Instruction Manual

Analyser AMS 3220

for AMS ZrO$_2$ - Probes

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1   Electronic Controller AMS 3220

The electronic controller AMS 3220 is the supply control and evaluation unit for all AMS ZrO$_2$-probes. It is TÜV-approved for large boilers in power plants, for industrial boilers and furnaces, for waste incinerators and for crematoria.
The unit can be delivered in several housing models, available also for CENELEC zone 1 operating.
The measuring range for flue gas applications covers 0,1 - 25 vol-% oxygen permitting the operator to adjust to the process values.
Considering process applications, measuring ranges from 0,1 vol-% to 100 vol-% O$_2$ can be applied. The calibration limits will be laid down in the E-PROM of the controller correspondingly.
Programming and controlling the entire measuring system will be executed with only three push buttons: one for the operation mode, two for the cursor. A display featuring two LCD rows indicates the measuring value and user fed data as well as the operation directions in plain text messages. The programming level is accessible only for authorised personal through a specific service mode.
The self diagnostics of the controller with the corresponding fault signals reduce the usually time consuming monitoring to a reasonable extent.
All instrument parameters can be comfortably set at the control unit: the calibration and alarm data, the assignment of the display lines, as well as the two analogue outputs 0/4 – 20 mA to the current measurement limits.
Particularly important regarding the reliability of the O$_2$ measurement is of course the identification and hence the error message while calibrating:

- The stability of the measuring signal during calibration and the plausibility of the calculated correction data are subject to the continuous check from the electronic controller.

Some additional functions have been integrated into the recently redesigned controller AMS 3220:

- TÜV-approval for large boilers in power plants, for industrial boilers and furnaces, for waste incinerators and for crematoria (certification-no.936/807023/A dated 08-14-2000).
- In connection with the appropriate pneumatic units for automatic calibration, it offers the AUTOCAL routine for all AMS ZrO$_2$ probes.
- For the EEx-d-probe AMS 3110/150, an EEx-d-housing for the electronic unit can be offered. Depending upon the application, either an EEx-IIC- or an EEx-d-IIB-housing is available for operating in CENELEC zone 1 and 2.
- The housing of the electronic unit is made out of painted steel sheet; the enclosure complies with IP65 and warrants an improved dissipation of the heat produced.
- Signal from the sensor and heating power are galvanically isolated to keep away wandering signals.
- Two galvanically separated signal outputs 0/4 ... 20 mA are standard.
- Digital interface RS232. CAN-bus interface is optionally available.
- An improved A/D-converter provides better resolution and the continuous measurement from 25 vol-% down to less than 0,1 vol-% Oxygen.

2 ZrO$_2$-Probes for the Measurement of Oxygen in Flue Gases

The wide range of applications of ZrO$_2$-probes for the measurement of oxygen requires the adaptation of this measuring system to varying process conditions like temperature, aggressive flue gas and even hazardous areas. A short response time and durability of the sensor are further major customer demands. In addition, however, ease of use, reliability, and minimum maintenance of the analysis system are important design features.
Twenty years of experience in system technology enable AMS Analysen-, Mess- und Systemtechnik to provide ZrO$_2$-probes with these features already built in while offering the instruments at an attractive price.

The oxygen measuring units are used for the determination of the oxygen concentration in flue gases of incinerators or in pure industrial gases covering the temperature range from 20°C to 1750°C.
Since the Zirconia measuring cell is located in the flue gas flow, the measurement takes place directly (in-situ) allowing the sample extraction and conditioning system to be omitted.
Specific applications demand probes aligned to the particular process environment: e.g. to hazardous areas classified as CENELEC zone 1 or 2, to residue free combustion processes using natural gas or to flue gas ducts with small diameters.

System features

- Specially AMS designed sensor for flue gas applications, operator replaceable
- TÜV-approval for large boilers in power plants, industrial furnaces and for waste incinerators and for crematoria
- Gas wetted parts made of stainless steel, other materials are available
- Range of probe lengths from 150 mm to 3000 mm
- Gas temperatures up to 1750°C
- EEx d II B + H$_2$-probe for CENELEC zone 1

To operate the ZrO$_2$-probes, a reference gas as well as a test gas for calibration is required. The corresponding tubing includes a pressure controller (or a diaphragm pump), a filter, switching valves and a flow meter, all parts being mounted in a special sample cabinet. For the gas supply, 6 mm Schott terminals have been chosen. Power and signal connections are fitted to a row of terminals located in the sample cabinet.
Ambient air or instrument air can be used as reference gas.
Furthermore, the automatic calibration of all AMS ZrO$_2$-probes within pre-selectable time periods is feasible while using the electronic unit AMS 3220.
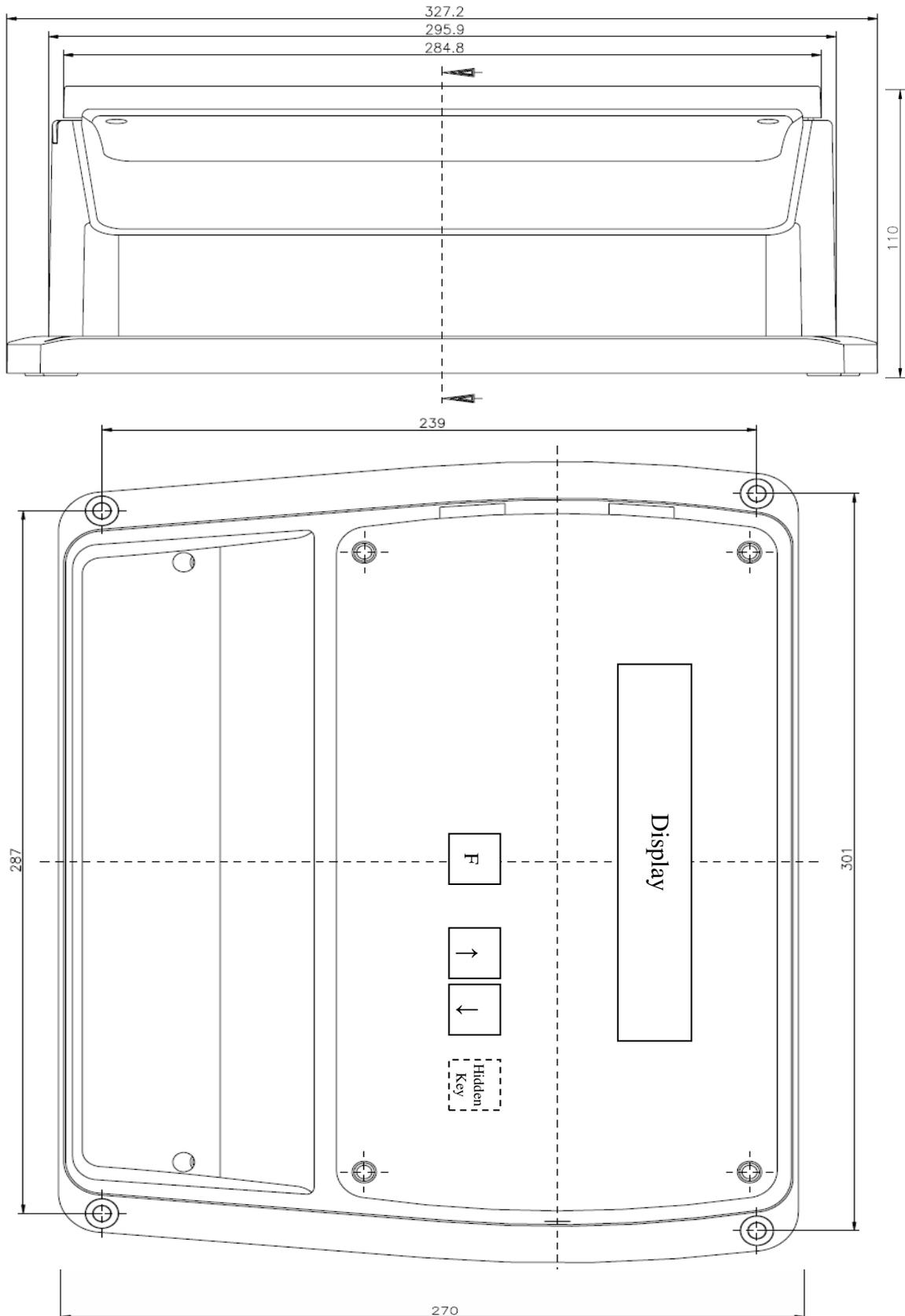Alternatively to the separated mounting of pneumatic unit and electronic controller a cabinet housing for both of them can be supplied.

3   Technical Data Electronic Controller AMS 3220

Measuring range(s)	standard: 0,1 to 25 vol-% O$_2$ for flue gas applications
Resolution of display	0,1 vol-% for measuring values ≥10,0 vol-% 0,01 vol-% for measuring values from 1,00 to 9,99 vol-% display in ppmv for measuring values <1 vol-%
Measuring accuracy	± 0,1 vol-% O$_2$ for standard measuring range
Repeatability of the measuring signal	± 0,5% rel. for range 25 vol-% to 10 vol-% O$_2$ ± 0,05 vol-% O$_2$ for range 10 vol-% to 0,2 vol-% O$_2$
Drift/month	1 % rel. for standard measuring range, flue gas applications
Display	alphanumeric display with 2 x 20 digits
Monitoring	sensor voltage, heating cartridge (resistance), limits
Signal outputs	analogue output 1: 0/4 - 20 mA, galvanically isolated, max. load 600 Ohm, freely programmable from 0,1 to 25 vol-% O$_2$ analogue output 2: (*Option) 0/4 – 20 mA, galvanically isolated, max. load 600 Ohm, not programmable, custom scaled
Galvanic isolation	signal input, signal outputs, heating power for the sensor
Alarms for measuring signals	2 potential free relay contacts max. 60 V / 0,5 A freely programmable for the entire measuring range for limits as well as for fast/hold
Status output	1 potential free relay contact, max. 60 V / 0,5 A; e.g. for sensor voltage, heating cartridge
Digital interface	RS232
Certifications	TÜV-approval for large boilers in power plants, for industrial boilers and furnaces, for waste incinerators and for crematoria
Electrical safety	CE 1996 as well as according to electromagnetic compatibility standards and safety rules for electrical instruments
Housing/protection	wall mounting case made out of painted steel sheet/IP 65 19" plug-in desktop EEx-II C- or EEx-dII B-housing
Dimensions	300 x 400 x 120 mm (WxHxD) for IP 65 housing
Weight	approx. 9 kg
Ambient temperature	5°C to 45°C
Voltage supply	24/115/230 V AC 50 or 60 Hz

Tab.1: **Technical Data ZrO$_2$-Probes**

ZrO$_2$-probe	3211-500	3211-500L	3211-600	3211-700	EEx-approved probe	EEx-approved probe for high temperatures	3211-000
gas temperature maximum	500°C	500°C	1750°C	1100°C	500°C	1100°C	450°C
protection	IP65	IP65	IP65	IP65	IP65 EEx d II B+H2 T3	IP65 EEx d II B+H2 T3	IP 44
time constant t$_{90}$-time	< 2 s ≤ 10 s	< 2 s ≤ 10 s	< 5 s ≤ 20 s	< 5 s ≤ 20 s	< 5 s ≤ 20 s	< 5 s ≤ 20 s	< 2 s ≤ 10 s
position	any but to be adjusted downwards	any but to be adjusted downwards	depending from sample tube material recommended vertical suspended	up to 900°C: any adjusted downwards >900°C: vertical suspended	any but to be adjusted downwards	any but to be adjusted downwards	any but to be adjusted downwards
weight (at length ...)	6,5 kg (1000 mm)	3 kg (500 mm)	6,5 kg (1000 mm)	7 kg (1000 mm)	10 kg (500 mm)	15 kg (1000 mm)	0,3 kg
dust content	beyond 5 g/m^3 a shield made of stainless steel is supplied to protect the sinter filter	beyond 5 g/m^3 a shield made of stainless steel is supplied to protect the sinter filter	beyond 20 g/m^3 a protection shield made of stainless steel is recommended	up to 20 g/m^3 wet dust not allowed!	beyond 5 g/m^3 a shield made of stainless steel is supplied to protect the sinter filter	beyond 20 g/m^3 a protection shield made of stainless steel is recommended	beyond 5 g/m^3 a shield made of stainless steel is supplied to protect the sinter filter
sample flow	beyond 20 m/s a shield made of stainless steel is supplied to protect the sinter filter	beyond 20 m/s a shield made of stainless steel is supplied to protect the sinter filter	no limitations	higher as 5 m/s	beyond 20 m/s a shield made of stainless steel is supplied to protect the sinter filter	no limitations	beyond 20 m/s a shield made of stainless steel is supplied to protect the sinter filter
probe heating time	10 minutes	10 minutes	10 minutes	10 minutes	10 minutes	10 minutes	10 minutes

4   Dimensional Drawing and Front View of the Electronic Controller AMS 3220

5   Electric Connection for Electronic Controller AMS 3220

5.1   Terminal Assignments

This Chapter only refers to the wall mounted housing for the AMS 3220 (IP65)! Please check the appendix for different housing models.
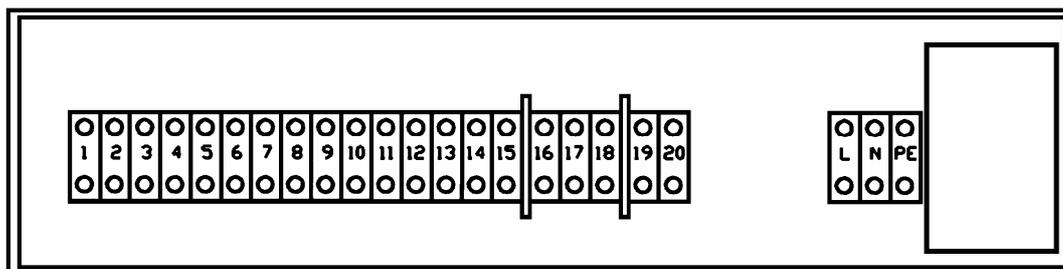

Fig.2: Terminal assignments wall mounted housing (IP65)

Terminal   Assignment

Connecting Terminals for the ZrO$_2$-Probe

1	Heater voltage	(+)
2	check current voltage	(+)
3	check current voltage	(−)
4	Heater voltage	(−)
5	Sensor signal (+)	
6	Sensor signal (−)	

Connecting Terminals for Alarm Relays/Outputs

7	[C]	Alarm 1
8	[NC]	SPDT- relay contacts, potential free
9	[NO]	max. load 60V / 0.5A, resistive load
10	[C]	Alarm 2
11	[NC]	SPDT- relay contacts, potential free
12	[NO]	max. load 60V / 0.5A, resistive load
13	[C]	Status signal (*ready: yes / no*)
14	[NC]	SPDT- relay contacts, potential free
15	[NO]	max. . load 60V / 0.5A

Connecting Terminals for Digital Interface RS 232 (OPTION)

16	[RX]	RS 232 –interface, no handshake wiring
17	[TX]	(*see also paragraph 6*)
18	[GND]	

Connecting Terminals for Analogue Outputs

19	Current Output 1	(+)	0/4 … 20mA, max. 700Ω
20	Current Output 1	(−)	galvanically isolated
21	Current Output 2	(+)	0/4 to 20 mA, max.700Ω
22	Current Output 2	(−)	galvanically isolated

Option

Connecting Terminals for Power Supply

L, N, PE   Power supply   230V$_{AC}$/<1A, 115 V$_{AC}$/<1A resp. 24V$_{AC}$/<2,5A
                                            (*see your order*)

5.2   Internal Wiring of Electronic Controller AMS 3220 and ZrO$_2$-Probe

> *Attention:*   The terminal numbers listed below refer to the wall mounted housing and to the ZrO$_2$- probe as ordered. For different terminal assignments please check the appendix!
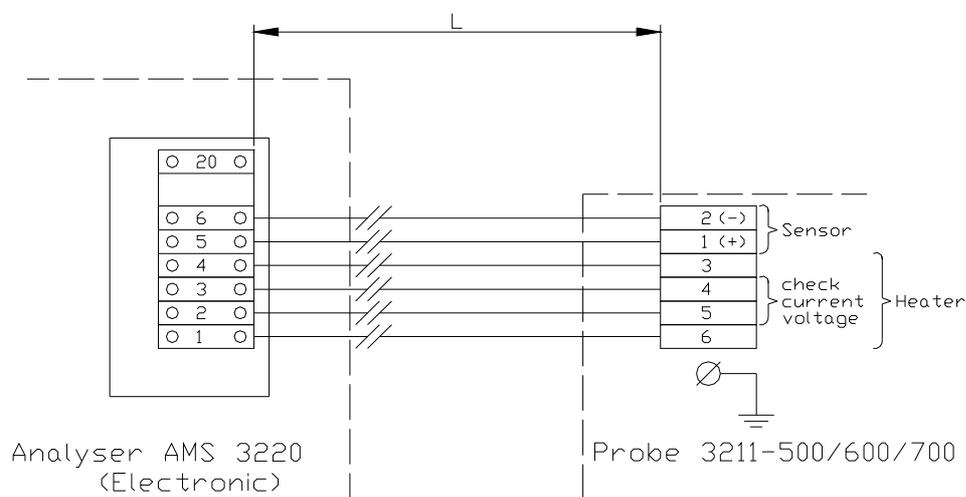
The electronic controller must be connected to the proper measuring probe (see your order form) as follows:

1) ZrO$_2$-Probe 3211-000

AMS 3220	probe with ready-made cable pins	
terminal 1	sensor heating	[colour: white]
terminal 2		
terminal 3		
terminal 4	sensor heater	[colour: white]
terminal 5	sensor (+)	[colour: black]
terminal 6	sensor (−)	[colour: grey]

2) ZrO$_2$-Probes 3211-500; -600; -700

AMS 3220	probe with Harting plug-in		
terminal 1	sensor heating	(+)	[terminal 6]
terminal 2	check current voltage	(+)	[terminal 5]
terminal 3	check current voltage	(-)	[terminal 4]
terminal 4	sensor heating	(-)	[terminal 3]
terminal 5	sensor	(+)	[terminal 1]
terminal 6	sensor	(-)	[terminal 2]

3) ZrO$_2$-Probe 3210-860/150 EEx d IIB + H2 T3 and High-Temperature Probe with EEx-d Certification

In classified areas, the electrical connection between the electronic controller and the ZrO$_2$-probe must be routed from an extra EEx e-approved terminal box (not included in the standard delivery, but it can be ordered from AMS)! It is important to provide the EEx e-approved box in the immediate vicinity of the measuring probe (permissible distance: max. 2 m).

AMS 3220	EEx e terminal box	probe with terminal	
terminal 1	terminal 6	heating (+)	[terminal 4]
terminal 2	terminal 5; bridged over to terminal 6		
terminal 3	terminal 4; bridged over to terminal 3		
terminal 4	terminal 3	heating($-$)	[terminal 3]
terminal 5	terminal 2	signal (+)	[terminal 1]
terminal 6	terminal 1	signal (-)	[terminal 2]
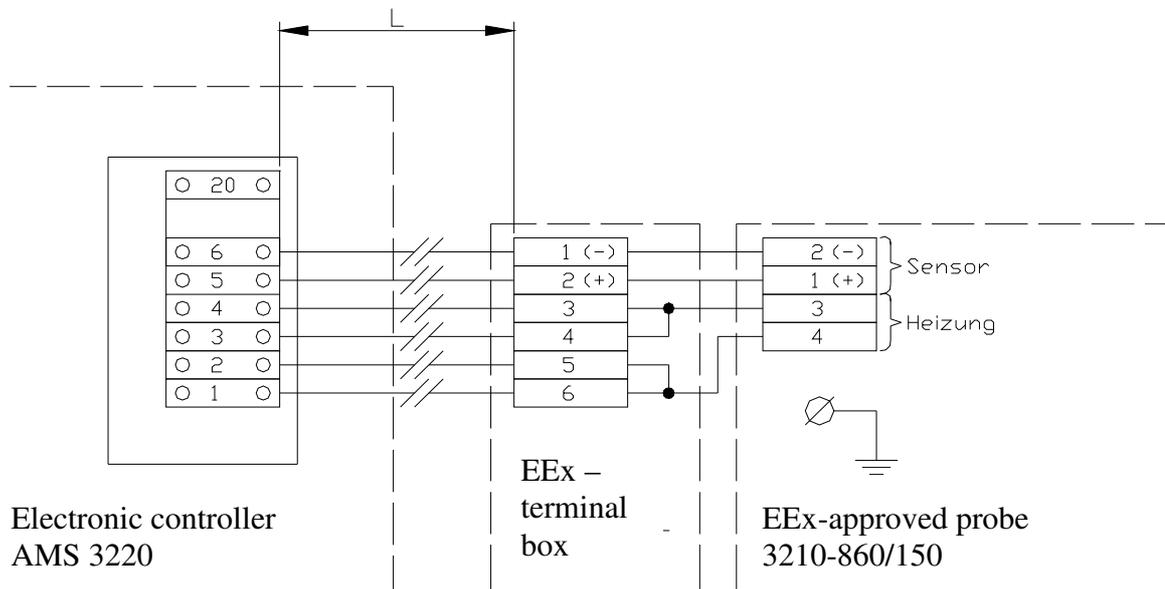
Fig.3: Electrical connection between electronic controller AMS 3220 and ZrO$_2$-probe 3210-860/150

5.3   Cable Lengths and Cable Cross-Sections

To connect the electronic controller to the measuring probe shielded conductors have to be used. The maximum load for the conductors is 48V/3A.

For cable lengths up to 150 m a joint cable with multiple conductors can be used for signal and heating. Above 150 m cable length usually the conductors for signal and heating should be routed separately.

1) Cable cross-sections for length up to 150 m

cable length "l"	minimum cross-section
up to 40 m	6 x 0.75 mm^2
from 40 to 60m	6 x 1.0 mm^2
from 60 to 90m	6 x 1.5 mm^2
from 90 to 150m	6 x 2.5 mm^2

2) Cable cross-sections for cables longer than 150 metres

Basically a six core cable has to be used with the core assignment as follows:

- 2 cores for the sensor signal

- 2 cores for the temperature signal (check current voltage)

- 2 cores for the heater voltage

The dimensions of the cross-sections for the signal and heater conductors required should be as follows:
- The sensor signal conductors (terminal no. "**5**" and "**6**" of the electronic controller AMS 3220) must show a <u>cross-section of at least 0,5mm^2</u>, regardless of the cable length. Larger cross-sections do not affect the measurement.
- The temperature signal conductors (terminal no. "**2**" and "**3**" of the electronic controller AMS 3220) must show a <u>cross-section of at least 0,5mm^2</u>, regardless of the cable length.
  Larger cross-sections do not affect the measurement.
- The cross-section of the heater conductor (terminal no. "**1**" and "**4**" of the electronic controller AMS 3220) has to be calculated as described below. In any case, it is important to observe that the overall resistance of the heating loop (excluding the sensor) does not exceed **3,2 Ohm!**

How to calculate the cross-section for the heater cores (example only):

Assume a cable with 4mm^2 cross-section and 4,7 Ohm / km / core resistance.
Which cable length fits to this?

- 4,7 Ohm / km / core results in 9,4 Ohm / km / connection
  (*The connection comprises two cores*)
- Prescription AMS: max. permissible resistance: 3,2 Ohm

$$maximum\ cable\ length\ \frac{3,2 Ohm}{9,4 Ohm\,/\,km} = 0,340\ km = 340\ m$$

The cable cross-section required may be split to different cores.

6   Preparations for Start-Up of Electronic Controller AMS 3220

The electronic controller AMS 3220 must be connected to the ZrO$_2$-probe as described in Chapter 5 of this manual.
All gas lines must be connected corresponding to their assignment, in doing so we recommend leak proofed fittings.

The reference air flow to the probe must be adjusted to 20 ... 40 Nl/h

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Only for the initial start-up, the RS232-interface cable/control cable for magnetic solenoids must be de-connected from the corresponding terminals, if the cable has been wired before.

I.   Switch on the analyser

    Immediately, the display indicates the system's identification number, and after some seconds' time the following message appears:

PREHEAT
WAIT...   ### s

    (waiting time : 600 sec.)

    If this warm-up period is finished the electronic controller automatically switches to the measuring mode. The first row of the display shows the current Oxygen concentration value. Pre-assigned by the factory the second row does not appear but is freely pro-grammable by the operator (see Chapter 7.1.2 of this manual).

II.   Function test
    The probe must be purged through the calibration gas line with air and bottled gas while monitoring the measuring value. The corresponding gas flow should be 30 to 60 Nl/h. This function test is pre aligned from the supplier; this means that solid and largely correct measuring values can be expected.

III.   Regarding the terminal assignment (see diagram in Chapter 5 of this manual) all alarms required must be connected to the proper terminal as well as the analogue output if needed.

IV.   *Option* – Connect the serial interface RS232 in accordance to the terminal diagram (see Chapter 5 of this manual).

V.   *Option* – Connect the magnetic solenoid control according to the terminal diagram (see the corresponding diagram in the appendix of this manual).

VI   If required: set the customer prescribed parameters according to Chapter 7 of this manual.

7 Measuring Mode and Parameter Mode of the Electronic Controller AMS 3220

7.1 Measuring Mode AMS 3220

The measuring value in vol-%-units is indicated in the <u>upper row</u> of the display like the readings for the operation parameters (*see #7.1.1.)*
Further information concerning the status of the device can be user assigned to the <u>lower row</u> as described in *#7.1.2*.

- All outputs and feedbacks are active.

7.1.1 Assignment of the Operation Parameter AMS 3220

The assignment of the operation parameters must follow this sequence:

- Press or toggle the "**F**"-button to indicate the parameter required.
- Through the cursor buttons the factory given alignments can be changed.
- Repeat pressing the "**F**"-button to indicate the parameters successively, use the cursor key to adjust the value required.

Not pressing any key on the control panel within 5 seconds puts the electronic controller automatically into the measuring mode regarding the parameters just set through the display.

Warning: Faulty parameters will also be accepted from the electronic controller without any confirmation of the apparent mistake.

Tab.2: Standard alignments (factory delivery)

Measurement Mode

Display Reading	Value
CAL LOW ##.## %	2,00
CAL HIGH ###.# %	20,95
ALARM 1 ###.# %	25
ALARM 1 TYPE HIGH/LOW	HIGH
ALARM 2 ###.# %	25
ALARM 2 TYPE HIGH/LOW	HIGH

Assignment Mode

Display Reading	Value
ALARM 1 MODE	Auto Reset
ALARM 1 HYST ## [rel.]	1%
ALARM 2 MODE	Auto Reset
ALARM 2 HYST ## [rel.]	1%
R-HEATER #.### Ω	8.200
RANGE LO #.## %	0,00
RANGE HI ##.## %	25,00

For all Operation Modes

Display Reading	Value
CHANGE 2nd LINE NO	Nothing

7.1.2 Alignment Sensor Signal, Heater Power and Value Alarms

Through the lower display row it can be aligned as follows:

- Press or toggle the "**F**"-button to obtain this reading

| CHANGE 2nd LINE
YES/NO | YES: assignment of the 2nd line can be changed
NO : assignment of the 2nd line cannot be changed |

      To call on YES or NO press the cursor button!

- The content of the 2nd line must be selected from the list shown below through the cursor buttons:

Tab.3: Choice for the "2ND LINE DISPLAYS;"

No	Display Reading	Description/Function
1	NOTHING	2nd line not visible
2	SENSOR VOLTAGE	Sensor signal [mV]
3	HEATER RESISTANCE	Current resistance of the sensor heater [Ω]
4	HEATER POWER	Current heater power [V]+[A]
5	ALARMS	Value alarms 1 and/or 2 if any active

7.2 Parameter Mode AMS 3220

To extend the already described variety of parameter selection to operate the AMS 3220 a **"hidden" button** has been built in.

7.2.1 The "**hidden**" button

To locate the "hidden" button, please check Chapter 4 of this manual for the front view of the electronic controller. This particular button is not directly visible on the front panel as indicated by the dashed lines in the diagram. It is placed just 3 cm to the right and parallel to the "↓" – cursor.

Pressing the "hidden" button leads to the lower programming level of the control menu. Changing the alignment of the parameter through the "hidden" button affects the entire mode of operation of the electronic controller AMS 3220 and thus may result in changing the complete production system. Hence, only authorised personal should be permitted to operate the "hidden" button.

After completing the alignment press the "hidden" button again to move to the upper level thus protecting the analyser against unintentional or unauthorised operation.
If the "hidden" button or any other button is not pressed within 10 minutes' time the electronic controller automatically returns to the main level. Continuously moving up and down does not affect the performance of the analyser as far as no alterations have been carried out.

Before starting to operate the "hidden" button and before changing the alignments or assignments in the electronic controller it is strongly recommended to read the instruction manual very carefully and to act only as advised. Otherwise severe personal injury and/or substantial damage to property can occur.

Warning: Faulty parameters will also be accepted from the electronic controller without any confirmation of the apparent mistake.

8   Alignment Operating Parameter Analysing System

8.1   Alignment Measuring Ranges Analysing System

The electronic controller features are freely programmable 0/4÷20 mA – analogue output (analogue output 1, see #8.2 of this manual).
To assign the analogue output 0/4 … 20 mA to the measuring range required follow these instructions:

- press the **"hidden" button** (see Chapter 4 of this manual)
- toggle the F-button until the following list appears on the display:

| RANGE LO   ###.# % | #### : start-of-scale value in vol-% |
|----------------------------| (*output 0 / 4 mA*) |

The start-of-scale value is freely eligible through the cursor buttons.

- toggle the F-button until the following list appears on the display:

| RANGE HI   ##.## % | #### : end-of-scale value in vol-% |
|----------------------------| (*output 20 mA*) |

Through the cursor button the end-of-scale value is freely eligible.

After completing the assignment of the measuring range it is recommended to move to the upper programming level by pressing the "hidden" button again. If the "hidden" button or any other button is not pressed within 10 minutes' time the electronic controller automatically returns to the main level.
Warning: Faulty parameters will also be accepted from the electronic controller without any confirmation of the apparent mistake.

8.2   Signal Output

Analogue output 1: 0/4÷20 mA for Oxygen concentration
programmable; signal output electrically isolated;

Analogue output 2: *Option:* 0/4÷20 mA, scale custom assigned
not programmable; signal output galvanically isolated;

8.3   Alarms

The analysing system is equipped with two different kinds of messages:

1) signal status analyser system
2) value alarms

8.3.1   Signal Status Analyser System

The analyser system features a relay controlled status signal. For the technical data of the relay see Chapter 3 and 5 of this manual. The status signal monitors the functions as follows:

warm-up phase
circuit break sensor heating
missing sensor heating circuit
power failure

The relay wiring is **FAIL SAFE**

8.3.2   Value Alarms

The value alarms 1 and 2 are freely configurable. A signal is triggered when the upper or lower limit marks are exceeded respectively. The alarm signal is transferred via the corresponding relay to the row of terminals on the rear panel of the electronic controller. Additionally, it is indicated on the display provided that this has been properly assigned according to Chapter 7.1.2 of this manual.

For the technical data and wiring of the alarms and the corresponding relays compare Chapter 3 and 5.

Alignment of the value alarms

The value alarms are independent from each other as well as from the measuring range. Each alarm may be assigned individually to a value in the range 0,2 ... 25 vol-%.

To align the alarm 1 follow the instructions listed below (alarm 2 has to be aligned correspondingly).

• Press the "**F**"-button until the following selection list appears:

| ALARM 1   ##.## % |

##.##: alarm limit in vol-% O$_2$

• Through the cursor buttons select the proper alarm value.
• Push the "**F**"-button until the following display appears:

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ALARM 1 TYPE
HIGH/LOW

- Through the cursor buttons select the type of alarm: HIGH or LOW.

- Not pressing any button within 5 minutes' time automatically puts the instrument back into the measuring mode.

8.4   Relays Alignment / Clear Alarms

- Press the "hidden" button (how to locate this button compare Chapter 4 of this manual)
- Press the **F**-button until the following selection list appears:

ALARM 1   MODE
****

***************** alarm modus indicated

- Through the cursor buttons one of the modes listed below may be chosen:

  - **HOLD** (MANUAL RESET)
    The alarm holds itself. Measuring values above or below the alarm threshold causes the flashing of the message AL 1 in the lower row of the display - if it was assigned before. To clear the message press the cursor button ↑ (the message AL 2 will only be cleared by pressing the cursor button ↓).

  - **DISABLED**
    The alarm is switched off.

  - **AUTO RESET**
    The alarm clears automatically. Measuring values above or below the alarm threshold are indicated as an alarm message on the lower row of the display but are then automatically reset (message cleared) if assigned before.

    To assign a particular deviation value permitted select AUTO RESET as described above and press the **F**-button again. The adjacent message appears on the display:

AL 1 HYST ## %[rel.]

difference to the alarm value in % [rel.]

    The value of the deviation can be selected through the cursor button from 0,1 ... 10 % (relative to the alarm threshold).

  - **DELAYED**
    The alarm clears itself. Measuring values above or below the alarm threshold are indicated as an alarm message on the lower row of the display but are then reset (message cleared) after a **pre-set delay time** if assigned before.
    To assign a particular deviation value permitted select AUTO RESET as described above and press the **F**-button again. The following message appears on the display:

AL 1 DELAY ## s	## Delay time in [s]

The delay time can be chosen from 1 … 60 seconds.

All alarms are also available at the terminals on the rear panel of the electronic controller via the relay wiring respectively (see Chapter 3 for the technical data of the relays and Chapter 5 for the terminal assignment).

After completing the assignment of the measuring range it is recommended to move to the upper programming level by pressing the "hidden" button again. If the "hidden" button or any other button is not pressed within 10 minutes' time the electronic controller automatically returns to the main level.

Warning: Faulty parameters will also be accepted from the electronic controller without any confirmation of the apparent mistake.

9   Calibration

9.1   Selecting Calibration Gases

The Oxygen analyser must be calibrated with two different calibration gases. Depending on the application, the calibration gases must be chosen as follows:

9.1.1   Measuring Oxygen Concentration in Process Gas Samples

To determine the Oxygen concentrations in a custom set range the calibration gases must cover the upper and the lower set point of this Oxygen concentration range.
Example: Measuring a process gas with an Oxygen concentration of about 1 … 10 vol-% in N$_2$ calibration gases with following oxygen concentrations are recommended:

> For the lower set point: 2 Vol-% O$_2$ in N$_2$, as the lower calibration point.
> For the upper set point: 20,95 Vol-% O$_2$ in N$_2$, as the upper calibration point.

9.1.2   Measuring Oxygen Concentration for Controlling and Alarming

Usually in these application areas the Oxygen concentration is relatively constant just varying in a narrow concentration range around the correct value. Correspondingly, for process control one calibration gas should show the correct Oxygen concentration value and for alarming purposes the lower or upper alarm value.
The Oxygen concentration of the second calibration gas should be aligned to the range of deviation from the correct Oxygen value, it may contain more or less Oxygen compared to process gas.

9.2   Calibration Procedure

The calibration procedure of the analysing system AMS 3220 occurs semi-automatic as well as in multiple steps.
A single calibration step is started manually but supervised and controlled automatically by the analyser.

> The calibration procedure may be stopped anytime through pressing the **F**-button. The system functions will not be affected through this handling.

While calibrating the system step by step as listed below one should carefully consider the different meaning of upper (**HI**) and lower calibration point (**LO**).

Calibration sequence:

    I. check set-points for calibration: see Chapter 9.2.1

    II. start calibration 9.2.2

    III. calibrating LO and HI: see 9.2.3

    IV. connect the process line, purging and measuring: see 9.2.4

Important:

During the calibration procedure all alarm messages and signal outputs are fixed. The last measuring value is indicated on the display for verification.

9.2.1 Assigning Set-Points and Calibration Points

Before starting the calibration of the analysing system the set points of the calibration gases used must be assigned to the instrument as described below.

- Press the **F**-button until the adjacent message appears:

CAL LOW   ##.## %

      ####   Oxygen concentration in vol-% O_2
                 for the lower calibration point

- With the help of the cursor buttons, assign the lower calibration point according to the calibration gas specification label.

- Press the **F**-button again until the following message appears:

CAL HIGH   ##.## %

      ####   Oxygen concentration in vol-% O_2
                 for the upper calibration point

- Through the cursor buttons, assign the upper calibration point according to the calibration gas specification label.

It is important for a reasonable calibration that the proportion of the Oxygen concentrations in the two reference gases employed should be at least

$$\frac{upper\ set\ \text{-}\ point}{lower\ set\ \text{-}\ point} \geq \frac{5}{1}$$

The analyser system monitors this proportion and set-points with a lower proportion as shown cannot be assigned to the analysing system.

9.2.2 Start the Calibration

> **Important I**
> **During the measuring phase no button should be pressed! Pressing the F-button after purge time breaks off the calibration procedure.**

> **Important II**
> While calibrating, the Oxygen concentration should not be altered or only slightly at the most.

> **Important III**
> Regarding the calibrating sequence it is recommended to calibrate the lower calibration point first and then the upper calibration point.

LO: Start the calibration of the lower calibrating point
Press and hold cursor button "↓", push F-button. Release the buttons. The adjacent message appears on the display.

| PUT LO-GAS   [##.## %] |
| PRESS F IF STABLE |

<u>Index:</u>   ##.##   measured Oxygen concentration

HI: Start the calibration of the upper calibration point
Press and hold cursor button "↑", push F-button. Release the buttons. The adjacent message appears on the display.

| PUT HI-GAS   [##.## %] |
| PRESS F IF STABLE |

<u>Index:</u>   ##.##   measured Oxygen concentration

Proceed as described in #9.2.3

9.2.3 Calibrating LO and HI

Connect the analyser system to the calibration gas line for the lower or upper calibration point respectively. Adjust the gas flow to 40 … 60 Nl/h. Monitor the current Oxygen concentration as indicated in brackets on the display. Wait until measured Oxygen concentration is stable.

*Press **F**-button and the following messages appear successively:*

CAL xx.xx %   [##.## %]
PURGING…   ttt s

Index
   xx.xx   pre-aligned calibration gas concentration
##.##   measured calibration gas concentration
ttt s   counter for purging time left

CAL xx.xx %   [##.## %]
SAMPLING…   ttt s

Index
  xx.xx   pre-aligned calibration gas concentra-
tion   ##.##   measured calibration gas concentration
ttt s   counter for sampling time left

Once this measuring sequence is finished the analyser automatically calculates and stores the calibration curve. The following message appears on the display:

PUT PR-GAS   [##.## %]
PRESS F IF STABLE

9.2.4   Connect the Process Line, Purging and Measuring

Connect the analyser system to the process line.

*Press the **F**-button, the adjacent message appears on the display:*

PROC GAS   [##.## %]   Index: ##.## measured Oxygen concentration
PURGING…   ttt s   *ttt*   time left over

The measuring procedure for the process gas either starts automatically after the purging time is finished or after pressing the **F**-button.

Important IV
Terminating the purging phase <u>before</u> the purging time has run out may cause unreliable measuring values for a short period of time since the measuring cell must align to the current Oxygen concentration.

9.3   Autocalibration (*optional*)

The autocalibration mode calibrates the analyser system automatically within pre-selectable time periods.
The autocalibration procedure is accessible only if the corresponding magnetic solenoid valves and the control system are supplied. To connect the electronic controller to the magnetic solenoid valves through a particular cable see the appendix of this manual.

Note
If the measuring value indicated changes while connecting the control cable for the magnetic solenoid valves, a ground loop may be the cause. To correct this fault detach the cable shield at one end of the control cable.

9.3.1   Assigning the Autocalibration

The autocalibration mode of the electronic controller is deactivated when delivered.
To align the autocalibration just follow the instructions as listed below.

- *Press or toggle the **F**-button until the following message appears on the display:*

AUTO CAL TYPE
****

  ********* selection list

- *press the cursor buttons to select the calibration sequence as listed below:*

  - **HIGH-LOW** = Start "CAL-HIGH" calibration first, then go on with "CAL-LOW"

  - **LOW-HIGH** = Start "CAL-LOW" calibration first, then go on with "CAL-HIGH"

    This sequence is recommended by the supplier.

  - **HIGH** = Only "CAL-HIGH" calibration will be executed
  - **LOW** = Only "CAL-LOW" calibration will be executed

- *Press or toggle the **F**-button until the following message appears on the display:*

AUTO CAL TIME	#### h
NEXT CAL TIME	**** h

  #### time interval required between two calibrations
  **** time period to the next calibration

- *Select the time interval between two calibrations through the cursor buttons.* The interval time can be freely chosen from 1 … 9999 hours with one hour steps.
  The lower row indicates the time left to the next calibration.

Note
Setting a time interval **starts** the calibration procedure at the time prescribed **automatically**.

Note
Setting AUTO CAL TIME = 0 and subsequently setting a time interval starts the calibration procedure immediately.

Note	
Setting "**AUTO. CAL. TIME"……0**	**Clears the autocalibration mode**

9.3.2 Execute Autocalibration

Note
<u>Before</u> executing autocalibration the assignment procedure (see Chapter 9.4.1) should be completed.

The autocalibration procedure takes into account the pre-assigned calibration sequence (compare Chapter 9.4.1). Therefore, by choosing the "LOW-HIGH"- or "HIGH-LOW"-mode the autocalibration procedure is performed automatically for both calibrations points.

The autocalibration mode starts

either

- **automatically** through selecting "AUTO CAL.TIME" and setting a time interval

or

- **manually** through *pressing the two cursor buttons simultaneously*.

The following messages appear successively on the display:

CAL xx.xx PPM [##.## PPM] PURGING... ttt	Index: xx.xx pre-assigned calibration value ##.## current measuring value ttt purging time left in seconds

CAL xx.xx PPM [##.## PPM] SAMPLING... ttt	Index: xx.xx pre-assigned calibration value ##.## current measuring value ttt sampling time left in seconds

The value in the upper row of the display indicates the calibration mode and the pre-assigned concentration value. The latter must correspond with the measuring value of the calibration gas currently used after the purging time has run out. Otherwise, the autocalibration procedure has to be stopped and the calibration procedure following Chapter 9.2 must be repeated.
After this, start the autocalibration mode manually through pressing again the two cursor buttons simultaneously.

Note
After finishing the *"PURGING"*-phase the indicated measuring value should be constant. The electronic controller controls the autocalibration procedure internally, possible faults are indicated on the display.

When the **Autocalibration is terminated** successfully the adjacent message appears on the display:

| PROC GAS   [##.## PPM] | ##.##   current measuring value |
| PURGING... ttt | ttt   purging time left in seconds |

This menu indicates that the ZrO$_2$-probe is now purged with process gas. When the purging phase is finished the electronic controller automatically starts measuring.

9.3.3 Adjusting the Purge Time

Note 1
Each calibration sequence starts and ends with purging the analyser for a specific time period primarily factory adjusted.

Note 2
Proper purging is required for reliable as well as solid measuring values. If the measuring values during the calibration sequence SAMPLING are not stable, an error message appears on the display and the purge time should be extended:

CALIBRATION INSTABLE

Note 3
Aligning the purge time may be required to take into account the volume of the supply gas lines.

Purge time setting

- *Press the **Hidden**-key, the adjacent message appears on the display*;
- press the "**F**"-key until this message appears:

PURGE TIME   ### s

- via the two arrow keys " ↑ " and " ↓ ", the purge time can be changed;

  (The Purge Time may be assigned individually to a value in the range 30 ... 900 (1200) sec)

- Not pressing any button within 5 minutes' time automatically puts the instrument back into the measuring mode.

9.4 Calibration Errors

The calibration procedure will be controlled continuously and calibration errors will be indicated on the display.

> **Note**
> Calibration errors cause the calibration procedure to stop. To launch the measuring mode again, just press the **F**-button.
> The interruption of a calibration sequence does not affect the performance of the analysing system.

Possible calibration errors indicated on the display:

A.
```
CALIBRATION ERROR 10
PRESS F TO CONTINUE
```

Cause:

This message may be caused by inconsistent measuring values due to inadmissible variations of the measuring signal.

Possible sources::
- Gas flow in the calibration gas line is too low
- Leaking calibration gas line
- Pressure variations in the calibration gas line
- Gas flow in the flue gas duct is too high
- Faulty sensor

B.
```
CALIBRATION ERROR 11
PRESS F TO CONTINUE
```

Cause:

This message may be caused from implausible calibration results.

Possible errors:
- No gas flow in the calibration gas line
- Incorrect calibration parameters

10 Options

10.1 Serial Interface RS232

The electronic controller can be optionally equipped with a serial interface RS232 to transfer the data to a remote computer through a specific evaluation programme or just a simple terminal programme.

Note
If the measuring value indicated changes while connecting the control cable for the magnetic solenoid valves, a ground loop may be the cause. To correct this fault detach the cable shield at one end of the control cable.

In order to connect the electronic controller and the remote computer via a serial interface RS232 follow these instructions:

1. The connecting line must be a non-modem-cable with the pin assignment as shown in drawing number 03-3220-000-36-A4 (see appendix).

2. Start the terminal programme on the remote computer and take care of the assignments as follows:

COM-Port:	(COM-interface at the computer)
Baud-Rate:	19200 bps
Start-Bits:	1
Data Bits:	8
Stop Bits:	1
Parity:	None

Data Protocol :

Whenever the master sends a data telegram to the instrument, the instrument is required either to
- send data
- change parameters or
- carry out a procedure

The instrument answers by sending the data required resp. by changing the parameters or by carrying out a procedure (e.g. calibration).

Each telegram is for one kind of information only. The instrument answers with a maximum delay of 0.2 seconds.

Each telegram consists of several ‚fields’, which are separated by a maximum of 5 ‚spacings’.

Each telegram is closed by <CR> (Carriage Return) .
The instrument recognises and evaluates a telegram only after receiving <CR> .

Description of 'Fields' and their meaning and formats

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Each telegram consists of a maximum of 6 ‚Fields' :

1st Field:	Definition of the meaning of the telegram
2nd Field:	Status Field in messages from the instrument only
3rd Field:	characterises the data transmitted
4th Field:	Field for data sent
5th Field:	optional field for supplementary data
6th Field:	Telegram End <CR>

Example
(for interpretation see further below) :

Telegram from Master to Instrument

S_11_-12.3456_<CR>

S	= 1st Field
11	= 3rd Field
-12.3456	= 4th Field
<CR>	= 6th Field

Telegram from Instrument to Master

L_0000_11_-12.3456_<CR>

L	= 1st Field
0000	= 2nd Field
11	= 3rd Field
-12.3456	= 4th Field
<CR>	= 6th Field

Description of the ‚Fields'

1st Field: Definition of the meaning of the telegram

From Master to Instrument :

G (Get) Master requests Instrument to send data

S (Set) Master requests Instrument to change a parameter

M (Make) Master requests Instrument to start a procedure (e.g. calibration)

From Instrument to Master

T Answer to **G** : Instrument sends data;

L Answer to **S** , Instrument confirms changed parameter

E Answer to **M ,** Instrument confirms execution of procedure

X this code indicates, that the self-checking procedures in the instrument have detected an error or a malfunction; such errors or malfunctions are stored in 'flags' and sent in Field 2 of the answer telegram from the instrument to the master.

2nd Field   :   Status Field: 16 Bit Error Flags,
→ for messages from the instrument to the master only !!

Coding is bit by bit :   0 = OK   1 = Error

B0:   Communication Error (RS232 frame error, timeout…)

B1:

B2:

B3:   Unknown Command

B4:   Parameter-Error (Parameter outside allowed range)

B5:   Command could not be executed

B6:

B7:

B8:   After power on **:**
Sensor has not yet reached the operating temperature

B9:   Instrument is busy with a calibration procedure

B10:

B11:

B12:   Sensor-Temperature Error

B13:

B14:   Heater (or heater line) broken

B15:   Heater shortcut

Format for transmission :   HEX

Examples :

	HEX	(Binary)
No Error :	0000	(00000000 00000000)
Heating up phase:	0100	(00000001 00000000)
Temp. Error, heater broken:	5000	(01010000 00000000)

**3rd Field   :   Characterisation of Data transmitted
2-digit number from 00 to 99**

00:	Reservied
01:	Instrument number
02:	**Oxygen Concentration Value**
03:	Sensor-Signal
04:	Heater Resistance; actual value (Sensor-Temperature)
10:	Status Signal
11:	Sensor „OFFSET" (= Sensor signal [mV] in air)
12:	Sensor „SPAN" (= Sensor signal change [mV] for an Oxygen concentration change of 1:10)
13:	Heater Resistance; programmed value
21:	Option: Tag-Number (by user)
22:	Option: Application (by user)
31:	Oxygen concentration for lower calibration point „Cal Low"
32:	Oxygen concentration for upper calibration point „Cal High"
80:	Abort calibration
81:	Start Calibration „Cal Low"
82:	Start Calibration „Cal High"

91 to 99 [reserved for future demand]

01 to 10	Master may only request the instrument to send those data
11 to 90	Master may either request those data to be sent ("**G**") or he may request to set new values ("**S**") Procedures (80, 81, 82) are started by "**M**"

The Oxygen concentration (02) is transmitted as mean value since the last command G 02
If no request to send the Oxygen concentration is received for more than 15 minutes, the transmitter starts a new averaging.

All other values are transmitted as the actual values whenever the re4spective command with a closing <CR> is received by the transmitter.

4th Field: **Data**

In this field, the data as characterised in field 3 are listed.
The length and the format of the field is determined by the type
of the data. The maximum length is 50 Bytes.

Format:

02	Oxygen (floating point) [Vol% o. ppm]		
03	Sensor-Signal	floating point [mV]	
04	Heater resistance (actual value)	floating point [Ohm]	
12	Status	0	OPERATING
		1	START UP
		2	PREHEATING
		3	SETUP-MODE
		4	CALIBRATION
		5	
		6	SYSTEM ALARM
11	OFFSET	floating point	
12	SPAN	floating point [dimensionslos]	
13	Heater resistance (programmed value)	floating point [Ohm]	
21	TAG-Number	string	
22	Application	string	
31	Cal Gas Low	floating point [Vol%]	
32	Cal Gas High	floating point [Vol%]	

5th Field: **Supplementary Data**

This field contains supplementary data for field 4, e.g. the dimensions
or units of the measured values [Vol%, ppm, mV, Ohm,….]
Field 5 is transmitted ‚on demand' only and may be omitted.
Maximum length is 20 Bytes.

6th Field: **Telegram End <CR>**

EXAMPLES :

Remark : In the following, a 'spacing' is indicated by **"_"**

| **1.** **Request from Master** | **Answer from Instrument** |

G_02_<CR>   **T_0000_02_20.95_%O2_<CR>**

G   Send Data   T   Data sent
02   Oxygen   0000 HEX : no error
<CR> Telegram end   02   Oxygen
                                        20.95 Oxygen Value
                                        %O2   Dimension
                                        <CR> Telegram end

Or, if the instrument is not o.k., par example :

X_5000_02_17.5_%O2_<CR>

X   Error from Instrument
5000 Temperature error,
      heater broken
02   Oxygen
17. 5 Sauerstoffwert
%O2   Dimension
<CR> Telegram end

2. **Command from Master**

S_11_-12.34_<CR>

S	Set Parameter
11	OFFSET
-12.34	new Value for Offset
<CR>	Telegram end
_	Spacing

Answer form Instrument

Status: *o.k.*

L_0000_11_-12.34_<CR>

L	Parameter changed
0000	no error
11	OFFSET
-12.34	new value for Offset
<CR>	Telegram end
_	Spacing

Status : not o.k.;
          could not change parameter

X_0001_11_>CR>

X	Malfunction
0001	Transmission error
11	OFFSET
<CR>	Telegram end
_	Spacing

3. **Command from Master**

M_81_<CR>

M	Command ‚Make'
81	Calibration „Cal Low"
<CR>	Telegram end
_	Spacing

Answer form Instrument

Status: *o.k.*

E_0000_81_11.5_ppm_<CR>

E	Executed
0000	no error
81	Calibration „Cal Low"
11.5	Value for Cal Low Gas
ppm	dimension
<CR>	Telegram end
_	Spacing

The calibration needs approx. 100 Seconds and may be aborted by **M_80_<CR>** at any time.

10.2 Magnetic Solenoid Control

The magnetic solenoid control board for the analysing system AMS 3220 is placed in a specific aluminium made box (dimensions 120x220x80 mm).

To connect electronic controller and solenoid control board a 1:1 connection line has to be supplied as described in the appendix.
Voltage supply: 115V$_{AC}$ or 230V$_{AC}$ (check your order form).

terminal-   plug- terminal-   terminal-   terminal-   terminal-
block 1   in   block 2   block 3   block 4   block 5
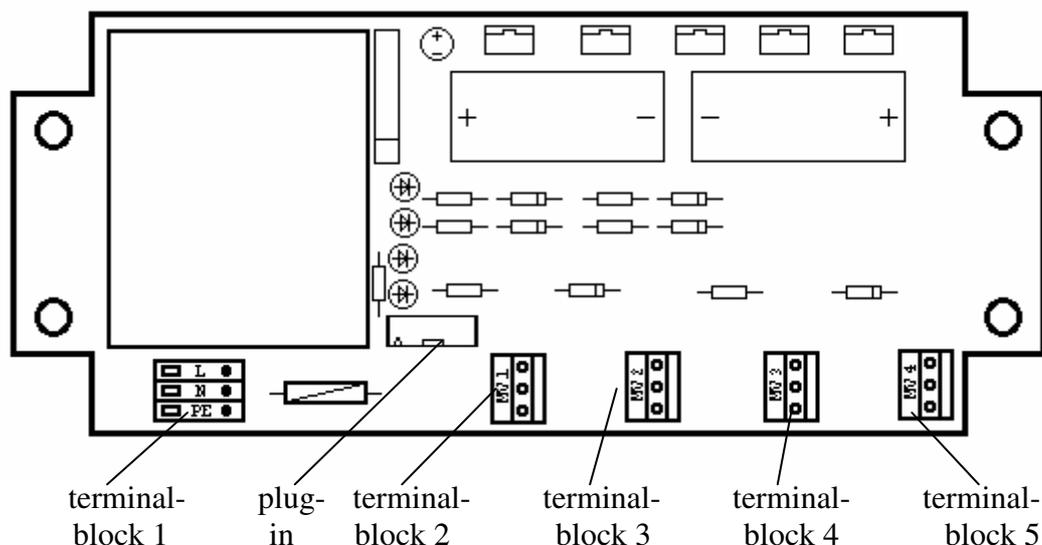
<u>Fig. 4:</u> Power board for magnetic solenoid control

The terminals on the power board are to assign as follows:
(see AMS Drawing No.: 00-3220-000-43-A3 at the appendix)

Terminal block	*Connection*
1	voltage supply 115V$_{AC}$ or 230V$_{AC}$ (power 20 VA)
2	magnetic solenoid valve switching over measuring/calibrating **[MV1]**
3	magnetic solenoid valve switching over calibration gas "HIGH" (air)/ calibration gas "LOW" **[MV2]**
4 + 5	free for optional control

Note
Connecting the terminals one should regard the proper polarity concerning the supply lines for the magnetic solenoid valves. The latter are designed for **24 V$_{DC}$ if** not described otherwise.

Note
Pay attention to the marks engraved on the board next to the terminals while assigning voltage supply and magnetic solenoid valves.

---

11 Error Messages

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- HEATER ALARM
  HEATER SHORTCUT

Cause:

Short-circuit in probe heating line terminal 1 and 4
(wall mountable housing)

error correction:

test the sensor heating lines for short-circuit
(probe heating line resistance is approximately 2Ω at room temperature and approx. 9Ω at operating temperature.)

- HEATER ALARM
  HEATER MISSING

Cause:

Broken or not connected probe heating line terminal 1 and 4
(wall mountable housing)

error correction:

I.   test terminal for connecting cables

or

II.   check probe heating lines for a break
        (probe heating line resistance is approximately 2Ω at room temperature and approx. 9Ω at operating temperature.)

- FACT DEF LOADED
  PRESS F TO START

Cause:

- faulty EEPROM
- faults causing a "RESET"
  e.g. a short-circuit in the probe heating line during normal operation

error correction:

- press **F**-button
- if the error message is not cleared the EEPROM is faulty and must be exchanged
- if the error message is cleared: the EPROM is ok and the factory supplied settings will be loaded again after the **F**-button has been pressed
- alarms and calibration points must be realigned
- re-calibration at the earliest after operating 1 hour

12 Service

The electronic controller AMS 3220 features a substantial self-diagnostic philosophy with fault signals. Maintenance is only necessary for the probe: cleaning from dust and deposits and in case the sensor has to be exchanged.

12.1 Calibration

Basically calibration should be executed for two concentrations (see #9).
It is recommended to calibrate after at least one hour operation and at regular operation temperature. Regularly repeating the calibration within 3 months period is also recommended. This calibration period might be extended up to 6 months due to the long-term stability of the ZrO_2. The calibration period might be shortened if the probe is exposed to aggressive chemicals, heavy dust deposits, high temperatures and temperature differences etc. Just monitor the successive measuring values at the calibration points for some time to detect solid deviations from the initial calibration.

12.2 Exchange of the Sensor, Lifetime

The average lifetime of the sensor is about two years. This time might be extended regarding applications with almost constant operation temperature and less aggressive gas mixtures e.g. for flue gas measurements in natural gas incinerators.
It is recommended to exchange the sensor after 30 months operation. Storing a sensor for up to two years does not affect its lifetime or performance.
The regular "ageing" of the sensor can be compensated for some time through calibrations repeated periodically.
Overused sensors exhibit faulty calibration values indicating the need for replacement.

12.3 Probe Maintenance

Service for the probe is restricted to cleaning from deposits or pollution. These effects are signalled through delayed response time and extended time needed for stable measuring values.

13 Messages

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14 Appendix

Drawings

Dimensions