

# Oxygen – Analyser Series PMA<sup>®</sup>

## PMA 20

Instruction Manual  
Version 1.00.01



## Content

<b>1</b>	<b>General information</b>	<b>4</b>
<b>2</b>	<b>Declaration of conformity</b>	<b>4</b>
<b>3</b>	<b>Safety instructions</b>	<b>5</b>
<b>4</b>	<b>Warranty</b>	<b>5</b>
<b>5</b>	<b>Used terms and signal indications</b>	<b>6</b>
<b>6</b>	<b>Introduction</b>	<b>7</b>
6.1	Serial number	7
<b>7</b>	<b>Application</b>	<b>7</b>
<b>8</b>	<b>Technical data</b>	<b>8</b>
<b>9</b>	<b>Description</b>	<b>9</b>
9.1	Front panel	10
9.2	Gas flow diagram of the analyser PMA 20	10
<b>10</b>	<b>The measuring principle</b>	<b>11</b>
<b>11</b>	<b>Receipt of goods and storage</b>	<b>12</b>
<b>12</b>	<b>Installation</b>	<b>12</b>
12.1	Connection of Sample gas inlet and sample gas outlet	13
<b>13</b>	<b>Standard gas conditioning system</b>	<b>13</b>
<b>14</b>	<b>Electrical connection</b>	<b>14</b>
14.1	Signal output	14
<b>15</b>	<b>Starting up</b>	<b>14</b>
<b>16</b>	<b>Calibration</b>	<b>15</b>
16.1	Zero calibration	15
16.1.1	Cross sensitivities	17
16.1.2	Consideration of cross sensitivities	18
16.2	Span calibration	19
<b>17</b>	<b>Measuring</b>	<b>21</b>
<b>18</b>	<b>Closing down</b>	<b>21</b>
<b>19</b>	<b>Maintenance</b>	<b>21</b>
<b>20</b>	<b>Trouble shooting</b>	<b>21</b>
<b>21</b>	<b>Spare parts list</b>	<b>22</b>
<b>22</b>	<b>Appendix</b>	<b>22</b>

## List of Illustrations

Figure 1	Dimensions PMA20	9
Figure 2	Front panel PMA20	10
Figure 3	Gas flow diagram PMA 10	10
Figure 4	Scheme of the measuring cell and optical signal processing	11
Figure 5	Standard gas conditioning system	13
Figure 6	Electrical connection PMA 20	14
Figure 7	Circuit diagram PMA 20	23
Figure 8	Circuit diagram oxygen transducer unit PMA1.02.0	24
Figure 9	Components list circuit diagram PMA1.02.0	25
Figure 10	Components list circuit diagram PMA1.02.0	26
Figure 11	Temperature sensor resistance dependent on temperature	27
Figure 12	Installation provisions and spare parts positions	28

**Dear customer,**

we have made up this operating manual in such a way that all necessary information about the product can be found and understood quickly and easily.

Should you still have any question, please do not hesitate to contact **M&C** directly or go through your appointed dealer. Respective contact addresses are to be found in the annexe to this operating manual.

Please also contact our homepage [www.mc-techgroup.com](http://www.mc-techgroup.com) for further information about our products. There, you can read or download the data sheets and operating manuals of all **M&C** products as well as further information in German, English and French.

This Operating Manual does not claim completeness and may be subject to technical modifications.

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## 1 GENERAL INFORMATION

The product described in this operating 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 operating 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 operating manual.

## 2 DECLARATION OF CONFORMITY



**CE - Certification**

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

### **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**.

### 3 SAFETY INSTRUCTIONS

**Please take care of the following basic safety procedures when mounting, starting up or operating this equipment:**

Read this operating manual before starting up and use of the equipment. The information and warnings given in this operating manual must be heeded.

Any 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 (IEC 364) when setting high-power electrical units with nominal voltages of up to 1000 V, together with the associated standards and stipulations.

Check the details on the type plate to ensure that the equipment is connected to the correct mains voltage.

Protection against touching dangerously high electrical voltages:

Before opening the equipment, it must be switched off and hold no voltages. This also applies to any external control circuits that are connected.

The device is only to be used within the permitted range of temperatures and pressures.

Check that the location is weather-protected. It should not be subject to either direct rain or moisture.

The device must not be used in hazardous areas.

Installation, maintenance, monitoring and any repairs may only be done by authorized personnel with respect to the relevant stipulations.

### 4 WARRANTY

If the equipment fails, please contact **M&C** directly or else go via your appointed **M&C** 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 device. 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.

## 5 USED TERMS AND SIGNAL INDICATIONS



**DANGER!**

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



**WARNING!**

This means that death, severe physical injuries and/or important material damages **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 operating manual which require user's attention.

**SKILLED STAFF**

These are persons with necessary qualification who are familiar with installation, use and maintenance of the product.

## 6 INTRODUCTION

The **M&C** oxygen analyser **PMA 20** is a temperature controlled instrument which has been designed for continuous measurements of oxygen concentrations in particlefree and dry sample gas.

### 6.1 SERIAL NUMBER

The type plate with the serial number is in the lid of the analyser.

Whenever you call **M&C** regarding questions or orders for the spares please give us the serial number of your **PMA 20**.

## 7 APPLICATION

Due to the extremely fast response time of the patented **M&C** magneto-dynamic measuring cell with no stagnant volume as well as the negligible cross sensitivity from other sample gas components, the **M&C** oxygen analyser **PMA 20** has a wide variety of applications. The analyser is a suitable and reliable instrument for monitoring oxygen concentrations in various gas analytical control applications including flue gas-, inert gas-, ambient air-, fermentation processes- and process or laboratory control measurements.

## 8

## TECHNICAL DATA

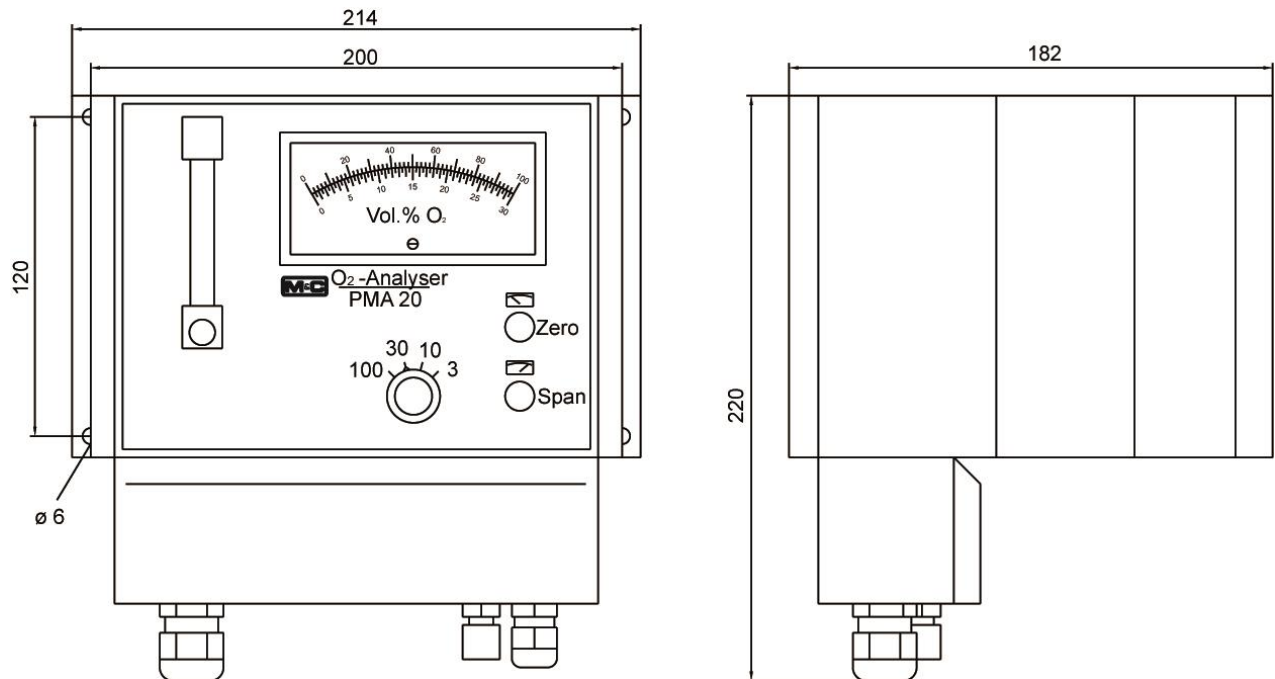
Oxygen analyser Series PMA®		Version PMA 20
Part No.	02A1000 = 230V 50Hz, 02A1000a = 115V 60Hz	
Measuring ranges	selectable for 0-3, 0-10, 0-30 and 0-100 vol.% O <sub>2</sub> , linear	
Indication	analogue meter with a scale of 0-30 and 0-100% for each selected range analogue meter with a scale of 0-30 and 0-100% for each selected range, digital meter, 3 1/2 digit 9 mm high for 0-100%O <sub>2</sub> reading, selectivity 0,1vol.% O <sub>2</sub>	
Output signal	0-1V DC non-isolated, load > 100 KΩ, for the range of 100 vol.%, and 0-20mA or 4-20mA* for the chosen range, non-isolated, max. load 300Ω	
Response time for 90% FSD	< 3 seconds at 60 NI/hr air	
Accuracy after calibration	deviation: analogue = ± 1% of span / digital = ± 0,1 vol.% O <sub>2</sub>	
Reproducibility deviation	analogue = < 1% of span / digital = ± 0,1 vol.% O <sub>2</sub>	
Influence of ambient temperature	no influence up to 45 °C	
Influence of barometric pressure	The oxygen reading varies in direct proportion to changes of the barometric pressure.	
Influence of sample gas flow	variation in gas flow between 0-60 NI/hr air will cause a difference of < 0,1 vol.% O <sub>2</sub> .	
Sample gas inlet pressure	0,01 up to 1 bar g, (PMA 20 required admission pressure for competent flow rate, no pump inside)	
Sample gas outlet pressure	Outlet of analyser must discharge freely into atmosphere.	
Flow rate of sample gas	max. 60 NI/hr air, adjustable with needle valve on the flowmeter 7-70 NI/hr	
Temperature of sample gas	-10 °C up to +40 °C, dry gas	
Analyser temperature	fixed at +50 °C	
Ambient temperature	-10 °C up to +45 °C	
Storage temperature	-20 °C up to +60 °C, relative humidity 0-90% RH	
Power supply	internal power unit for 230VAC standard or 115VAC available (a)* +/-10%, 40-60Hz, 26,5VA	
Electrical connections	terminals 2,5 mm <sup>2</sup> ; 1x PG11, 1x PG13,5 cable gland	
Materials in contact with sample gas	Platinum, Glass, Polypropylene, Stainless Steel 316, FPM, Epoxy resin	
Sample gas connection	PP hose connectors DN 4/6 for 4 mm i.d. and 6 mm o.d. tube	
Protection / electrical standard	IP 53 EN 60529 / EN 61010	
Housing / colour	plastic wall mounting housing / blue/grey	
Dimension / weight	height 220 mm, width 214 mm, length 182 mm / approx. 3 kg	
Options		
02A9015	Extra charge for PMA 20 in solvent resistant version with special measuring cell type PMC-1LB. Material: O-ring: Kalrez, flowmeter: PVDF, tubing and fittings: PVDF/SS316.	
02A9005	Extra charge for PMA 20 in chlorine resistant execution with a special measuring cell type PMC-1CL2. All gas bearing tubes PTFE/PVDF equipped with purge gas connectors.	
02A9010	Extra charge for qualification test according to TA-Luft + EN 14181 resp. 13. and 17. BImSchV	
02A9000	Extra charge for PMA with combined analogue/digital display. analogue meter with a scale of 0-30 and 0-100% for each selected range, digital meter, 3 1/2 digit 9 mm high LCD-indicator for 0-100%O <sub>2</sub> reading, selectivity 0,1vol.% O <sub>2</sub> or digital meter 3 1/2 digit 18 mm high LCD for 0-100% O <sub>2</sub> reading, selectivity 0.1 vol.% O <sub>2</sub>	

\* Please specify with order.



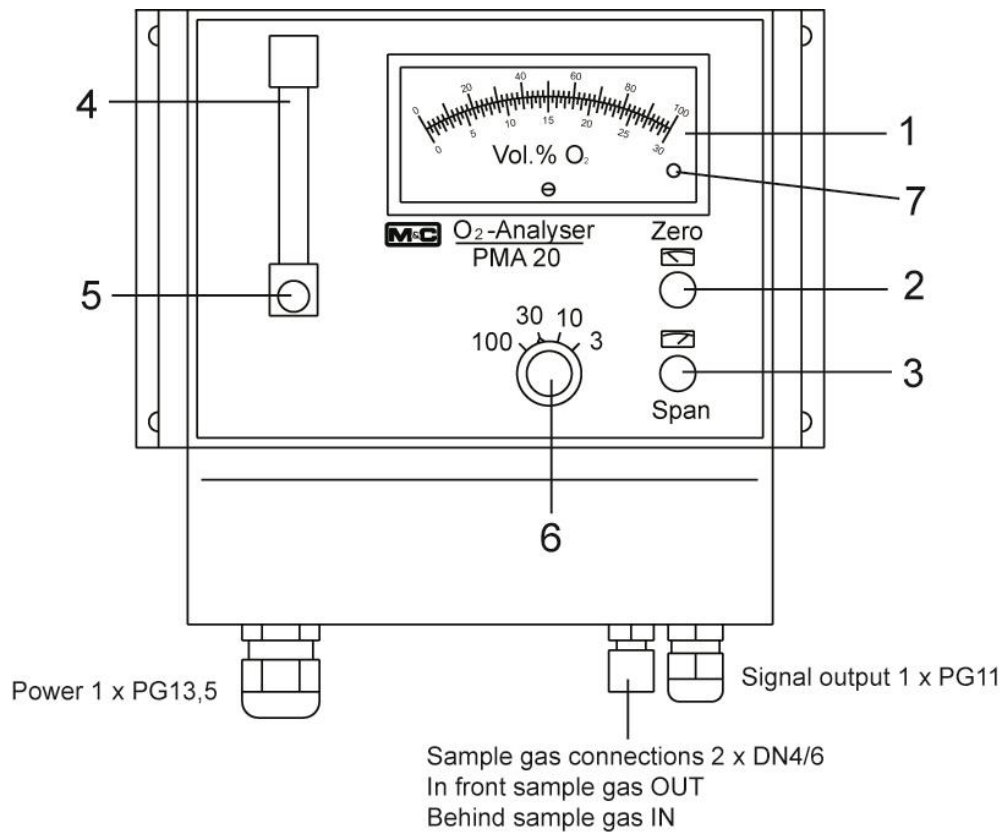
## 9 DESCRIPTION

The **PMA 20** is a reliable and easy-to-operate instrument. It is built into a compact wall mounting housing. The transducer unit maintains a constant operating temperature of 50 °C and a flashing LED on the control panel indicates the proper operating temperature of the analyser. The four measuring ranges are displayed on the analogue meter with 30/ 100% scale. Two output signals are available. Sample gas connections as well as connectors for incoming power supply and output signals are located inside the terminal box of the housing. The sample gas enters the analyser via an external protective fine-filter. The required flow rate can be adjusted at the flowmeter with needle valve, mounted on the front panel upstream the **M&C** measuring cell. The internal tubing is made of FPM and PP. Option: "TÜV certificate" or chlorine resistant version.



**Figure 1** Dimensions PMA20

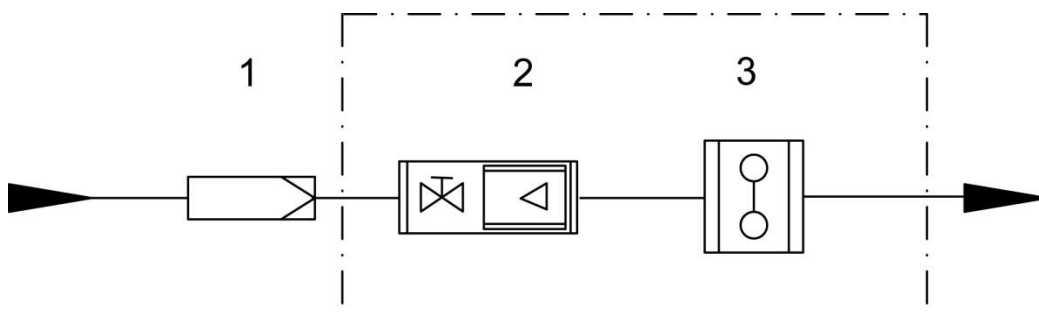
## 9.1 FRONT PANEL



- |          |                       |          |                                 |
|----------|-----------------------|----------|---------------------------------|
| <b>1</b> | Analog indication     | <b>4</b> | Flow meter                      |
| <b>2</b> | Zero potentiometer    | <b>5</b> | Needle valve 7 - 70 NI/hr       |
| <b>3</b> | Span potentiometer    | <b>6</b> | Measuring range selector switch |
| <b>7</b> | LED - heating control |          |                                 |

Figure 2 Front panel PMA20

## 9.2 GAS FLOW DIAGRAM OF THE ANALYSER PMA 20



- |          |                              |          |                |
|----------|------------------------------|----------|----------------|
| <b>1</b> | Fine filter                  | <b>3</b> | Measuring cell |
| <b>2</b> | Flow meter with needle valve |          |                |

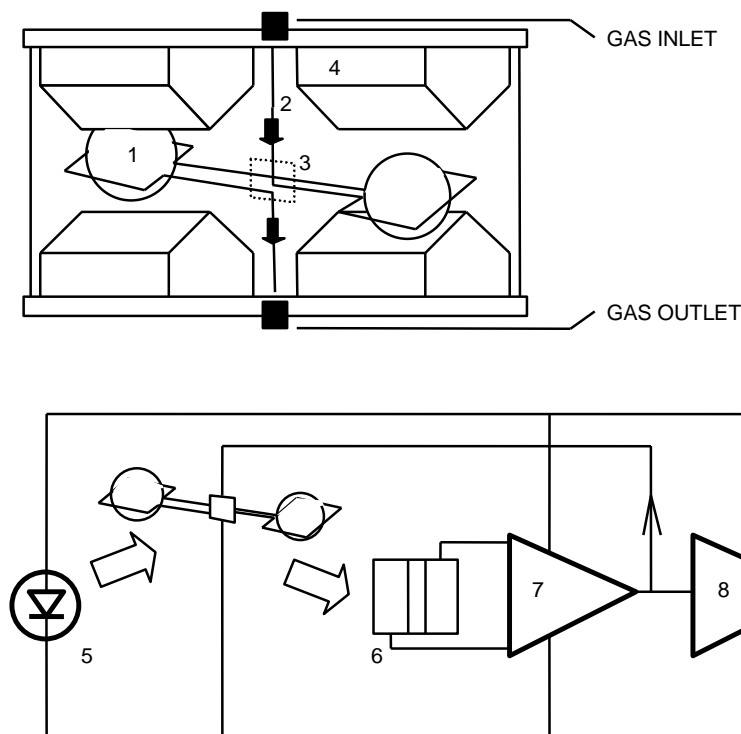
Figure 3 Gas flow diagram PMA 10

## 10 THE 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.



**Figure 4** Scheme of the measuring cell and optical signal processing

The measuring cell consists of two nitrogen-filled spheres ① which are arranged in the form of a dumbbell. In the dumbbell's central point of rotation, a small mirror ③ is placed. The dumbbell is surrounded by a wire coil needed for the compensation procedure. The described system is fixed rotationally symmetrical inside a glass tube via a tightening strap out of platinum ② and is screwed up with two pole pieces ④.

Two permanent magnets are producing an inhomogeneous magnetic field. When oxygen is flowing in, the molecules of the oxygen are drawn into the magnetic field. In consequence, the lines of electric flux on the cuneiform pole pieces ④ are compressed. The nitrogen-filled diamagnetic spheres are pushed out of the magnetic field. This causes a rotation of the dumbbell. The rotation is detected via an optical system consisting of mirror ③, projection LED ⑤ and photoelectric cell ⑥.

In case the dumbbell is pushed out of the magnetic field, the tension of the photoelectric cell is immediately changed. The measuring amplifiers ⑦ and ⑧ are producing a respective current which develops via the wire coil on the dumbbell an electro-magnetic load moment. The load moment is resetting the dumbbell into its zero position.

Every change of the oxygen concentration produces a lineary proportional change of the compensation current and can be read directly in % O<sub>2</sub> as oxygen value on the display ⑨.

Due to its very small stagnant volume (2 cm<sup>3</sup>) and the direct flow of the **M&C** measuring cell, an extremely fast response time (T<sub>90</sub>-time) of 1 second for a high gas flow can be realized.

## 11 RECEIPT OF GOODS AND STORAGE

The analyser **PMA 20** is a completely pre-installed unit.

- Please take the analyser 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 analyser PMA 20 must be stored in a wheather - protected and frost-proof area !**

## 12 INSTALLATION

The **PMA 20** is intended for stationary operation. In combination with a gas conditioning according to the requirements a long lasting operability and a minimum of maintenance is guaranteed.



**CAUTION!**

**The sample gas has to be dust free and dry to prevent a contamination and condensation in the analyser.**

**Basically always connect a fine filter (e.g. type FP-2T, Part No. 01F1200) upstream.**



**CAUTION!**

**In case of outdoor operation protect the analyser against sun, wind and rain.**

**At the installation location constant climatic ambient conditions (pressure, temperature) are necessary to prevent a distortion of the measurement and a condensation in the measuring cell in case the ambient temperature is falling below the dew point temperature of the sample gas.**

**A vibration-free location is ideal for mounting; if this is not possible, appropriate measures have to be taken. The analyser must not be installed in direct proximity of heat sources.**

**The position of operation is not necessarily horizontal.**



**DANGER!**

**The analyser is allowed to be operated only in non-hazardous areas and with non-ignitable gases and gas mixtures.**

Mounting is done at the four exterior fixing holes (6mm) with adequate screws. Leave enough space (approx. 120mm) at the right side of the housing for opening the housing in case of maintenance.

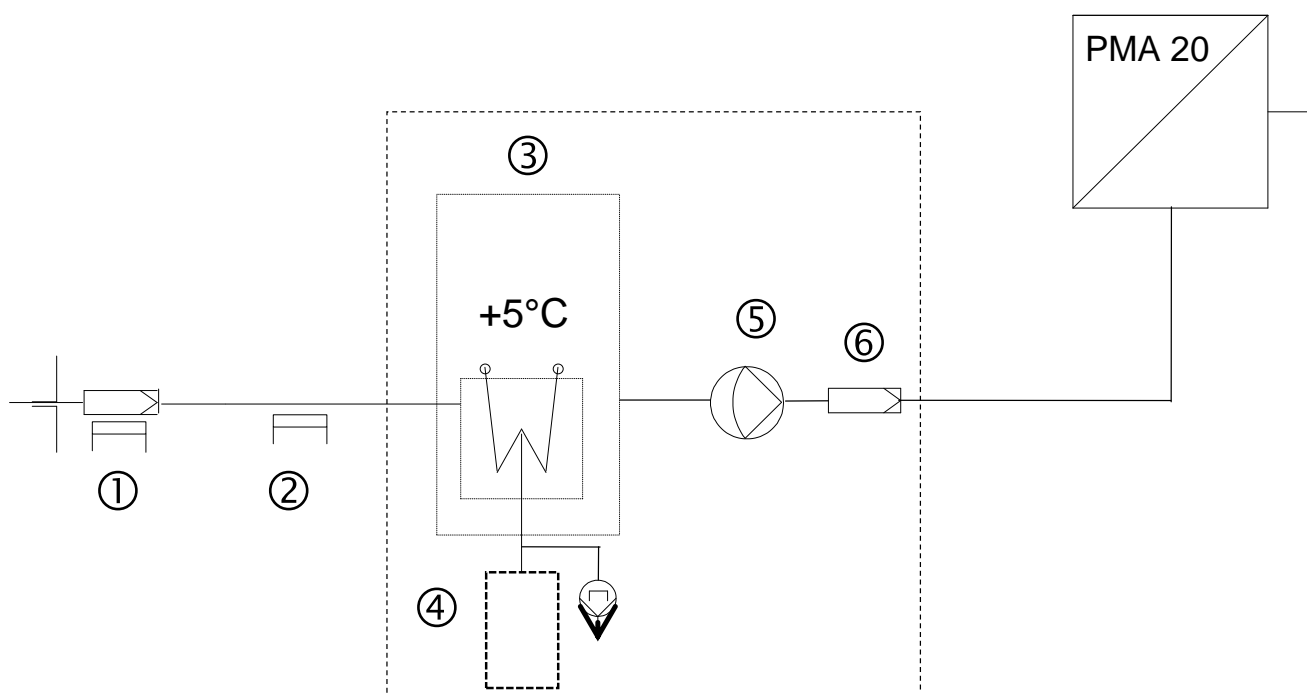
## 12.1 CONNECTION OF SAMPLE GAS INLET AND SAMPLE GAS OUTLET

The sample gas inlet and outlet are placed at the bottom side of the analyser and have tube connections DN4/6mm.

- Connect the sample gas inlet (rear connection) with a corresponding gas conditioning with e.g. a PTFE hose DN4/6.

**ATTENTION** Avoid back pressure in the sample gas outlet because an increase of pressure will distort the oxygen indication.  
Do not bend the connection hoses.

## 13 STANDARD GAS CONDITIONING SYSTEM



**Figure 5** Standard gas conditioning system

- 1 : Heated gas sample probe (e.g. probe SP2000-H)  
 2 : Heated gas sample line (e.g. 4M4/6)  
 3 : Sample gas cooler (e.g. ECM-1G)  
 4 : Peristaltic pump or condensate collecting vessel (e.g. SR25.1 or TG-1)  
 5 : Diaphragm pump (e.g. N3)  
 6 : Fine filter (FP-2T)

## 14 ELECTRICAL CONNECTION

The electrical connection is done at the terminals in the connection box below the analyser:

- Loosen the two screws of the lid and remove it.



**CAUTION!**

**False supply voltage can damage the equipment. When connecting the equipment, please ensure that the supply voltage is identical with the information provided on the model type plate!**

**Power**

PE	L	N
<b>X1</b>		

**SW1**



**Signal output**

0	+	0	+
mA		mV	
X2			

**Figure 6 Electrical connection PMA 20**

- Lead power cable with wire cross section 2,5mm<sup>2</sup> through the left cable gland with clamping range 8-12mm cable diameter and connect according to figure 6 at terminal X1.
- Check whether service-power-switch (SW1), which is located to the left of terminal X2, is in position 1 (left position).

### 14.1 SIGNAL OUTPUT

The **PMA 20** has two signal outputs as standard. One signal is 0-1V for 100% O<sub>2</sub> (independent of the chosen measuring range). The second signal is 0-20 or 4-20mA according to the order with a burden of 500Ohm for each measuring range. The output signals are not galvanically isolated.

- Lead signal cable with wire cross section 1,5mm<sup>2</sup> through the right cable gland with clamping range 6-8mm cable diameter and connect according to figure 6 at terminal X2.
- Remount lid.

## 15 STARTING UP

- Check electrical connections and gas connections.
- Turn measuring range selection switch from „0“ to the desired measuring range. The analyser is ready for operation immediately.
- Check mechanical zero of the indication; if necessary adjust zero position by turning the slotted screw in the pane of the indication instrument.
- Turn measuring range selection switch to 30%.
- Switch on mains voltage.
- The indication instrument shows 21% O<sub>2</sub> with ambient air in the measuring cell and the LED for heater control lights up permanently.

- After approximately 30 min. the LED in the indication instrument starts flashing. After 12 hours the transmitter has reached a temperature balance and the analyser is ready for calibration.

## 16 CALIBRATION

The accuracy of an analyser mainly is dependent on its calibration.



### NOTE!

**Before calibration it has to be assured that the calibration conditions correspond to the conditions during measurement. The flow rate and the barometric pressure conditions have to be constant. Under this terms a calibration of the analyser is necessary approximately one time a week to maintain the accuracy. If flow rate or barometric pressure conditions are changing significantly, a new calibration is necessary. During calibration the device must not be exposed to vibrations.**

For zero calibration of the analyser an oxygen-free gas, mostly nitrogen (N<sub>2</sub> 5.0) is used. For span calibration with **M&C** O<sub>2</sub>-analysers it is possible to abandon on special test gas mixtures because of the measuring principle and the linear measuring ranges. Dry and clean air is sufficient. For measurement concentrations > 40% O<sub>2</sub> a calibration with corresponding test gas could be possibly recommendable.

### 16.1 ZERO CALIBRATION

- Connect a flexible PVC- or FEP-hose with the pressure reducer of the N<sub>2</sub>-zero-gas bottle. The pressure reducer should have an output control range of max. 0 – 1,5 bar abs..

**CAUTION! The outlet pressure is only allowed to be adjusted at max. 0,1 bar. Otherwise the measuring cell of the analyser will be destroyed.**

- Open the bottle valve and than the closed pressure reducer outlet valve and purge the pressure reducer and the complete hose line for approximately 5 sec. the pressure reducer and the complete hose line.
- Check the adjusted control pressure and reduce if necessary to ≤ 0,1bar, then shut off the pressure reducer valve again.
- Connect the hose end of the zero-gas bottle connection to the gas inlet of the analyser.
- Open the pressure reducer valve slowly, to avoid pressure peaks.
- Adjust the flow rate to 50 NI/hr at the flow meter.



### NOTE!

**Always calibrate at the flow rate that is adjusted for the measurement too.**

- Wait approximately 20 – 30 sec. until the indication has stabilised.
- Turn measuring range selection switch to position 3%
- If necessary adjust zero accurately to 0 % O<sub>2</sub> with a screw driver at the zero potentiometer in the front panel

- Check output signals at 0,0% O<sub>2</sub> :

Output signal	Measurement
0-1 V	0 V
0-20 mA	0 mA
4-20 mA	4 mA

**NOTE!**

If a gas mixture is analysed, the single gas components have to be checked concerning potential cross sensitivity and regarded for zero calibration. (see chapter 16.1.1 and 16.1.2).

- Shut off pressure outlet valve and bottle valve.
- Disconnect hose connection from the analyser.

Zero calibration is finished.

**NOTE!**

After zero calibration the span has to be calibrated too.



### 16.1.1 CROSS SENSITIVITIES

The following table shows the cross sensitivities of the most important gases at 20°C and 50°C. All values are based on a zero calibration with N<sub>2</sub> and a span calibration with 100 Vol.% O<sub>2</sub>. The deviations are each valid for 100 Vol.% of the respective gas.

Gas	Molecular formula	20°C	50°C
Acetaldehyde	C <sub>2</sub> H <sub>4</sub> O	- 0,31	- 0,34
Acetone	C <sub>3</sub> H <sub>6</sub> O	- 0,63	- 0,69
Acetylene	C <sub>2</sub> H <sub>2</sub>	- 0,26	- 0,28
Ammonia	NH <sub>3</sub>	- 0,17	- 0,19
Argon	Ar	- 0,23	- 0,25
Benzene	C <sub>6</sub> H <sub>6</sub>	- 1,24	- 1,34
Bromine	Br <sub>2</sub>	- 1,78	- 1,97
Butadiene	C <sub>4</sub> H <sub>6</sub>	- 0,85	- 0,93
n-Butane	C <sub>4</sub> H <sub>10</sub>	- 1,10	- 1,22
Iso Butylen	C <sub>4</sub> H <sub>7</sub>	- 0,94	- 1,06
Chlorine	Cl <sub>2</sub>	- 0,83	- 0,91
Diacetylene	(CHCl) <sub>2</sub>	- 1,09	- 1,20
Nitrous monoxide	N <sub>2</sub> O	- 0,20	- 0,22
Ethane	C <sub>2</sub> H <sub>4</sub>	- 0,43	- 0,47
Ethylbenzene	C <sub>8</sub> H <sub>10</sub>	- 1,89	- 2,08
Ethylene	C <sub>2</sub> H <sub>4</sub>	- 0,20	- 0,22
Ethylene glycol	(CH <sub>2</sub> OH) <sub>2</sub>	- 0,78	- 0,88
Ethylene oxide	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	- 0,54	- 0,60
Furan	C <sub>4</sub> H <sub>4</sub> O	- 0,90	- 0,99
Helium	He	+ 0,29	+ 0,32
n-Hexane	C <sub>6</sub> H <sub>14</sub>	- 1,78	- 1,97
Hydrogen chloride	HCL	- 0,31	- 0,34
Hydrogen fluoride	HF	+ 0,12	+ 0,14
Hydrogen sulfide	H <sub>2</sub> S	- 0,41	- 0,43
Carbon dioxide	CO <sub>2</sub>	- 0,27	- 0,29
Carbon monoxide	CO	- 0,06	- 0,07
Krypton	Kr	- 0,49	- 0,54
Methane	CH <sub>4</sub>	- 0,16	- 0,17
Methanol	CH <sub>4</sub> O	- 0,27	- 0,31
Methylen chloride	CH <sub>2</sub> Cl <sub>2</sub>	- 1,00	- 1,10
Methyl propene	C <sub>4</sub> H <sub>8</sub>	- 0,94	- 1,06
Monosilan	SiH <sub>4</sub>	- 0,24	- 0,27
Neon	Ne	+ 0,16	+ 0,17
n-Octane	C <sub>8</sub> H <sub>18</sub>	- 2,45	- 2,70
Phenol	C <sub>6</sub> H <sub>6</sub> O	- 1,40	- 1,54
Propane	C <sub>3</sub> H <sub>8</sub>	- 0,77	- 0,85
Propylene	C <sub>3</sub> H <sub>6</sub>	- 0,57	- 0,62
Propylene chloride	C <sub>3</sub> H <sub>7</sub> Cl	- 1,42	- 1,44
Propylene oxide	C <sub>3</sub> H <sub>6</sub> O	- 0,90	- 1,00
<b>Oxygen</b>	<b>O<sub>2</sub></b>	<b>+100,00</b>	<b>+100,00</b>
Sulfur dioxide	SO <sub>2</sub>	- 0,18	- 0,20
Sulfur fluoride	SF <sub>6</sub>	- 0,98	- 1,05
Monosilane	SiH <sub>4</sub>	- 0,24	- 0,27
<b>Nitrogen</b>	<b>N<sub>2</sub></b>	<b>0,00</b>	<b>0,00</b>
Nitrogen dioxide	NO <sub>2</sub>	+ 5,00	+ 16,00
Nitrogen monoxide	NO	+ 42,70	+ 43,00
Styrene	C <sub>8</sub> H <sub>8</sub>	- 1,63	- 1,80
Toluene	C <sub>7</sub> H <sub>8</sub>	- 1,57	- 1,73
Vinyl chloride	C <sub>2</sub> H <sub>3</sub> Cl	- 0,68	- 0,74
Vinyl fluoride	CH <sub>3</sub> F	- 0,49	- 0,54
Water (Steam)	H <sub>2</sub> O	- 0,03	- 0,03
Hydrogen	H <sub>2</sub>	+ 0,23	+ 0,26
Xenon	Xe	- 0,95	- 1,02

## 16.1.2 CONSIDERATION OF CROSS SENSITIVITIES

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<sub>2</sub>) protective atmosphere at 20°C

In the table of cross sensitivities you can read the value for CO<sub>2</sub> at 20°C 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 this example, the atmosphere contains exclusively CO<sub>2</sub> and O<sub>2</sub>. For this reason, the influence of cross sensitivity can be eliminated without problem by using carbon dioxide (CO<sub>2</sub>) instead of nitrogen for the zero calibration.

### Example 2: Determination of the oxygen content of a gas mixture at 20°C

1 Vol.% C<sub>2</sub>H<sub>6</sub> (Ethane);  
5 Vol.% O<sub>2</sub>;  
40 Vol.% CO<sub>2</sub>;  
54 Vol.% N<sub>2</sub>.

Zero point calibration with nitrogen (N<sub>2</sub>).

The cross sensitivity values of above table are based on 100 Vol.% of the respective gases. Therefore, a conversion must be made to the effective volume concentration. In principle, the following is valid:

$$\text{Effective cross sensitivity} = \frac{\text{Table value} * \text{Volume concentration}}{100} \quad [\text{Vol.\%}]$$

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

C<sub>2</sub>H<sub>6</sub> : -0,0043 Vol.%;

CO<sub>2</sub> : -0,1080 Vol.%;

N<sub>2</sub> : 0,0000 Vol.%.

Σ = -0,1123 Vol.%

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

The correction factor is calculated as follows:

$$\text{Correction factor} = \frac{100}{(100 - \text{O}_2\text{-concentration})}$$

It is incidental:

$$\frac{100}{(100 - 5)} = \underline{1,0526}$$

For the gas mixture the rectified sum cross sensitivity then is calculated in good approximation:

$$1,0526 \times -0,1123 \text{ Vol.\%} = \underline{\underline{-0,1182 \text{ Vol.\%}}}$$

The rectified sum cross sensitivity with change of sign now can be used for the correction of the zero calibration. In this case zero had to be adjusted at +0,1182 Vol.%.

In case the cross sensitivities should be ignored in the above mentioned example, this would result in a relative error of approximately 2%.



**NOTE!**

**After zero calibration the span has to be calibrated too.**

## 16.2 SPAN CALIBRATION

Before span calibration a finished zero calibration is necessary.

- Turn the measuring range selection switch to the measuring range in which the calibration should be done. In case of measuring value concentrations <30% O<sub>2</sub> a calibration with dry clean air in the range of 30% O<sub>2</sub> is recommended. Turn the measuring range selection switch to 30%. In case of measuring value concentrations >40% O<sub>2</sub> a calibration in the 100% range with adequate test gas is recommended. Turn the measuring range selection switch to 100%.
- Connect a flexible PVC- or FEP-hose with the pressure reducer of the N<sub>2</sub>-zero-gas bottle. The pressure reducer should have an output control range of max. 0 – 1,5 bar abs..

**CAUTION!** The outlet pressure is only allowed to be adjusted at max. 0,1 bar. Otherwise the measuring cell of the analyser will be destroyed.

- Open the bottle valve and then the closed pressure reducer outlet valve and purge the pressure reducer and the complete hose line for approximately 5 sec. the pressure reducer and the complete hose line.
- Check the adjusted control pressure and reduce if necessary to ≤ 0,1bar, then shut off the pressure reducer valve again.

- Connect the hose end of the instrument air or check gas bottle connection to the gas inlet of the analyser.
- Open the pressure reducer valve slowly, to avoid pressure peaks.
- Adjust the flow rate to 50 l/h at the flow meter.

**NOTE!**

**Always calibrate at the flow rate that is adjusted for the measurement too.**

- Wait approximately 20 – 30 sec. until the indication has stabilised.
- If necessary adjust span accurately according to the check gas concentration with a screw driver at the span potentiometer in the front panel. In case of air e.g. to 20,9 % O<sub>2</sub>.
- Check output signals at 20,9% O<sub>2</sub> :

Output signal	Measurement range 100 % O <sub>2</sub>	Measurement range 30 % O <sub>2</sub>
0-1 V	0,209 V	0,697 V
0-20 mA	4,18 mA	13,93 mA
4-20 mA	7,34 mA	15,15 mA

- Shut pressure reducer valve and

bottle- resp. Instrument air valve resp. integrated sample gas pump.

- Disconnect hose connection at the analyser.

Determination of the output signal:

$$\frac{(S_e - S_{np}) \text{ V resp. mA} \times \text{gas concentration Vol \% O}_2}{\text{upper range value Vol \% O}_2} + S_{np}$$

S<sub>e</sub> = Final value, signal output

S<sub>np</sub> = Zero, signal output

- Shut off pressure reducer output valve and bottle valve. Druckreglerausgangsventil und Flaschenventil schließen. Disconnect hose connection at the analyser.

The span calibration is finished.

**NOTE!**

**If during the span calibration great variations have to be compensated (>2% O<sub>2</sub>) at the potentiometers, a second zero and span calibration is reasonable.**

**ATTENTION**

**After finishing the calibration turn measuring selection switch to the desired measuring range.**

**The mA-output signal is dependant on the measuring range!**

## 17 MEASURING

For the first starting up at a new location, all steps in chapter 16 and 17 have to be performed. By the requirements of precision the interval of the new calibration can be carried out daily or weekly.

**CAUTION!** The sample gas must be free from all liquid or solid particles, i.e. the dew point of the gas has to be below the equipment temperature so that no condensate will occur inside the equipment. If necessary, lower the dew point by means of a cooler or dryer. For dust filtration use a filter of 2 micron porosity !

We will be pleased to inform you about an optimal gas conditioning

The analyser now is ready for operation.

## 18 CLOSING DOWN

In case of a short time closing down of the the analyser no further precautions are required. In case of a closing down of the analyser for a longer period, it is recommended to flush the analyser with dry and clean inert gas (eg. surrounding air) in order to prevent a damage of the measuring cell by aggressive and corrosive liquid gases.

## 19 MAINTENANCE

The analyser, woking with a physical measuring principle, requires no intensive and complex maintenance. But the preceding components necessary for the sample gas conditioning are to be maintained with special attention according to the respective operating manuals.

The calibration of zero and span is to be effected with the corresponding test gases according to stability of the operating conditions and to the demands on the accuracy. Recommended interval of calibration for standard applications: 1 x per week.

## 20 TROUBLE SHOOTING

Error	Possible reason	Check/Repair
No indication	No supply voltage	Check supply voltage according to type plate. Check wether mains cable is plugged in accurate. Check fine fuse in the low heat device socket.
No sample gas flow	Sample line or filter is blocked  Contamination of the internal diaphragm pump	Check sample system.

## 21 SPARE PARTS LIST

Wear, tear and replacement part requirements depend on specific operating conditions. The recommended quantities are based on experience and they are not binding.

Oxygen analyser PMA 20					
(C) Consumable parts (R) Recommended spare parts (S) Spare parts					
		Recommended quantity being in operation [years]			
Part No.	Indication	C/R/S	1	2	3
90 A 3005	Analog panel meter	S	-	-	1
90 A 2005	Measuring range switch with wiring and front PCB	S	-	-	1
90 A 0020	Zero potentiometer 5k	S	-	-	1
90 A 0025	Span potentiometer 1k	S	-	-	1
90 A 0010	Measuring cell PMC 1	S	-	-	1
90 A 0015	Flowmeter glass 7-70 NI/h	S	-	-	1
90 A 3010	Solid state relay A3P-202N	S	-	-	1
90 A 3015	Temperature cut out 72°C	S	-	-	1
90 A 3020	Temperature sensor	S	-	-	1
05 V 3230	Bulkhead union DN4/6, material: PP	R	2	2	2
05 V 6500	Ferrule DN4/6, material : PP	R	4	4	4
05 V 6505	Spare parts union nutM10-4/6, material : PP	R	4	4	4

## 22 APPENDIX

- Circuit diagram PMA 20
- Circuit diagram oxygen transducer unit PMA1.02.0
- Components list circuit diagram PMA1.02.0
- Temperature sensor resistance dependent on temperature
- Installation provisions and spare parts positions



Further product documentation can be seen and downloaded from our home page:  
[www.mc-techgroup.com](http://www.mc-techgroup.com)

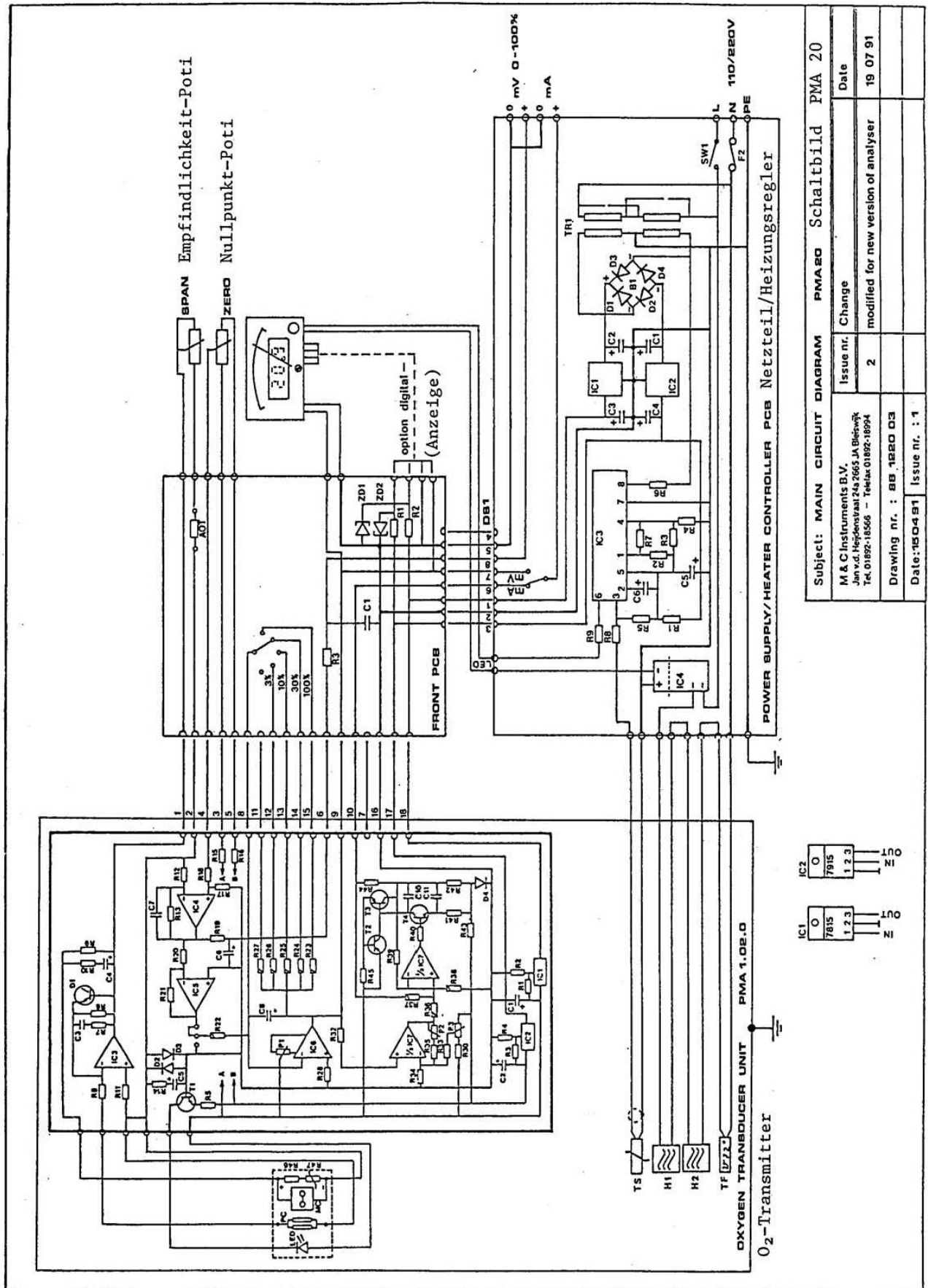


Figure 7

Circuit diagram PMA 20

Subject: MAIN CIRCUIT DIAGRAM		PMA 20	Schaltbild	PMA 20
M & C Instruments B.V.		Change		
Jan v.d. Heijdenstraat 24a 2665 JA Bleswijk		Date		
Tel. 01892-18568 - Telefax 01892-18994		Issue nr.	2	19 07 91
Drawing nr. : 88 1280 03		modified for new version of analyser		
Date: 160491		Issue nr. : 1		



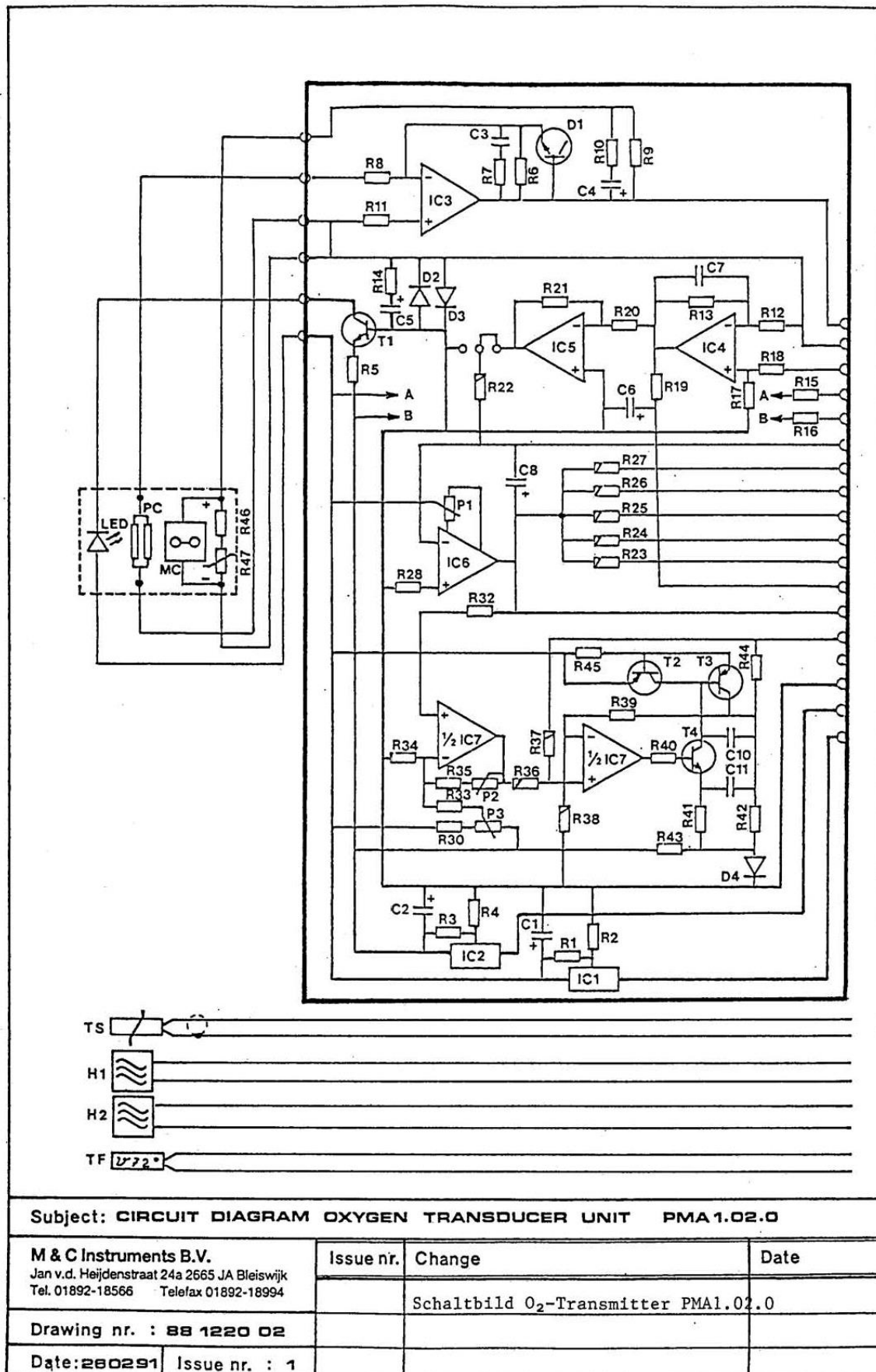


Figure 8

Circuit diagram oxygen transducer unit PMA1.02.0



C 1	1 $\mu$ F	16V	
C 2	1 $\mu$ F	16V	
C 3	0,68 nF	32V	
C 4	100 $\mu$ F	10V	
C 5	22 $\mu$ F	25V	
C 6	47 $\mu$ F	16V	
C 7	47 nF	32V	
C 8	1 $\mu$ F	16V	
C 10	1,5 nF	32V	
C 11	1,5 nF	32V	
D 1 (transistor)	BC 517		
D 2	1N4148		
D 3	1N4148		
D 4	1N4148		
IC 1	LM 317		
IC 2	LM 337		
IC 3	OP 77	alternate	AD 707 JN
IC 4	OP 07	alternate	AD 707 JN
IC 5	OP 07	alternate	AD 707 JN
IC 6	OP 77	alternate	AD 707 JN
IC 7	OP221		
P 1	20 K		
P 2	10 K		
P 3	100 K		
T 1	BC 517		
T 2	BC 212		
T 3	2N2905		
R 1	470 E		
R 2	3,9 K		
R 3	3,9 K		
R 4	470 E		
R 5	560 E		
R 6	22 M		
R 7	100 K		
R 8	1 K		
R 9	330 E		
R 10	22 E		

Bestückungsliste O<sub>2</sub>-Transmitter PMA 1.02.0

Subject: COMPONENTS LIST CIRCUIT DIAGRAM PMA 1.02.0			
<b>M &amp; C Instruments B.V.</b> Jan v.d. Heijdenstraat 24a 2665 JA Bleiswijk Tel. 01892-18566    Telefax 01892-18994	Issue nr.	Change	Date
Drawing nr. : 88 1220 02			
Date: 080391	Issue nr. : 1		

Figure 9

Components list circuit diagram PMA1.02.0

R 11	1 K	
R 12	22 E	
R 13	160 E	
R 14	22 E	
R 15	10 K	
R 16	10 K	
R 17	150 E	
R 18	4 K 7	
R 19	470 E	
R 20	10 K	
R 21	10 K	
R 22	1 K 5	0,1%
R 23	1 K 5	0,1%
R 24	4,49 K	0,1%
R 25	15 K	0,1%
R 26	49,9 K	0,1%
R 27	150 K	0,1%
R 28	1 K	
R 30	8 K 2	
R 32	100 K	
R 33	1 M	
R 34	100 K	
R 35	43,2 K	
R 36	100 K	
R 37	49,9 K	0,1%
R 38	2 K 2	0,1%
R 39	49,9 K	0,1%
R 40	2 K 2	
R 41	10 K	
R 42	10 K	
R 43	10 K	
R 44	47 E	
R 45	22 E	
R 46	27 E	
R 47	47 E	NTC

MC	Measuring Cell
PC	Photo-cells
LED	Light Emitting Diode
TS	Temperature Sensor KTY 11
H 1	Heater 110V 12W
H 2	Heater 110V 12W
TF	Thermal Fuse

Bestückungsliste O<sub>2</sub>-Transmitter PMA 1.02.0

Subject: COMPONENTS LIST CIRCUIT DIAGRAM PMA 1.02.0			
<b>M &amp; C Instruments B.V.</b> Jan v.d. Heijdenstraat 24a 2665 JA Bleiswijk Tel. 01892-18566 Telefax 01892-18994	Issue nr.	Change	Date
Drawing nr. : 88 1220 02			
Date: 060397	Issue nr. : 1		

Figure 10

Components list circuit diagram PMA1.02.0

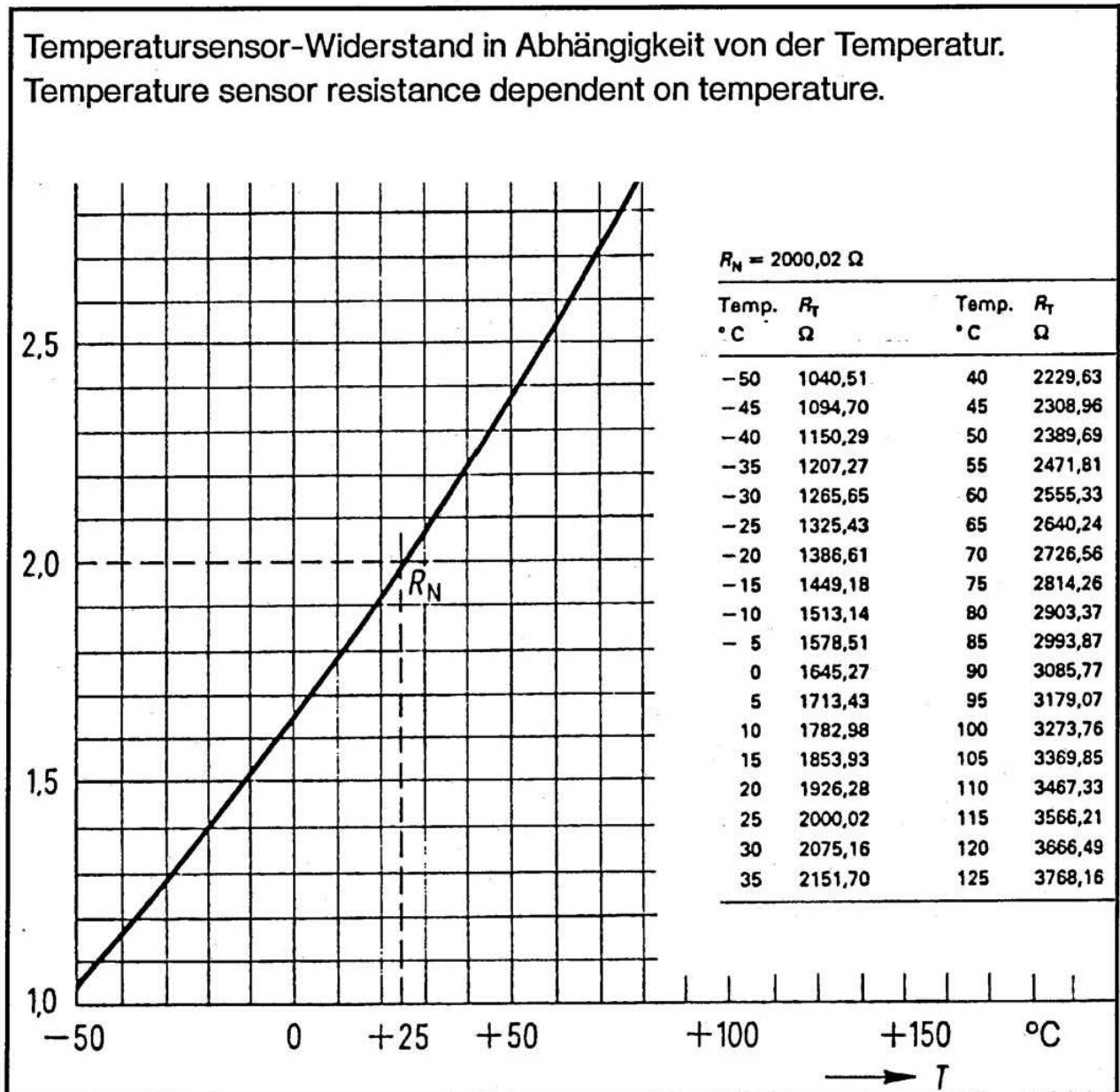


Figure 11

Temperature sensor resistance dependent on temperature

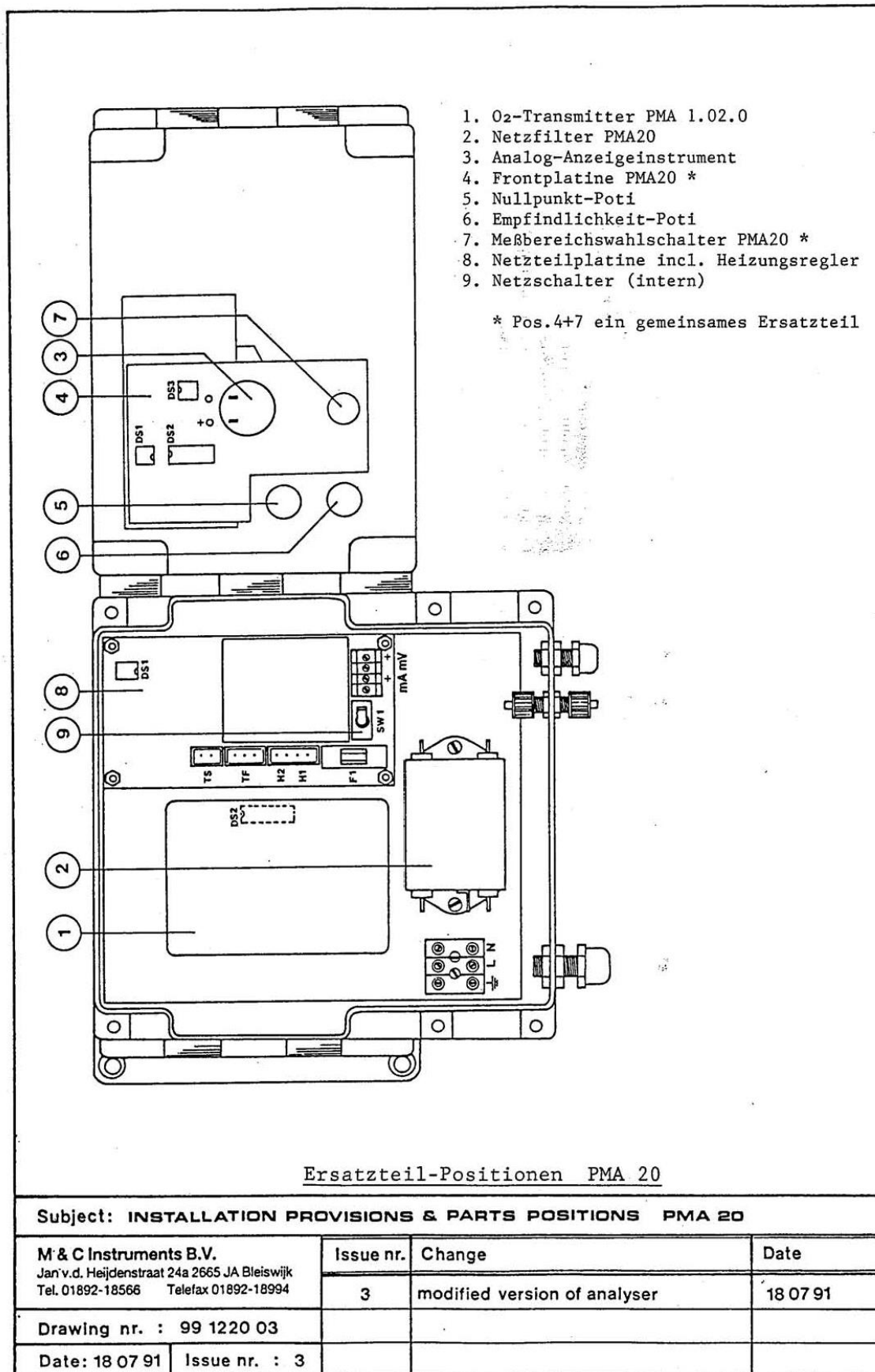


Figure 12

Installation provisions and spare parts positions