard device and 1.5 bar abs. for devices with enclosure purging or enclosure ventilation.

The analyzer is suitable for use in explosive atmosphere group II category 2.
Equipment with protection Ex II 2G Ex db eb IIC T4 Gb (see type plate) is suitable to measure explosive gases of group II category 2.
The oxygen analyzer PMA50 EX is suitable for analyzing gas mixtures classified in Zone 1 with an oxygen content of up to 21 % by volume.
Higher oxygen concentrations are not covered by the ATEX directive.

16 SUPPLY CONNECTIONS

16.1 CONNECTIONS: SAMPLE GAS INLET AND SAMPLE GAS OUTLET

The sample gas inlet and outlet are placed on the lower side of the analyzer. Both are equipped with breathing and draining devices type **MC95A**. The breathing and draining devices have a 1/4" NPT female thread.

Warning

The Ex-approval of the oxygen analyzer is only valid in connection with the approved breathing and draining devices. For this reason, it is not allowed to remove them or to use other types of breathing and draining devices!

16.2 OPTION PURGING ENCLOSURE OR ENCLOSURE VENTILATION

According to the Ex-Certificate (see annexe) purging of the enclosure is also required in case of increased inlet pressure of 1.1 to max. 1.5 bar abs. To do this, choose the option Part No. 05A9005. For increased pressure **and** corrosive gases, the analyzer must be equipped with the option enclosure purging (Part No. 05A9000).

When measuring corrosive gases, it is recommended to equip the analyzer also with the option enclosure purging (Part No. 05A9000). This reduces the risk of the analyzer being destroyed by corrosion in the event of leaking gas paths.

Purge gas inlet and outlet or vent, equipped with breathing and draining devices type **MC95A** with 1/4" NPT female connections 3 (see Figure 1), are located on the top of the analyzer housing.

Dry air or nitrogen has to be used for purging the enclosure. The purge gas flow rate has to be adjusted between 10 Nl/h and 60 Nl/h. The purge gas inlet pressure is max. 1.1 bar abs.

For retrofitting the analyzer with the option enclosure purging, the following components are necessary:

- 2 x breathing and draining devices type **MC95A**, part number 90A5150
- 1 x male connector DN 4/6-1/4""NPT female, part number 05V2060 for the purge gas connection.

Warning

Use breathing and draining devices with LOCTITE™ Type 270 to prevent unintentional release of the devices!

16.3 ELECTRICAL CONNECTION

Warning

If you do not use the correct supply voltage, the equipment may be destroyed. Please take care of the correct supply voltage as indicated on the type plate.

The equipotential bonding terminals of the analyzer housing and the terminal box must always be connected in case of installation in hazardous area.

Ensure sufficient grounding of the housing! (potential equalisation)

Note

When setting high-power electrical units with nominal voltages of up to 1000V, attention must be paid to the requirements of IEC 364 (DIN VDE 0100) together with the associated standards and regulations and ElexV!

Main switch and corresponding fuse must be provided externally by the customer.
All electrical connections are located in inside the terminal box below the analyzer housing (see appendix).
After loosening the cover screw connection, the following terminal connections are freely accessible:

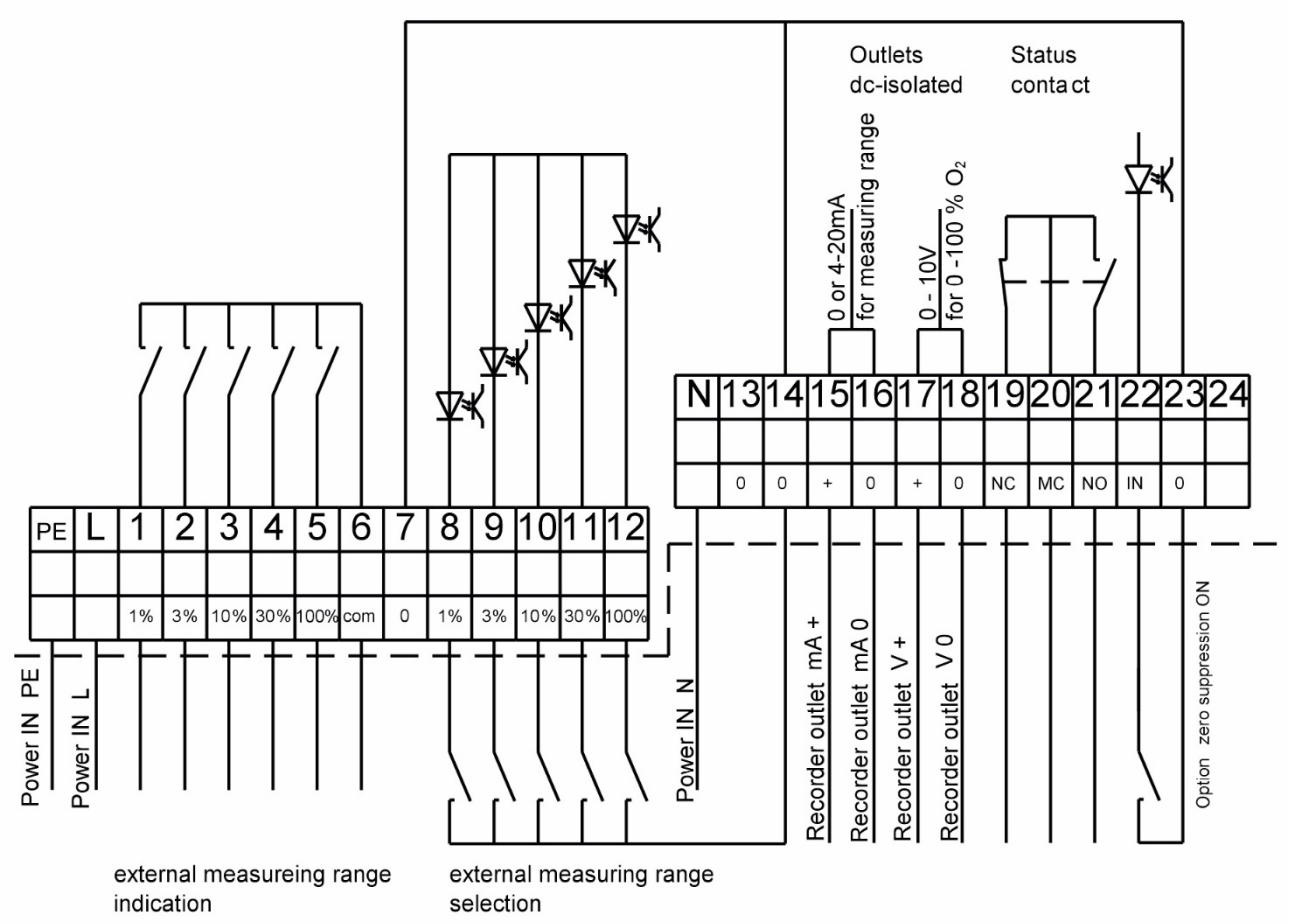


Figure 6 Electrical connection inside the connection box of the PMA50 EX

The cables used for connecting the PMA50 EX analyzer must have a diameter of 7-13 mm for cable glands M20 (small) and 14-18 mm for cable glands M25 (large).
Replace unused cable glands with a suitable blind plug (II 2G Ex eb).
The equipotential bonding terminal 4 (see Figure 1) is located at the top left side of the housing.

17 PREPARATIONS FOR COMMISSIONING

Before initial startup, all plant- and process-specific safety measures must be observed. It is mandatory for the operator to complete the enclosed risk assessment of the product.
The gas exposure risk must be assessed by the operator with regard to the hazards posed by process and calibration gas and the setup at the installation site (e.g. tubing, system cabinet/container/plant). If the risk assessment reveals increased exposure hazards, further measures are required.
A visible label must be attached to the installation site in accordance with the risk assessment provided by the operator.

18 STARTING UP

The following steps must be carried out when commissioning the analyzer:

- Before starting the equipment for the first time, check that the electrical connections and the gas connections have been executed as requested. The voltage indicated on the type plate must correspond to the mains supply.

- Deviations of the zero point of the analog display can be corrected by using the adjusting screw below the digital display. To do this, the housing of the analyzer must be opened in a voltage-free state.

- Set the measuring range selector switch to 30 % and switch on the analyzer using the external main switch. The display of the analyzer now shows an O_2 value of less than 21 % in ambient air.

- The warm-up phase of the analyzer is indicated by the permanently lit heating control LED 13 on the front panel (Figure 1). After about 30 minutes the **PMA50 EX** has reached its operating temperature. This is indicated by a flashing of the heating control LED 13 (see Figure 1).

Note

Calibrate the analyzer after starting-up. The temperature is stable after approx. 3 hours. Now, the analyzer can be calibrated according to the following instructions. To check how stable the status of the analyzer is, start another calibration after 24 hours!

19 CALIBRATION

Before carrying out calibration work, the plant- and process-specific safety measures must be observed!

The accuracy of the measurement depends on the accuracy of the analyzer calibration.

The linearity of the measuring ranges allows a two-point calibration, that of the zero point and the measuring range end value.

Recommendation for calibration intervals: The weekly calibration of the analyzer guarantees the required accuracy of the measurements. Due to the direct proportional dependence of the oxygen display to the barometric or process pressure, the calibration interval can be reduced accordingly to one day in case of large pressure fluctuations.

Note

Basically, carry out the calibration under measuring conditions, i.e. keeping the flow rate, the room temperature and the barometric pressure conditions constant. Avoid vibrations!

19.1 ZERO CALIBRATION

To do a zero-point calibration of the analyzer, use an O2-free gas, e.g. nitrogen (N_2) 5.0. Follow the steps below:

- Connect the flexible PVC or Viton tube with the bottle's pressure reducer of the N_2-zero gas bottle;

Warning

The pressure reducer should have a maximum outlet measuring range of 0 to 1.5 bar abs. and should always be adjusted to a low outlet pressure of max. 1.1 bar abs. This protects the measuring cell against destruction due to high pressure!

- First of all, open the bottle valve, then open the outlet valve of the pressure regulator;
- The pressure regulator and the tubing have to be purged for about 5 seconds;
- Check adjusted control pressure and reduce to ≤ 1.1 bar abs. if necessary, then shut-off the outlet valve of the pressure regulator again;
- Connect the free tube end of the zero gas bottle connection to the external flow meter or, if available, to the external calibration valve;
- Open the outlet valve of the pressure regulator slowly, in order to avoid pressure peaks;
- Adjust the zero gas volume flow with the needle valve of the flow meter to max. 60 l/h. The volume flow of the calibration gas should always be adapted to the sample gas volume flow;

Note

Always calibrate at the same gas flow as used for the measurement.

- Wait approx. 30 seconds until display is stable;
- Set the range switch 8 (see Figure 1) to 0-1 % O_2 (with a screw driver);
- If necessary, adjust the zero point to 0 % via the zero point potentiometer 7 (Figure 1) (with a screw driver);
- Check the analogue output signals at 0% O_2;

Ouput signal	Signal to be measured
0-10 V DC	0 V
0-20 mA	0 mA
4-20 mA	4 mA

Note

If a gas mixture is analyzed, the individual components shall be checked for possible cross-sensitivity and taken into account accordingly during zero calibration (see chapter 20).

- Shut the output valve of the pressure regulator and bottle valve and disconnect the tube connection to the analyzer.

Note

After zero calibration, the full scale value must also be calibrated!

19.2 FULL SCALE VALUE CALIBRATION

Note

For oxygen concentrations of the sample gas below 30 % O_2, dry air can be used for calibration. Higher concentrations ideally require a test gas corresponding to the full scale value!

Before calibrating the full scale value, always check the zero point.

The following calibration procedure has to be carried out:

- Adjust measuring range selection switch to the range in which the calibration will be carried out.
- Connect the flexible PVC or Viton tube with the bottle pressure reducer of the test gas bottle, if necessary with ambient air or instrument air.

Warning

The pressure reducer should have a maximum outlet measuring range of 0 to 1.5 bar abs. and should always be adjusted to a low outlet pressure of max. 1.1 bar abs. This protects the measuring cell against destruction due to high pressure!

- First open the bottle valve, then open the closed output valve of the pressure regulator;
- Purge the pressure regulator and the tubing for about 5 seconds;
- Check adjusted control pressure and reduce to ≤ 1.1 bar abs. if necessary, then shut-off the outlet valve of the pressure regulator again.
- Connect the free tube end of the test gas bottle connection to the gas inlet of the analyzer or, if available, the external calibration valve;
- Open slowly the output valve of the pressure reducer in order to avoid pressure peaks;
- Set the test gas volume flow to max. 60 l/h using the needle valve of the flow meter. The volume flow of the calibration gas should always correspond to the sample gas volume flow;

Note

Always calibrate at the same gas flow as used for the measurement.

- Wait approx. 30 seconds until the display is stable. If necessary, adjust the O_2-value of the test gas via the end value potentiometer 9 (Figure 1) (with a screw driver at air 20.93 %);

- Check the analog output signals;

- The signal to be measured can be calculated as follows:

$$\text{Measured value} = \frac{(\text{max. signal output} - \text{min. signal output}) \times \text{Concentration [\%]}}{\text{Full scale value [\%]}} + \text{min. Signal output}$$

A test gas concentration of 20.93 % (air) would result in the following:

Output signal	**Signal to be measured with full scale value**	
	100 %	
0-10 V DC	2.09 V	
Output signal	**Signal to be measured with full scale value**	
	30 %	100 %
0-20 mA	13.95 mA	4.19 mA
4-20 mA	15.16 mA	7.35 mA

Note

The mA-signal depends on the set measuring range. Therefore, it is important to check the correctness of the selected measuring range!

- Shut-off the output valve of the pressure regulator and the bottle valve and disconnect the tube connection to the analyzer.

The full scale value calibration has been completed.

Attention

After calibration set the measuring range selection switch to desired measuring range again.
The mA-output signal is dependent on the selected measuring range!

20 MEASURING

During initial commissioning at a new measurement location, all the steps described above must be followed.

The accuracy requirements for the analysis determine the interval of recalibration.

The sample gas quantity should be adjusted between 10 Nl/h and 60 Nl/h air (external flow meter).

After selecting the desired measuring range, the analyzer is ready for measurement.

Caution The sample gas must be free of all components in liquid and solid form, i.e. the dew point of the sample gas must always be considerably lower than the instrument or ambient temperature so that condensation does not occur in the instrument. If necessary, lower the dew point using a cooler or dryer. For dust filtration, connect a filter with 2 µm filtration rating upstream!

Feel free to ask us about an optimal gas treatment!

Note In principle, measurements should only be carried out while keeping the flow rate and room temperature constant.

21 CROSS SENSITIVITIES

The following table shows the cross sensitivities of the most important gases at 20 °C [68 °F] and 50 °C [122 °F]. All values are based on a zero calibration with N_2 and a full scale value calibration with 100 vol% O_2. The deviations are each valid for 100 vol% of the respective gas.

Gas	Molecular formula	20 °C [68 °F]	50 °C [122 °F]
Acetaldehyde	C_2H_4O	-0.31	-0.34
Acetone	C_3H_6O	-0.63	-0.69
Acetylene	C_2H_2	-0.26	-0.28
Ammonia	NH_3	-0.17	-0.19
Argon	Ar	-0.23	-0.25
Benzene	C_6H_6	-1.24	-1.34
Bromine	Br_2	-1.78	-1.97
Butadiene	C_4H_6	-0.85	-0.93
n-Butane	C_4H_{10}	-1.10	-1.22
Isobutylene	C_4H_8	-0.94	-1.06
Chlorine	Cl_2	-0.83	-0.91
Diacetylene	C_4H_2	-1.09	-1.20
Dinitrogen oxide	N_2O	-0.20	-0.22
Ethane	C_2H_6	-0.43	-0.47
Ethylbenzene	C_8H_{10}	-1.89	-2.08
Ethylene	C_2H_4	-0.20	-0.22
Ethylene glycol	$(CH_2OH)_2$	-0.78	-0.88
Ethylene oxide	C_2H_4O	-0.54	-0.60
Furan	C_4H_4O	-0.90	-0.99
Helium	He	+0.29	+0.32
n-Hexane	C_6H_{14}	-1.78	-1.97
Hydrogen chloride	HCl	-0.31	-0.34
Hydrogen fluoride	HF	+0.12	+0.14
Hydrogen sulphide	H_2S	-0.41	-0.43
Carbon dioxide	CO_2	-0.27	-0.29
Carbon monoxide	CO	-0.06	-0.07
Krypton	Kr	-0.49	-0.54
Methane	CH_4	-0.16	-0.17
Methanol	CH_4O	-0.27	-0.31
Methylen chloride	CH_2Cl_2	-1.00	-1.10
Neon	Ne	+0.16	+0.17
n-Octane	C_8H_{18}	-2.45	-2.70
Phenol	C_6H_6O	-1.40	-1.54
Propane	C_3H_8	-0.77	-0.85
Propylene	C_3H_6	-0.57	-0.62
Propylene chloride	C_3H_7Cl	-1.42	-1.44
Propylene oxide	C_3H_6O	-0.90	-1.00
Oxygen	**O_2**	**+100,00**	**+100.00**
Sulphur dioxide	SO_2	-0.18	-0.20
Sulphur hexafluoride	SF_6	-0.98	-1.05
Silane	SiH_4	-0.24	-0.27
Nitrogen	**N_2**	**0.00**	**0.00**
Nitrogen dioxide	NO_2	+5.00	+16.00
Nitrogen monoxide	NO	+42.70	+43.00
Styrene	C_8H_8	-1.63	-1.80
Toluene	C_7H_8	-1.57	-1.73
Vinyl chloride	C_2H_3Cl	-0.68	-0.74
Vinyl fluoride	C_2H_3F	-0.49	-0.54
Water (vapour)	H_2O	-0.03	-0.03
Hydrogen	H_2	+0.23	+0.26
Xenon	Xe	-0.95	-1.02

The selectivity of the above mentioned measuring principle is based on the high susceptibility of oxygen to other gases (see table).

The following examples shall show how cross sensitivities can be considered for the zero calibration.

Example 1: Determination of the rest content of oxygen in a 100 % carbon dioxide (CO_2) protective atmosphere at 20 °C [68 °F]

In the table of cross sensitivities you can read the value for CO_2 at 20 °C [68 °F] of –0.27. This means that for calibration with nitrogen the zero point must be set to +0.27 % in order to compensate the deviation of the display in good approximation.

In this example, the atmosphere contains exclusively CO_2 and O_2. For this reason, the influence of cross sensitivity can be eliminated without problem by using carbon dioxide (CO_2) instead of nitrogen for the zero calibration.

Example 2: Determination of the oxygen content of a gas mixture at 20 °C [68 °F]

1 vol% C_2H_6 (Ethane);
5 vol% O_2;
40 vol% CO_2;
54 vol% N_2.

Zero point calibration with nitrogen (N_2).

The cross sensitivity values of the table above, are based on 100 vol% of the respective gases. A conversion to the actual volume concentration must therefore take place. In principle, the following is valid:

$$\text{Actual cross sensitivity} = \frac{\text{Table value} * \text{Volume concentration}}{100} \text{ [vol\%]}$$

For the components of the gas mixture, the following values are found:

C_2H_6 : -0.0043 vol%;

CO_2 : -0.1080 vol%;

N_2: 0.0000 vol%.

Σ = -0.1123 vol%

To determine the total cross sensitivity as exactly as possible, a correction factor has to be determined, because the total cross sensitivity relates not to 100 % but to 100 % minus the oxygen concentration (here 95 %).

The correction factor is calculated as follows:

$$\text{Correction factor} = \frac{100}{(100 - O_2\text{-concentration})}$$

This results in the following correction factor:

$$\frac{100}{(100 - 5)} = \underline{1.0526}$$

For the gas mixture, the corrected total cross sensitivity for 0 vol% oxygen is therefore calculated in good approximation:

1.0526 x -0.1123 vol% = <u>-0.1182 vol%</u>

The corrected total cross sensitivity with plus/minus sign change can now be used for correction during zero calibration. In this example, the zero point would have to be adjusted in good approximation to +0.12 vol%.

Neglecting the cross sensitivities in this example would mean a relative error of approx. 2 %.

Note

After zero calibration the full scale value has to be calibrated too.

If the full scale value is not calibrated with 100 vol% oxygen, a correction of the cross sensitivity may be necessary.

Example: Full scale value calibration with air:

The correction factor is calculated as follows:

$$\text{Correction factor} = \frac{(100 - O_2\text{-concentration})}{100}$$

This results in the following correction factor:

$$\frac{(100 - 20.93)}{100} = 0.7907$$

For the gas mixture in example 2 the corrected total cross sensitivity then is calculated in good approximation for 20.93 vol% oxygen:

0.7907 x -0.1182 vol% = -0.0935 vol%

The corrected total cross sensitivity with plus/minus sign change now can be used for the correction of the full scale value calibration. In this case span has to be adjusted at:

20.93 vol% + 0.0935 vol% = 21.02 vol%.

22 CLOSING DOWN

If the system to be monitored is shut down for a short time, the analyzer should remain ready for operation. No special measures are still required.

If the analyzer is to be shut down for a long period of time, it is recommended to purge the analyzer with dry, clean inert gas (e.g. ambient air) to avoid damage to the measuring cell due to aggressive and corrosive humid gases.

23 STORAGE AND TRANSPORT

Note

The analyzer should be stored in a protected frost-free area!

24 MAINTENANCE

Before carrying out any maintenance work, the safety requirements specific to the instalment and the process must be heeded!

Warning

Dangerous voltage. Before performing any maintenance work, disconnect the analyzer and all external circuits connected to the analyzer from the power supply.

For use in hazardous areas it is absolutely necessary to observe the ex-instructions!

Note

Only original spare parts and those corresponding to M&C specifications must be used!

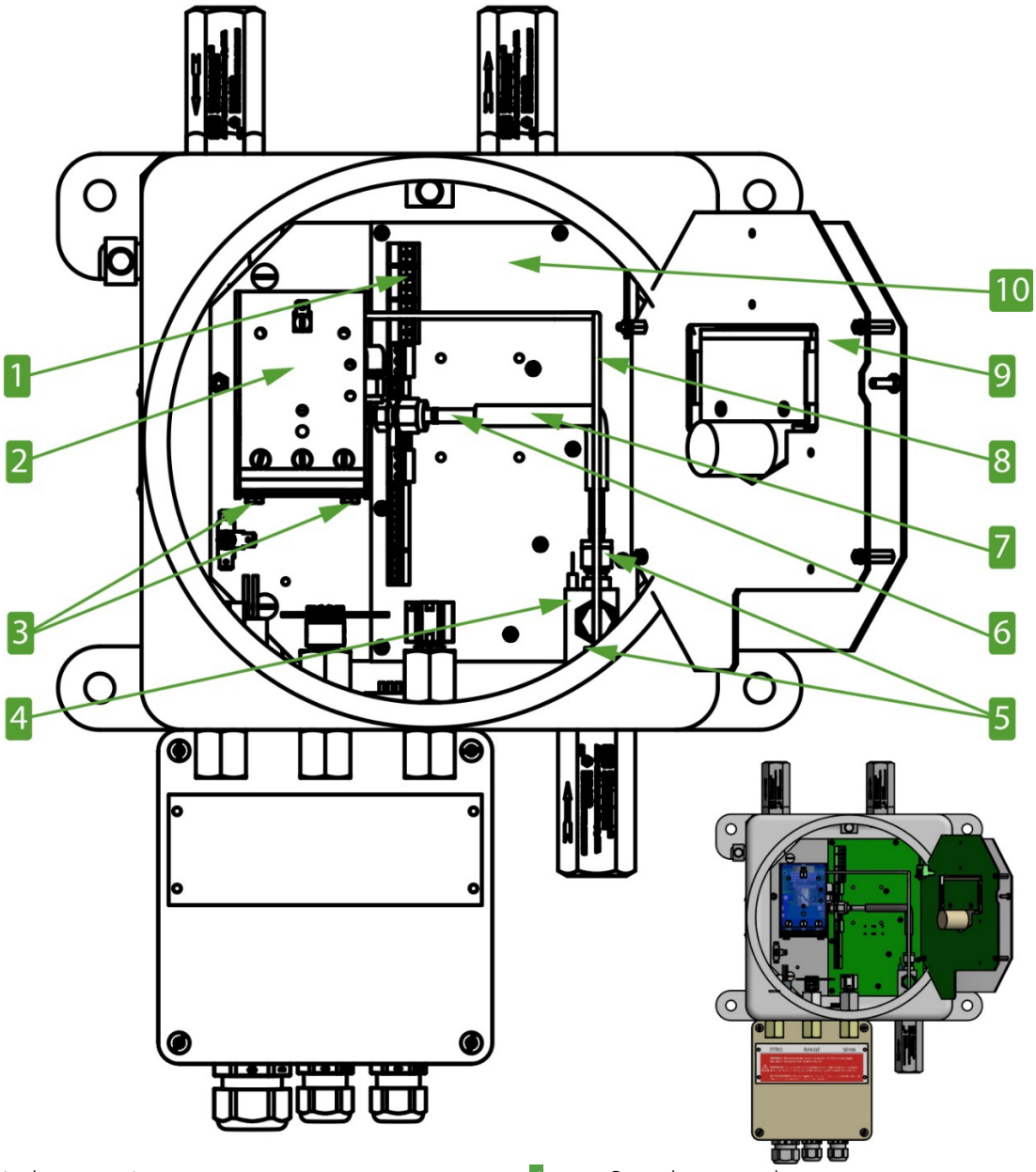
The physical measuring principle and the special design of the analyzer minimize the maintenance requirements.
The preceding components necessary for the sample gas conditioning are to be maintained according to the respective instruction manuals.

The calibration of zero point and full scale value must be carried out with the corresponding test gases according to the instructions.

Recommended interval of calibration for standard applications: 1 x per week.

24.1 REMOVAL OF THE MEASURING CELL

Figure 7 shows a drawing of the internal analyzer design **PMA 50 EX**.



1	Electrical connections	6	Sample gas outlet
2	Transmitter type 1.07.X.	7	Flexible tube
3	Hex screws	8	Sample gas inlet
4	Flow sensor, stainless steel	9	Front controller board
5	Union nuts sample gas inlet and outlet	10	Power supply and temperature board

Figure 7 Drawing of the internal analyzer design

For dismounting the measuring cell, the following procedure is recommended:

Warning

During all work on the analyzer it must be ensured that both the working environment and the analyzer itself are free of explosive or flammable gases!

Warning

Dangerous voltage. Before performing any maintenance work, disconnect the analyzer and all external circuits connected to the analyzer from the power supply.

- Loosen the inside hex screws of the housing window;
- Unscrew the window lid of the analyzer;
- Loosen the fastening screw (M4 in the middle left) of the inside front plate;
- Pull out the front plate and swing it out to the right side;
- Remove carefully the black isolating cap from the transmitter unit;

Warning

Hot transmitter surface up to 55 °C [131 °F].

Touching may lead to burnings.

Wear safety gloves!

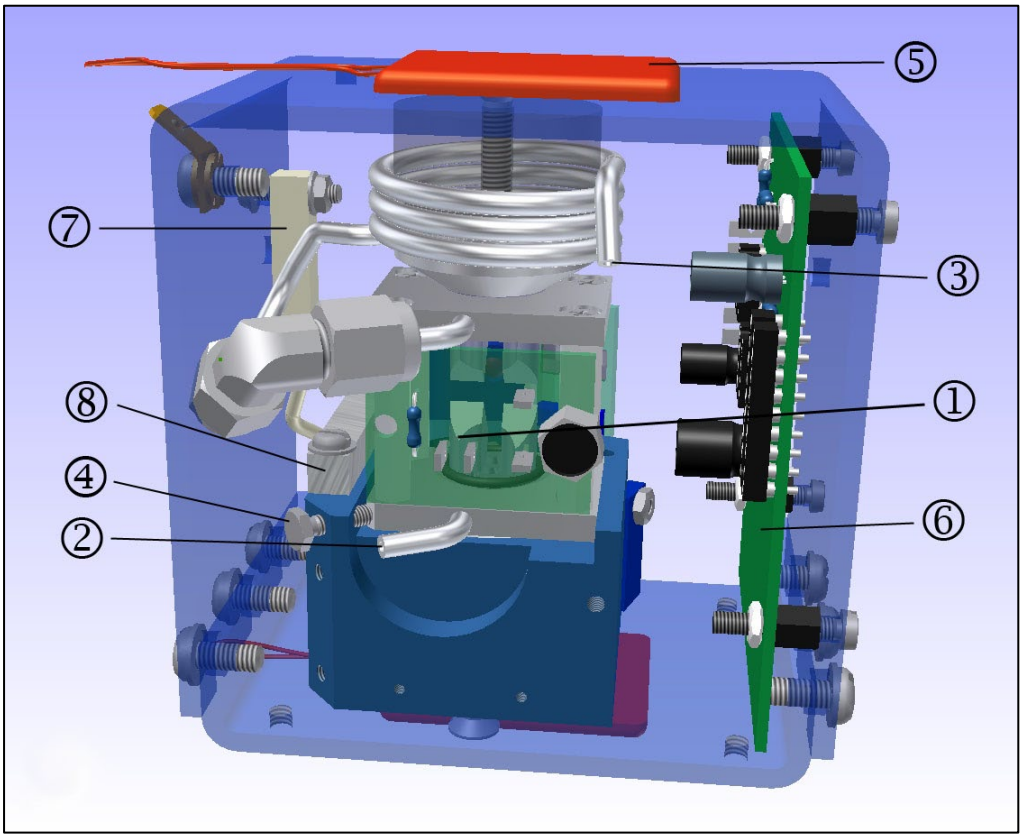
- Loosen the threaded tube couplings 5 of the sample gas inlet and the sample gas outlet (see Figure 7);

Warning

Strong magnetic field. Before dismounting the transmitter unit, remove all sensible parts (eg. wrist watch etc.)!

- Pull off the green 2-, 3- and 4-pole plug-in connections (on terminal X1, X2 and X3) from the power supply board;
- Loosen the earth connection (green-yellow) of the transmitter unit (2 see Figure 7);
- Loosen the four hex screws 3 (see Figure 7) on top of the transmitter mounting plate;
- Loosen union nuts 5 at sample in- 8 and outlet 6 (see Figure 7);

Now, the complete transmitter unit can be taken out of the housing. All further procedures should be executed on a clean work bench outside the hazardous area. Put the transmitter unit in a position as shown in Figure 8 (18-pin plug must show to the right side).



① Electrical connections meas. cell
② Gas outlet measuring cell
③ Gas inlet measuring cell
④ Fastening screw for measuring cell
⑤ Heater element
⑥ Transmitter board
⑦ Temperature fuse (cut-off at 72 °C [161.6 °F])
⑧ Temperature sensor

Figure 8 Transmitter unit

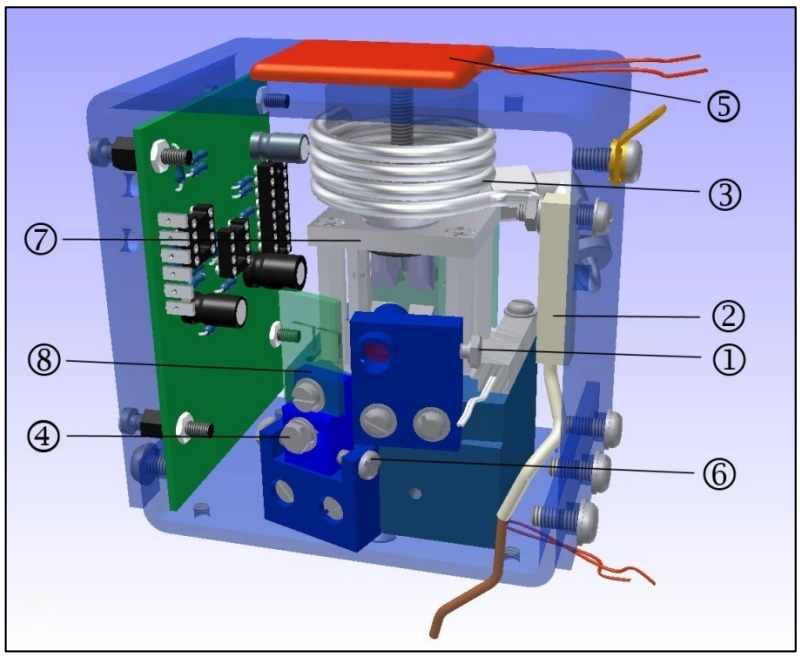
- Unsolder the brown and yellow cable from the terminals ① (see Figure 8) on the back side of the measuring cell; do not overheat the terminals; mark the cables accordingly;
- Disconnect the tubing for the sample gas outlet ② and sample gas inlet ③;
- Loosen the fastening screw of the measuring cell ④ with a screw driver and pick carefully the cell;
- Exchange only with measuring cells of the same type;
- Turn the transmitter as shown in Figure 9 and loosen the fastening screw of the photocell ④.

Install the measuring cell in reverse order; make sure the dumbbell is in the correct position!

In case there are minimally different positions of the dumpbells inside the measuring cells when mounting a new cell, it is absolutely necessary to adjust the zero point mechanically.

24.2 MECHANICAL ZERO POINT ADJUSTMENT

The mechanical zero point adjustment has to be done as described in the following.



1 LED
2 Temperature fuse (cut-off at 72 °C [161.6 °F])
3 Sample gas heating coil
4 Fastening screw photo cell
5 Heater element
6 Adjustment screw photo cell
7 Measuring cell
8 Photo cell

Figure 9 Transmitter unit for mechanical zero point adjustment

- Before switching on the analyzer, set the range selector to 30 %. Check the zero point of the analog display and adjust it if necessary to 0 % via the adjustment screw below the digital display;
- Switch on the analyzer via the external switch. Normally, the analog display will indicate a value of 21 % oxygen, because the cell is filled with ambient air;
- The warming up is indicated by the permanently lit heating control-LED (13 Figure 1) in the front plate of the analyzer; after approx. 30 minutes, the flashing display signalizes that the required operating temperature has been reached;
- Set the potentiometer for zero point and full scale value in the middle position; you can do this by turning the potentiometer with a screw driver fully to the left and then turn it five turns back to the right;
- Charge the analyzer with a zero gas volume flow of approx. 40 l/h;
- With a precise adjustment of the zero point, the analog display should indicate 0.0 vol% oxygen;

If this does not happen, please execute the following steps:

- Open the housing of the analyzer (see chapter 24.1);
- Remove carefully the isolating cap of the transmitter unit; now, all screws of the photo cell holder are visible (see Figure 9);
- Set the range switch to 3 %;
- Turn the adjustment screw **6** (see Figure 9) of the photo cell as long clockwise or anticlockwise as on the display appears a value of nearly 0.0 vol% oxygen;
- After the mechanical zero point adjustment, the fixing screw of the photo cell holder **4** must be tightened again;
- Now, the zero point adjustment has been done;
- Place carefully the isolating cap on the analyzer and close it according to chapter 24.1.

25 PROPER DISPOSAL OF THE DEVICE

At the end of the service life of our products, it is important to take care of the appropriate disposal of obsolete electrical and non-electrical devices. To help protect our environment, follow the rules and regulations of your country regarding recycling and waste management.

26 SPARE PARTS LIST

The demand for wear and spare parts depends on the specific operating conditions. The recommended quantities for wear and recommended spare parts are based on experience and are not binding.

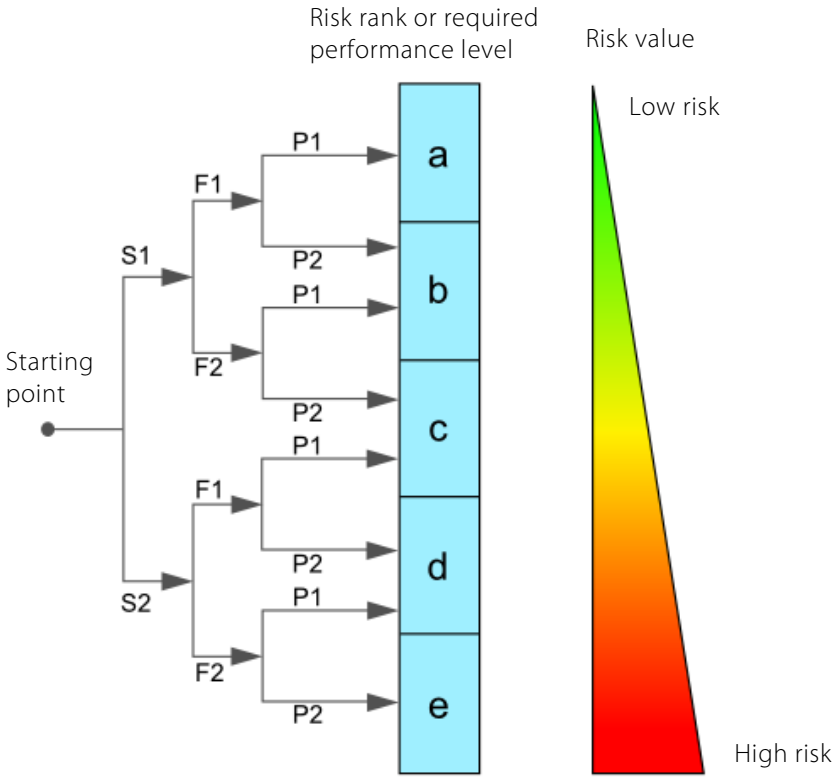
O_2 Analyzer PMA50 EX					
(C) Consumable parts **(R) Recommended spare parts** **(S) Spare parts**					
		Recommended piece number for use (years)			
Part-No.	**Description**	**C/R/S**	**1**	**2**	**3**
90A0020	Zero potentiometer / span potentiometer 5K	S	-	-	-
90A0079	Digital-analog panel, Typ PMA30/50, 4 1/2 digit 9 mm high LCD-indicator	S	-	-	-
90A1002	Digital panel, Typ PMA30/50, 4 1/2 digit 18 mm high LCD-indicator				
90A0010	Measuring cell **PMC-1**	S	-	-	-
90A0009	Special measuring cell **PMC-1 LB**, solvent-resistent, with O-rings Kalrez®	S	-	-	-
90A0006	Special measuring cell with glass solder	S			
90A0035	Projection-LED	S	-	-	-
90A0040	Photo cell unit	S	-	-	-
90A3010	Solid-State-Relais **A3P-202N**	S	-	-	-
90A3015	Temperature fuse (cut-off 72 °C [161.6 °F])	S	1	2	3
90A3020	Temperature sensor	S	-	-	-
90A3030	Heater element 50 mm x 40 mm	S	-	-	-
90A5150	Breathing and draining device **MC95C**	R	-	1	1
90A5154	Ribbon cable from selector switch to front board 14-pins 250 mm	T			
90A5155	Ribbon cable from Transducer to front board 18-pins 280 mm	T			
90A5158	Ribbon cable from power supply to front board 26-pins 250 mm	T			
90A5159	Ribbon cable from power supply to front board 16-pins. 240 mm	T			

27 RISK ASSESSMENT

The risk assessment provided in this chapter is intended for all work activities on the product. The hazards can occur in the work steps of assembly, commissioning, maintenance, disassembly and in the event of a product fault. During normal operation, the product is protected by a system cabinet or appropriate covers. Only qualified personnel is permitted to perform the work. The following minimum knowledge is required for the work:

- Employee instruction provided in process engineering
- Employee instruction provided in electrical engineering
- Detailed knowledge of the instruction manual and the applicable safety regulations

The product complies with the current regulations according to state-of-the-art science and technology. Nevertheless, not all sources of danger can be eliminated while observing technical protective measures. Therefore, the following risk assessment and the description of exposure hazards refer to the work steps mentioned above.



Severity of injury:
S1 = 1 = minor (reversible injury)
S2 = 2 = serious (irreversible injury, death)

Frequency and duration:
F1 = 1 = infrequent or short exposure to hazard
F2 = 2 = frequent (more than once per hour/shift)

Possibility of preventing or limiting the damage
P1 = 1 = possible
P2 = 2 = hardly possible

Figure 10 Overview risk assessment

Aggressive condensate possible

Risk rank group A
Chemical burns due to aggressive media possible!
This applies to all liquids in vessels and in the product.
In general, for electrical and mechanical work on the product, wear personal protective equipment (PPE) in accordance with the risk assessment.

Caution hot surfaces

Risk rank group A
The temperature inside the product can be higher than > 60 °C.
The hot parts are shielded by mechanical devices. Before opening the products, they must be disconnected from the power supply and a cooling time of more than > 20 minutes must be observed. In general, for electrical and mechanical work on the product, wear personal protective equipment (PPE) in accordance with the risk assessment.

Caution electric shock

Risk rank group C
When installing high-power systems with nominal voltages of up to 1000 V, the requirements of VDE 0100 and their relevant standards and regulations must be observed!
This also applies to any connected alarm and control circuits. Before opening the products, they must always be disconnected from the power supply.

Gas hazard

Risk rank group A-B-C
The hazard potential mainly depends on the gas to be extracted.
If toxic gases, oxygen displacing or explosive gases are conveyed with the product, an additional risk assessment by the operator is mandatory.
In principle, the gas paths must be purged with inert gas or air before opening the gas-carrying parts.
The escape of potentially harmful gas from the open process connections must be prevented.
The relevant safety regulations must be observed for the media to be conveyed. If necessary, flush the gas-carrying parts with a suitable inert gas. In the event of a gas leakage, the product may only be opened with suitable PPE or with a monitoring system.
Furthermore, the work safety regulations of the operator must be observed.

Caution crushing hazard

Risk rank group A
The work must be performed by trained personnel only.
This applies to products weighing less than < 40 kg [≈ 88.2 lbs]:
The product can be transported by 1 to 2 person(s). The instructions for appropriate personal protective equipment (PPE) must be observed.
The weight specifications are contained in the technical data of this product.
Furthermore, the work safety regulations of the operator must be observed.

28 APPENDIX

- Safety handbook according to SIL
- Circuit diagram front board PMA50 EX
- Assembly front board PMA50 EX
- Circuit diagram mains adapter PMA50 EX
- Assembly / connection mains adapter PMA50 EX
- Cut-out magnification front board for adjustment of temperature alarm (TP10, P19) (TP11: actual temperature) und flow alarm threshold (P20)
- Cut-out magnification front board couple sensor bridge for application of a transmitter without couple sensor
- Cut-out magnification front board for adjustment of reference voltage, amplification and offset of the O2-signal
- Cut-out magnification mains adapter for adjustment of the temperature, current and voltage output
- Cut-out magnification mains adapter for adjustment of burden and limitation of the current output
- Ex-Certificate of Conformity No.: **IBExU 16 ATEX 1192; IECEx IBE 16.0041**
- SIL-declaration of conformity

Further product documentation can be seen and downloaded from our home page: www.mc-techgroup.com.

Safety handbook according to SIL

Contemplated devices

It was contemplated the PMA 50 EX with part no. **05A1000(a)** and the following options:

- Enclosure ventilation and enclosure purging (part no. **05A9005** and **05A9000**),
- Measuring cell solvant resistant or with glass solder (part no. **90A0009** u. **90A0006**)

Excluded are the PMA 50 EX/P/PD… with pressure compensation, part no. **05A2500(a)** as well as the options 0-20 mA outlet, part no. **05A2505(a)** resp. zero suppression, part no. **05A9015**.

Device description and safety function

The safety function of the device is the measurement of the oxygen concentration in the measuring cell which is provided as linear current signal 4-20 mA. The status relay as transmission of a summary fault indication is element of the safety function. Current signals <3.2 mA and > 20.5 mA as well as an open status contact have to be evaluated as failure from a downstream device.

The SIL-qualification is valid for all adjustable measuring ranges. It applies for alarm of rising oxygen concentration (dangerous fault: oxygen signal is to small) as well as for alarm of decreasing oxygen concentration (dangerous fault: oxygen signal is too big).

For one channel and two channel operation of the oxygen analyzer PMA 50 EX the following parameters have been determined.

	Single channel 1oo1	**Redundant 1oo2**	*Single channel 1oo1*	**Redundant 1oo2**
Safety function	Mesurement of the oxygen concentration		Mesurement of the oxygen concentration	
Dangerous error	Oxygen signal too low		Oxygen signal too big	
Measuring range	Depending on the measuring task		Depending on the measuring task	
Device type	B (but without µP and software)		B (but without µP and software)	
Proof test interval	1 year		1 year	
MTTR	24 hr		24 hr	
SFF	91,3 %		96,4 %	
HFT	0	1	0	1
SIL–ability	**2**	**3**	**2**	**3**
β factor	—	5 %	—	5 %
PFD	3.83×10^{-4}	1.93×10^{-5}	1.66×10^{-4}	8.34×10^{-6}
λ_{du}	8.44×10^{-8} (per hr)		3.52×10^{-8} (per hr)	
λ_{dd}	4.62×10^{-7} (per hr)		4.62×10^{-7} (per hr)	
λ_{su}	4.25×10^{-7} (per hr)		4.74×10^{-7} (per hr)	
λ_{sd}	5.70×10^{-11} (per hr)		5.70×10^{-11} (per hr)	

Operating conditions

Ambient conditions:
Temperature: 0 °C to +50 °C
Pressure: 0.9- 1.1 bar abs.
Vibrations have to be avoided.

The sample gas has to be dry (dew point 5 °C) and dust free and the sample gas inlet temperature is not allowed to exceed 50 °C. The maximum inlet pressure is 1.1 bar abs. for the standard device and 1.5 bar abs. for devices with enclosure purging or enclosure ventilation. Generally a fine filter with min. 2 µm has to be installed upstream.

Sample gas has to discharge freely into atmosphere at the sample gas outlet because a pressure rise at the outlet and therefore in the measuring cell will result in false readings.

Especially the accuracy of the adjusted measuring range has to be observed, because the current outlet 4-20 mA is dependent on the measuring range. If the measuring range is choosen externally it is mandatory necessary to analyze the external measuring indication (see Fig. 5).

The analyzer has to be maintained and calibrated regularly expertly according to the manufacturer's data.
The maintenance intervals for monitoring of inertization processes have to be specified according to leaflet BGI 518 of the Main Association of Trade Associations (= leaflet T 023 of the trade association chemistry) edition 07/2009. For other applications the leaflet BGI 836 of the Main Association of Trade Associations (= leaflet T 021 of the trade association chemistry) edition 07/2009 has to be applied.

Yearly proof test

Minimum once a year a proof test of the whole safety chain has to be performed. Thus also the yearly system check according to the Industrial Safety Regulation is covered.
For the analyzer the prooftest comprises the regular calibration / adjustment as well as triggering and test of the switch function of the status relay (fail safe relay).

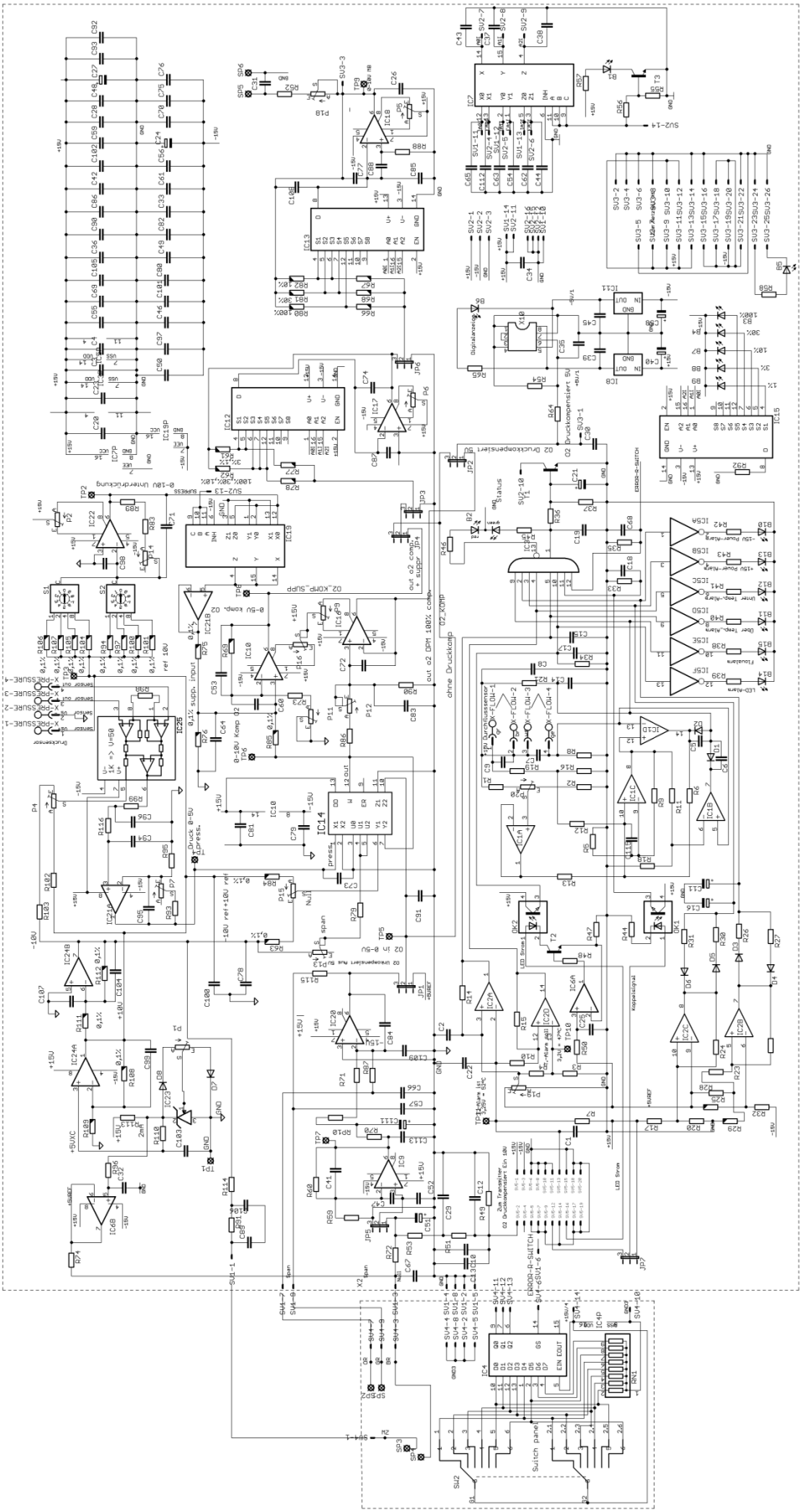


Figure 11 Circuit diagram front board PMA50 EX

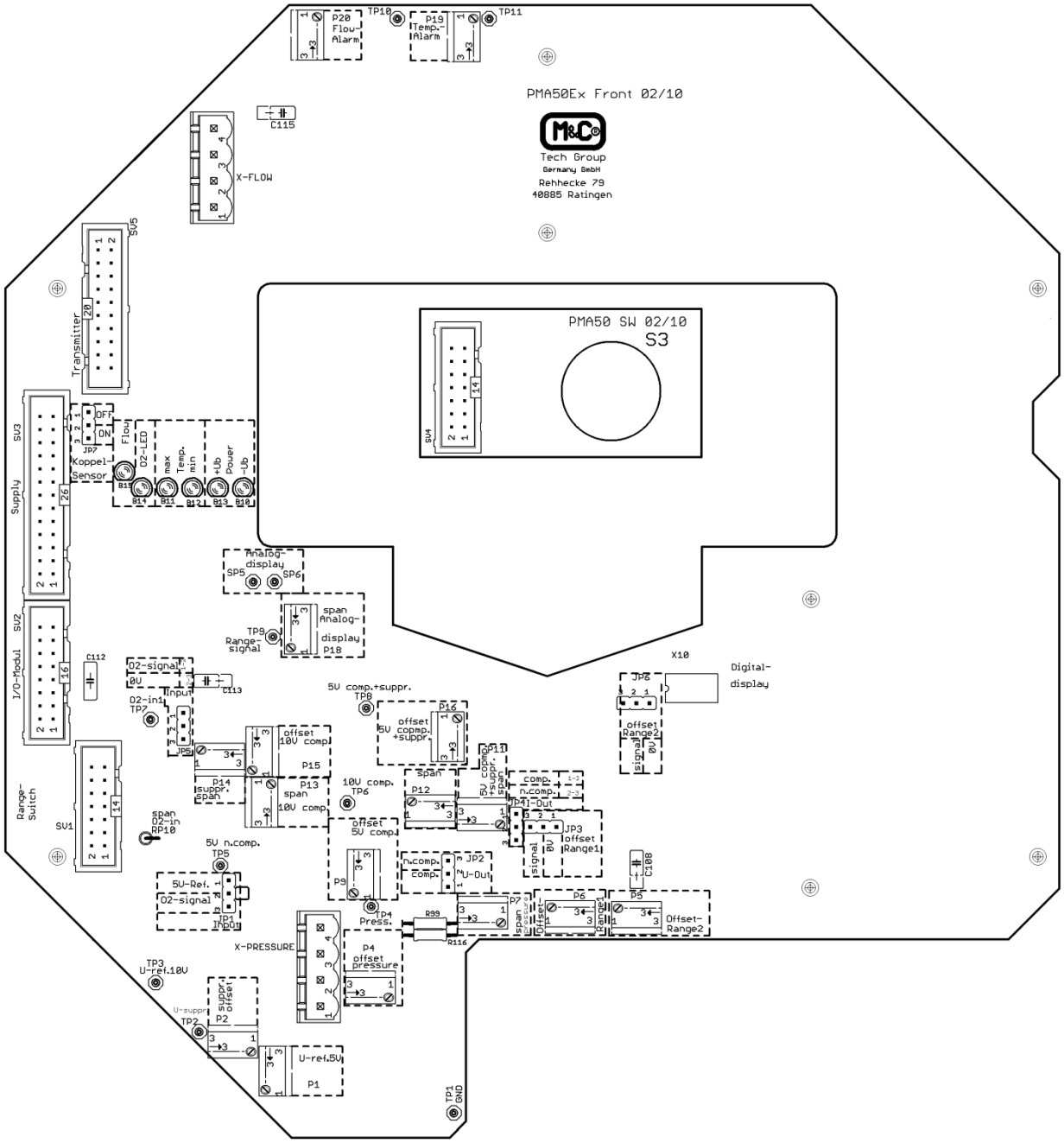


Figure 12 Assembly front board PMA50 EX

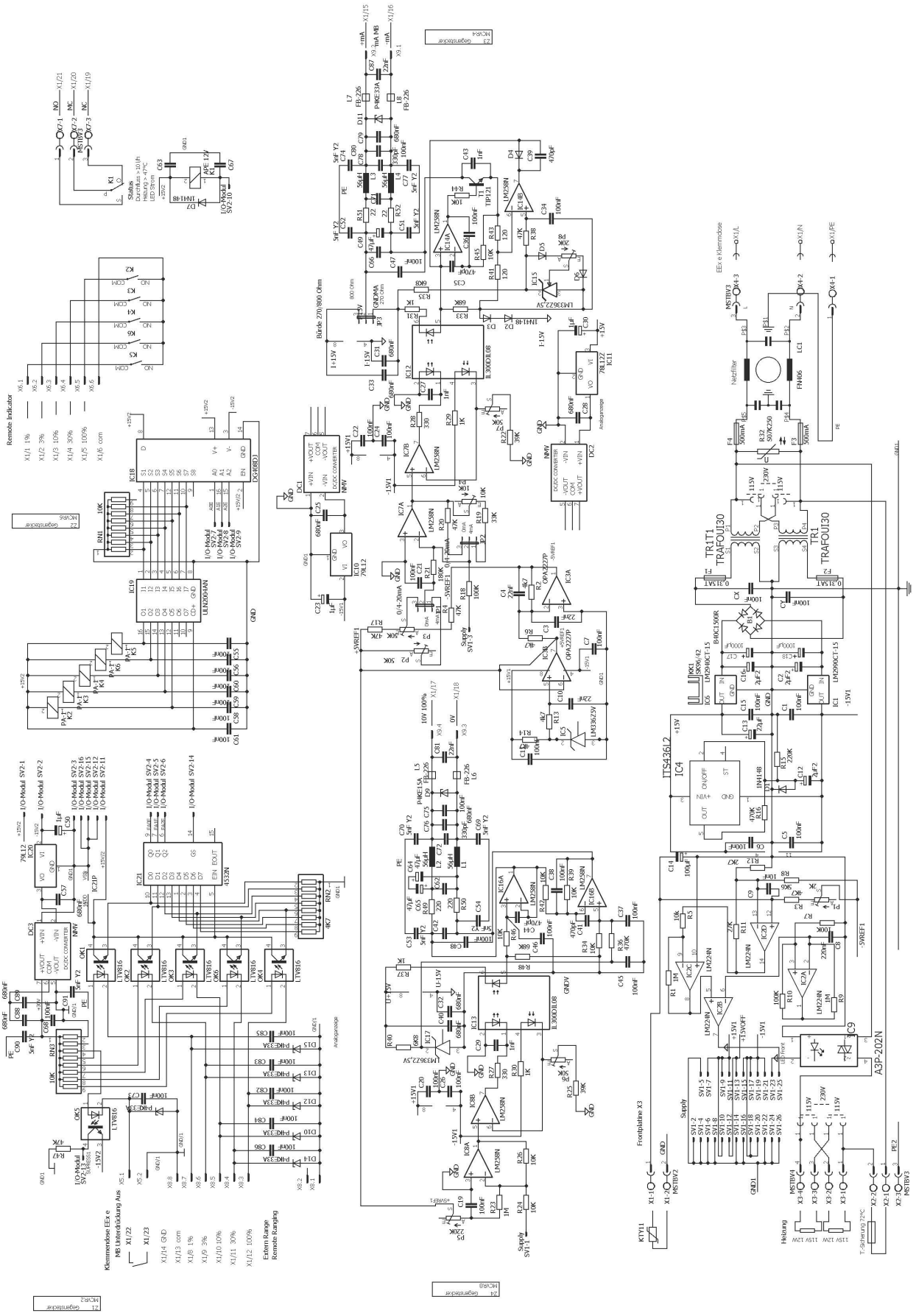


Figure 13 Circuit diagram mains adapter PMA50 EX

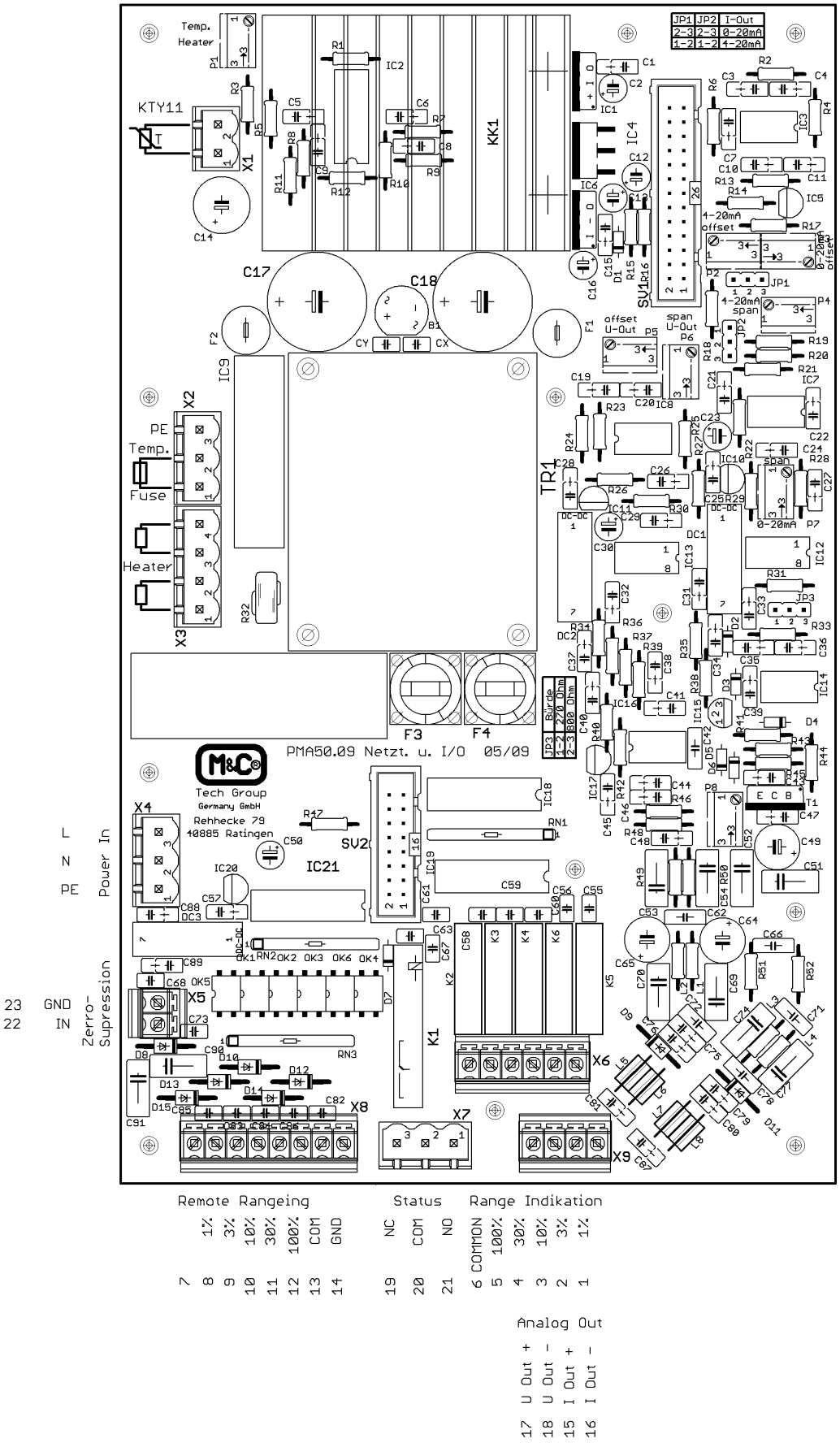


Figure 14 Assembly/connection mains adapter PMA50 EX

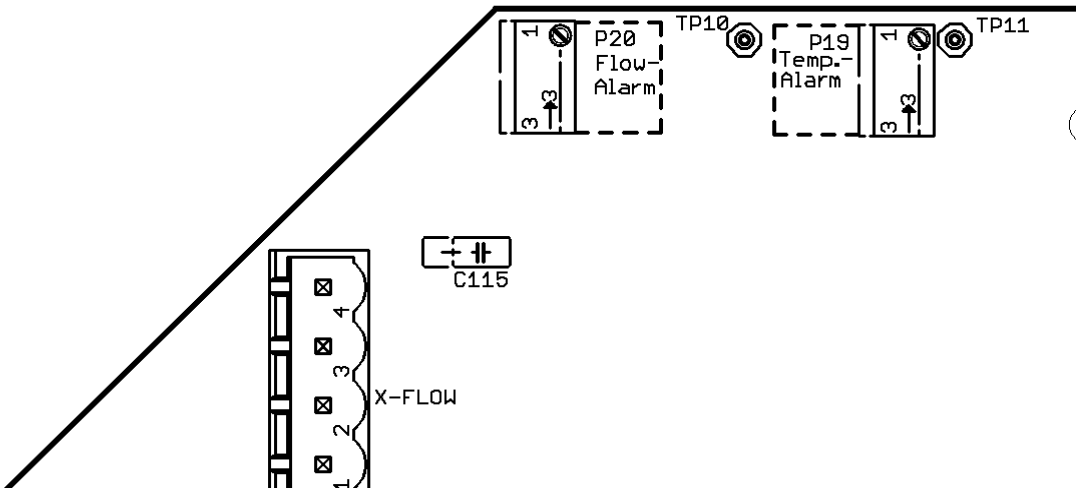


Figure 15 **Cut-out magnification front board for adjustment of temperature alarm (TP10, P19) (TP11: current temperature) und flow alarm threshold (P20)**

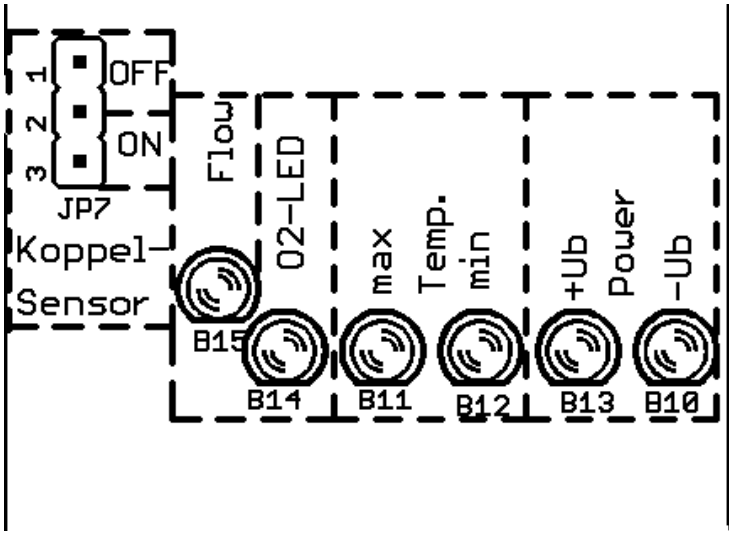


Figure 16 **Cut-out magnification front board couple sensor bridge for application of a transmitter without couple sensor**

Failure indication:
B15: Flow-min failure
B14: Transmitter LED-current failure
B11: Transmitter temperature max failure
B12: Transmitter temperature min failure
B13: Power supply $+U_B$ failure
B10: Power supply $-U_B$ failure

(Couple sensor failure and failure range-selector internal are not displayed optical.)

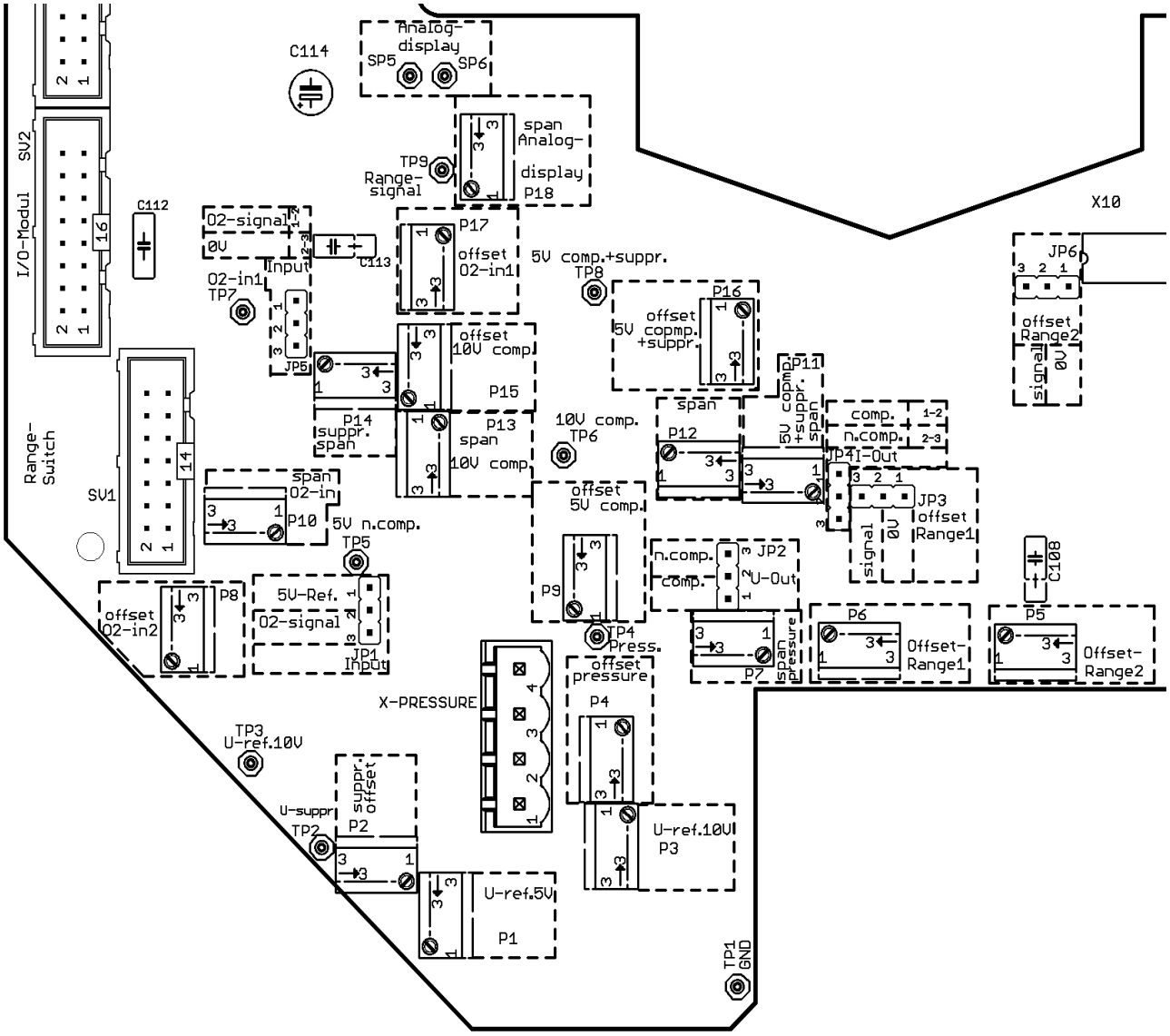


Figure 17 **Cut-out magnification front board for adjustment of reference voltage , amplification and offset of the O_2-signal**

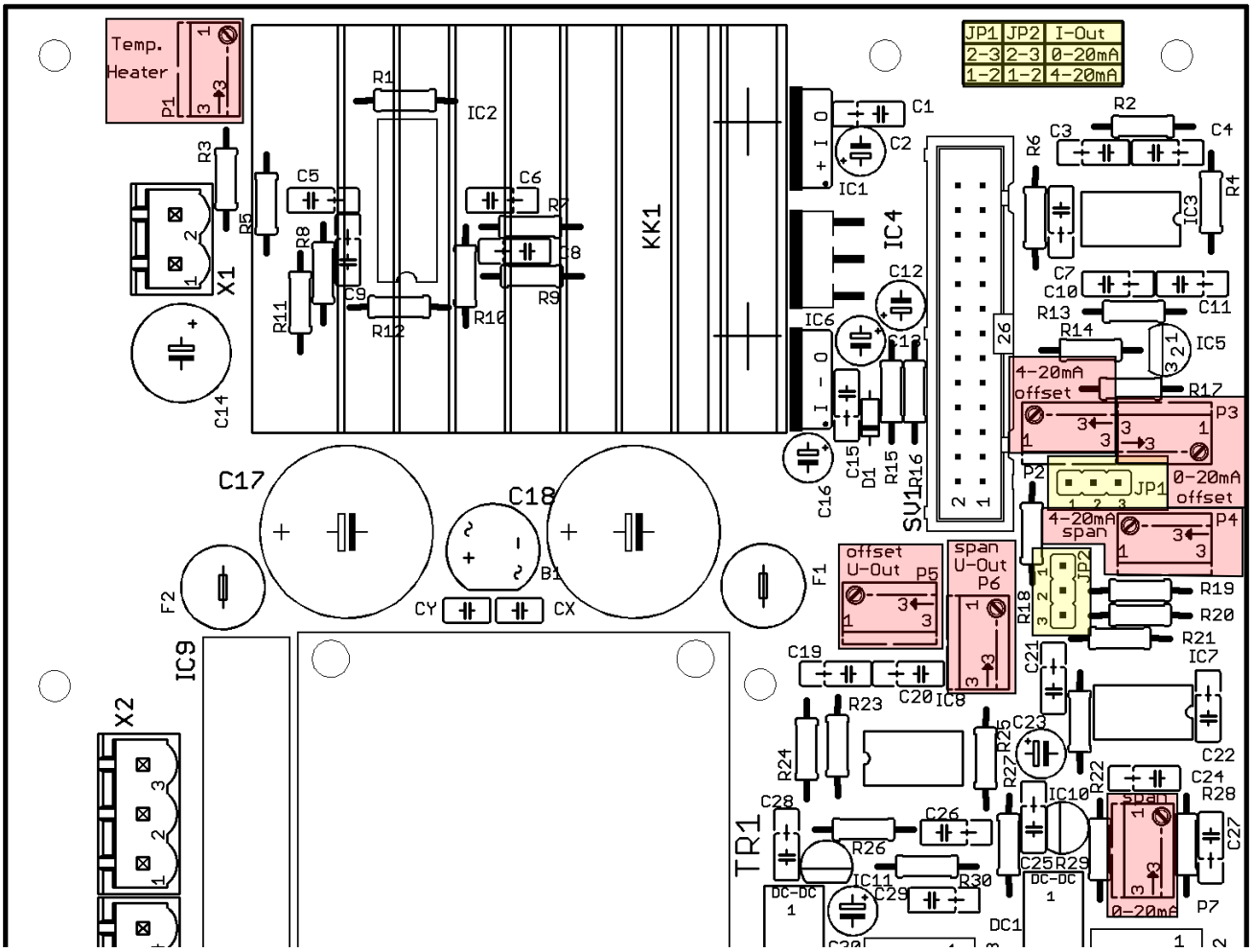


Figure 18 Cut-out magnification mains adapter for adjustment of the temperature, current and voltage output

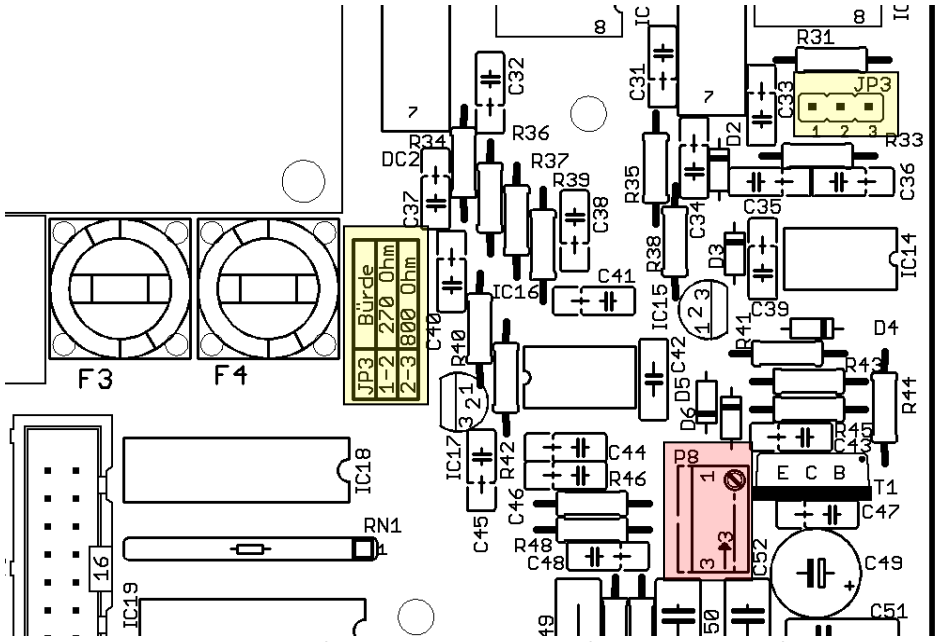


Figure 19 Cut-out magnification mains adapter for adjustment of burden and limitation of the current output

IBExU Institut für Sicherheitstechnik GmbH
An-Institut der TU Bergakademie Freiberg

[1] **EU-TYPE EXAMINATION CERTIFICATE** - Translation

[2] Equipment or protective systems
intended for use in potentially explosive atmospheres, Directive 2014/34/EU

[3] EU-type examination certificate number **IBExU16ATEX1192 X** | Issue 0

[4] Product: **Oxygen analyzer**
Type: PMA 50 Ex

[5] Manufacturer: M&C TechGroup Germany GmbH

[6] Address: Rehhecke 79
40885 Ratingen
GERMANY

[7] This product and any acceptable variation thereto is specified in the schedule to this certificate and the documents therein referred to.

[8] IBExU Institut für Sicherheitstechnik GmbH, notified body number 0637 in accordance with Article 17 of Directive 2014/34/EU of the European Parliament and of the Council, dated 26 February 2014, certifies that this product has been found to comply with the essential health and safety requirements relating to the design and construction of products intended for use in potentially explosive atmospheres given in Annex II to the Directive.

The examination and test results are recorded in the confidential test report IB-16-3-004.

[9] Compliance with the essential health and safety requirements has been assured by compliance with:
EN 60079-0:2012+A11:2013, EN 60079-1:2014 and EN 60079-7:2015
except in respect of those requirements listed at item [18] of the schedule.

[10] If the sign "X" is placed after the certificate number, it indicates that the product is subject to the specific conditions of use specified in the schedule to this certificate.

[11] This EU-type examination certificate relates only to the design and construction of the specified product. Further requirements of the Directive apply to the manufacturing process and supply of this product. These are not covered by this certificate.

[12] The marking of the product shall include the following:

Ex II 2G Ex db eb IIC T4 Gb

$-10\ °C \leq T_{amb} \leq +50\ °C$

IBExU Institut für Sicherheitstechnik GmbH
Fuchsmühlenweg 7
09599 Freiberg, GERMANY

Tel: + 49 (0) 37 31 / 38 05 0
Fax: + 49 (0) 37 31 / 38 05 10

By order

Dipl.-Ing. [FH] Henker

- Seal -
(notified body number 0637)

Certificates without signature and seal are not valid. Certificates may only be duplicated completely and unchanged. In case of dispute, the German text shall prevail.

Freiberg, 2017-11-06

IBExU Institut für Sicherheitstechnik GmbH
An-Institut der TU Bergakademie Freiberg

[13] **Schedule**

[14] **Certificate number IBExU16ATEX1192 X** | Issue 0

[15] **Description of product**
The Oxygen analyzer is suitable for determination of the oxygen content of an explosive test gas in a range of maximum 21 % oxygen by means of a paramagnetic oxygen measuring cell.
The Oxygen analyzer consists of a flameproof enclosure which contains the oxygen measuring cell, the transmitter and display as well as a termination compartment in type of protection "e".
The gas input and ventilation or purging, optionally is carried out by the separately certified Breathing and Draining Device MC95A.

Technical data:

ambient temperature range:	-10 °C up to +50 °C
line voltage:	115 V AC or 230 V AC (50 Hz or 60 Hz)
output signal:	0-10 V and 0/4-20 mA

[16] **Test report**
The test results are recorded in the confidential test report IB-16-3-004 of 2017-11-06.

The test documents are part of the test report and they are listed there.

Summary of the test results
The oxygen analyzer type PMA 50 Ex mentioned under [4] fulfils the requirements of the explosion protection for the Equipment Group II and Category 2G in type of protection flameproof enclosure "d" in combination with increased safety "e".

Safety information:
When using explosive test gasses which are assigned in Zone 0 an additional protective systems against flames has to be used, each in input and output of measuring gas. The system is made of stainless steel.

[17] **Specific conditions of use**
The oxygen analyzer may only be used with an external flow limiting device.

[18] **Essential health and safety requirements**
In addition to the essential health and safety requirements (EHSRs) covered by the standards listed at item [9], the following are considered relevant to this product, and conformity is demonstrated in the test report:
None

[19] **Drawings and Documents**
The documents are listed in the test report.

IBExU Institut für Sicherheitstechnik GmbH
Fuchsmühlenweg 7
09599 Freiberg, GERMANY

By order

Dipl.-Ing. [FH] Henker

Freiberg, 2017-11-06

IBExU Institut für Sicherheitstechnik GmbH
An-Institut der TU Bergakademie Freiberg

[1] EU-BAUMUSTERPRÜFBESCHEINIGUNG

[2] Geräte und Schutzsysteme zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen, Richtlinie 2014/34/EU

[3] EU-Baumusterprüfbescheinigung Nummer **IBExU16ATEX1192 X** | Ausgabe 0

[4] Produkt: **Sauerstoffanalysator**
Typ: PMA 50 Ex

[5] Hersteller: M&C TechGroup Germany GmbH

[6] Anschrift: Rehhecke 79
40885 Ratingen
GERMANY

[7] Dieses Produkt sowie die verschiedenen zulässigen Ausführungen sind in der Anlage zu dieser Bescheinigung sowie den darin aufgeführten Unterlagen festgelegt.

[8] IBExU Institut für Sicherheitstechnik GmbH, notifizierte Stelle mit der Nummer 0637 in Übereinstimmung mit Artikel 17 der Richtlinie 2014/34/EU des Europäischen Parlaments und des Rates vom 26. Februar 2014, bestätigt, dass dieses Produkt die wesentlichen Sicherheits- und Gesundheitsanforderungen für die Konzeption und den Bau von Produkten zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen aus Anhang II der Richtlinie erfüllt.

Die Untersuchungs- und Prüfergebnisse werden in dem vertraulichen Prüfbericht IB-16-3-004 festgehalten.

[9] Die Beachtung der wesentlichen Sicherheits- und Gesundheitsanforderungen wurde in Übereinstimmung mit folgenden Normen gewährleistet:
EN 60079-0:2012+A11:2013, EN 60079-1:2014 und EN 60079-7:2015
Hiervon ausgenommen sind jene Anforderungen, die unter Punkt [18] der Anlage aufgelistet werden.

[10] Ein „X" hinter der Bescheinigungsnummer weist darauf hin, dass das Produkt den besonderen Bedingungen für die Verwendung unterliegt, die in der Anlage zu dieser Bescheinigung festgehalten sind.

[11] Diese EU-Baumusterprüfbescheinigung bezieht sich ausschließlich auf die Konzeption und den Bau des angegebenen Produkts. Für den Fertigungsprozess und die Bereitstellung dieses Produkts gelten weitere Anforderungen der Richtlinie. Diese fallen jedoch nicht in den Anwendungsbereich dieser Bescheinigung.

[12] Die Kennzeichnung des Produkts muss Folgendes beinhalten:

Ⓔx II 2G Ex db eb IIC T4 Gb

$-10\ °C \leq T_a \leq +50\ °C$

IBExU Institut für Sicherheitstechnik GmbH
Fuchsmühlenweg 7
09599 Freiberg, GERMANY

Tel: + 49 (0) 37 31 / 38 05 0
Fax: + 49 (0) 37 31 / 38 05 10

Im Auftrag

Dipl.-Ing. [FH] Henker

- Siegel -
(notifizierte Stelle Nummer 0637)

Bescheinigungen ohne Siegel und Unterschrift haben keine Gültigkeit. Bescheinigungen dürfen nur vollständig und unverändert vervielfältigt werden.

Freiberg, 06.11.2017

IBExU Institut für Sicherheitstechnik GmbH
An-Institut der TU Bergakademie Freiberg

[13] **Anlage**

[14] **Bescheinigung Nummer IBExU16ATEX1192 X** | Ausgabe 0

[15] **Beschreibung des Produkts**
Der Sauerstoffanalysator Typ PMA 50 Ex ist geeignet zur Bestimmung des Sauerstoffgehaltes eines explosionsfähigen Messgases in einem Bereich von max. 21 % O_2 mittels einer paramagnetischen Sauerstoffmesszelle. Der Sauerstoffanalysator besteht aus einem Gehäuse der Zündschutzart druckfeste Kapselung "d", in dem sich die Sauerstoffmesszelle, der Transmitter und das Display befinden, sowie einem Anschlusskasten in der Zündschutzart erhöhte Sicherheit "e".
Die Gaseinleitung und optionale Gehäuseentlüftung oder Gehäusespülung erfolgten über die separat bescheinigten MC95A Atmungs- und Entwässerungseinrichtungen.

Technische Daten:

Umgebungstemperaturbereich:	-10 °C bis +50 °C
Nennspannung:	115 V AC oder 230 V AC (50 Hz oder 60 Hz)
Ausgangssignal:	0-10 V und 0/4-20 mA

[16] **Prüfbericht**
Die Prüfergebnisse sind im vertraulichen Prüfbericht IB-16-3-004 vom 06.11.2017 festgehalten.

Die Prüfunterlagen sind Teil des Prüfberichts und werden darin aufgelistet.

Zusammenfassung der Prüfergebnisse
Der unter [4] genannte Sauerstoffanalysator Typ PMA 50 Ex erfüllt die Anforderungen des Explosionsschutzes für Geräte der Gruppe II, Kategorie 2G in Zündschutzart druckfeste Kapselung „d" und erhöhte Sicherheit „e".

Sicherheitstechnischer Hinweis:
Bei der Verwendung explosionsfähiger Messgasgemische, die Zone 0 zugeordnet sind, ist je ein weiteres geeignetes Schutzsystem gegen Flammenrückschlag im Messgas-Eingang und im Messgas-Ausgang vorzusehen. Der gesamte Aufbau ist in Edelstahl ausgeführt.

[17] **Besondere Bedingungen für die Verwendung**
Der Sauerstoffanalysator darf nur mit einem externen Durchflussmengenbegrenzer betrieben werden.

[18] **Wesentliche Sicherheits- und Gesundheitsanforderungen**
Zusätzlich zu den wesentlichen Sicherheits- und Gesundheitsanforderungen, die in den Anwendungsbereich der unter Punkt [9] genannten Normen fallen, wird Folgendes für dieses Produkt als relevant angesehen und die Konformität wird im Prüfbericht dargelegt:
Keine

[19] **Zeichnungen und Unterlagen**
Die Dokumente sind im Prüfbericht aufgelistet.

IBExU Institut für Sicherheitstechnik GmbH
Fuchsmühlenweg 7
09599 Freiberg, GERMANY

Im Auftrag

A. Henker

Dipl.-Ing. [FH] Henker

Freiberg, 06.11.2017

TechGroup

Declaration of conformity SIL

Product name: **Oxygen analyser PMA 50 Ex**

The indicated product corresponds to the following European and/or international standards about the functional security:

DIN EN 61508 chapters 1 – 7 (2002 and 2003) [corresponds to IEC 61508 : 1998]

The following parameters for the single and the two-channel application of the oxygen analyser PMA 50 Ex have been determined. The calculation of the parameters has been made by the company GWW GasWarn Dr. Wenker GmbH on the basis of documentation and fault analysis of M&C. The correctness of the indications is confirmed in the attached statement of conformity from GWW GasWarn Dr. Wenkler GmbH as independent authorised expert.
On the back side of this declaration, you will find explanations about the type of equipment „B" as well as about the equipment versions included in the evaluation. Furthermore, there are noted the application conditions which are required to be respected in order to achieve the SIL qualification.

	One-channel 1oo1	**Redundant 1oo2**	**One-channel 1oo1**	**Redundant 1oo2**
Safety function	Measurement of oxygen concentration		Measurement of oxygen concentration	
Dangerous fault	Oxygen signal is too small		Oxygen signal is too big	
Measuring range	Depending on measurement task		Depending on measurement task	
Type of equipment	B (but without µP and software)		B (but without µP and software)	
Prooftest Interval	1 year		1 year	
MTTR	24 h		24 h	
SFF	91,3 %		96,4 %	
HFT	0	1	0	1
SIL–qualification	**2**	3	**2**	3
β Factor	—	5 %	—	5 %
PFD	$3{,}83 \times 10^{-4}$	$1{,}93 \times 10^{-5}$	$1{,}66 \times 10^{-4}$	$8{,}34 \times 10^{-6}$
λ_{du}	$8{,}44 \times 10^{-8}$ (per h)		$3{,}52 \times 10^{-8}$ (per h)	
λ_{dd}	$4{,}62 \times 10^{-7}$ (per h)		$4{,}62 \times 10^{-7}$ (per h)	
λ_{su}	$4{,}25 \times 10^{-7}$ (per h)		$4{,}74 \times 10^{-7}$ (per h)	
λ_{sd}	$5{,}70 \times 10^{-11}$ (per h)		$5{,}70 \times 10^{-11}$ (per h)	

Ratingen, 09.02.2010

M&C TechGroup Germany GmbH

M&C TechGroup Germany GmbH
Remscheider Str. 79
D-40885 Ratingen
www.mc-techgroup.com

M&C_SIL-Konformitätserklärung_PMA_50_Ex.pdf

M&C® TechGroup

Equipment type B

For "simple" instruments (Type A according DIN EN 61508) with clearly defined erroneous function, it is sufficient to have a SFF between 60 % and 90 % in order to achieve the SIL qualification of 2. All instruments with a microprocessor respectively with software belong to type B because they hold a complex erroneous function. For these instruments, a SFF > 90% is necessary.
The oxygen analyser PMA 50 Ex has neither got a software nor a microprocessor. Nevertheless, this instrument has been classified into type B, because there are several electronic components with integrated circuits (IC's) that have got a complex erroneous function.

Observed instrument versions

The SIL qualification is valid for all adjustable measuring ranges. It is valid for the alarm of increasing oxygen concentration (dangerous fault: oxygen signal is too small) as well as for the alarm of decreasing oxygen concentration (dangerous fault: oxygen signal is too big).
Included are the options ventilate arrestor and purge gas connection (part No. 05A9005 and 05A9000), measuring cell in solvent resistant version or with glass solder (part No. 90A0009 and 90A0006) as well as transmitter for measuring of gases out of zone 0 (identification II 1/2 G EEx de [ia] IIC T5).
On the outlet side, only the 4-20 mA signal in connection with the status contact is regarded. Current signals < 3,2 mA and > 20,5 mA as well as an open status contact must be evaluated as trouble by a downstream instrument.

Application conditions

The values about the SIL qualification of the control unit in connection with the determined error rates are only valid if the following application conditions are met:

The safety instructions given in the manufacturer documentation must be heeded.

Ambient conditions: Temperature: -10 °C to +50 °C ; Pressure: 0,9 – 1,1 bar absolute ; Vibrations must be avoided.

The sample gas must be dry (Dew point 5°C) and free of dust. The sample gas inlet temperature must not exceed 50°C. The maximum inlet pressure of the standard equipment is 1,1 bar abs., and it is 1,5 bar abs. for the instruments with housing purging or ventilation device.

In principle, a fine filter with at least 2µm must be installed upstream.

It must be assured that the sample gas can flow off freely into atmosphere at the sample gas outlet, because every increase of pressure at the sample gas outlet and thus also in the measuring cell will falsify the oxygen indication.

Due to the current output 4-20 mA being dependent on the measuring range, special attention must be paid to the correctness of the adjusted measuring range. In case the measuring range is selected externally, it is obligatory to evaluate the measuring range indication also externally (see operating manuel figure 5).

Current signals < 3,2 mA and > 20,5 mA as well as an open status contact must be evaluated as trouble by a downstream instrument.

The analyser must be maintained and calibrated by a qualified personnel in regular periods and according to the manufacturer's indications.

The time intervals for the control of inerting processes must be determined according to data sheet BGI 518, edition 07/2009 of the central federation of industrial professional associations (Hauptverband der Berufsgenossenschaften) (= data sheet T 023 of the BG chemistry). For other applications, the data sheet BGI 836 of the central federation of industrial professional associations (= data sheet T 021 of BG chemistry) must be applied.

Yearly Prooftest

At least once a year, a prooftest must be executed for the complete safety chain. This includes also the yearly system control according to the operation reliability regulation (Betriebssicherheitsverordnung). The prooftest of the analyser covers the usual calibration/adjustment as well as the activation and examination of the switching function of the status relais (fault indication relais).