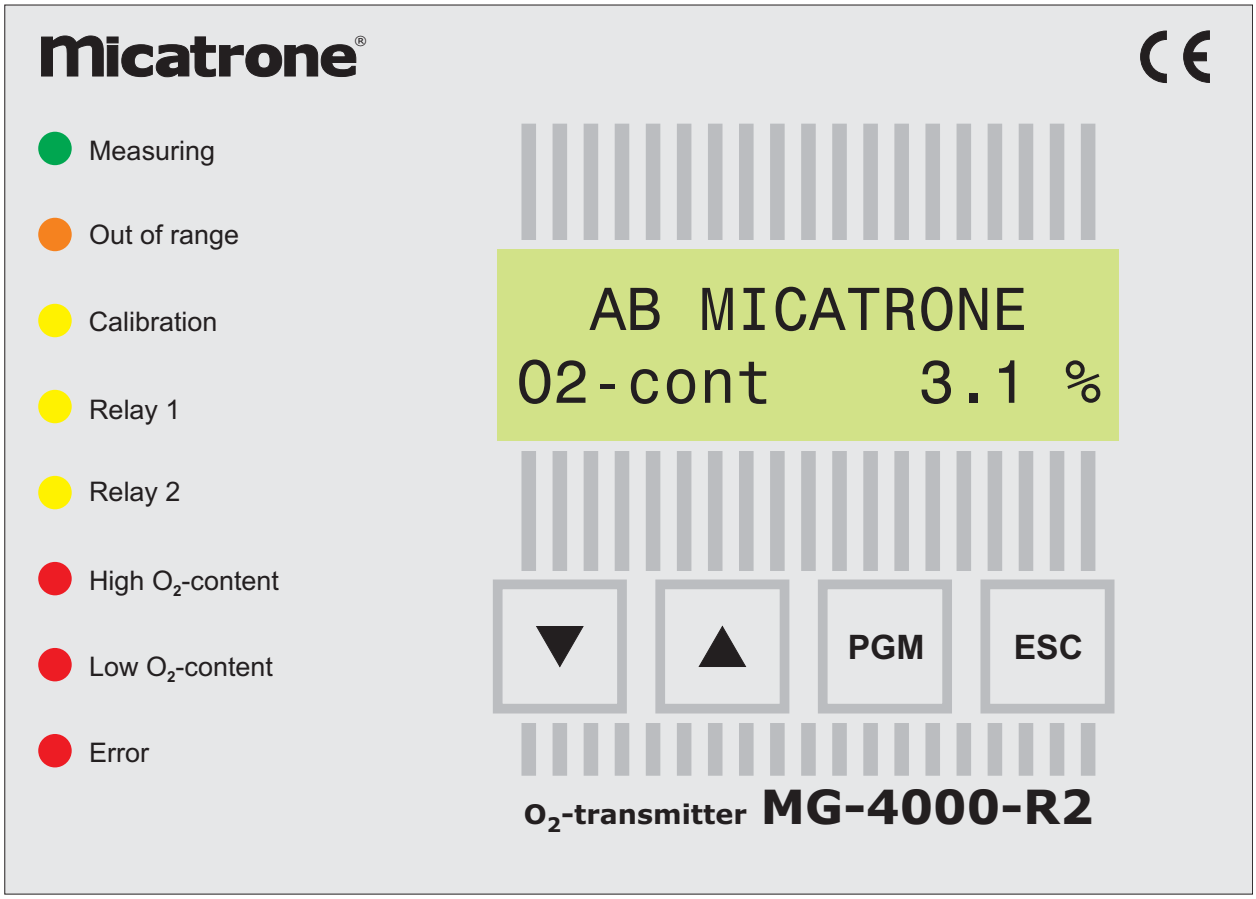
Micatrone®

Operating and Installation manual

Oxygen (O2) transmitter with monitoring

MG-4000-R2

Mi-262gb / 2010-04-13



USE

MG-4000-R2 is designed to measure the O_2-content in flue gases from oil burners, gas burners and biomass-fired boilers. MG-4000-R2 can, together with a controller, optimize the air/fuel ratio. The result is the highest possible firing efficiency can be obtained and sustained over time independent of changes in the fuel and combustion air.

The probe (MG-4000-R2/S) is installed in the flue gas duct directly after the boiler. The tip of the probe is easy to adjust so that it is positioned in the centre of the flue gas zone. No special gas is required for calibration, this is done directly in the surrounding air. Installation and use are as easy as using a standard temperature sensor.

The O_2-transmitter consists of two parts: the probe and the central unit. The probe houses a sensor of zirconium dioxide (ZrO_2), heating element, signal amplifier and generator for the ion pump. The central unit houses the electronics for measuring the sensor signal, analogue outputs, relay contacts for the alarm outputs, control panel and the power supply. All functions in the central unit are managed and monitored by a microprocessor.

Current measurement values, error indications and set parameters are all presented on the integrated display.

8 LEDs provide a quick indication of the operating status.

TABLE OF CONTENTS

MEASUREMENT PRINCIPLE

At higher temperatures (>500 °C) stabilised zirconium dioxide (ZrO_2) is a solid electrolyte for oxygen. This can be used in two ways:

1. To transport oxygen through a ZrO_2-disc (ion pump) according to Faraday's first law.

2. To measure the ratio of partial pressure from oxygen on each side of a ZrO_2-disc according to Nernst's equation.

Most modern oxygen meters available on the market use one of the aforementioned principles. To avoid disadvantages such as relatively large probes, linearization of measurement signals, reference air, etc. both principles can be combined into a **dynamic oxygen sensor**.

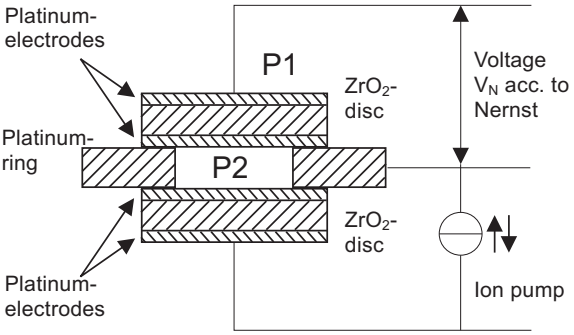


Figure 1
Principle construction for a dynamic O_2-sensor.

The sensor consists of two identical ZrO_2-discs with platinum electrodes and a platinum ring which creates a small chamber between the discs. One disc is used as a reversible ion pump according to Faraday. The other disc generates a measurement voltage proportional to the ratio of the oxygen partial pressure in the chamber (P_2) and surroundings (P_1) according to Nernst.

When measuring, the reversible ion pump will alternately pressurise and evacuate the chamber. Reversing takes place at two preset voltage levels V_1 and V_2 on the Nernst voltage V_N.

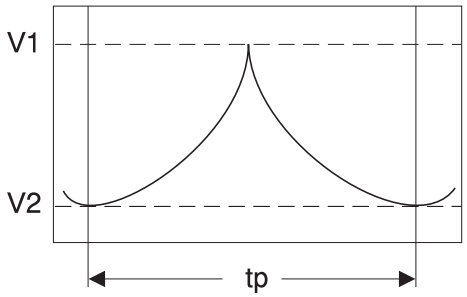


Figure 2
Measuring signal from the O_2-sensor.

The time of a pump cycle (tp) becomes directly proportional to the surrounding partial pressure from the oxygen (P_1). An increase in the surrounding oxygen content increases the partial pressure (P_1) and tp increases. With a decreasing oxygen content tp falls. At 0 % O_2 tp is approximately 0.5 seconds and in fresh air (20.7 % O_2) tp is approximately 7 seconds.

The sensor is enclosed by a heating element to maintain the temperature of the ZrO_2-discs at 700 °C. This makes the sensor insensitive to changes in the flue gas temperature and the flow rate.

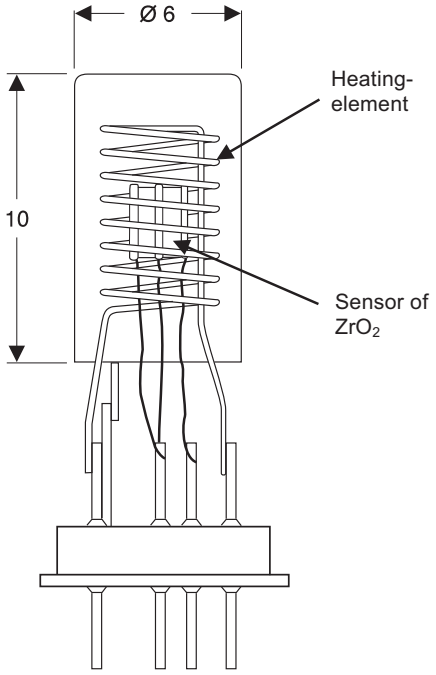


Figure 3
Cross-section view of the sensor element.

- *Based on this principle the sensor is very small and with that the probe can be made small.*
- *No reference air is required and the Nernst voltage does not need to be linearized.*

O_2-transmitter installed in the flue gas duct measure the oxygen content in moist flue gases. Transmitters that take samples of the flue gas measure the oxygen content in dry flue gases.

The following relationship between moist and dry flue gases applies with reasonable accuracy for an excess of air up to approx. 50 % when firing with oil.

Oxygen content (moist gas) = 0.9 x oxygen content (dry gas)

NOTE! If the probe is subjected to reducing atmospheres, e.g. high content of CO (carbon monoxide), this will reduce the service life of the probe. It is important that the O_2-control works correctly.

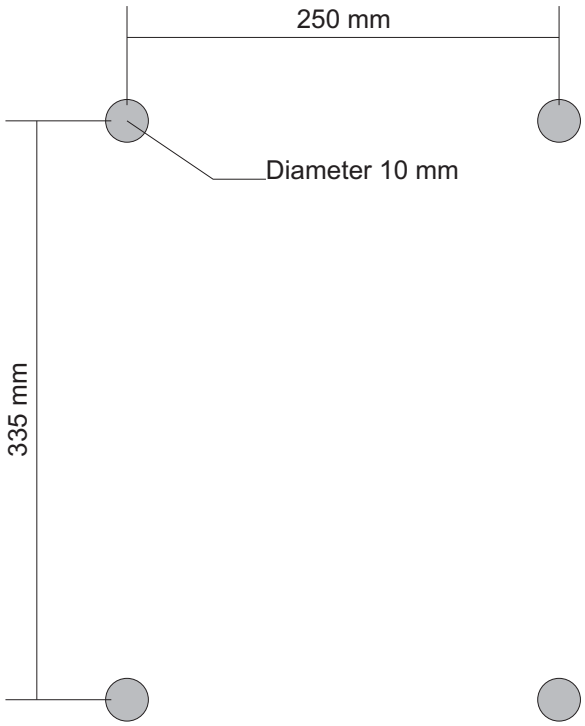
INSTALLATION

Central unit

MG-4000-R2 should be located fully visible and easily accessible. It is important to remember the ambient temperature, max. 45 °C when positioning the unit. The case is fitted with hinges on the left-hand side of the cover for easy opening. Make sure the cover can be opened fully.

Outside dimensions:
H x W x D = 360 x 300 x 140 mm.

Hole pattern for wall mounting:



When choosing the position for installation, remember the following:

1. The central unit must not be subjected to an ambient temperature higher than 45 °C. Preferably the ambient temperature should be below 30 °C.

2. The signal cable between the probe and the central unit must be a screened 10 conductor cable e.g. FKAR-G 10 x 0.5 mm^2. The area of each conductor should be at least 0.5 mm^2. The correct cable, which is a prerequisite for reliable operations, is enclosed.

3. The length of the signal cable between the probe and the central unit should be as short as is practically possible, maximum 10 m.

4. The signal cable between the probe and the central unit must not be routed together with cables used for low or high voltages.
   The minimum permitted distance to low and high voltage cables is 30 cm. Cables must cross at right angles.

5. Avoid placement where the central unit is subjected to vibration.

6. The central unit should be positioned so that the control panel is approximately at eye level.

Probe

When installing the probe it is important to select correct placement. It should be easy to remove the probe from the flue gas duct and easy to connect the signal cable between the probe and the central unit.

1. Fit a 3/4" union on the flue duct after the boiler. Make sure the union extends outside of the insulation to facilitate installation of the probe. It should be installed at a 15° angle to the horizontal plane, so that the tip of the probe points slightly downward (see figure 4), alt. top mounted (see figure 6). This is to protect the probe from condensation water.

2. Always install the supplied radiation protection on the probe's insertion tube to prevent the sensor's electronics from overheating. Sole use of the radiation protection is not recommended, the flue gas duct should also be insulated.

3. The probe should be inserted so far that at least 10 cm of the tube hangs free inside the duct. This is so the tip of the probe is not cooled via the union.

4. The supplied warning sign concerning precautions that should be taken when the boiler is swept must be set up where it is fully visible.

Galvanic isolation

The O_2-probe should always be mounted using the attached compression fitting which is fitted with a isolation socket made of PTFE (TEFLON ĝ) to seperate the probe galvanically from protective earth (ground) in the boiler/flue-gas duct which could interfere with the measuring. Check that no electrical connection is between the probe and boiler/duct by measuring the resistance between them both.

Warning against dry-firing!

When "dry-firing" a biomass-fired boiler, the probe must not be placed in the flue gas duct.

Wiring

The cable between the probe and the central unit must NOT be extended. Leave an "eye" on the cable by the probe so that the probe can be easily removed from the flue gas duct for calibration and duct sweeping.

The cable between the probe and the central unit and cables to analogue output signals and data communications must be screened for the best measurement result. The screen must be connected to the ground rail in the central unit.

NOTE!

The probe must be operational (voltage fed) and always maintain the operating temperature if it is installed in the flue gas duct, irrespective of whether the boiler is operational or not. When the probe is not in use it should be kept in the surrounding air. Wipe the probe dry if it is moist before insertion.

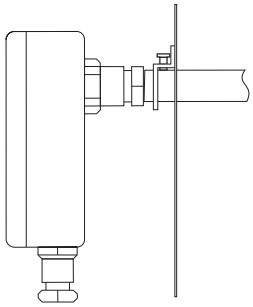
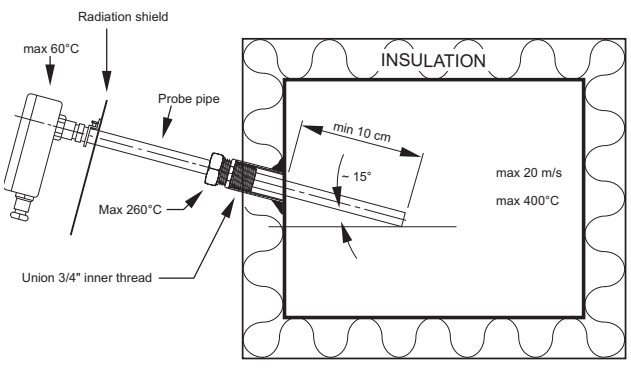


Figure 5
Radiation shield for connection box

NOTE! The measuring probe connection box should not be exposed to tempertures above 60 °C and must therefore be protected against the radiation heat caused by the flue gas duct or the boiler. Good insulation of the flue gas duct and enough space between the insulation and the probes connection box is important. Always use the



Figur 4
Side mounting of the probe

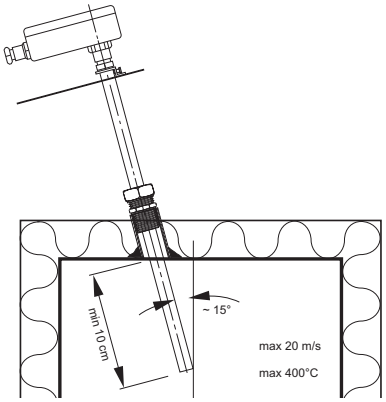


Figure 6
Top mounting of the probe

OXYGENE SENSOR CROSS SENSITIVITY

Cross sensitivity with other gases:

The oxygen sensor measures partial oxygen pressure. Gases or chemicals that will have an influence on the life of the sensor or on the measuring results are:

Combustible Gases

Small amounts of combustible gases will be burned at the hot Pt-electrode surfaces or Al_2O_3 filters of the sensor.

In general combustion will be stoichiometric as long as enough oxygen is available, the sensor will measure the residual oxygen pressure. Investigated were:

- *H_2 (Hydrogen) up to 2%; stoichiometric combustion*
- *CO (Carbon Monoxide) up to 2%; stoichiometric combustion*
- *CH_4 (Methane) up to 2.5%; stoichiometric combustion*
- *NH_3 (Ammonia) up to 1500 ppm; stoichiometric combustion*

Heavy Metals

Vapours of metals like Zn (Zinc), Cd (Cadmium), Pb (Lead), Bi (Bismuth) will have an effect on the catalytic properties of the Pt– electrodes. Exposures to these metal vapours has to be avoided.

Halogen and Sulphur Compounds

Small amounts (< 100ppm) of Halogens and/or Sulphur compounds have no effect on the performance of the oxygen sensor. Higher amounts of these gases will in time cause readout problems or, especially in condensing environments, corrosion of sensor parts. Investigated gases are:

- *Halogens, F_2 (Flourine), Cl_2 (Chlorine)*
- *HCL (Hydrogen Chloride), HF (Hydrogen Fluoride)*
- *SO_2 (Sulphur Dioxide)*
- *H_2S (Hydrogen Sulphide)*
- *Freons*
- *CS_2 (Carbon Disulfide)*

Reducing Atmospheres

Long time exposure to reducing atmospheres may in time impair the catalytic effect of the Pt-electrodes and has to be avoided.

Others

- *Vapours (organic silicone compounds) of RTV (Room Temperature Vulcanised) rubbers are well known pollutants of zirconia based oxygen sensors. The organic part of the compound will be burned at hot sensor parts, leaving behind a very fine divided SiO_2 (Silicone Dioxide/Silica). This SiO_2 completely blocks the pores and active parts of the electrodes. If RTV rubbers are used we advise to use high quality, well cured.*
- *Dust. Fine dust (Carbon parts/soot) might cause clogging of the porous stainless steel filter and might have an effect on the response speed of the sensor.*
- *Heavy Shocks or Vibrations might alter sensor properties.*
- *Water vapour. Condensing water vapour might cause clogging of filters or internal corrosion of sensor parts. We advise to keep the sensor at operating temperature or standby temperature when exposed to exhaust gases. Direct exposure to water droplets has to be avoided.*

ELECTRICAL CONNECTION

Description

Voltage supply

MG-4000-R2 is fed with 230 VAC, 50 Hz on terminals 1 (neutral) and 3 (phase). The supply should incorporate a circuit-breaker to facilitate servicing.

Alarm function

On terminals 5-7 and 8-10, are two potential free switching relay contacts. The relay contact function can be programmed on MG-4000-R2, e.g. alarm with low O_2-content and probe error. The relay contacts are low voltage, 230 VAC.

Probe

Terminals 11-19 are connected to the probe's terminals 1-9.

Output signals

MG-4000-R2 has two analogue output signals for the current O_2-content, a mA-signal (0/4..20 mA) on terminals 21 (+) and 22 (-) and a Volt-signal (0/2...10 V) on terminals 23 (+) and 24 (-).

NOTE! Common neutral (-). The output signals are not galvanically isolated from each other.

Communication

MG-4000-R2 has 2 interfaces, RS-232 and RS-485. Only one interface at a time can be used.

RS-232 is connected to a modular jack (RJ45) and is designed for Micatrone's Programming adapter, part no. 60-0972-2.

RS-485 is connected to terminals 25 (A) and 26 (B) and requires MG-4000-R2 to be equipped with Micatrone's Communication module, part no. 60-0973.

If both RS-232 and RS-485 are connected simultaneously RS-232 is given priority for communications. Also see the operating description for communications on page 12.

Signals to the probe

Terminal 11

Positive supply to the probe's electronics.
+7 Volt DC, 2.5 mA.

Terminal 12

Feedback signal from heating element in sensor.
$\pm$ 50 mVolt, square wave 1 kHz at 700 °C.

Terminal 13

Control signal to the ion pump for evacuation.
+6 / -4 Volt, square wave 1 kHz.

Terminal 14

Supply to the heating element.
1.7 A, approx. 4.2 Volt DC on probe.

Terminal 15

Measurement zero from the electronics.

Terminal 16

Neutral wire to the heating element.

Terminal 17

Control signal to the ion pump for pressurising.
+6 / -4 Volt, square wave 1 kHz.

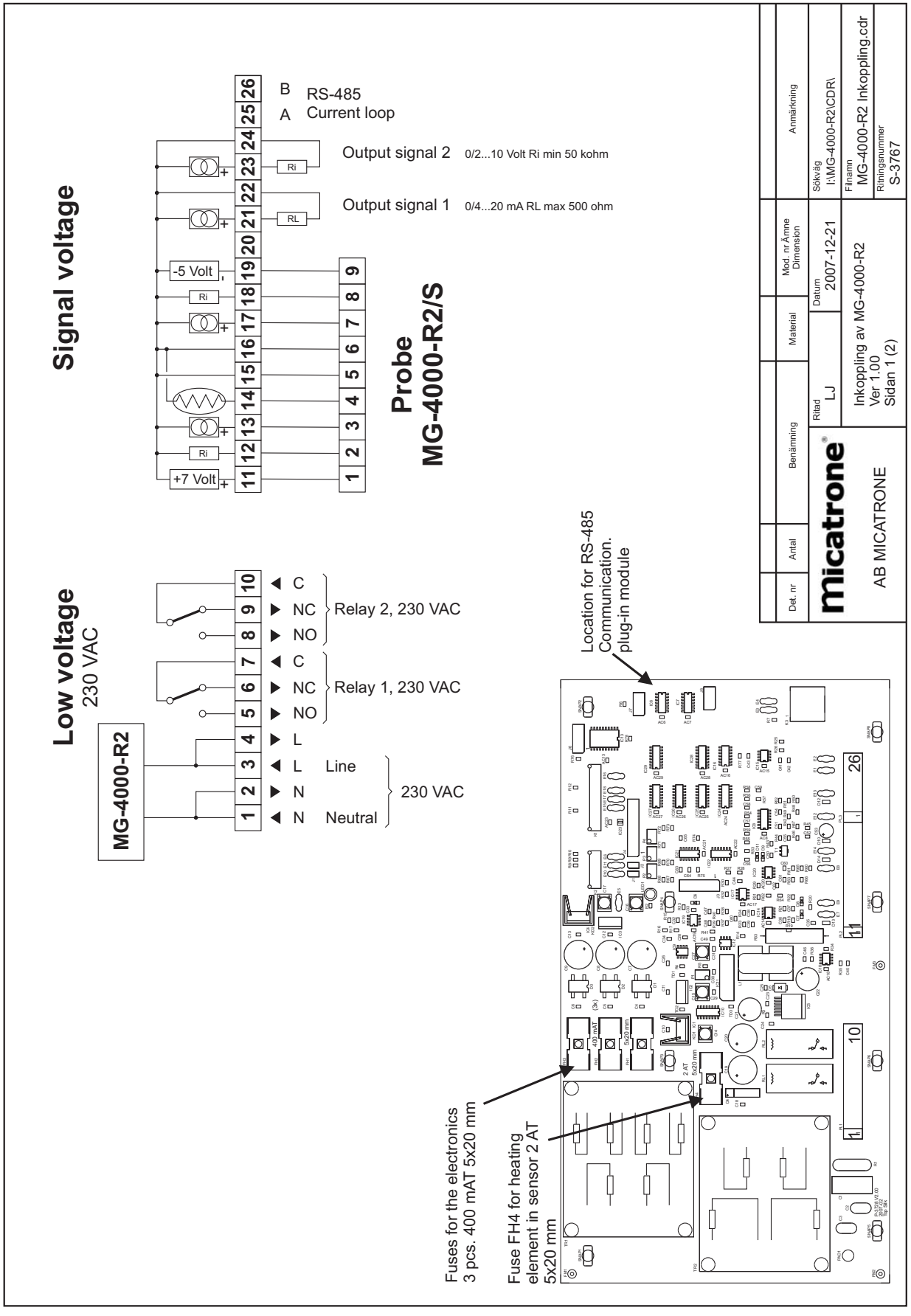
Terminal 18

Measurement signal from the zirconium dioxide sensor. Periodic signal 0...4 Volt DC.

Terminal 19

Negative supply to the probe's electronic.
-5 Volt DC, 2.5 mA.

Connection diagram for Central unit and Probe



Translation chart MG-4000 // MG-4000-R2

MG-4000-R2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

MG-4000

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Det. nr	Antal	Benämning	Material	Mod. nr Ämne Dimension	Anmärkning

Micatrone®

AB MICATRONE

Ritad: LJ	Datum: 2007-12-21	Sökväg: I:\MG-4000-R2\CDR\
Inkoppling av MG-4000-R2 Ver 1.00 Sidan 2 (2)		Filnamn: MG-4000-R2 Inkoppling.cdr
		Ritningsnummer: S-3767

INITIALIZE OPERATION

NOTE! The probe must be operational (voltage fed) and always maintain operating temperature if fitted in the flue gas duct, irrespective of whether the boiler is operational or shutdown. If the probe is not operational it should be stored in the surrounding air.

NOTE! If the probe is subjected to reducing atmospheres, e.g. high content of CO (carbon monoxide), this will reduce the service life of the probe. It is important that the O_2-control works correctly.

Check that all connections between the probe and the central unit are correct before MG-4000-R2 is connected to the mains supply, 230 VAC.

When the power is switched on MG-4000-R2 will start to heat the probe. This takes approx. 120 seconds and during this period the "Out of range" LED will flash.

Should an error be discovered, e.g. a faulty connection on the signal cable between the probe and the central unit, the "Error" LED lights and the fault is presented in plain text on the display. For a description of how to rectify the error, refer to page 19.

If it is the first time that MG-4000-R2 has been started the settings for the selected measurement range and output signals should be checked. MG-4000-R2 also needs to be calibrated in fresh air to match the central unit with the probe, see page 17.

Par.no:	Description	Range	Value
O2-measurement			
1	Range	0..5% 0..10% 0..20% 0..100%	
2	High O2	0,0...99,9	
3	Low O2	0,0...99,9	
4	Barometer	800...1200	

Par.no:	Description	Range	Value
Outputs			
28	Source 1	O2-cont	
29	Signal 1	0..20mA 4..20mA	
30	Source 2	O2-cont	
31	Signal 2	0..10V 2..10V	

FUNCTIONS

Measurement values

O_2-content

MG-4000-R2 measures the O_2-content in flue gas using a zirconium dioxide sensor. The measurement range of the output signal can be selected between **0...5%, 0...10%, 0...20%** or **0...100%** O_2. If the measured O_2-content is outside of the selected measurement range an orange LED is lit on the control panel.

MG-4000-R2 has visual alarms (red LEDs on the control panel) for specific high and low O_2-content. The limits are stated in % O_2-content.

Par.no:	Description	Range	Value
O2-measurement			
1	Range	0..5% 0..10% 0..20% 0..100%	
2	High O2	0,0...99,9	
3	Low O2	0,0...99,9	
4	Barometer	800...1200	

The probe must first be calibrated to provide accurate measurements. Calibration is performed in fresh air, see page 17. The current barometric pressure can be programmed during calibration on MG-4000-R2 to give the best possible accuracy. The value is stated in mBar.

Nernst

Indicates the measurement signal from the probe. Nernst will vary between 0 and 4 Volts during normal measurements.

Current & Voltage

Indicates the present current and voltage to the probe's heating element.

Temperature

Indicates the present temperature of the probe's zirconium dioxide sensor.

Output signals

MG-4000-R2 produces two output signals (one for mA and one for Volt). The output signals state the current O_2-content for the selected measurement range.

Output signal 1 can be selected between 0...20 mA or 4...20 mA and output signal 2 can be selected between 0...10 Volt or 2...10 Volt.

Par.no:	Description	Range	Value
Outputs			
28	Source 1	O2-cont	
29	Signal 1	0..20mA 4..20mA	
30	Source 2	O2-cont	
31	Signal 2	0..10V 2..10V	

Relays

MG-4000-R2 has two potential free switching contacts that can be used to monitor the 0_2-content or the function of the probe.

Par.no:	Description	Range	Value
Relay 1			
14	Function	OFF HIGH LOW	
15	Source	O2-cont ERROR	
16	Level	0,0...99,9	
17	Hysteresis	0,1...99,9	
18	Delay on [s]	0...999	
19	Dly fall [s]	0...999	
20	Norm.pos.	FALLEN ACTIVE	
Relay 2			
21	Funktion	OFF HIGH LOW	
22	Source	O2-cont ERROR	
23	Level	0,0...99,9	
24	Hysteresis	0,1...99,9	
25	Delay on [s]	0...999	
26	Dly fall [s]	0...999	
27	Norm.pos.	FALLEN ACTIVE	

The function is activated in parameter 14/21 by selecting whether the high or low signal is to be monitored. Select a source (input signal) in parameter 15/22. If error indication is chosen the function (parameter 14/21) needs to be programmed to HIGH.

When monitoring the O_2-content a level is programmed (parameter 16/23) and a hysteresis (parameter 17/24). The level and the hysteresis are stated in % O_2-content. These two parameters are not used when monitoring error indication.

Switching on and off can be delayed by the chosen number of seconds in parameters 18/25 and 19/26. In parameter 20/27 the position of the switching contact is selected when the monitoring state is in normal mode. A yellow LED on the control panel comes on when the relay contact is active.

Communication

A communications module (accessory) can be fitted in MG-4000-R2 to provide data communications using RS-485 (2-wire current loop) as the interface.

There is also an adapter for RS-232 (serial port) available as an accessory. The adapter is intended for temporary use, for example, during installation and trimming and does NOT require a communications module to be installed. Only one interface (RS-485 or RS-232) can be used at any time.

The protocol used is Comli. Parameters and measurement values are read with message type 2 and new values for parameters are transferred with message type 0. The Comli number is the same as the parameter number. Data communications can be limited so that only reading is possible. (parameter 36).

Par.no:	Description	Range	Value
Communication			
32	Address	1...247	21
33	Location	0...32767	0
34	Protocol	COMLI	COMLI
35	Baud	600 b 1200 b 2400 b 4800 b 9600 b	4800 b
36	Protect	NO YES	NO

PROGRAMMING

LCD display

MG-4000-R2 has a two-row alphanumeric LCD display with back light and can show 16 characters on each row. Normally the display indicates present operating values but it is also used to indicate measurement values and programmed parameter values.

```
  AB MICATRONE
O2-cont    3.1 %
```

Keypad

MG-4000-R2 has a keypad with four keys, marked, ▼ ▲, PGM and ESC.

- *The arrow keys, ▼ ▲, are used to scroll between different parameter groups, parameters and functions and increase or decrease the value of programmed parameters.*
- *The PGM key is used for programming and indicating of set parameters.*
- *By pressing the ESC key ongoing programming can be aborted. The ESC key is also used when returning to the start menu.*

Start menu

The start menu is the entry point for indication and programming of parameters along with special functions such as default programming and calibration.

```
MG-4000-R2
START-MENU
```

If the start menu is not showed on the display, press repeatedly on the ESC button. The start menu is by default replaced to indicate operating values. One press of the ESC button shows the start menu for a short while and returns automatically to indicate operating values. Use the arrow keys, 6 5, to scroll between different display alternatives as follows.

Top row	Bottom row
AB MICATRONE	O_2-content
Voltage	Current
Voltage	Temperature
Current	Temperature
Status Relay 1, Function	Status Relay 2, Function
Error message	
Serial number	

The indication of parameters

One press of the PGM key when default start menu is showing will activate an automatic scroll and list all parameters for about two seconds. The top row indicating the parameter group and bottom row the parameter and its value. The listing will end when all parameters has been showed, or if the ESC key is pressed.

```
Internals
Prog.ver.   1.00
```

Programming a parameter

Programme menu

The program menu includes all parameters and measuring values that are accessible. All parameters are divided into different parameter groups where each function has its own group.

To activate the program menu, continuously press the PGM key until following display is shown. Release the key.

```
MG-4000-R2
PROGRAM-MENU
```

The second parameter group is shown on the top row.

```
O2-measuring
```

Parameter selection

By using the arrow keys, ▼ ▲, different groups of parameters can be selected. If the last group is shown and the arrow key, ▼, is pressed, the first menu is shown and vice versa.

Parameter groups			
1	Internals	5	Outputs
2	O2-measuring	6	Communication
3	Relay 1	7	Current values
4	Relay 2	8	Status

When the desired group is shown, it can be selected by pressing the PGM key once. The first parameter inside the selected group is shown on the bottom row of the display.

```
O2-measuring
Range      0..10%
```

With the arrow keys, ▼ ▲, all parameters inside the group can be selected. If the last parameter in the selected group is shown and the arrow key, ▼, is pressed, the first parameter is shown and vice versa.

To select another group of parameters when a parameters is shown on the bottom row, press the ESC key. The programming mode is cancelled when the ESC key is pressed repeatedly until the default start menu is shown.

Programming a value

Parameters with a numeric value (integers and decimal values):

When the selected parameter is sh own in the display it can be selected for programming by pressing the PGM key once. The first digit will flash to indicate that it can be changed using the arrow keys, ▼ ▲.

```
O2-measuring
Low O2        00.5
```

If the digit flashing is “9” and the arrow key, ▲, is pressed, the counter will start from “0” and count forwards (-9 for parameters that accept negative values) without changing any other of the digits in the value. The counter will continue in the opposite way if the digit is flashing “0” and the arrow key, ▼, is pressed. Continue to the next digit by pressing the PGM key again.

When the last digit is set and the PGM key is pressed the actual change of the parameter value is affected. The entire bottom row in the display will flash to confirm that the programming was successful.

Parameters with preset alternatives

When the selected parameter is shown in the display it can be selected for programming by pressing the PGM key once. The entire text will flash to indicate that it can be changed to the preset alternatives using the arrow keys, ▼ ▲.

```
Relay 1
Function      HIGH
```

The same procedure as with digits will occur if an arrow key, ▼ ▲, is pressed when the last, respectively the first, parameter alternative is shown.

By pressing the PGM key, when the desired parameter alternative is shown, will execute the programming and change the parameter. The entire bottom row in the display will flash to confirm that the programming was successful.

Cancelling programming mode

Ongoing programming can be cancelled by pressing the ESC key. The parameter value will stop flashing and the original value remains the same.

The function menu

To activate the function menu, press both PGM and ESC key simontaneously and keep the keys pressed until the following display is shown. Release the buttons.

```
MG-4000-R2
FUNCTIONS-MENU
```

The first function is shown in the display.

```
Calibration of
probe
```

Selecting a function:

With the arrow keys, ▼ ▲, different functions can be selected, for instance, default programming and calibration. If the last function is shown and the arrow key, ▼, is pressed, the first function will shown again and vice versa.

Functions	
1	Calibration of probe
2	Default settings, Communication
3	Default settings, Factory
4	Calibration analogue inputs *)
5	Calibration analogue outputs *)

When the desired function is displayed it can be selected by pressing the PGM key.
The functions menu can be aborted by pressing the ESC key.

*) Calibration of analogue inputs and outputs require use of special equipment. All analogue signals are factory calibrated and should not during normal circumstances have to be calibrated again.

Default settings

Communication

Par.no:	Description	Range	Value
Communication			
32	Address	1...247	21
33	Location	0...32767	0
34	Protocol	COMLI	COMLI
35	Baud	600 b 1200 b 2400 b 4800 b 9600 b	4800 b
36	Protect	NO YES	NO

Default settings

Factory

Par.no:	Description	Range	Value
Internals			
0	Prog.ver.	0,00...9,99	1,00
O2-measuring			
1	Range	0..5% 0..10% 0..20% 0..100%	0..10%
2	High O2	0,0...99,9	10,0
3	Low O2	0,0...99,9	0,5
4	Barometer	800...1200	1013
Relay 1			
14	Function	OFF HIGH LOW	LOW
15	Source	O2-cont ERROR	O2-cont
16	Level	0,0...99,9	0,5
17	Hysteresis	0,1...99,9	0,1
18	Delay on [s]	0...999	10
19	Dly fall [s]	0...999	2
20	Norm.pos.	FALLEN ACTIVE	ACTIVE
Relay 2			
21	Function	OFF HIGH LOW	HIGH
22	Source	O2-cont ERROR	ERROR
23	Level	0,0...99,9	0,0
24	Hysteresis	0,1...99,9	0,1
25	Delay on [s]	0...999	0
26	Dly fall [s]	0...999	0
27	Norm.pos.	FALLEN ACTIVE	ACTIVE
Outputs			
28	Source 1	O2-cont	O2-cont
29	Signal 1	0..20mA 4..20mA	4..20mA
30	Source 2	O2-cont	O2-cont
31	Signal 2	0..10V 2..10V	0..10V
Communication			
32	Address	1...247	21
33	Location	0...32767	0
34	Protocol	COMLI	COMLI
35	Baud	600 b 1200 b 2400 b 4800 b 9600 b	4800 b
36	Protect	NO YES	NO

INDICATIONS

Displays

Different operating values are shown on displays in the start menu, see page 13. Use the arrow-keys, ▼ or ▲, to scroll through the different displays with operating values.

Top row	Bottom row
AB MICATRONE	O_2-content
Voltage	Current
Voltage	Temperature
Current	Temperature
Status Relay 1, Function	Status Relay 2, Function
Error message	
Serial number	

LEDs

The LEDs on the control panel indicate the following:

Measuring

Flashes green for each new measurement period/pump cycle (tp) from the probe, see page 3.

Out of range

Lit orange when the measured O_2-content is outside of the measurement range selected in parameter 1.

Calibration

Lit orange while calibration of the probe is in progress.

Relay 1

Lit yellow when the relay contact for terminals 5-7 is active.

Relay 2

Lit yellow when the relay contact for terminals 8-10 is active.

High O_2-content

Lit red when the measured O_2-content exceeds the value set in parameter 2.

Low O_2-content

Lit red when the measured O_2-content is below the value set in parameter 3.

Error

Lit red in the event of a probe error. The error is shown in plain text on the display, see page 19.

Measurement values

The following measurement values can be read on the display from the program menu, see page 13.

Par.no:	Description	Range	Value
Measuring values			
100	O2-cont.	0,0...99,9	
101	Nernst	-0,50...4,50	
102	Current	0,00...3,00	
103	Voltage	0,00...9,99	
104	Temp.	550...850	
105	Reg. active	NO YES	
106	Reg. out	0,00...100,00	
107	CSP	0...999	
108	Counter	0...65535	
109	Counter OF	-99...99	
90	Cal. Temp.	550...850	
91	Cal. Level	20000...60000	

Status

The following status values can be read on the display from the program menu, see page 13.

Par.no:	Description	Range	Value
Status			
110	R1 Func.	OFF W ON ON W FALL FALL	
112	R2 Func.	OFF W ON ON W FALL FALL	
114	Counting...	STOP UP DOWN	
115	Ionpump...	STOP PRESS EVACU	

Key to status texts

R1 Func. and R2 Func.

OFF	The relay function is shutoff = not used.
W ON	Waiting for operation = the measurement value has passed the limit, but the time for operation has not elapsed.
ON	The measurement value has passed the limit, but the time for operation has elapsed.
W FALL	Waiting for release = the measurement value is on the normal side of the limit + connection difference, but the time for release has not elapsed.
FALL	The measurement value is on the normal side of the limit + connection difference, but the time for release has elapsed.

PROBE CALIBRATION

Introduction

The central unit and probe must be calibrated together for MG-4000-R2 to measure the correct O_2-content. If any of the units are replaced a new calibration must be made. Calibration takes about 10 minutes to complete.

Step 1

Make sure MG-4000-R2 is connected to the mains supply and the probe. Start calibration at the earliest 10 minutes after MG-4000-R2 has been started, i.e. that both the mains supply and probe have been connected. If no error is indicated it is assumed that the probe has reached its working temperature, approx 700 °C.

Calibration is performed from the function menu, see page 17. When the following is displayed:

```
Calibration of
probe
```

press PGM to start calibration.

The following text is now shown:

```
[PGM] Continue
[ESC] Abort
```

You can cancel calibration at any time by pressing ESC.

```

Aborting...
```

The function menu is displayed again. No calibration has been performed and the previous calibration value still applies.

Press PGM to continue the calibration. The programmed barometric pressure in mBar is now displayed.

```
Barometer   1013
OK?    [PGM/ESC]
```

Press PGM if the value is OK, otherwise you must cancel (press ESC) and program the barometric pressure in question via the program menu, see page 13.

Step 2

The following text is now shown:

```
Place probe in
air    [PGM/ESC]
```

The probe is calibrated in fresh air. Remove the probe from the flue gas duct and place/hang the probe so that at **least 10 cm of the tip of the probe is hanging freely in the air**.

Remember that the tip is extremely hot. **A risk of burns exists!** Press PGM to continue.

If calibration is started less than 10 minutes after the mains supply has been connected to MG-4000-R2 the unit will wait until the time remaining has elapsed before continuing with the calibration.

```
Waiting...  123

```

When the counter reaches zero calibration continues with the next step.

Step 3

The Calibration LED now comes on and the central unit makes 9 readings from the probe.

```
0 of 9

```

The measurement value and temperature from the probe are shown for each reading.

```
1 of 9    39468
             700
```

Five dashes are shown if the measurement value is not approved. If more than 2 measurements fail the probe cannot be calibrated.

```
Calibration ERR
           [ESC]
```

Cancel calibration and check the probe, see page 19.

Step 4

The Calibration LED goes out when calibration is complete and the following text is displayed.

```
Calibrering OK
 39532 699 [PGM]
```

The 2 numbers are values from the most recent calibration and do not need to be the values shown in the example above. Calibration is approved!

Press PGM to continue. You will now be asked whether the new calibration should be saved and used from now on.

```
Cnt:39532  T:699
Save?  [PGM/ESC]
```

Press PGM to save or ESC to cancel.

```
Cnt:39532  T:699
Saving...
```

Step 5

Reinsert the probe in the flue gas duct.

```
Place probe in
flue   [PGM/ESC]
```

Press PGM to complete calibration.

```

Completes...
```

Press ESC to close the function menu.

Step 6

Double check the calibration, i.e. measure the O_2-content with the probe in the flue gas duct and read the measurement value on the central unit. Estimate whether the measurement value is reasonable or make a reference measurement using another O_2-transmitter. Change the air or fuel supply and check that the O_2-content changes.

MAINTENANCE

NOTE! The probe must be operational (voltage fed) and always maintain operating temperature if fitted in the flue gas duct, irrespective of whether the boiler is operational or shutdown. If the probe is not operational it should be stored in the surrounding air.

NOTE! If the probe is subjected to reducing atmospheres, e.g. high content of CO (carbon monoxide), this will reduce the service life of the probe. It is important that the O_2-control works correctly.

A design without moving parts means the probe is fairly insensitive to external influences; resulting in a long service life.

However, you should remove the probe from the flue gas duct maybe once after each firing season to check that the tip of the probe is not clogged by soot or deposits. These deposits can affect the probe's time constant, i.e. the reaction time will increase with the increase in deposits.

If the tip of the probe is dirty it can be carefully cleaned using a cloth dampened with, e.g. methylated spirit or petroleum spirits. Make sure that the tip has had time to cool to room temperature.

MG-4000-R2 should be recalibrated for the first time after about 2 months, then roughly once per firing season.

Fuses

MG-4000-R2 contains 4 fine-wire fuses. These are positioned to the right of the transformer and are numbered FH3, FH2, FH1 and FH4 from the top. Also see the figure on the terminal diagram.

FH3, 400 mA slow-burn.
Fuse for the control panel and processor card.

FH2, 400 mA slow-burn.
Fuse for the galvanically isolated supply for data communications.

FH1, 400 mA slow-burn.
Fuse for the relay coils and supply to the probe's electronics.

FH4, 2 A slow-burn.
Fuse for the probe's heating element.

TROUBLE SHOOTING

No text displayed

Check that MG-4000-R2 is voltage fed, 230 VAC on terminals 1 and 3.

Check the 3 fuses to the right of the uppermost transformer on the left-hand side of the PCB. They should be 400 mAT, 5x20 mm glass-tube fuses.

The Out of range LED flashes

MG-4000-R2 has just been started and the probe is warming up.

The Out of range LED is lit

MG-4000-R2 is measuring O_2-content that is outside of the selected measurement range. This is normal when the boiler has stopped and the flue gas duct contains fresh air. If this occurs when the boiler is operational a larger measurement range should be selected in parameter 1.

The High O_2-content LED is lit

MG-4000-R2 is measuring O_2-content in excess of the value in parameter 2.

The Low O_2-content LED is lit

MG-4000-R2 is measuring O_2-content below the value in parameter 3.

MG-4000-R2 shows incorrect O_2-content

Calibrate, see page 17.

MG-4000-R2 cannot be calibrated

Check the connections between the central unit and the probe.

Read the Counter measurement value via the program menu. The value should be between 30000 and 50000 when the probe is warm and is in fresh air at normal barometric pressure.

Error indications

Should MG-4000-R2 discover an internal fault, for example on the probe, this is indicated by a red LED on the control panel and text on the display.

In the event of an error the O_2-content will indicate 0.0 % O_2 and the output signals will drop to a minimum. This is to guarantee an excess of air for combustion.

Relay 1 and Relay 2 can be programmed to send out a signal when an error occurs, see page 12.

The error texts that can appear on the display are presented below.

Nernst, Signal too high/low

The measurement signal from the probe has been outside of its working range 0...4 Volt for some time. Restart MG-4000-R2 to try to reset the error. Check the connections between the central unit and the probe. Try another probe.

Current, Signal too high.

Too much current, > 2.5 A, is fed from the central unit to the heating element in the probe. Try another probe.

Current, Signal too low.

Too little current, < 0.5 A, is fed from the central unit to the heating element in the probe. Check fuse FH4 in the central unit. Check the connections between the central unit and the probe. Try another probe.

Voltage, Signal too high.

Too high voltage, > 8.0 Volt, is fed from the central unit to the heating element in the probe. Check the connections between the central unit and the probe. Try another probe.

Voltage, Signal too low.

Too low voltage, < 2.0 Volt, is being fed from the central unit to the heating element in the probe. Check fuse FH in the central unit. Check the connections between the central unit and the probe. Try another probe.

Temperature, Signal too high/low

The probe does not maintain the right working temperature. Restart MG-4000-R2 to try to reset the error. Check the connections between the central unit and the probe. Try another probe.

No measurement period, Defective probe

Restart MG-4000-R2 to try to reset the error. Check the connections between the central unit and the probe. Try another probe.

TECHNICAL DATA

Central unit MG-4000-R2

General

Supply voltage:	230 VAC, 50/60 Hz
Power consumption:	35 VA
Ambient temperature:	0...45 °C, recommended < 30 °C
El. connections:	Max. 2 pcs. 1,5 mm^2/term.
Cable entries:	12 holes ø 20 mm
Degree of protection:	IP 65
Dimensions: h x w x d	360 x 300 x 140 mm
Weight:	6,5 kg

O_2-measuring

Range:	0...5 % O_2 0...10 % O_2 0...20 % O_2 0...100 % O_2
Resolution:	0,1 % O_2
Accuracy:	max 5 % of range max 0,2 %-units of the O_2-content
Time constant:	< 10 seconds
Heating time:	< 200 seconds

Relay outputs

Max. load:	230 VAC, 2A

Outputs

mA

Signal range:	0/4...20 mA
Max. load:	500 W

Volt

Signal range:	0/2...10 Volt DC
Min. load:	50 kW

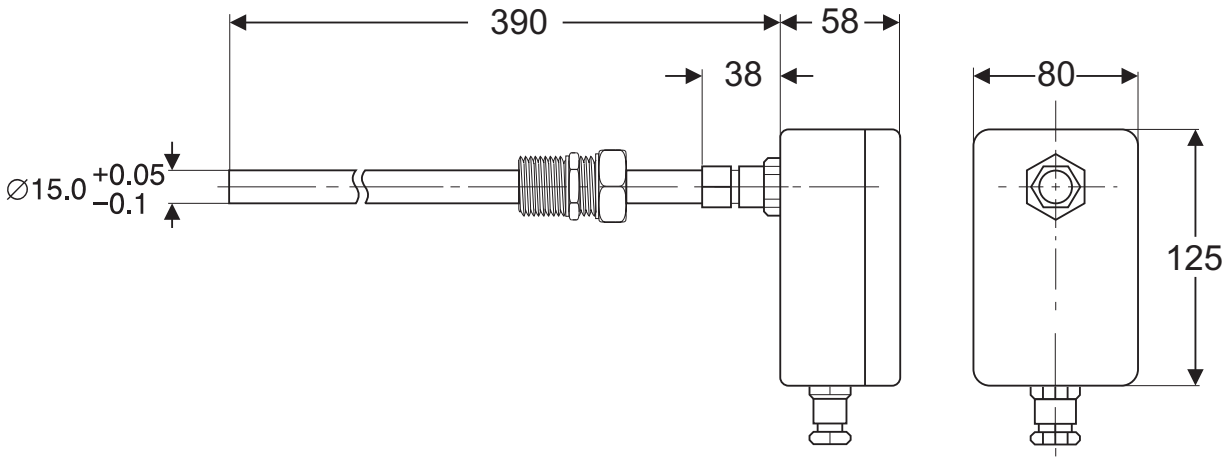
Data communication (optional)

Interface:	RS-485 or. RS-232
Protocol:	Comli

Measuring probe MG-4000-R2/S

General

Temperature range for flue gases:	0...400 °C
Flue gas velocity:	max 20 m/s
Ambient temperature for connection box:	0...60 °C
Max. temperature at the compression fitting:	260 °C
El. connections:	1.5 mm^2/term.
Cable entries:	1 hole ø 20 mm
Cable to central unit:	FKAR-G 10x0,5 mm^2
Cable length:	max 10 m
Degree of protection:	IP 65
Material insertion tube:	Stainless steel
Material connections box:	Aluminium
Duct fitting:	G 3/4"
Weight:	1,5 kg



Figur 7
Dimensions measuring probe MG-4000-R2/S

LIST OF PARAMETERS

Par.no:	Description	Range	Value
Internals			
0	Prog.ver.	0,00...9,99	
O2-measuring			
1	Range	0..5% 0..10% 0..20% 0..100%	
2	High O2	0,0...99,9	
3	Low O2	0,0...99,9	
4	Barometer	800...1200	
Relay 1			
14	Function	OFF HIGH LOW	
15	Source	O2-cont ERROR	
16	Level	0,0...99,9	
17	Hysteresis	0,1...99,9	
18	Delay on [s]	0...999	
19	Dly fall [s]	0...999	
20	Norm.pos.	FALLEN ACTIVE	
Relay 2			
21	Function	OFF HIGH LOW	
22	Source	O2-cont ERROR	
23	Level	0,0...99,9	
24	Hysteresis	0,1...99,9	
25	Delay on [s]	0...999	
26	Dly fall [s]	0...999	
27	Norm.pos.	FALLEN ACTIVE	
Outputs			
28	Source 1	O2-cont	
29	Signal 1	0..20mA 4..20mA	
30	Source 2	O2-cont	
31	Signal 2	0..10V 2..10V	
Communication			
32	Address	1...247	
33	Location	0...32767	
34	Protocol	COMLI	
35	Baud	600 b 1200 b 2400 b 4800 b 9600 b	
36	Protect	NO YES	

Par.no:	Description	Range	Value
Current values			
100	O2-cont	0,0...99,9	
101	Nernst	-0,50...4,50	
102	Current	0,00...3,00	
103	Voltage	0,00...9,99	
104	Temp.	550...850	
105	Reg. active	NO YES	
106	Reg. out	0,00...100,00	
107	CSP	0...999	
108	Counter	0...65535	
109	Counter OF	-99...99	
90	Cal. Temp.	550...850	
91	Cal. Level	20000...60000	
Status			
110	R1 Func.	OFF W ON ON W FALL FALL	
112	R2 Func.	OFF W ON ON W FALL FALL	
114	Counting...	STOP UP DOWN	
115	Ionpump...	STOP PRESS EVACU	

AB MICATRONE
Åldermansvägen 3
SE-171 48 SOLNA
SWEDEN

Telephone: +46 8-470 25 00
Fax: +46 8-470 25 99
Internet: www.micatrone.se
E-mail: info@micatrone.se