INSTRUCTION MANUAL

Microprocessor controlled oxygen analyser PMA®

Version PMA100 (V1.52)

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This instruction manual does not claim completeness and is subject to technical modifications.

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1. Electrical standards

The electrical standard corresponds to the **safety regulations concerning the low-voltage recommendation 73/23 EWG in version 93/68 EWG** and the **recommendation of electromagnetic compatibility 89/336 EWG in version 93/68 EWG**.
We meet the following standards:
EN 61010 part 1 / EN 50081 part 1 / EN 50082 part 1
EN 55014 / EN 60555 part 2 & 3 / EN 60335 part 1

2. Important safety informations

Please note the following basic safety procedures when using this equipment:

- 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 IEC 364 (DIN VDE 0100) 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 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 weatherprotected. It should not be subject to either direct rain or moisture.
- The equipment may not be operated in an area at risk from explosion.
- Installation, maintenance, monitoring and any repairs may only be done by authorised personnel with respect to the relevant stipulations.

3. 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 send in a sufficient and proper protective packaging.

4. Used terms and signal indication

SKILLED STAFF

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

The signals are used according to **DIN 4844** and **EU Recommendation 91/C53/06**.

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

5. Introduction

5.1 Analyser model

The Oxygen analyser type **PMA100** is produced by **M&C** Products Analysentechnik in Ratingen, Germany.

5.2 Patent references

The **M&C** paramagnetic measuring cell is patented in Europe and the USA under the following patent numbers:

- Germany Pat.-Nr. 36 33 750
- France Pat.-Nr. 87 13 608
- United Kingdom Pat.-Nr. 21 96 127
- The Netherlands Pat.-Nr. 188 2449
- USA Pat.-Nr. 4,807,463

5.3 Serial number

The type plate with the serial number is located at the back panel of the analyser. Whenever you call **M&C** regarding questions or orders for spares please give us the serial number of your **PMA**.

5.4 Power supply

The power supply for the oxygen analyser **PMA100** is 230V, 50Hz or 115V, 60Hz ('a' added to the Serial-No.). For detailed information please look at the type plate of your analyser. Variations of the power supply in a range of +10% to - 15% have no influence on the function of the analyser.

5.5 Mounting system

The analyser is build in a 19" housing, for rack or table-mounting.

6. Application

The transducer of the **PMA100** works at a stable temperature of +55°C. Therefore the analyser is suitable for continuous measurements of oxygen concentrations in particle-free and dry sample gases.
Safe operation, reliability and minimized maintenance are the characteristic of the **PMA100**.
The operation of the instrument is based upon the principle of the magneto-dynamic cell which is the most accurate and reliable cell for determining the oxygen content in gas mixtures in a range of 0 to 100 Vol.-%.
The patented **M&C** measuring cell has been improved in order to achieve stability, minimum drift of temperature and extremely fast response time. Due to this fast response time and the negligible cross-sensitivity from other gases the **PMA100** is applicable in a wide range of processes, like:

- monitoring of flue gases,
- inerting installations,
- fermentation processes,
- process- and lab-measurements, etc.

7. Description

7.1 Measuring principle

The paramagnetic susceptibility of oxygen is significantly greater than that of other common gases, and for this reason the molecules of oxygen are attracted much more strongly by a magnetic field than the molecules of other gases. Most of the other gases are slightly diamagnetic, e.g. the molecules are then repelled by a magnetic field.

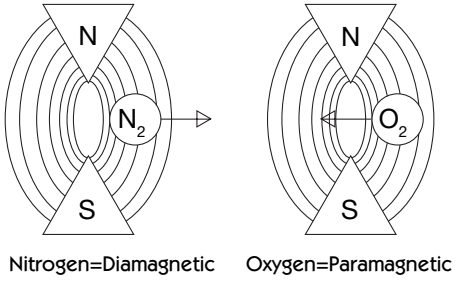


Fig. 1: Magnetic susceptibility of gases

The principle of the magneto-dynamic cell is based upon Faraday's method of determining the magnetic susceptibility of gas. The cell consists of two nitrogen-filled quarts spheres arranged in the form of a dumb bell. A single turn of platinum wire is placed around the dumb bell which is suspended in a symmetrical non-uniform magnetic field. When the surrounding gas contains oxygen, the dumb bell spheres are pushed out of the magnetic field by the change in the field which is caused by the relatively strong paramagnetic oxygen. The torque acting on the dumb bell will be proportional to the paramagnetism of the surrounding gas and consequently it can be used as a measure of the oxygen concentration.

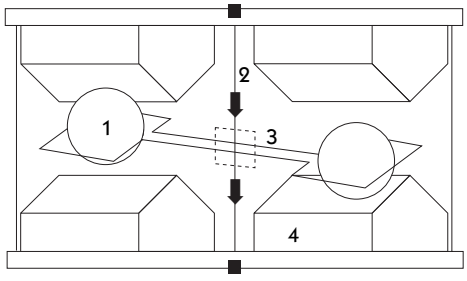
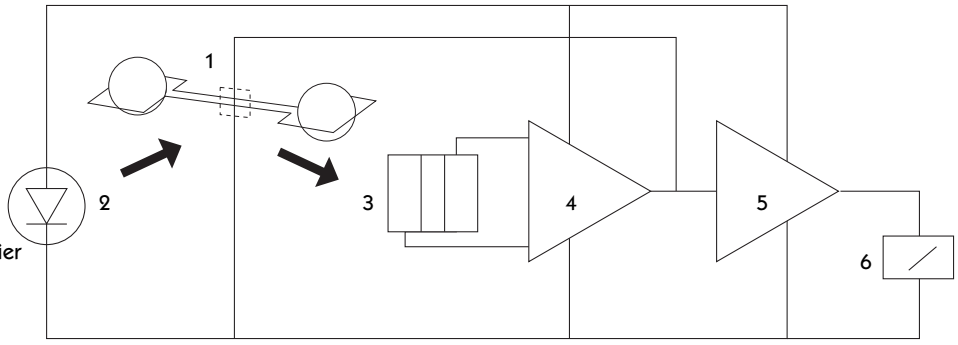


Fig. 2: The measuring cell in theory

The distortion of the dumb bell is sensed by a light-beam and projected on a mirror attached to the dumb bell whereof it is reflected to a pair of photo cells (Fig. 3). When both photo cells are illuminated equally the output will be zero. The output from the photo cells is connected to an amplifier, which in turn is fed to the feedback coil of the measuring cell. If the oxygen content of the gas sample changes,



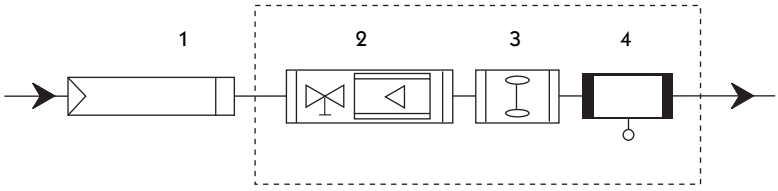
1: Measuring cell
2: „LED“ light beam
3: Photo cell
4: Feed back amplifier
5: Output amplifier
6: Meter indication

Fig. 3: Principle of operation

the corresponding output of the amplifier, which is a current and also proportional to the oxygen content, produces a magnetic field in the feedback coil opposing the forces and thereby causing the dumb bell to rotate.
Since the feedback current from the amplifier is proportional to the oxygen content of the gas sample, the output signals produced by the amplifier will be accurate and linear. The paramagnetic susceptibility of oxygen varies inversely as the square of the absolute temperature. Therefore, a temperature sensitive element in contact with the measuring cell assembly is included in the feedback current circuit in order to provide compensation for changes in analyser temperature.

7.2 Flow diagram

The flow can be adjusted in a range of 25 - 60Nl/h air at the flowmeter with needle valve (2) built on the front panel of the analyser.
The flow sensor at the outlet of the measuring cell (3) de–tects the sample flow if it decreases under 25l/hr.
We recommend a conditioning system upstream the analyser **PMA100**, e.g. consisting of a cooler and fine filter.



1: external filter
2: flowmeter with needle valve
3: patented **M&C** measuring cell **PMA100**
4: flow control

Fig. 4: Flow diagram of the analyser

We like to inform you about suitable M&C equipment.

7.3 Dimensions and weight

The analyser is build in a 19” housing, also suitable for table mounting. Fig. 5 shows the dimensions of the **PMA100**. Please take additional 60mm fitting-depth into consideration when installing the analyser.
The weight of the analyser is approx. 11 kg.

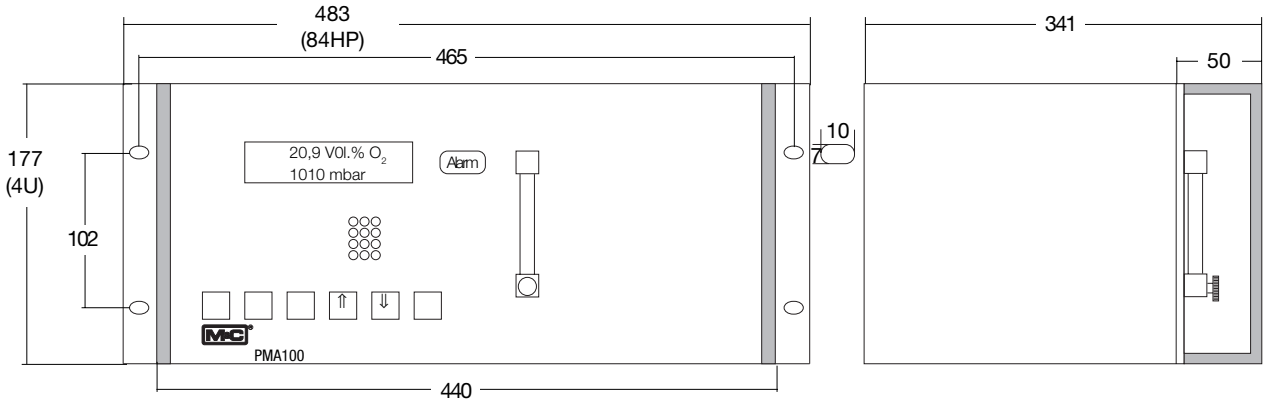


Fig. 5: Dimensions of the PMA100

7.4 Front panel

The following figure shows the front panel of the oxygen analyser **PMA100**.
You can see the double-lined LCD display ① , the alarm LED ② , the flowmeter with needle valve ③ , status LEDs ④ and the six operating keys ⑤ .
The sample flow can be adjusted at the needle valve in a range of 25-60Nl/hr.
The control panel refers to NAMUR standard and is devided into:

- **Select** key
- **Enter** key
- Direction key ⇑
- Direction key ⇓
- **Cal** key
- **Meas**uring key

(for more functional description see chapter 12)

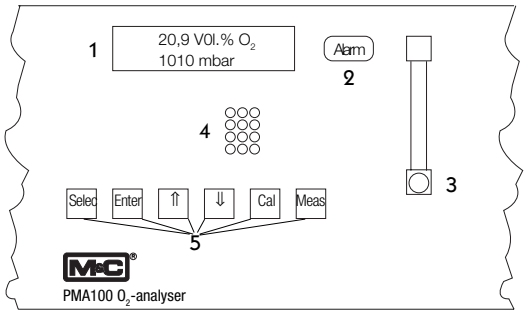


Fig. 6: Front panel with display, operating keys and flowmeter

7.5 Technical data

Part No.	03A3000(a): PMA100, power supply $230V_{AC}$, 50Hz, $115V_{AC}$, 60Hz signal: 4-20mA; (a)=115V
Measuring ranges	4 linear measuring ranges free selectable, lowest span 1%, basis parameterizing: 0-1; 0-10; 0-25; 0-100Vol.% O_2 *; manual, automatic or remote range control and range indication is possible
Indication, suitable in German, English and French	2 line, 16-sign. LCD-display, resolution 0,01Vol.%O_2, continuous O_2-indication and read off O_2-transducer temperature, mA-signal, measur- ing range, time, date, error/alarm message, process pressure
Output signals	selection: isolated 0-20, 2-20, 4-20*, 4-20.5mA for the selected range, max. load 500Ω; interface RS232, AK communication protocol, bi-directional, option: interface RS485
Relay outputs, free configurable	4 potential free relay contacts NO, contact rating max. $48V_{DC}$, 500mA, 15W
Binary outputs	$24V_{DC}$, max. 400mA, controlling of 3 external valves for calibration
Binary inputs, free configurable	potential free, 4 x 12 - $24V_{DC}$, max. 20mA or internal $24V_{DC}$ supply voltage
Flow alarm	caloric conductibility sensor in the outlet of the cell
Status alarm	for min. flow, transducer temp. < 50°C, processor error, pressure sensor: LED-indication and potential free contact output,NO, max. $48V_{DC}$, 500mA, 15W and mA output signal, f.e. 22mA
Alarm contact	for underflow or exeeding of the measuring range, termination of the calibration, external alarm, concentration alarm: LED-indication and potential free contact output, NO, max. $48V_{DC}$, 500mA, 15W
Response time for 90%-FSD	< 3sec at 60 Nl/hr air
Accuracy after calibration	deviation ± 1% of 2-100% span, ±2% of 1% span
Reproducibility	deviation < 1% of span
Influence of ambient temperature Influence of barometric or process pressure Influence of sample gas flow	no influence up to 50°C the oxygen reading varies in direct proportion to the baromatric or process pressure variation option: integrated process pressure compensation for the range 0,6 to 1,6bar abs., part no.: 03A9300 variation in gas flow between 0 and 60 Nl/hr air will cause a difference in reading of < 0,1Vol.%O_2
Sample gas - inlet pressure - outlet pressure - flow rate - temperature	 0,01 up to 0,5bar g (PMA100 requires positive pressure for adequate flow rate, no pump inside) outlet of analyser should discharge freely into atmosphere, or see option: pressure compensation 25 - 60 Nl/hr air -10°C up to +50°C dry gas
O_2-transducer temperature Ambient temperature Storage temperature	fixed at +55°C -10°C up to +50°C -20°C up to +60°C, rel. humidity 0-90% RH
Power supply Electrical connections	internal power unit for $230V_{AC}$ or $115V_{AC}$ available, (a) +/-10%, 40-60 Hz, 35VA mains supply: 3-pol. chassis plug with 2m cable; signals: 4 x Sub-D plug
Materials in contact with sample gas	platinum, epoxy resin, glass, FPM, stainless steel 316, PTFE, PVDF
Sample gas connection	1/8“ NPT internal thread*, option with tube connector DN 4/6 PVDF available part no.: 05V1045
Protection / Electrical standard	IP40 (EN60529) / EN61010
Housing/ Front colour	19“ rack mounting with front handles grey RAL 7032
Dimensions/ Weight	width: 84HP; hight: 4U; depth: 350mm + approx. 60mm installation space approx. 11 kg

* standard/basis execution

8. Supply connections

8.1 Medium

Note!
The oxygen analyser **PMA100** is suitable for continuous measurements of oxygen concentrations in particle-free and dry sample gases. Therefore it is recommended to use a gas conditioning system upstream the analyser, e.g. equipped with a cooler and a particle filter.

We like to inform you about suitable M&C equipment.

The following diagram shows the connections on the back panel of the **PMA100**.

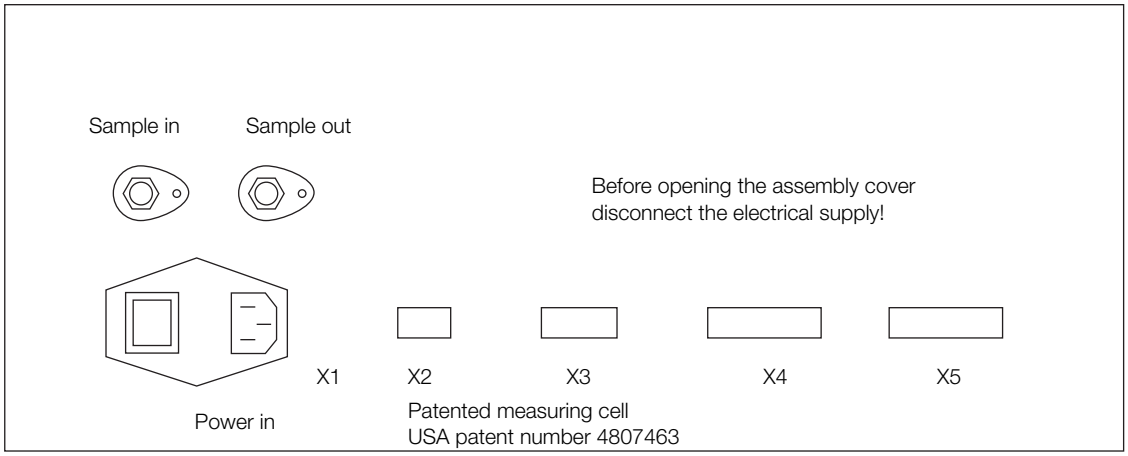


Fig. 7: Connections on the back panel of the PMA100

For connection of the sample gas in- and outlet use 1/8" NPT male fittings.

We like to inform you about our range of tube and pipe connectors.

8.2 Electrical

The analyser **PMA100** is equipped with an internal power switch. The 2m cable with 3-pole plug at the end is part of the standard supply.

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!

Note!
For the erection of power installations with rated voltages up to 1000V, the requirements of **VDE 0100** and relevant standards and specifications must be observed!
The main circuit must be equipped with a fuse corresponding to the nominal current (over current protection); for electrical details see technical data (chapter 7.5).

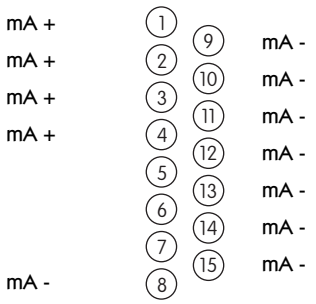


Fig. 8: 15-pole Sub-D socket X3

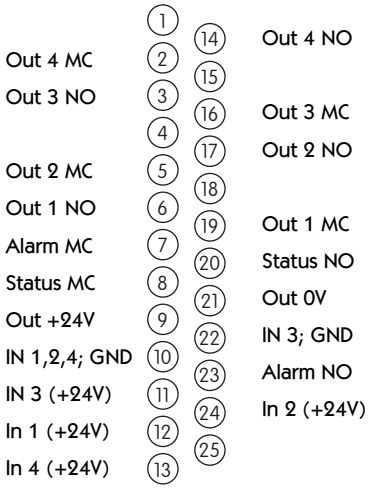


Fig. 9: 25-pole Sub-D plug X4

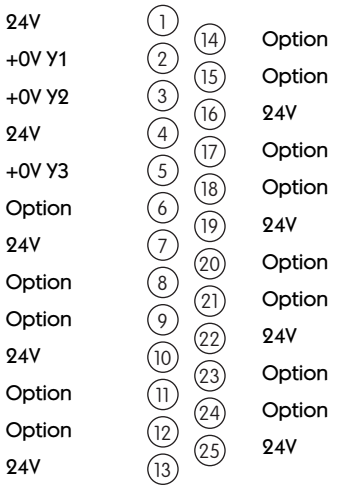


Fig. 10: 25-pole Sub-D socket X5

8.2.1 mA output

The mA output is available on the back panel of the **PMA100** (see fig.8) at the 15-pole Sub-D socket **X3**. The following figure shows the configuration of the terminal. For multichannel version the outputs are arranged as follows:

① channel 1,
② channel 2,
③ channel 3,
④ channel 4.

The menu-driven handling of the mA outputs is described in chapter 12.

8.2.2 In- and output contacts

Fig. 9 shows the configuration of the terminal **X4**. The following connections are available at the 25-pole Sub-D plug:

- four binary inputs, In1 to In4, with 12V - 24V, max. 20mA,
- four binary output contacts, Out1 to Out4, with 48V, max. 500mA,
- one alarm contact, Alarm MC and Alarm NO, with 48V, max. 500mA,
- one status contact output, Status MC and Status NO, with 48V, max. 500mA. and
- one supply power contact, Out +24V and Out 0V, with 24V, max. 100mA.

The menu-driven handling of the in- and outputs is described in chapter 12.

8.2.3 Connector for solenoid valves

Fig. 10 shows the 25-pole Sub-D socket **X5** with the supply power to control three external solenoid valves. At the moment three conections are available:

- pin 2 connection for the zero gas solenoid valve, 24V, max. 400mA,
- pin 3 connection for the span gas solenoid valve, 24V, max. 400mA, and
- pin 5 connection for the sample gas solenoid valve, 24V, max. 400mA.

The menu-driven handling of the in- and outputs is described in chapter 12.

9. Receipt and storage

The **PMA100** is completely pre-installed and normally delivered in one packaging 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 delivery note;
- 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 **PMA100** must be stored in a wheather-protected frost-free area!

10. Installation

The **PMA100** is built in a 19“ housing, which is also suitable for table mounting.
Accurate and proper installation of the **PMA100** analyser will not only minimize instrument breakdown, but it will also result in reliable operation of the analyser.
The operator must be satisfied that the analyser installation and positioning is safe for extremes of conditions which could occur in the operating environment of the analyser.
Choose installation sites which are reasonable free from vibration sources, and are not subjected to large temperature fluctuations outside the analyser specifications.
Without any precautions avoid any back pressure different from barometric pressure at the gas outlet of the analyser.

Note that the PMA100 analyser is only suitable for measuring of non-hazardous gas mixtures in non-hazardous areas!

11. Starting up

Before using the equipment for the first time, check that the safety measures specific to the installation and process are complied with.

Before connecting the analyser to the mains, compare the mains voltage with the information on the type plate of the analyser.

Note!
The working temperature of the analyser is 55°C. After starting, the analyser warms up. The current temperature is displayed.
During the warm-up time the menu of the analyser is locked for use.

12.Menu description

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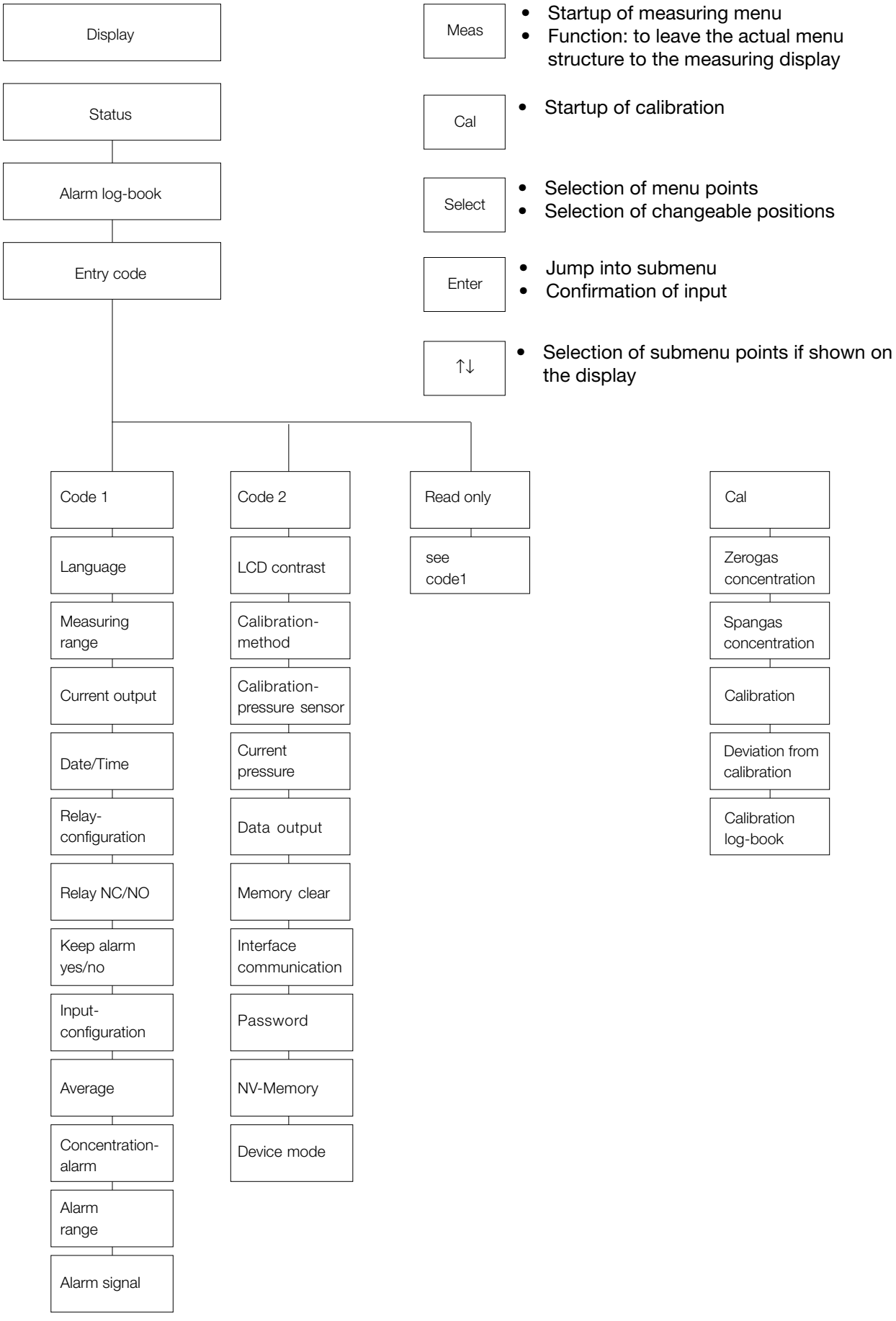
Overview menu-drive



Overview operating keys

Meas	• Startup of measuring menu • Function: to leave the actual menu structure to the measuring display
Cal	• Startup of calibration
Select	• Selection of menu points • Selection of changeable positions
Enter	• Jump into submenu • Confirmation of input
↑↓	• Selection of submenu points if shown on the display

MC Para O_2 V 1.52 TM M&C Products

12.2 Warming up

After switching on the analyser type **PMA100**, the warming-up begins.
The following display appears for approximately 20 seconds:

- **M&C** logo
- current O_2-concentration
- Software-version implemented in the **PMA100**
- and the trademark.

press: 1005 mbar

		⇑	⇓		

After further 20 seconds the display changes. Via the Direction keys ⇑⇓ the following current values can be indicated:

- measuring range,
- temperatur of the transducer,
- pressure in the measuring-cell,
- date/time,
- current output.

The second line displays the heating procedure.
The warming-up is finished by reaching a temperature of 54°C. The display shows either the current value (see above) or an error message. The second line of the display presents the current oxygen concentration (for multi-channel version the concentration of the respective channel).

press: 1005 mbar heating 22.5°C

Select					

The **Select** key leads to the next menu point.

12.3 Alarm log-book

The starting time and the 9 last alarms are stored. The Direction keys ⇑⇓ can be used going through the alarm log-book. The current alarm message is shown on the display like **E** ....

alarm log-book

Select					

The **Select** key leads to the entry of the access code.

enter to config. Code: 0000

	Enter				

The **Enter** key opens the access code menu for the first, second respectively read only level.
The first changeable position is underlined. With the Direction keys ⇑⇓ the value of the position can be changed in between 0 and 9. A jump to the next position happens via the **Select** key. The entry of the complete code has to be confirmed by the **Enter** key and is shown in the second line of the display.
The codes are preadjusted at the factory:
Code: 0010 level 1
Code: 1000 level 2
Code: 0000 read only-level;

enter to config. Code: 0000

Select		⇑	⇓		
	Enter				

The read only-level allows a passage through all menu points of level 1 via the **Select** key. In this level parameters can not be changed.

enter to config. Level 1

Select		⇑	⇓		

The **Select** key leads to level 1 - measuring parameters, relay-, input and output configuration.

12.4 Parameterising level 1

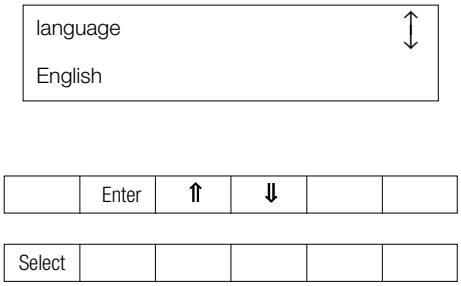
12.4.1 Language

The following languages are selectable by the Direction keys ⇑⇓ :

- English,
- German,
- French.

Enter confirms the choice.

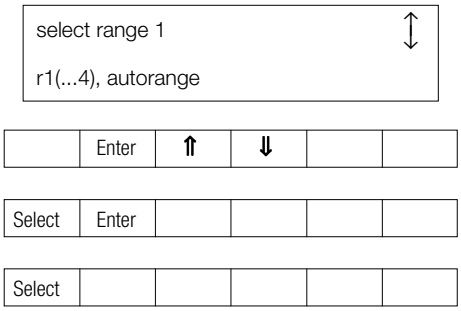
The **Select** key leads to the next menu point.



12.4.2 Select range

After the entry of the code for level 1 the display opens to the select range menu. Four variable ranges and the autorange are available. The functions can be selected by the Direction keys ⇑⇓ . With the autorange always the favourable range is used.
In combination with the autorange function, unused measuring ranges are requested to be set to 0 (see 12.4.3).

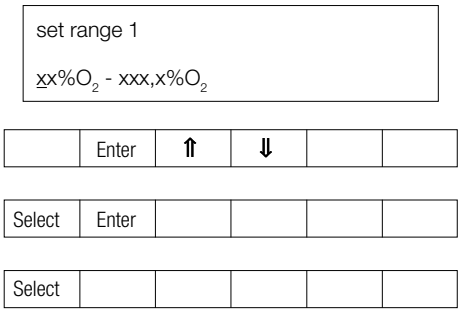
The **Select** key leads to the next menu point.



12.4.3 Set range

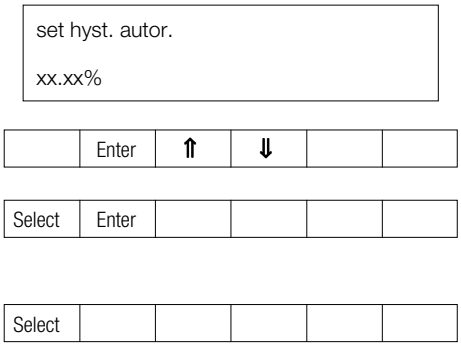
The desired ranges 1 to 4 or the autorange are selected by the Direction keys ⇑⇓ . The display is opened for changes by the **Enter** key. The first changeable position is underlined and can be changed operating the Direction keys ⇑⇓ . A jump to the next position happens via the **Select** key. The entry of the complete measuring range has to be confirmed by the **Enter** key.

The **Select** key leads to the next menu point.



12.4.4 Set autorange hysteresis

This adjustment is important using the autorange function. The %-value is related to the smallest span of the relevant switching ranges and determines the interval switching into the next lower range (see 14.1).
The entry starts with the **Enter** key. The first changeable position is underlined and can be changed operating the Direction keys ⇑⇓. A jump to the next position happens via the **Select** key.
The entry has to be confirmed by the **Enter** key, and the **Select** key leads to the next menu point.

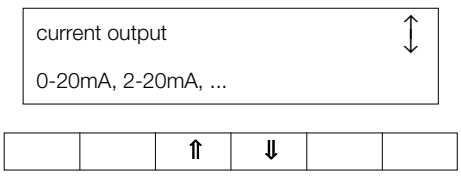


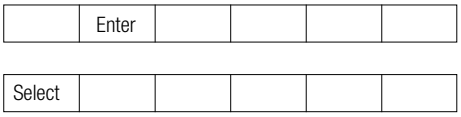
12.4.5 Current output

Two adjustments are possible:
1. fixed output signal and
2. output signal with range of tolerance showing the underflow respectively exceeding of the signal range.

The following ranges are preseted:

- 0 - 20mA
- 2 - 20mA
- 4 - 20mA
- 0 - 20mA + 0,45mA
- 2 - 20mA ± 0,45mA
- 4 - 20mA ± 0,45mA

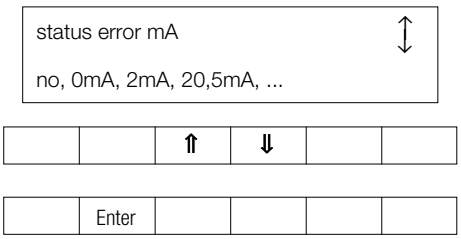




A selection is done by the Direction keys ⇑⇓ and confirmed by the **Enter** key.

The **Select** key leads to the next menu point.

12.4.6 Status error mA

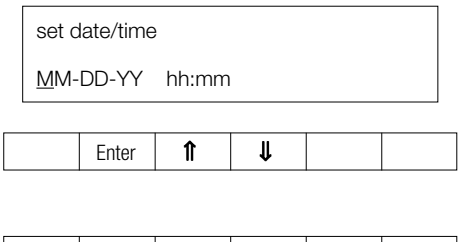


Using a permanent current output signal, status errors can be identified. The output signal is selected via the Direction keys ⇑⇓ and confirmed by the **Enter** key.
The following output signals are available:

- no output signal
- 0 mA
- 2 mA
- 20,5 mA
- 21 mA
- 22 mA
- 22,5 mA
- 23 mA
- 24 mA

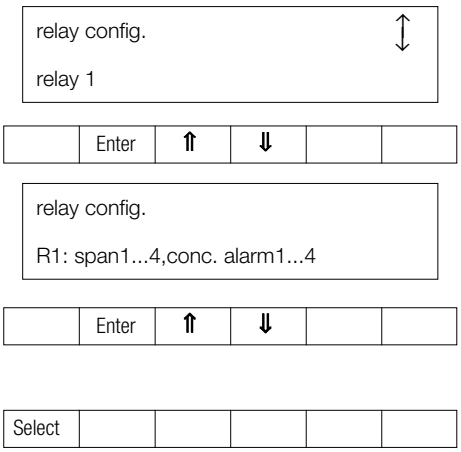
The **Select** key leads to the next menu point.

12.4.7 Set date/time



The **Enter** key enables the entry of the date/time values: first month, day and year, then hour and minute.
The first changeable position is underlined and can be changed operating the Direction keys ⇑⇓ .
A jump to the next position happens via the **Select** key.
The entry has to be confirmed by the **Enter** key, and operating once more the **Select** key leads to the next menu point.

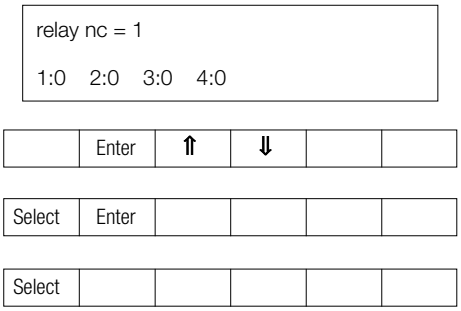
12.4.8 Relay configuration



This menu point determines the function of maximum four relays, R1 to R4 (see 7.5 technical data). A selection of the relays is done by the Direction keys ⇑⇓ .
The **Enter** key opens the Entry and the Direction keys ⇑⇓ select the desired function:

- allocation of the measuring ranges 1 to 4
- measuring span error
- concentration alarm (1 to 4)
- calibration
- flow alarm
- external alarm (see 12.4.9).

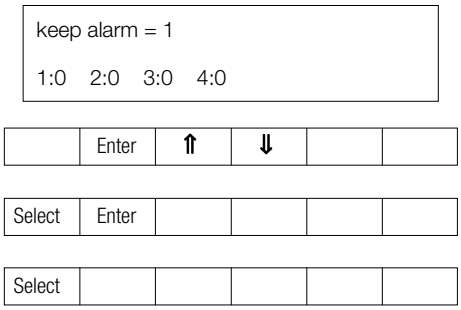
The **Enter** key confirms the selection.
The **Select** key leads to the next menu point.



This menu point selects whether the relay functions as:
0 normally open contact
1 normally closed contact
The entry starts with the **Enter** key. The first changeable position is underlined and can be changed operating the Direction keys ⇑⇓ . A jump to the next position happens via the **Select** key.
The entry has to be confirmed by the **Enter** key, and the **Select** key leads to the next menu point.

An alarm situation can be kept. If yes, one input must be configured as a reset (see 12.4.9).
The entry starts with the **Enter** key. The first changeable position is underlined and can be changed operating the Direction keys ⇑⇓ . A jump to the next position happens via the **Select** key.
The entry has to be confirmed by the **Enter** key, and the

Select key leads to the next menu point.



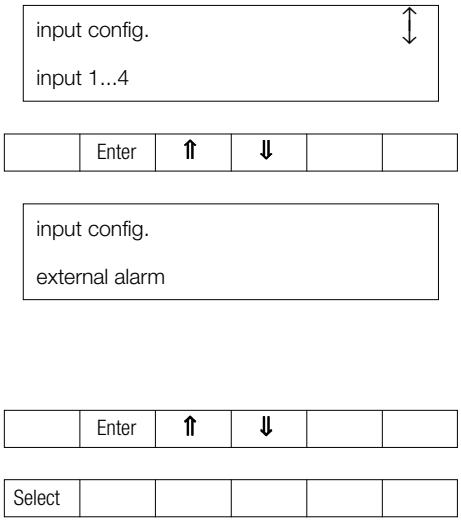
12.4.9 Input configuration

Inputs 1 to 4 are selected by the Direction keys ⇑⇓ (see 7.5). The Enter key opens the entry. The Direction keys ⇑⇓ select one of the following input functions:

- external alarm (passing through an incoming signal),
- set span 1 to 4,
- autocalibration offset,
- autocalibration,
- alarm reset,
  resets all alarms, which are setted to ‘keep alarm=1’ in the previous menu point. The signal for the reset function must be an impulse.

The choice has to be confirmed via the **Enter** key.

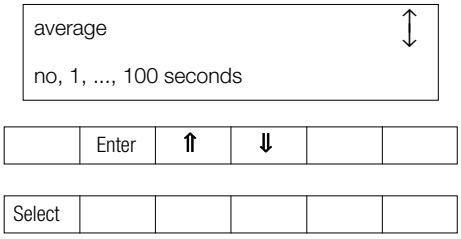
The **Select** key leads to the next menu point.



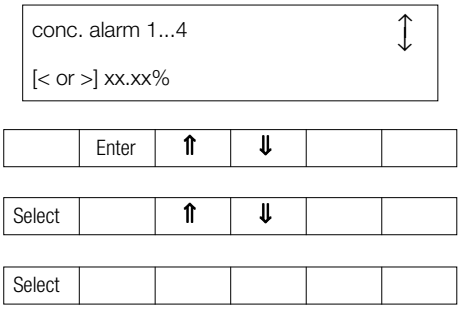
12.4.10 Average

This menu point opens the possibility to determine an average value over a maximum measuring time of 100 seconds. This average value is displayed. The desired value can be selected via the Direction keys ⇑⇓.

The **Enter** key operates the confirmation and the **Select** key leads to the next menu point.

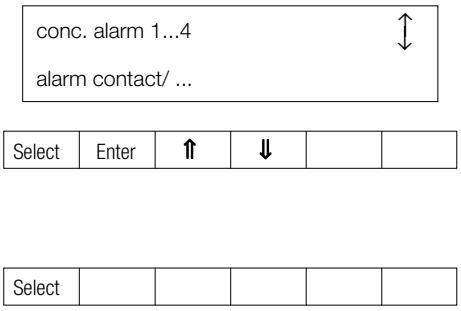


12.4.11 Concentration alarm



The user is able to set maximum four threshold values in Vol.-% O_2 as a minimum or maximum alarm limit. The values 1 to 4 are selected by the Direction keys ⇑⇓ . The **Enter** key opens the entry. The cursor jumps to the first changeable position, the <-/>-sign for minimum respectively maximum limit. A selection is operated via the Direction keys ⇑⇓ . A jump to the next position happens via the **Select** key. The entry has to be confirmed by the **Enter** key.
The **Select** key leads to the next menu point.

- **Display concentration alarm**

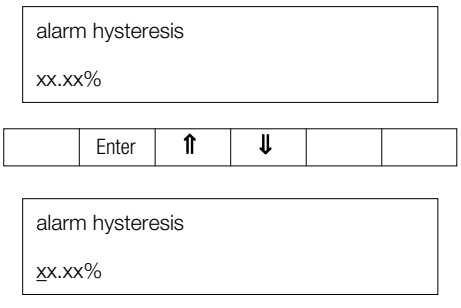


The following menu point determines whether a concentration alarm is displayed as:

- alarm contact,
- status contact, or
- no.

A selection happens via the Direction keys ⇑⇓, and is confirmed by the **Enter** key. If 'no' is selected, the alarm signal can be used as a relay control output (see 12.4.8).
The **Select** key leads to the next threshold value.
After reaching the 4th value the **Select** key leads to the next menu point.

- **Alarm range**

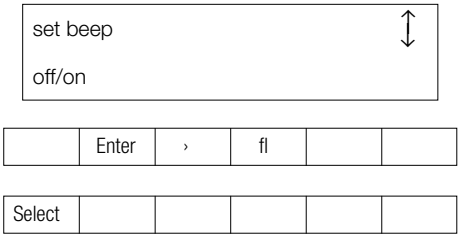


The alarm range is determined by a percentile of the alarm threshold value.
The **Enter** key opens the menu for the entry of above mentioned value. The first changeable position is underlined and can be changed operating the Direction keys ⇑⇓ .

A jump to the next position happens via the **Select** key.

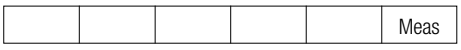
The entry has to be confirmed by the **Enter** key, and operating once more the **Select** key leads to the next menu point.

- **Set alarm beep**



The optical alarm display can be supported by a beep alarm signal. The function beep on or off is selected via the Direction keys ⇑⇓ . The **Enter** key confirms the choice.

Operating the **Select** key leads to the beginning of the menu.

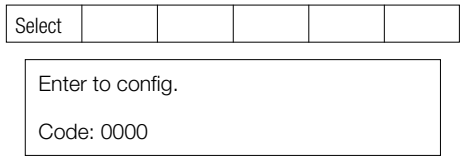


Anytime you want to start up the menu anew press the **Meas**uring key.

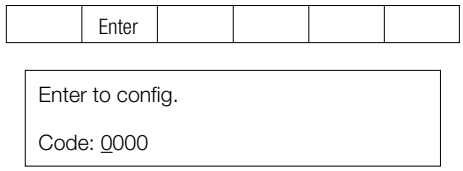
12.5 Parameterising level 2

12.5.1 Step into the menu

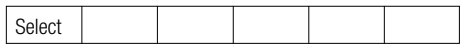
System parameters can be changed in level 2. Operating the **MEAS** key leads back to the configuration level. Operating two times the **Select** key leads from the measuring menu to the entry of the access code (see 12.2).



The **Enter** key opens the menu. The first changeable position is underlined and can be changed via the Direction keys ⇑⇓ . Operating the **Select** key jumps to the next position. The entry of the complete code (1000 preadjusted at the factory) has to be confirmed by the **Enter** key.

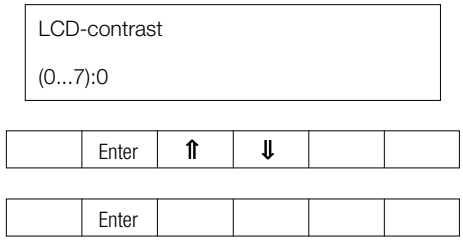


The **Select** key leads to the next menu point.



12.5.2 LCD contrast

The display background gets darker with increasing ambient temperatures. To get a better contrast, the letters on the display can be changed to more light colour. The **Enter** key opens the entry display. The desired contrast is set by the Direction keys ⇑⇓ inbetween a range of 0 to 7 (light coloured letters). The **Enter** key confirms the entry.



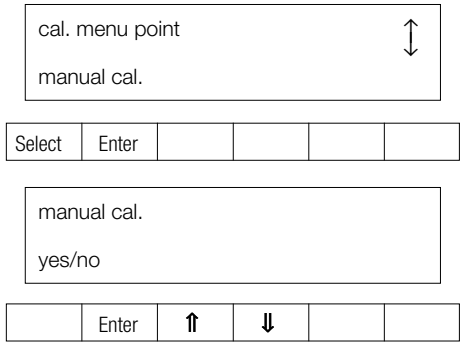
The **Select** key leads to the next menu point.

12.5.3 Calibration method

It is possible to choose or enable the calibration methods by the Direction keys ⇑⇓:

- manual calibration,
- manual calibration offset,
- autocalibration offset,
- autocalibration.

With **Enter** you step into the calibration menu.
The desired function is set by the Direction keys ⇑⇓ , and confirmed by the **Enter** key.

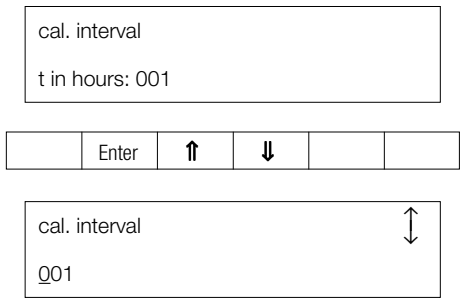


Select leads to the next menu point.

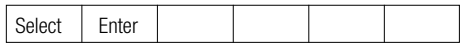
12.5.4 Calibration interval

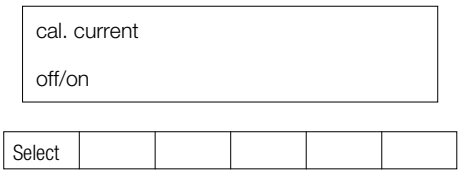
This menu point determines the time steps (in hours) using the autocalibration function (see 13.).

Enter opens the display, and the data input is operated by the Direction keys ⇑⇓ .



The **Enter** key confirms the entry, and the **Select** key leads to the next menu point.

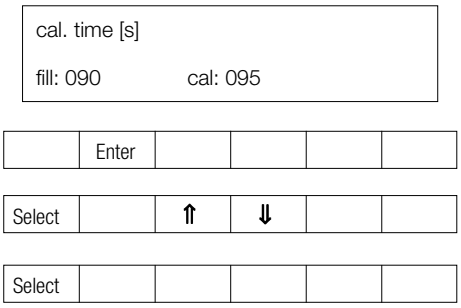




12.5.5 Current signal with calibration

During the calibration a mA-signal can be put out as:
off mA-signal of the last measuring value
on current signal of the respective calibration gas

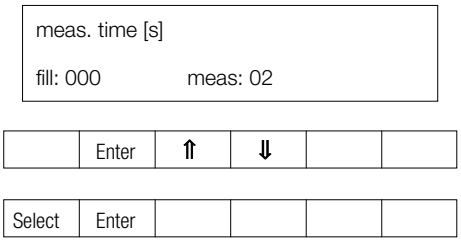
The **Select** key leads to the next menu point.



12.5.6 Calibration time

This menu point sets the backflush respectively calibration time in case of the autocalibration function. The entry of the time steps happens in seconds and counts backwards from the final value (see 13.3). **Enter** opens the display, and the data input is operated by the Direction keys ⇑⇓ .

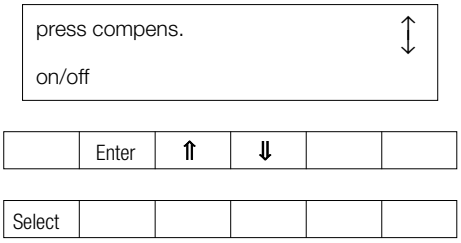
The **Enter** key confirms the entry, and the **Select** key leads to the next menu point.



12.5.7 Measuring time

This menu point sets the backflush respectively measuring time in case of the measuring point switch function. **Enter** opens the display, and the data input is operated by the Direction keys ⇑⇓ .

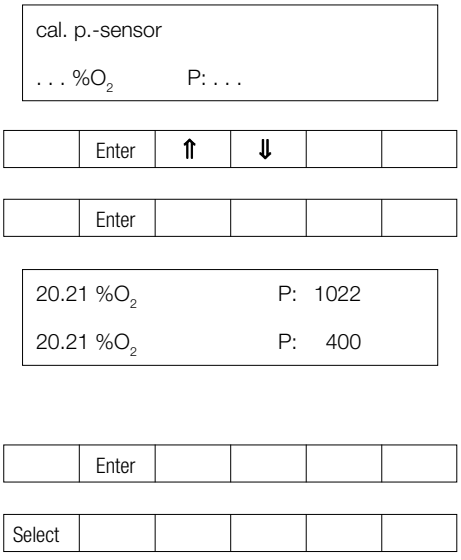
The **Enter** key confirmsthe entry, and the **Select** key leads to the next menu point.



12.5.8 Pressure compensation

A pressure compensation is implemented in the oxygen analyser type **PMA100**. The compensation is switched on or off via the Direction keys ⇑⇓ , and confirmed by the **Enter** key.

The **Select** key leads to the next menu point.



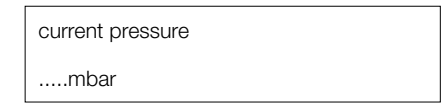
12.6 Calibration of the pressure sensor

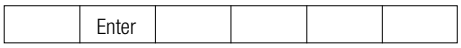
Three steps are necessary to calibrate the pressure sensor:
1. Air is given to the analyser under normal ambient pressure. Operating the **Enter** key starts the calibration procedure. The cursor jumps to the first changeable point. If necessary the value for the current pressure can be corrected operating the Direction keys ⇑⇓ . After operating the **Enter** key the display changes. The first line shows the O_2-concen–tration and the pressure on the low level.
2. The pressure has to be increased by minimum 300 mbar (max. pressure 0,6bar), throttling the flow at the sample outlet of the analyser. The second line on the display shows the variable pressure.
3. After compensation of the two O_2- readings (first and second line) the calibration is confirmed operating the **Enter** key.
The **Select** key leads to the next menu point.

⚠ Zero and span calibration have to be carried out after calibration of the pressure sensor.

• **Current pressure**

The **Enter** key opens the display to change the value for the current pressure. The corrected value has no influence on the O_2- reading. The modified pressure value is con–firmed by the **Enter** key.





The **Select** key leads to the next menu point.

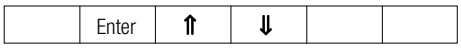
• **Data output**

The measuring data can be handed as follows:

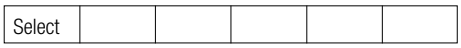
- **no** data output,
- stored on the internal **RAM**,
- send to a **Printer**, or
- stored on **RAM** and send to a **Printer**.

Data stored on the internal RAM are available via the serial interface.

The functions can be selected via the Direction keys ⇑⇓ , and confirmed by the **Enter** key.



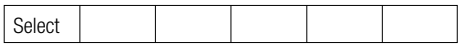
The **Select** key leads to the next menu point.



• **Memory clear**

It is possible to reset the data memory with the **Enter** key.

Select leads to the next menu point.

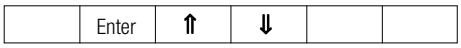


12.7 Interface communication and passwords

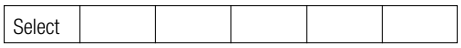
12.7.1 Baud rate (correlation with the ser. interface RS232)

The desired baud rate can be selected via the Direction keys ⇑⇓ . Available are:

2400
9600
19200
38400



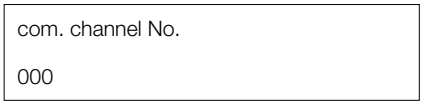
The **Enter** key confirms the choice and the **Select** key leads to the next menu point.

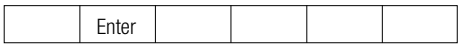


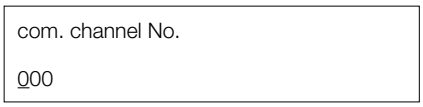
12.7.2 Communication channel (communication with the ser. interface RS232/485)

To communicate with the serial interface of an external device the COM port No. of the **PMA100** has to be adapted to the external COM port No. .

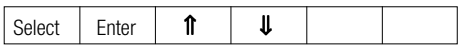
Enter opens the display to put in the COM port No. via the Direction keys ⇑⇓ .



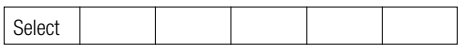




Repeatedly operating the **Enter** key confirms the data input.



Select leads to the following menu point.



STX&ETX char.

STX: $02 ETX: $03

	Enter	⇑	⇓		

Select	Enter				

Select					

12.7.3 STX and ETX character

It is necessary to determine a start respectively stop signal for the communication on the basis of an AK protocol. **Enter** opens the submenu. The first changeable position is underlined and can be changed operating the Direction keys ⇑⇓ . A jump to the next position happens via the **Select** key. The entry has to be confirmed by the **Enter** key.

Operating once more the **Select** key leads to the next menu point.

password 1

Code: 0001

	Enter				

password 1

Code: 0001

Select	Enter	⇑	⇓		

Select					

12.7.4 Change password level 1

The preadjusted password can be changed by a four-digit individual code.

Enter opens the submenu. The first changeable position is underlined and can be changed operating the Direction keys ⇑⇓ . A jump to the next position happens via the **Select** key.
The code must contain a figure > 0.
The entry has to be confirmed by the **Enter** key.

Operating once more the **Select** key leads to the next menu point.

Select					

12.7.5 Change password level 2

Follow the steps in chapter 12.7.4
Attention! Password 1 and password 2 must be different.
With **Select** you leave level 2 to the measuring menu.

D:x.xxx P :xxxx

T:xx.xx ADC :0...7

	Enter	⇑	⇓		

12.8.1 Inquiry of the transducer channel

The display shows on the first line the analogue value (D) of the transducer channel in [mV] and optional the current pressure (P) in [mbar]. The second line displays the current transducer temperature (T) in [°C] and the selected transducer channel (ADC) and a number to change the display from the standard (1) to the configuration of the valves (2), respectively to the configuration of the relays and alarms (0).
Operating the **Enter** key enables the choice of the transducer channel (0-7, only standard configuration).
The following are functional:
3 = current analogue value ‘pressure’,
6 = current analogue value ‘O_2-concentration’, and
7 = current analogue value ‘temperature’.

	Enter				

Select					

A renewed operation of the **Enter** key confirms the entry, and the **Select** key leads to the next menu point.

read NV-memory

..$.....0

Select					

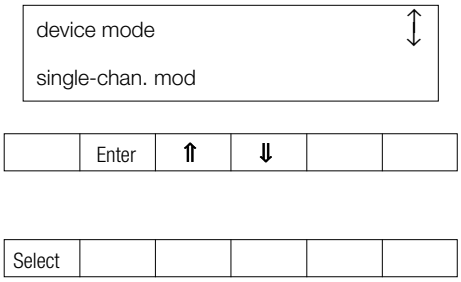
12.8.2 Read NV-Memory Editor

The NV-Memory Editor describes the basic respectively the programming level of the analyser. An access to this level is only possible with the approval of the manufacturer.

The **Select** key leads to the next menu point.

12.8.3 Device mode

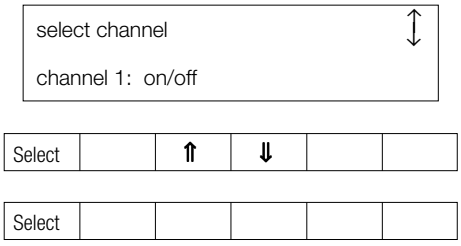
This menu point selects via the Direction keys ⇑⇓ whether the analyser works as a single-channel version or as a multi-channel (max. 4 channels) version.
The choice is confirmed by the **Enter** key. If single-channel version is selected the **Select** key leads to the beginning of the menu.
Operating the **Select** key with the multi-channel version leads to the next menu point.



12.8.4 Select channel

The channels 1 to 4 can be activated or deactivated by the Direction keys ⇑⇓ .
The **Select** key leads to the next channel.

After the 4th channel, the **Select** key leads to the next menu point.

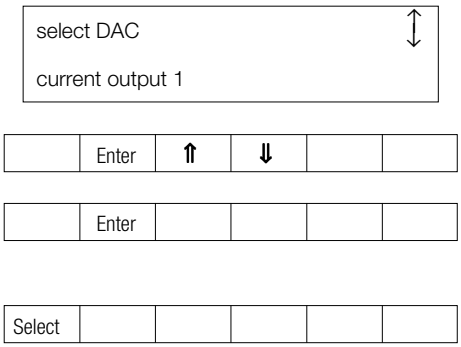


12.8.5 Arrangement of the mA-outputs

At this menu point max. 4 channels can be reserved via the Direction keys ⇑⇓ with mA-signals for the following functions:

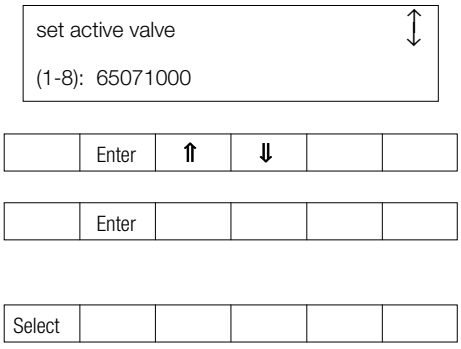
- O_2- value channel 1 to 4,
- process pressure channel 1 to 4, and
- cell temperature.

The jump into the submenu happens via the **Enter** key.
The respective function is selected via the Direction keys ⇑⇓ , and confirmed by the **Enter** key.
Select leads to the next menu point.



12.8.6 Set active valve

Maximum 8 solenoid valves are pre-reserved with an identification No.
The **Select** key leads to the beginning of the menu.



				Cal	

zero conc. xx.xx%O_2

	Enter				

zero conc. (-)xx.xx%O_2

Select	Enter	⇑	⇓		

Select					

	Enter				

span-conc. 0.00% O_2

Select	Enter	⇑	⇓		

Select					

Manual cal. press Enter

	Enter				

0 calibration 00.00 d: (-)00.00

	Enter				

span calibration 00.00 d: (-)00.00

12.8 Zero- and span calibration

Operating the **Cal** key leads to the display represented beside.
A jump into the entry mode of the zero calibration happens automatically.

12.8.1 Zero gas concentration

Enter opens the display. The Direction keys ⇑⇓ operate the input of the zero gas concentration (cross sensitivities see chapter 13.2). The first changeable position is underlined and can be changed operating the Direction keys ⇑⇓ . A jump to the next position happens via the **Select** key. The entry has to be confirmed by the **Enter** key.

⚠ The value for the zero gas concentration must be lower than the value for the span gas concentration

Operating once more the **Select** key leads to the next menu point.

12.8.2 Span gas concentration

Enter opens the display. The Direction keys ⇑⇓ operate the input of the span gas concentration. The first changeable position is underlined and can be changed operating the Direction keys ⇑⇓ . A jump to the next position happens via the **Select** key. The entry has to be confirmed by the **Enter** key.

⚠ The value for the span gas concentration must be higher than the value for the zero gas concentration.

Operating once more the **Select** key leads to the next menu point.

12.8.3 Calibration

Four calibration modes are available and pre-selected in menu point 12.5.3:

- manual calibration,
- manual calibration offset,
- autocalibration offset, and
- autocalibration.

- **Manual calibration**

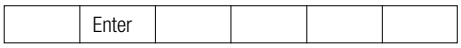
The **Enter** key starts the calibration procedure.
After reaching a stable level for the zero gas concentration (line 2 displays the current value) pressing the **Enter** key leads automatically to the span calibration. The deviation in %O_2 to the last calibration is shown on the display (value „d“).

After reaching a stable level for the span gas concentration (line 2 displays the current value) pressing the **Enter** key closes the calibration procedure, and the analyser jumps automatically into the measurement level. The deviation in %O_2 to the last calibration is shown on the display (value „d“) during the calibration procedure.

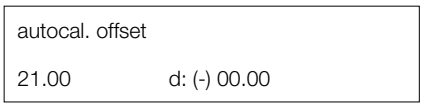
A fault during the calibration procedure is represented on the display as **E** ... followed by the message: O_2-calibration. The fault is also stored in the calibration log-book.

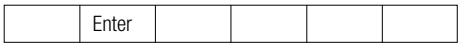
• **Manual calibration offset**

Enter starts the calibration procedure.



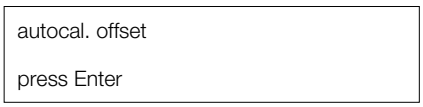
After reaching a stable level for the span gas concentration (line 2 displays the current value), pressing the **Enter** key closes the calibration procedure. The analyser jumps automatically into the measurement level.
A fault during the calibration is represented on the display as E ... followed by the message: O_2-calibration.
The calibration fault is also stored in the calibration log-book.

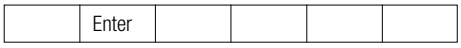




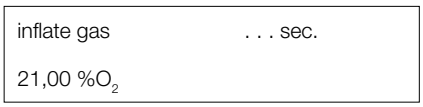
• **Autocalibration offset**

Enter starts the procedure.

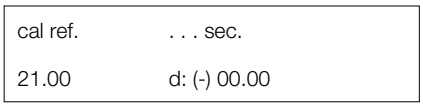


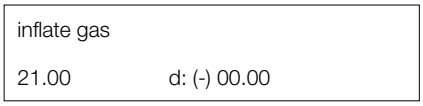


The calibration procedure happens automatically.
The analyser is purged with span gas. The purging time which counts backwards is setted in menu point12.5.6



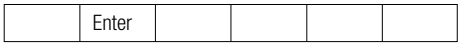
The next step is calibrating the analyser with span gas. The calibration time is setted in menu point 12.5.6.
The time counts backwards. After reaching a stable value the time steps double.
In the following the analyser is purged with sample gas for the time mentioned above.
When the calibration procedure is finished, the analyser jumps automatically into the measurement level.
A fault during the calibration is displayed as:
E ... O_2-calibration, and is also stored in the calibration log-book.



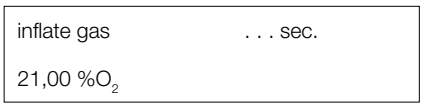


• **Autocalibration**

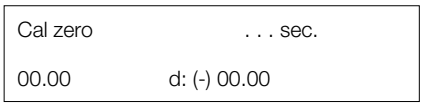
Enter starts the calibration. The times for purging and calibration are setted in menu point 12.5.6.



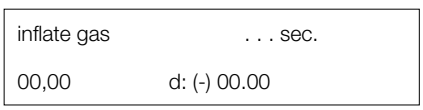
First the analyser is purged with zero gas.

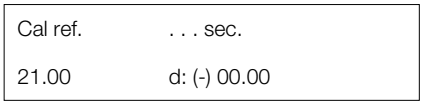


Then the analyser is calibrated with zero gas.



The same procedure happens with span gas.





inflate gas	. . . sec.
21.00	d: (-) 00.00

Afterwards the analyser is purged with sample gas.

After finishing the procedure the analyser jumps automatically into the measurement level.
A fault during the calibration is displayed as:
E ... O_2-calibration, and is also stored in the calibration log-book.

The next menu point can be reached stepping into the calibration mode via the **Cal** key and passing the previous menu points with the **Select** key.

Select				Cal	

12.8.4 Deviation from calibration

calib. diff.	
ofs: (-)x.x%	g: x.x%

The display shows the deviation from the basic calibration carried out in the factory. The offset is given of the possible deviation (±100%).

Select					

Select leads to the following menu point.

12.8.5 Calibration log-book

cal. log-book	
M 10.11.99	11:o7

It is possible to read back the data (date and time) of the last 9 calibrations via the Direction keys ⇑⇓ .

The kind of calibration is marked as follows:
M manual calibration,
O manual calibration offset,
S autocalibration offset,
A autocalibration.
A fault during the calibration is displayed as (e.g.) :
E O 10.11.9911:07

Select					

Select leads to the beginning of the calibration

13. Calibration

13.1 Calibration

Four calibration modes are available with the analyser **PMA100**:

- manual calibration,
- manual calibration offset,
- autocalibration offset, and
- autocalibration.

The calibration gases are given to the 'sample in' connection, located on the back panel of the **PMA100** (see 8.1, fig. 7).
In case of autocalibration two respectively three valves are controlled by the analyser menu. The connection of the calibration valves is described in chapter 8.2.
A detailed description of the menu-driven handling is given in chapter 12.
Faults during the calibration procedure are displayed in the main menu like:
E... O_2-calibration.
The fault message is also stored in the calibration log-book with an E... followed by the shortcut for the calibration mode, the date, and the time the calibration is carried out.
If the zero and the span gas concentration deviates more than 5Vol.-% to the adjusted concentration, a calibration cannot be carried out. The deviation is displayed as an error message.
In case of autocalibration flow through the analyser is necessary. Otherwise an error message is displayed and the calibration cannot be carried out. The offset calibration is a single-point calibration and can be carried out, e. g. with ambient air only.
The calibration modell depends on the fact that in spite of a drift the zero point remains nearly to zero, and the calibration of the span gives a proper accuracy.
It is recommended to use a span gas concentration very close to the required measuring range.

13.2 Cross-sensitivity

The paramagnetic measuring principle is based on the very high magnetic susceptibility of oxygen. In comparison to oxygen, other gases have such a minor susceptibility, most of them are not even worth mentioning. Exception to this are the nitrogen oxides. However, as this gas is in most cases present in a very low concentration, the error is still negligible.
The next table shows a list of cross-sensitivities. All values based on a zero calibration with 100 Vol.-% N_2 and a span calibration with 100 Vol.-% O_2. The cross-sensitivities in the table are valid for 100 Vol.-% of the corresponding gas.

Gas	Formula	+ 20°C	+ 50°C
Argon	Ar	- 0,23	- 0,25
Acetylene	C_2H_2	- 0,26	- 0,28
Acetone	C_3H_6O	- 0,63	- 0,69
Acetaldehyde	C_2H_4O	- 0,31	- 0,34
Ammonia	NH_3	- 0,17	- 0,19
Benzene	C_6H_6	- 1,24	- 1,34
Bromine	Br_2	- 1,78	- 1,97
Butadiene	C_4H_6	- 0,85	- 0,93
Methyl propene	C_4H_8	- 0,94	- 1,06
n-Butane	C_4H_{10}	- 1,10	- 1,22
Chlorine	Cl_2	- 0,83	- 0,91
Hydrogen chloride	HCL	- 0,31	- 0,34
Nitrous oxide	N_2O	- 0,20	- 0,22
Diacetylene	$(CHCl)_2$	- 1,09	- 1,20
Ethane	C_2H_4	- 0,43	- 0,47
Ethylen oxide	$C_2H_4O_2$	- 0,54	- 0,60
Ethylene	C_2H_4	- 0,20	- 0,22
Ethylene glycol	$(CH_2OH)_2$	- 0,78	- 0,88
Ethylbenzene	C_8H_{10}	- 1,89	- 2,08
Hydrogen fluoride	HF	+ 0,12	+ 0,14
Furan	C_4H_4O	- 0,90	- 0,99
Helium	He	+ 0,29	+ 0,32
n-Hexane	C_6H_{14}	- 1,78	- 1,97
Krypton	Kr	- 0,49	- 0,54
Carbon monoxide	CO	- 0,06	- 0,07
Carbon dioxide	CO_2	- 0,27	- 0,29
Methane	CH_4	- 0,16	- 0,17
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 oxide	C_3H_6O	- 0,90	- 1,00
Propylene chloride	C_3H_7Cl	- 1,42	- 1,44
Monosilane	SiH_4	- 0,24	- 0,27
Styrene	C_8H_8	- 1,63	- 1,80
Nitrogen	N_2	0,00	0,00
Nitrogen oxide	NO	+ 42,70	+ 43,00
Nitrogen dioxide	NO_2	+ 5,00	+ 16,00
Oxygen	O_2	+100,00	+100,00
Sulphur dioxide	SO_2	- 0,18	- 0,20
Silphur fluoride	SF_6	- 0,98	- 1,05
Hydrogen sulphide	H_2S	- 0,41	- 0,43
Toluene	C_7H_8	- 1,57	- 1,73
Vinyl chloride	C_2H_3Cl	- 0,68	- 0,74
Vinyl fluoride	CH_3F	- 0,49	- 0,54
Water (steam)	H_2O	- 0,03	- 0,03
Hydrogen	H_2	+ 0,23	+ 0,26
Xenon	Xe	- 0,95	- 1,02

Fig. 10: Table of cross-sensitivities

Example :
The residual oxygen percentage should be measured in a closed 100% carbon dioxide (CO_2) atmosphere. The „zero-calibration“ is done by means of Nitrogen (N_2).
According to the list of cross-sensitivities the error for CO_2 at 20°C is -0,27%. In order to obtain a higher accuracy this means for the calibration that the reading should be adjusted at +0,27% with N_2, in order to compensate the error of CO_2.
Since the values of cross-sensitivities are based on 100 Vol.-% of that particular gas, the error at 50 Vol.-% CO_2 and 50 Vol.-% N_2 is -0,135%.

14. Measuring

The connections for sample gas inlet and outlet are located on the back panel of the **PMA100** oxygen analyser (see 8.1). A detailed description of the menu-driven handling is given in chapter 12.

Note!
The oxygen analyser **PMA100** is suitable for continuous measurements of oxygen concentrations in particle-free and dry sample gases. Therefore it is recommended to use a gas conditioning system downstream the analyser equipped with a cooler and a particle filter.

14.1 Automatically range switch

The function of the automatically range switch is pre-selected in menu point 12.4.2 or via the serial interface. It is recommended to set unused measuring ranges to '0' (see 12.4.3). The analyser uses the suitable measuring range automatically. Fig. 11 shows the switching between two overlapping measuring ranges, 0 - 50Vol.-% and 30 - 40Vol.-%.
Going through the measuring ranges upward the analyser switches exact at the range limits, in this example at 30Vol.-% respectively 40Vol.-%.
Going down through the measuring ranges the autorange hysteresis determines the interval switching into the next lower range. The %-value, which is set in menu point 12.4.4, is related to the smallest span of the switching relevant ranges. The resultant value in Vol.-% O_2 is added to the respected range. The switching relevant range in the example (30 - 40Vol.-%) is 10Vol.-%. This means a switching interval of 1Vol.-% if the adjusted hysteresis is 10%. The switching points are at 39Vol.-% respectively 29Vol.-%.
The mA-output is related to the extended measuring range 2. This means:
29Vol.-% - 0 mA, and
40Vol.-% - 20 mA .

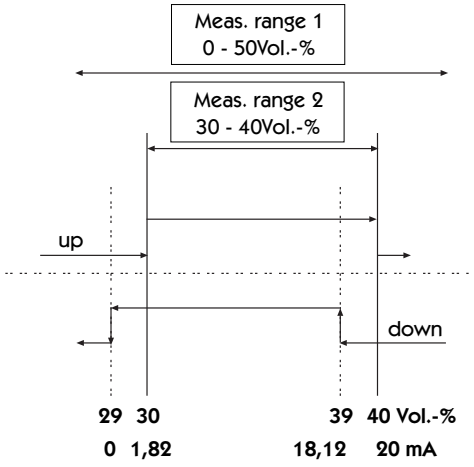


Fig. 11: Automatically range switch hysteresis 10%

14.2 Expanded measuring range

Expanded measuring ranges are selected in menu point 12.4.3. The minimum range is 1Vol.-% O_2. The selected mA-output signal (see 12.4.5) is related to the respective span.
Example:
- measuring range 99 - 100Vol.-%,
- 4 - 20mA.

This means a resolution of 1/16Vol.-% O_2 per mA.

⚠ Changing pressure can cause extremely high deviations using small measuring ranges without pressure compensation.

15. Function of in- and output contacts and alarms

The following in- and output contacts are available at the Sub-D socket **X4** at the back panel of the analyser (specification see 8.2.2):

- 4 binary inputs,
- 4 relay output contacts,
- 1 common relay alarm contact, and
- 1 common relay status contact.

The binary inputs can be reserved for the following funct–ions (configuration see 12.4.9):

- **external alarm:** an external alarm signal, e.g. a cooler- or liquid alarm from the conditioning system upstream the analyser, can be locked on. This signal releases a respec–tiv alarm message (alarm LED and display on the front panel of the **PMA100**). If one of the output contacts is locked on with 'external alarm' (see 12), the input signal is passing through.
- **set span:** the measuring ranges 1 to 4 can be chosen externally.
- **autocalibration offset and autocalibration:** starting signal for the autocalibration functions.
- **reset of stored alarms:** alarms which are kept after the release (see 12.4.8) can be resetted with a pulsed signal.

The function of the output contacts are as follows (configu-ration see 12.4.8):

- **measuring range:** this function gives a feedback about the current active range. The ranges 1 - 4 can be selected.
- **conc. alarm:** it is possible to lock max. 4 concentration alarms on the relay outputs (configuration see 12.4.11).
- **calibration:** a signal is given when the analyser works in the calibration mode.
- **flow alarm:** in addition to the internal signals like alarm LED, display or status contact the flow alarm can be locked on one of the relay output contacts.
- **external alarm:** an external alarm signal can be passed to one of the relay output contacts (see above).

Alarms are signalised via the alarm LED and the analyser display. In addition to this a common alarm relay contact is available. An exception is the concentration alarm. The alarm limits are fixed in menu point 12.4.11. The display of the concentration alarm (alarm LED, analyser display, com-mon output or status alarm) must be confirmed separately in menu point 12.4.11. An allocation of the concentration alarm can be realised via the relay contact outputs (see above).

The following alarm messages are available at the common alarm output:
- concentration alarm 1 - 4 (if allocated, see above)

Status messages like:
- flow alarm,
- transducer temperature,
- hardware fault, and
- fault of the pressure sensor
- leaving the current measuring range.

are signalised via the alarm LED, the analyser display and the status contact output. Menu point 12.4.6 enables to identify a status fault via a permanent mA-output signal. It is available at the Sub-D socket **X3** (see 8.2.1).
The mA-measuring signal is overlaid by the status signal output.

16. Closing down

- In case of a temporary closing down of the process con–trol systems around the analyser, the AC mains supply of the analyser must remain „ON“.
- In case of a temporary closing down of the analyser itself, there are no special precautions required.
- In case of a closing down of the analyser for a longer period, it is recommended to flush the analyser with clean air in order to prevent that harmful gases will be left in the instrument and damage the measuring cell.

17. Maintenance and repair

Before carrying out any maintenance or service activities, the engineer concerned must ensure that the analyser is disconnected from the electrical supply of power!

- Maintenance of the analyser should be performed by qualified personnel, and the frequency of maintenance may vary as a result of operating experience.

- Any used spare parts must be specified as **M&C** spare parts.

- Routine maintenance of the **PMA100** oxygen analyser is limited to frequently checking the zero and span point calibration. If the values are not correct, the instrument should be recalibrated according to the procedure as outlined in this instruction manual.

- In the event of an incorrect reading of the analyser or a system failure make certain that the sampling system is in a good condition and that all sample handling components are working properly.

- Check that gas cooler, filters, condensate drain or other components are not blocked with dirt or any foreign matter. Ensure that the sample gas is connected correctly and is flowing properly through the system, and make a visual inspection of the analyser for loose or leaking connections.

Note!
It is strictly recommended that the repair of the analyser should be performed by high qualified as well as experienced personnel, and that any spare part which is used should be specified as M&C spare part !

18. Trouble shooting

Fault description	Display	Solution
Measuring cell doesn't work properly at 100 Vol.-% (suppressed measuring range 99-100 Vol.-%)	E:01 resp. F:01, depending on the language	Give air resp. nitrogen to the analyser and restart the analyser
Calibration fault:span gas is switched off while proceeding the calibration of the span.	Display of the calibration fault until a new calibration is carried out; the displayed value is related to the last calibration.	Start new calibration.
Calibration limits of the A/D-converter exeeded.		Check the limits (see below) testing the converter channel (see menu); When limits are exeeded a calibration at the manufacturer has to be carried out.

Limits testing the converter channel (see menu):

Checking the zero point with nitrogen N_2

U_{min}[V]	U_{max}[V]
0,005	0,147

Checking the span with ambient air (20,93 Vol.-%) at normal pressure and different voltages of the zero point:

Zero point [V]	U_{min} [V]	U_{max} [V]
0,005	0,306	0,344
0,078	0,370	0,398
0,147	0,430	0,457

Checking the span with 100 Vol.-% oxygen O_2 at normal pressure and different voltages of the zero point:

Zero point [V]	U_{min} [V]	U_{max} [V]
0,005	1,440	1,580
0,078	1,470	1,610
0,147	1,500	1,630

19.Spare part list

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

Oxygen Analyser Type PMA100

(C) consumable parts
(R) recommended spare parts
(S) Spare parts

			recommended quantity PMA being in operation (years)		
Part.-No.	**Indication**	**C/R/S**	**1**	**2**	**3**
90 A 0010	Measuring cell PMC1	S	-	-	1
90 A 0015	Flowmeter glass 7-70 Nl/hr	S	-	-	1

20.Appendix

For further documentation:

Look on our homepage:
www.muc-products.de