EMISSION MONITORING SYSTEMS

We care about the environment

PART 1

OPERATING MANUAL

MRU AIR fair since 1984 ®
EMISSION MONITORING SYSTEMS

OXYGEN MONITORING SYSTEM
OMS 420

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Inspect Shipment for Damage

Carefully inspect the entire shipment for damage in the presence of the shipper's agent, removing packaging material if necessary. Note any damage to packaging and/or goods on Packing List and have it signed by the shipper's agent prior to accepting the shipment. Submit damage claim to MRU immediately.

NOTE: Damage claims not received by MRU within 3 days of receipt of shipment will not be accepted.

Save the original box and the packing material for use if the analyzer must be shipped in the future.

The products described in this manual are subject to continuous development and improvement and it is therefore acknowledged that this manual may contain errors or omissions. MRU encourages customer feedback and welcomes any comments or suggestions relating to the product or documentation.

This manual is intended solely as a guide to the use of the product.

MRU shall not be liable for any loss or damage whatsoever arising from content errors or misinterpretation of information's from this manual or any mis-use resulting from the use of this manual.

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1 Content

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2.2 OMS 420

Thank you for purchasing the MRU OMS420 In-Situ oxygen and combustibles (O_2 and COe monitoring probe.

- Please read this instruction manual carefully before attempting to operate the analyzer. After you have become familiar with this manual, move on to installation, operation and maintenance of the analyzer. Incorrect use of the analyzer could cause an accident or injury.
- Product development and improvement are dynamic goals of MRU, and specifications of this analyzer are subject to change without prior notice.
- Modification of this analyzer is strictly prohibited unless written approval is obtained from the manufacturer. MRU will not be responsible for any issues of any kind resulting from any modification made to the analyzer without written permission.
- It is important that this manual remains in the custody of the actual operator of the analyzer.
- After reading the manual carefully, it should be stored in a safe, but accessible place.
- This instruction manual should be delivered to the end user immediately upon delivery.

NOTICE:

- It is prohibited to transfer part or all of this manual in written format without MRU written permission
- Product development and improvement are dynamic goals of MRU, and descriptions and illustrations of the analyzer used herein are subject to change without prior notice.

Please note:

Our warranty and guarantee obligations for OMS420 do not cover the usage of the analog signal 4 - 20 mA for regulation- and control-purposes.
We exclude any liability for consequential damages.

3 RETURNED GOODS

Packing regulation of 12.07.1991

If your local waste facility does not except MRU packing materials for disposal, you may return it to MRU or our local sales representative. Packing materials returned to MRU must be returned prepaid.

3.1 Return of analyzer according to ElektroG

MRU GmbH is required to accept the return, for proper disposal, of all analyzers delivered after 13th of August 2005. Analyzers must be returned to MRU prepaid.

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4 Safety

- The O_2 probe may only be used in original, undamaged condition and in accordance with the operation manual.
- All individuals dealing with the installation, commissioning, operation and maintenance of the analyzer or probe must be qualified to do so and must strictly observe this operation manual.
- Unauthorized modifications to any part of the analyzer or probe can create safety risks and are not permitted.
- Power other than that specified in this manual must never be provided to the probe.
- Service of transmitter electronics by non skilled personnel is not allowed.
- Do not allow condensate to come into contact with the sensors.
- Do not attempt to clean the probe with water.
- The probe shall not be used in under-stoichiometric combustion conditions, due to the possible presence of flammable gases, eventually over the LEL (low explosion level).
- Power must always be provided to the probe, even during boiler shut-down, to prevent the formation of condensate which can damage the sensors.
- Do not use the probe for any purpose other than that specified in this manual.
- Exposure to corrosive gases such as silicone vapor, alkaline and heavy metals, P, Pb, high SO_2, etc. will shorten the life time of the sensors.

- **It is mandatory to the user to insure that all persons operating this equipment are properly trained in its operation and fully understand the operating principals of the equipment.**
- ***MRU GmbH, its affiliates and agents cannot be held responsible in any way for damage or injuries resulting from improper use, misuse or neglect in operating this equipment.***

Caution

Probes installed inside flue ducts and stacks operate at elevated temperatures (often 1.000° F and higher) create danger of serious skin burns to operators if proper handling precautions and extreme care are not taken.

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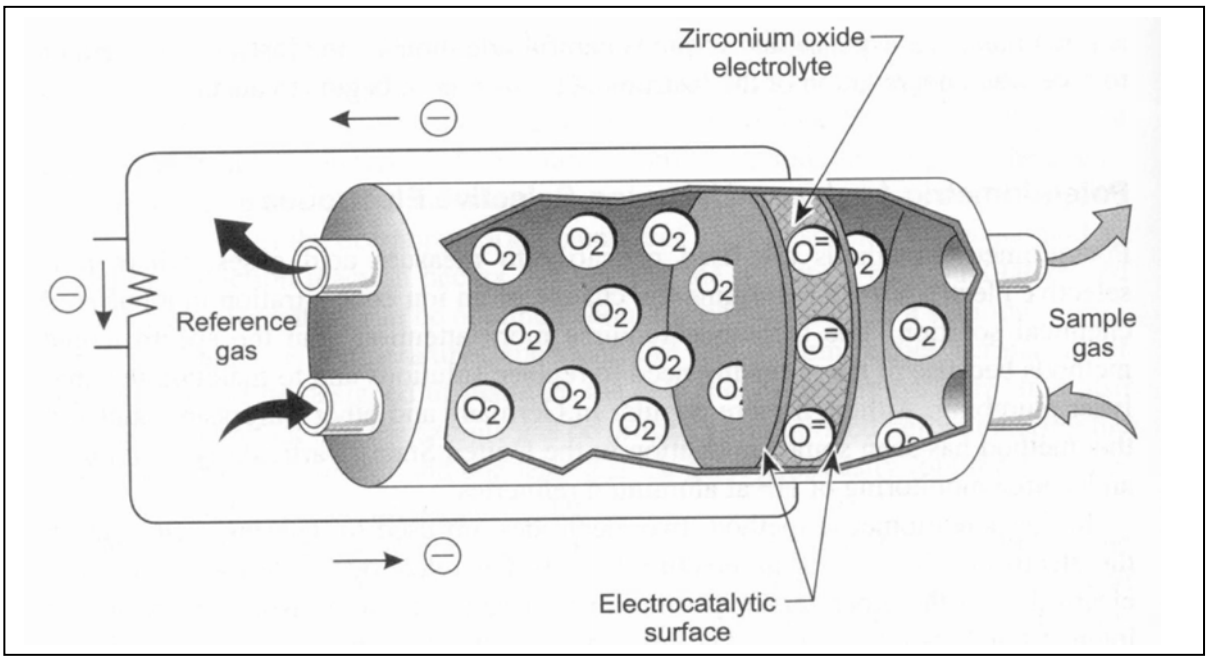
5 O_2 sensor – operating theory

Heated zirconium oxide (ZrO_2) is used as a ceramic solid electrolyte that is a good oxygen ion conductor at temperatures of approximately 1.550 ° F (850 °C), generated by an internal low power (20 W) heater element. The heater element is a PTC type, self-regulating device that does not require a thermocouple for temperature regulation. Constant sensor temperature is maintained by controlling the heater voltage and current to fixed resistance of the heater element.



The electro-motive force (emf) that is generated across the solid electrolyte by the presence of oxygen ions can be measured as a sensor voltage (according to Nernst law).

$$U_S = U_0 + \frac{RT}{4F} \ln \frac{P_{O2\ ref}}{P_{O2\ sample}}$$

where:

U_0	=	offset voltage (for $P_{O2\ ref} = P_{O2sample}$)
R	=	universal gas constant
T	=	zirconium temperature
F	=	Faraday constant
P_{O2ref}	=	oxygen partial pressure reference side
$P_{O2sample}$	=	oxygen partial pressure sample side

This voltage is measured by micro-controller based transmitter electronics and converted into a standard 4 – 20 mA signal, linearized for oxygen in the range of 0 – 25 %.

The expected lifetime of this sensor is about 5 years + under normal operating conditions, and is not dependent on fuel type, but:

CAUTION:

- If combustible gas (CO, H_2, HC) in high concentrations are present in the sample gas, erroneous O_2 readings will result due to local combustion at the sensors' hot surface.
- Exposure to corrosive gases (silicone vapor, alkaline and heavy metals, P, Pb, high SO_2, etc.) will shorten the life of the sensor.
- Condensation of flue gas moisture close to the sensor's flange must be prevented.

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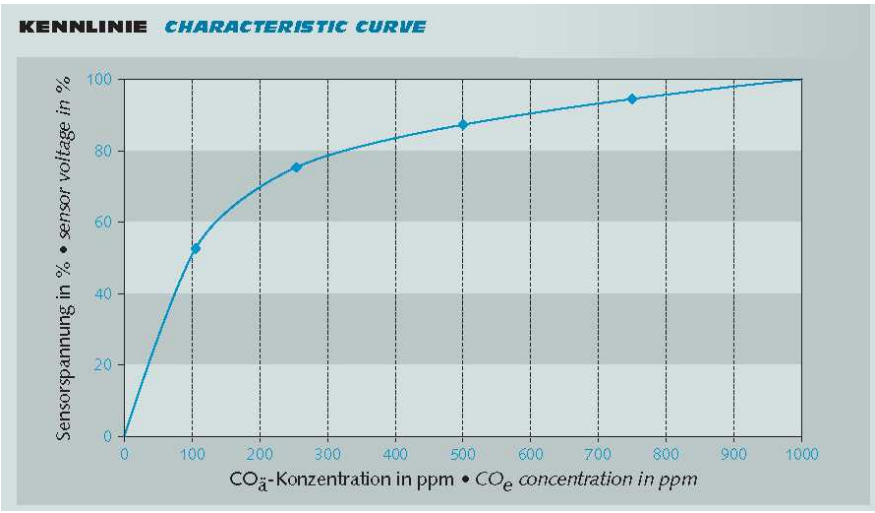
6 COe sensor – operating theory

A solid ceramic electrolyte with thin-layer technology is used to measure the combustible gases (CxHy equivalent CO_2). The ceramic electrolyte is a good oxygen ion conductor at temperatures of approximately 1.300 ° F (700 °C) generated by an internal, low power (10 W) self regulating heater element.

The heated electrolyte has an initial voltage (U_0 approximately zero mV) in the absence of combustible gases (H_2, CO or CH_4 or C_3H_8, etc). In presence of these gases, the output voltage increases (see chart below) as these gases are oxidized at the hot surface of sensor



The cell voltage is measured by micro-controller based transmitter electronics and converted into a standard, linearized 4 – 20 mA signal for combustibles equivalent carbon monoxide (COe) in the range of approximate 0 – 1000 ppm.

Since the sensor is reacting to the presence of any combustible gas, but calibrated with CO+H_2, equivalent CO measurements will be reported.

The expected lifetime of this sensor is about 5 years + under normal operating conditions, and is not dependent on fuel type, but:

CAUTION:

- **Exposure to corrosive gases (silicone vapor, alkaline and heavy metals, P, Pb, high SO_2, etc.) will shorten the life of the sensor.**

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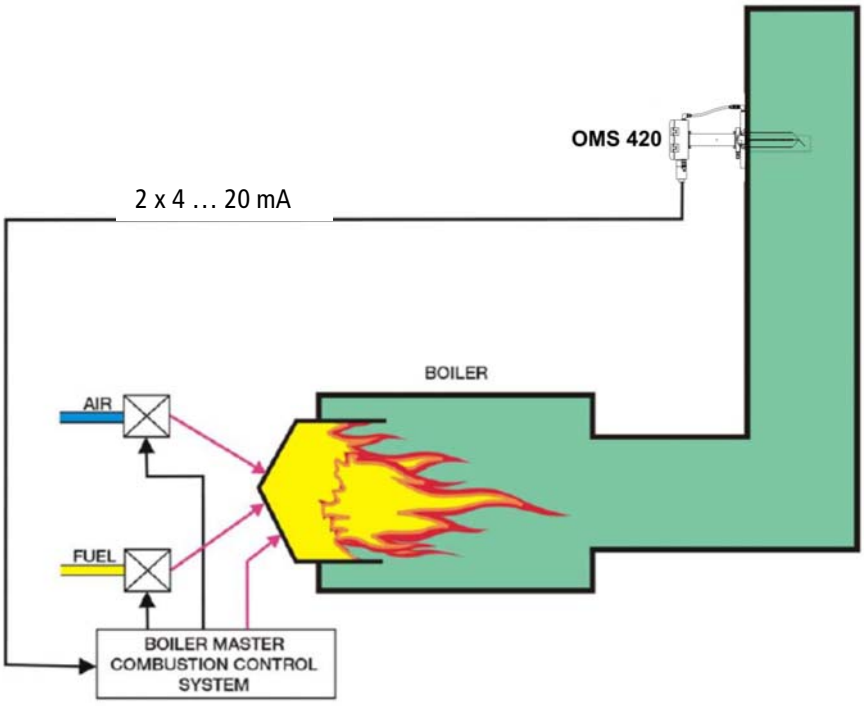
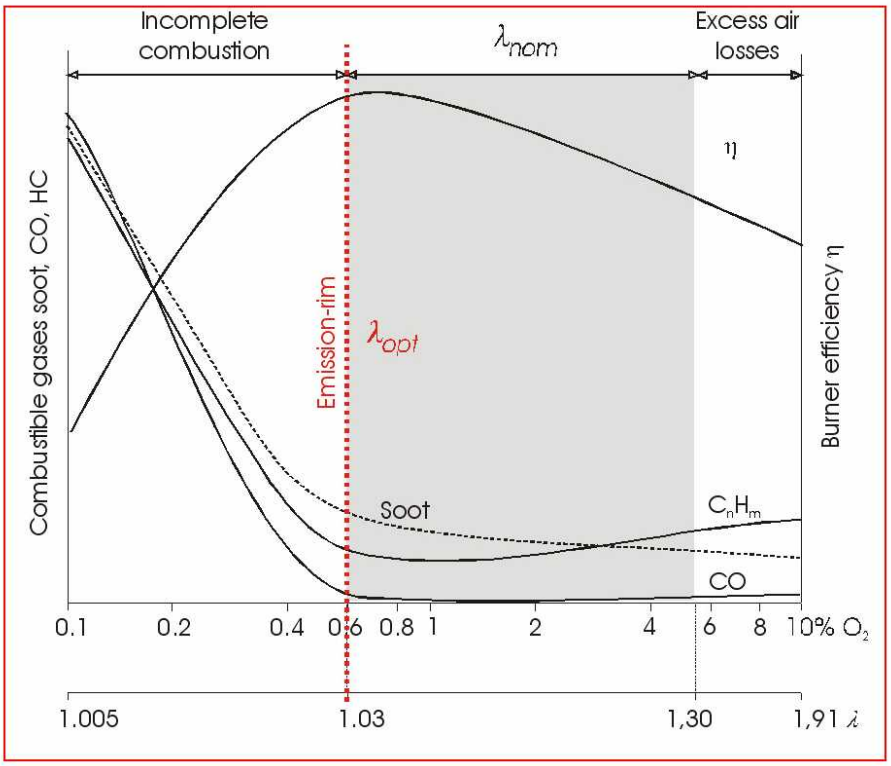
7 System components, general information

The OMS420 is used to continuously measure oxygen and combustible gas concentrations in flue and stacks of industrial boilers or furnaces, and those measurements are used to finely tune the combustion process.

7.1 Optimizing combustion



Optimum combustion conditions are achieved by decreasing the amount of excess air in the stack gas to the point where combustibles start to increase. See combustion diagram below:



The absolute value of combustibles in the stack gas of a burner depends very much on the design and construction of the burner/boiler. Combustibles (CxHy) are lower in a well-designed system than they are one that is poorly designed.

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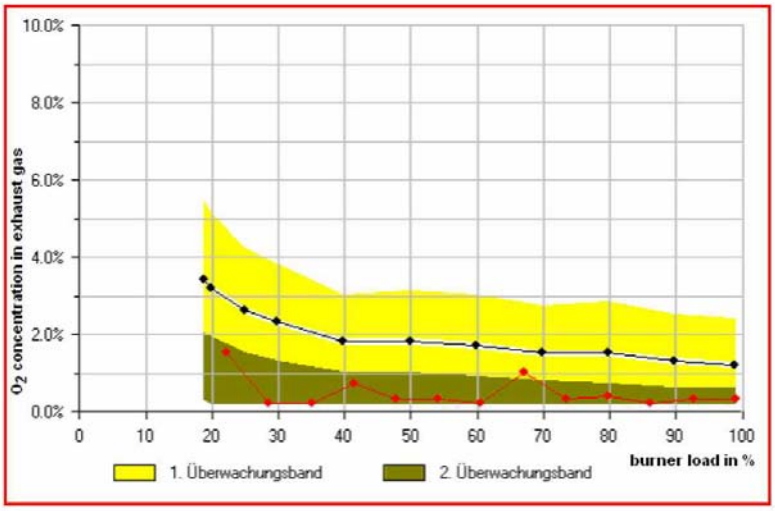
It is important to monitor the rising level of combustibles, labeled $_{opt}$ in the above diagram, and to trim the air/fuel ratio of the burner to compensate for changing ambient conditions (pressure and humidity) and maintain the point of maximum heat efficiency.

The diagram below illustrates the burner operating under two conditions:

Conventional operation with increased safety margin (higher O2 concentration in the stack gas).

Improved operation with optimized combustion (lowest O2 concentration in the stack gas without a corresponding increase in combustibles).



The difference between the yellow area and the brown area represents the degree of combustion optimization, which in turn represents savings in fuel.

7.2 OMS420 features

The main features of OMS420 system are:

- Compact, reliable and rugged industrial design.
- Special reference air not required (uses ambient by natural diffusion).
- True wet gas analysis and calculation of dry oxygen level if humidity of gas is known.
- Fast response time.
- Low energy consumption for both O2 and COe sensors.
- Micro-controller based electronics with backlit, graphic LCD display.
- Linearized, galvanic isolated 4 - 20 mA signal outputs for both O2 and COe.
- RS485 galvanic isolated digital data transfer (Modbus protocol RTU).
- Field replaceable transmitter
- Fast, safe and easy servicing by a single technician without removing the probe from the stack
- Dust tight and water proof enclosure IP65 (NEMA 4)
- Easy operation and maintenance

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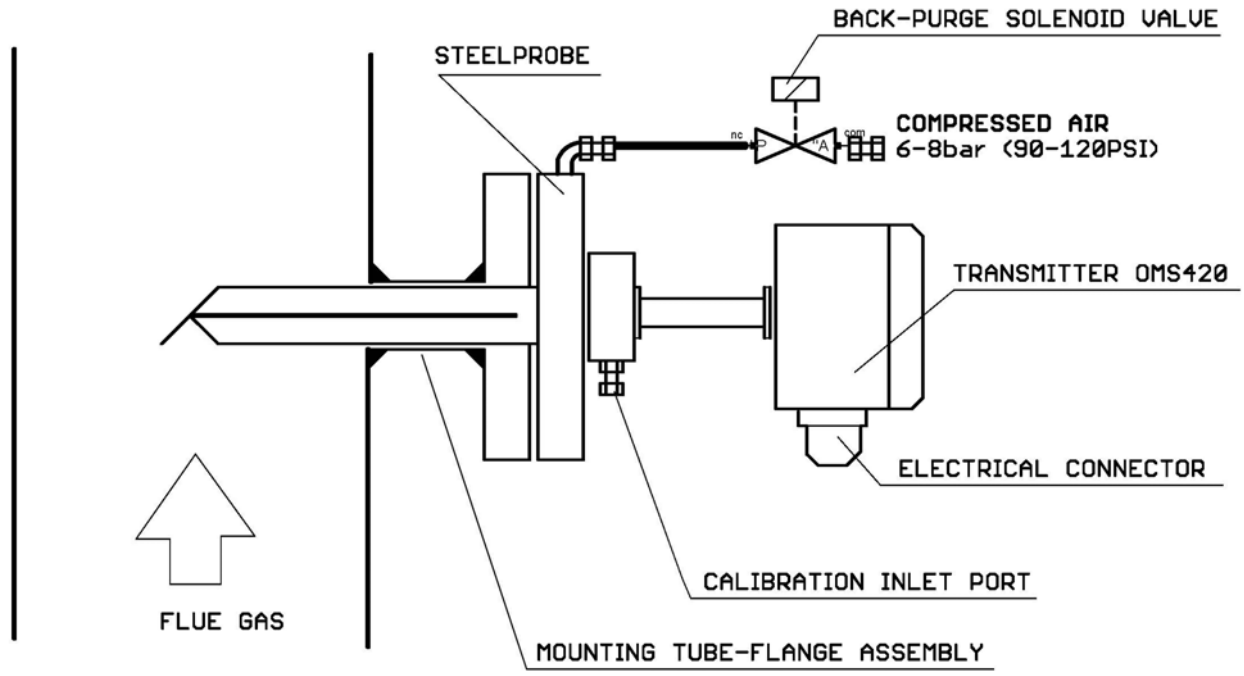
7.3 Probe models

There are three distinctive models of the OMS420 probe available:

- The **compact** model **OMS420**, which uses the flow guidance tube principle. The probe tube can be made of stainless steel for stack gas temperatures up to 1.200 ° F (650 °C) or made of AISI300 steel for stack gas temperatures up to 1.800 ° F (1.000 °C)
- The **remote transmitter** model **OMS420RT**, which is similar to above model but has the transmitter electronics separated from the probe by means of a 10 m (30 ft) special cable
- The **high temperature** model **OMS420HT** has no flow guidance tube but uses a ceramic tube and an air jet pump (ejector) to extract the sample from the tip of ceramic tube. It can be used for clean flue gas temperatures up to 3.100 °F (1.700 °C).

7.3.1 Compact model OMS420 (# 61417)

This model shall be used at site with low heat radiated from the process (ambient temperature to transmitter electronics is less then 140 °F / 60 °C).



Compact model components are:

- probe with flow guidance tube and flange (ANSI150 or DN80 or DN65)
- mounting flange assembly (supplied by user)
- transmitter with electronics and sensors for O_2 and COe
- back purge system (option) for high dust conditions → only for site with flying ash type of dust
- pneumatic device (option) for automatic calibration

For higher temperature, less then 2.000 °F (1.200 °C), but higher then 1.200 ° F (650 °C), the model OMS420RT with alloy AISI300 steel is recommended.

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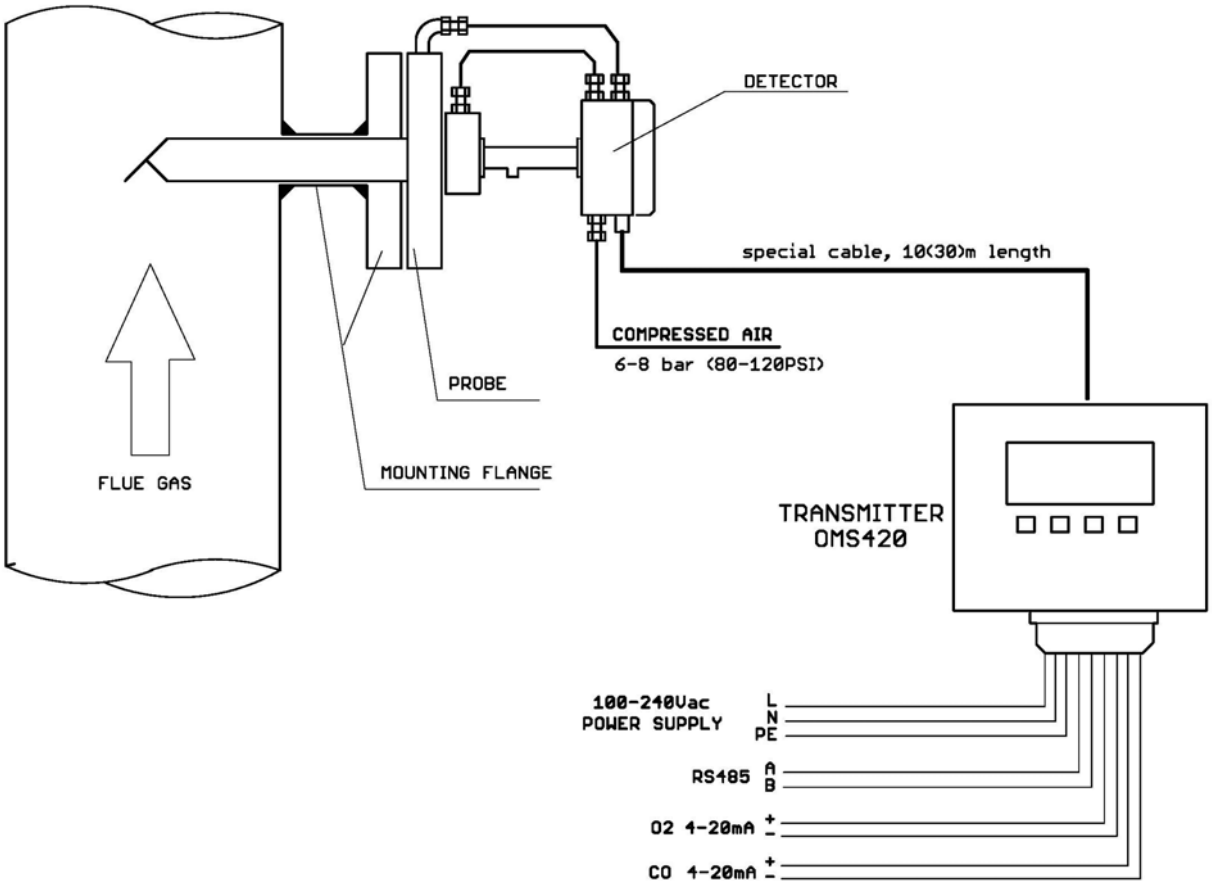
7.3.2 Remote transmitter model OMS420RT (# 63467RT)

This model shall be used when radiated heat from the process (duct, stack etc) will cause rising of ambient temperature higher then 130 °F (+55 °C)



Remote transmitter model components are:

- probe with flow guidance tube and flange (ANSI150 or DN80 or DN65)
  - SS316Ti material for temperature below 1.200 °F (650 °C)
  - AISI300 material for temperature below 1.800 °F (1.000 °C)
- mounting flange assembly (supplied by user)
- detector head with junction box for sensors O_2 and COe
- transmitter with electronics and switched power supply
- special cable between junction box and transmitter
- back purge system (option) for high dust conditions → only for site with flying ash type of dust
- pneumatic device (option) for automatic calibration

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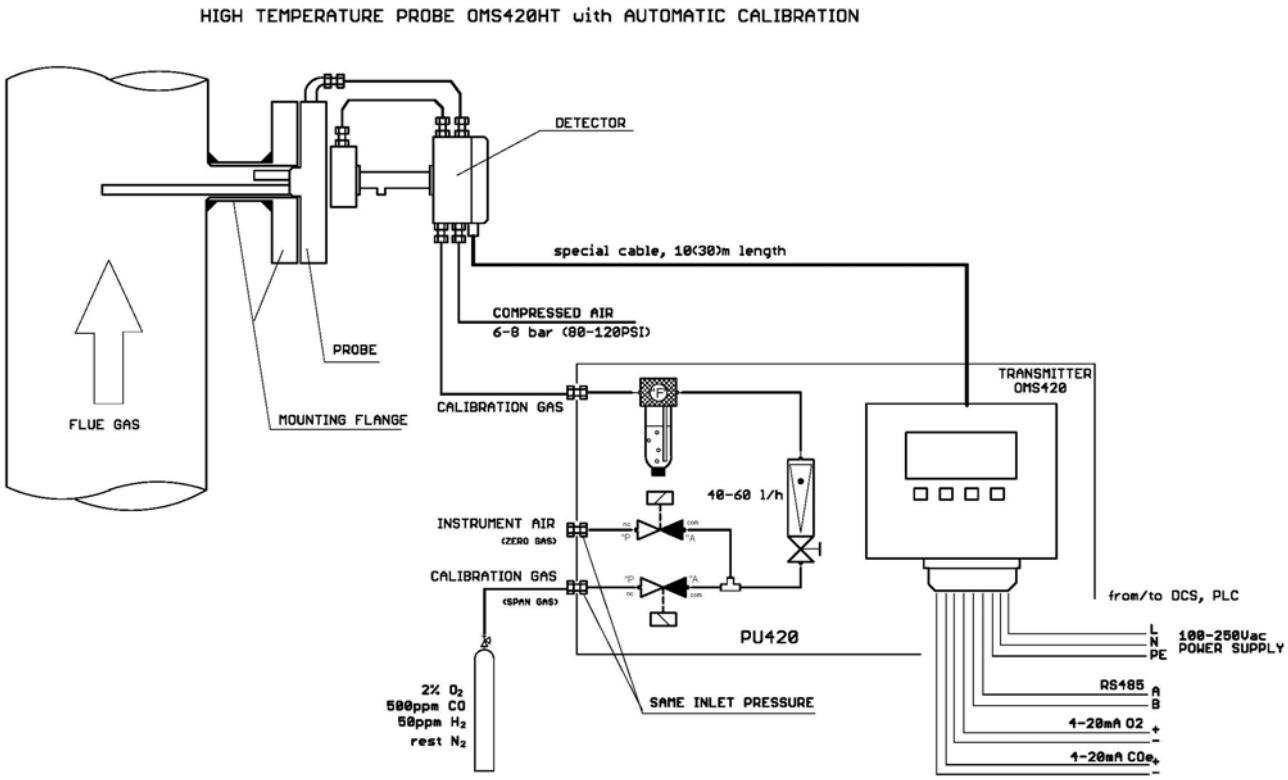
7.3.3 High temperature model OMS420HT (# 63467HT)

This model shall be used at sites with clean and high temperature flue gas, less then 3.100 °F (1.700 °C)



High temperature model components are:

- probe with ceramic tube, ejector and flange (ANSI150 or DN80 or DN65)
- mounting flange assembly (supplied by user)
- detector head with junction box for sensors O2 and COe
- transmitter with electronics and switched power supply
- special cable between junction box and transmitter
- pneumatic device (option) for automatic calibration
- back purge is not available for this model

The main differences between the remote transmitter model and the high temperature models are:

- the use of ceramic tube of sampling probe on the high temperature model
- the use of an ejector (air jet pump) to draw sample to the sensors..

When the ejector is purging instrument air with some 300 l/ h, a negative pressure on the back-side of a nozzle will be created. The negative pressure draws the sample gas from the tip of ceramic tube to the sensors.

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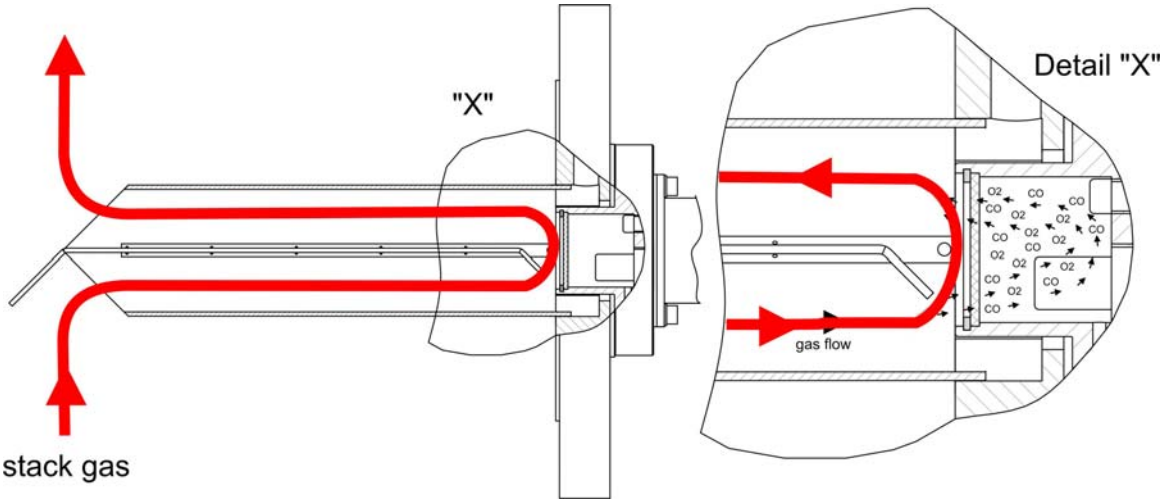
7.4 Principle of flow guidance tube

The construction of the sampling probe is using the flow guidance principle



The tube is divided in half by a metal plate welded into the middle of the tube.

The probe is mounted on the stack by means of an 8-hole flange (ANSI 4", 150 lbs or DN100). The tip of the divider plate is oriented facing towards the flow, which directs the stack gas into and through the tube at the same velocity as the flow in the stack.

The detector body is mounted on the flanged side of the tube through a hole in the flange cut for that purpose. In the body, behind a filter screen (the measuring side of detector), the two sensors for oxygen and combustibles are exposed to the stack gas flowing through the filter screen. In the detector behind the sensors, ambient air for reference gas diffuses through another filter screen (for dust protection) and flushes the backside of sensors (the reference side of the detector).

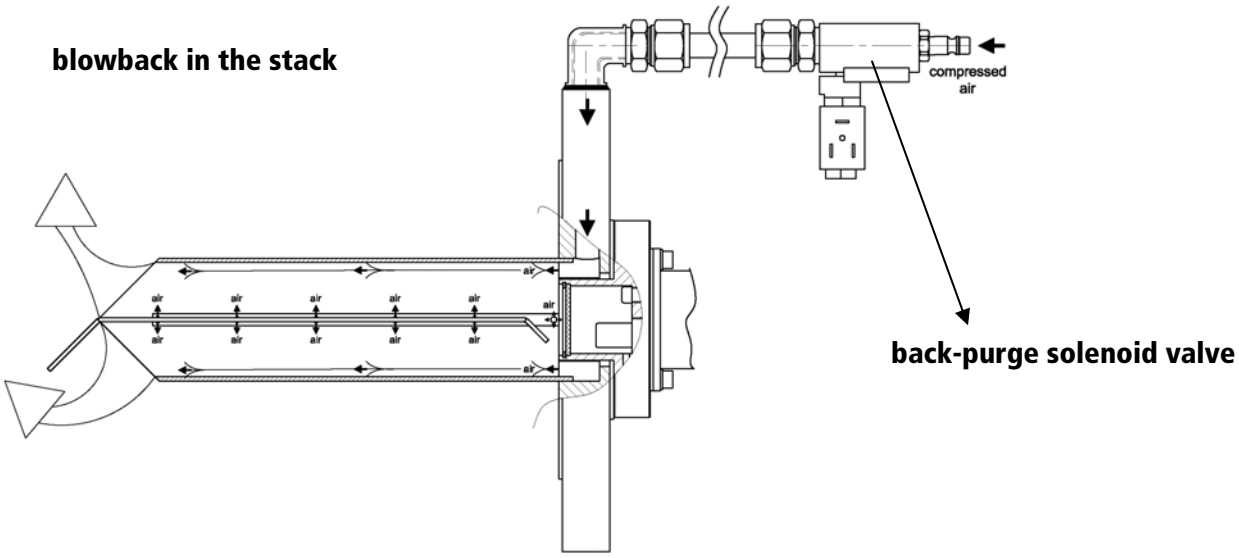


Illustration for compact probe only

The flange feeds compressed air to several holes placed strategically around the detector and through a small tube, with air-releasing orifices spaced along its entire length, which is mounted along the metal plate in the center of the probe. The timing, duration and number of pulses of compressed air is controlled by user-settable electronic parameters and released by a solenoid valve. During purging, compressed air blows across the filter screen protecting the sensors, and from the holes in the tiny blow-back tube in the center of the probe, dislodging any accumulation of particulates so they will flow freely out of the probe and back into the stack.

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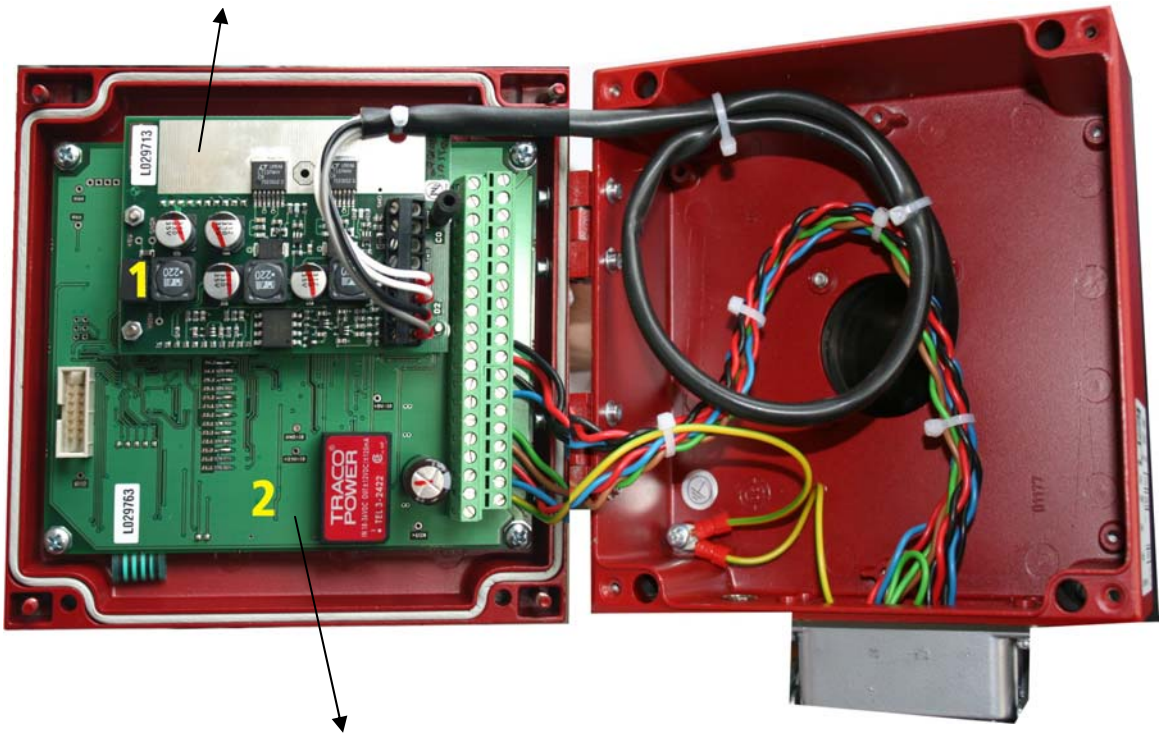
7.5 Transmitter electronics

The transmitter is housed in an aluminum enclosure (IP65, NEMA4X) that contains:

- Printed circuit board with u-processor (PCB "MAIN")
- Backlit, graphic display and dust proof keypad
- Printed circuit board for the sensor connection (PCB "OMS")
- Electrical connector for power supply and data transfer

„OMS" pcb (1)

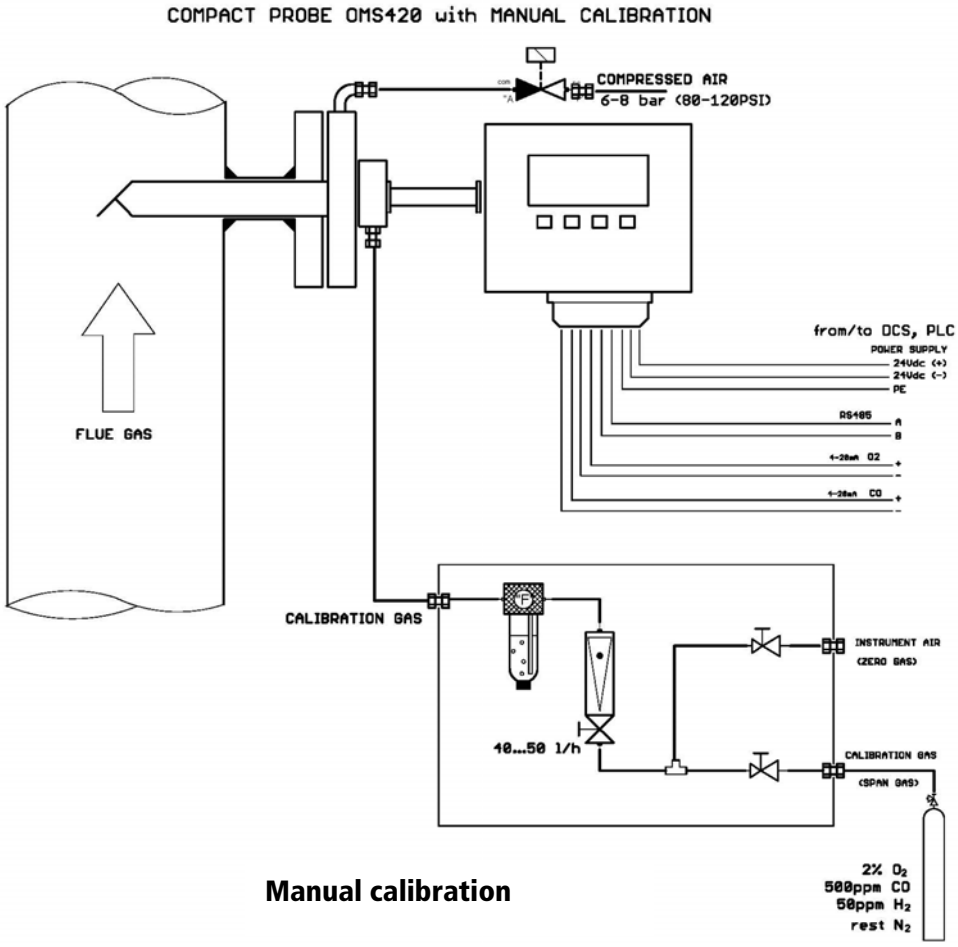


MAIN" pcb (2)

7.6 Manual calibration

To perform calibration of the instrument, the user can use following schematic diagram (or similar).

It is required to use moistured calibration gas (see § 4.7) and two hand-ball valves to select between instrument air (zero gas) and calibration gas (span gas) supply to calibration inlet port of unit.



Manual calibration

The procedure of calibration is described in chapter § 6.7.

7.7 Recommended calibration gas

For automatic calibration or manual calibration (see procedure in chapter 6.7.3) customer shall use following calibration gases:

1) zero gas = instrument air (21 %O_2 , 0 ppm HC)
2) span gas = 2…3 %O_2 ; 400…600 ppm CO ; 40…60 ppm H_2 ; rest N_2

Note: It is highly recommended to use water bubblier to moisture the calibration gas!!!

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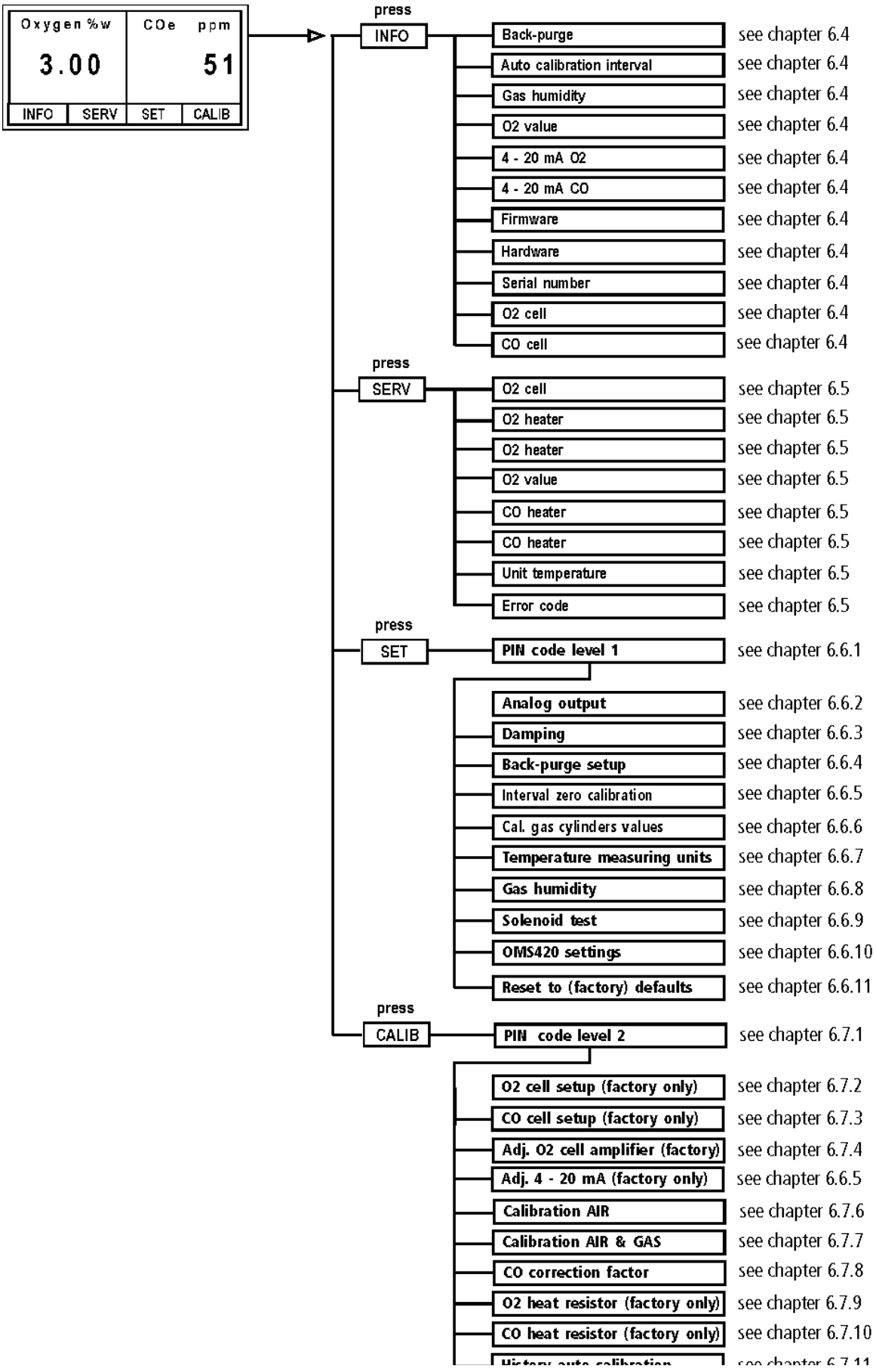
8 Software flow chart



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9 Operation

9.1 Start-up

Prior to start-up, use the following check list to verify that all conditions are set for proper start-up:

Checklist transmitter

- Transmitter removed from the probe? (Note: always power up with transmitter removed from the probe/stack!!)
- Cast cover closed and screwed on?
- Transmitter easily accessible and visible?
- Ambient temperature around transmitter electronics in operating range of 0 °F to 140 °F (-20°C to 60 °C)?
- Correct location of transmission cable (not in close proximity to high power supply cables or engines)?
- Connection for power supply connected properly?
- Signal connection connected properly?
- Power supply (factory provided line power fuse) switched on?
- Start up considerations:

Wiring: Most problems are due to incorrect wiring. Please double check the wiring. Shield should be grounded only at one side of the cable.

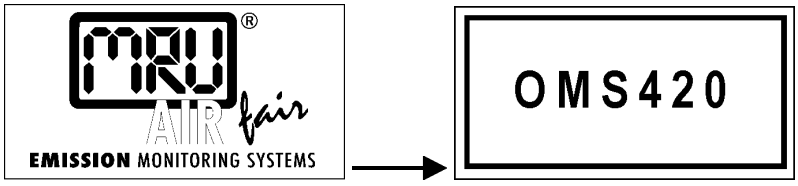
Leaks: Check the calibration inlet port plug for correct fit.

Insulation: Check that the mounting flange has been properly insulated to prevent gas condensation.

Temperature: Check mounting flange temperature: min. 160 °F (70 °C) and max. 300 °F (150 °C).

Check ambient temperature of transmitter for max. 100 °F (+60 °C).

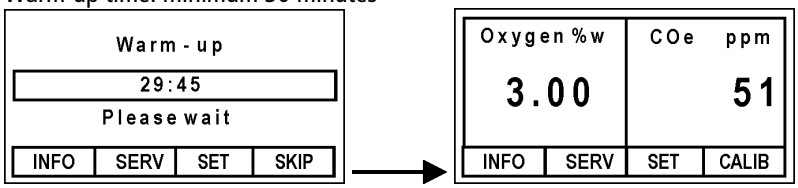
Note: ***If flange temperature at site with mounted probe and transmitter is below 160 °F (70 °C) it is necessary to use a flange heater (ask MRU) to prevent condensation!!!***



After power is switched on, the MRU logo and model of the unit will be displayed!

9.2 Warm-up

Warm-up time: minimum 30 minutes



LCD will display a time count down for 30 minutes.

During warm-up, some inside measured values (heaters current and voltages) will be compared with credible thresholds and in case of "out-of-range", an error message will be displayed. After countdown, if everything is OK, the message will change from "please wait" to the main measuring menu.

The "SKIP" function is used only for service purposes, to allow the operator to access other unit functions without waiting until the end of warm-up interval time. During this time, measurement values are not credible.

During warm-up, all other menus (info, service and setting) are accessible.

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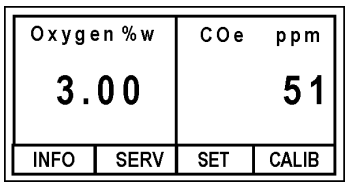
9.3 Main measuring menu

After warm-up, the unit will start automatically by displaying the main measurement menu.

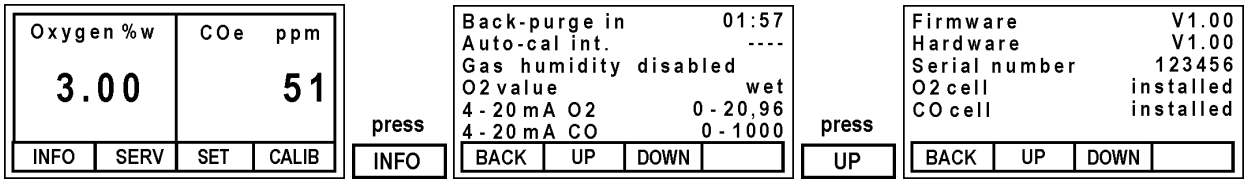
O_2 real time value with 0.01% resolution
CO_e real time value with ppm resolution



NOTE:
If between 30 min no button is pressed during the measurement, the level will be set on "0". I.e. the menus SET and CALIB are only by renewed PIN input usable.

Press "INFO" key for "info" menu **(see chapter 9.4)**
Press "SERV" key for "service" menu **(see chapter 9.5)**
Press "SET" key for "settings" menu **(see chapter 9.6)**
Press "CALIB" key for "calibration" menu **(see chapter 9.7)**

9.4 Info menu



In the "INFO" menu the following parameters can be called up from a scroll up/down list:

- Next back-purge — in hours/minutes
- Next automatic set to zero — in days/hours
- If the display shows „----„ — the automatic set to zero is not activated
- Gas humidity — display in % 1 - 25 or disabled
- O2 value — wet: The O2 display is calculated to "wet" (*)
  dry: The O2 display is calculated to "dry"(*).
  The gas humidity can be set by "SET" to "Set gas humidity"
- 4 - 20 mA 02 — setting range of analog O2 output
- 4 - 20 mA CO — setting range of analog COe output
- Firmware — installed firmware version
- Hardware — installed hardware version
- Serial number — display of the serial number
- O2 sensor — installed
- CO sensor — installed/not installed

(*) Formula for O2 calculation dry/wet

$O2\max = 20.97\%$ oxygen content in air
$O2wet =$ measured O2-value in wet stack gas
$O2dry =$ calculated (%) O2-value dry

$H =$ water content (%) in stack gas, (value entered manually), $H = 100 \cdot \left(1 - \frac{O2wet}{O2dry}\right)$

therefore calculation of $O2dry = O2wet \cdot \left(\frac{100}{100 - H}\right)$

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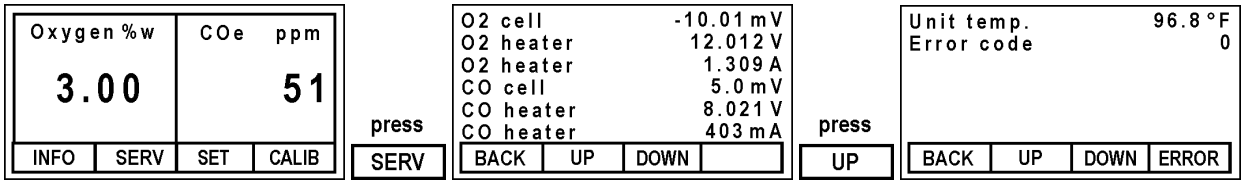
9.5 Service menu



Displays actual 6 lines from a scroll up/down list with measured (A/D converter) components information.

Press the "UP" or "DOWN" key and return back to main measuring menu by pressing "BACK".

	standard value	**allowed deviation**
O_2 cell	- 10 mV (with operation temperature and 21 % O_2)	± 5 mV
O_2 heater	12 V (depending on flange temperature)	± 2 V
O_2 heater	1,3 A (heater current)	± 0,3 A
CO cell	5 mV (after warm-up and with fresh air)	± 10 mV
CO heater	7,5 V (depending on flange temperature)	-3,0 V…. + 1 V
CO heater	0,4 A (heater current)	± 0,1 A
Unit temperature		less then 160 °F (70 °C)

Typical mV-values for COe sensor:
O_2 = 3 %, CO = 200 ppm → 98,0 mV
O_2 = 3 %, CO = 500 ppm → 190,0 mV
O_2 = 10 %, CO = 200 ppm → 32,0 mV
O_2 = 10 %, CO = 500 ppm → 93,0 mV

If the system detects an error, the plain text meaning will be displayed after pressing "ERROR" key

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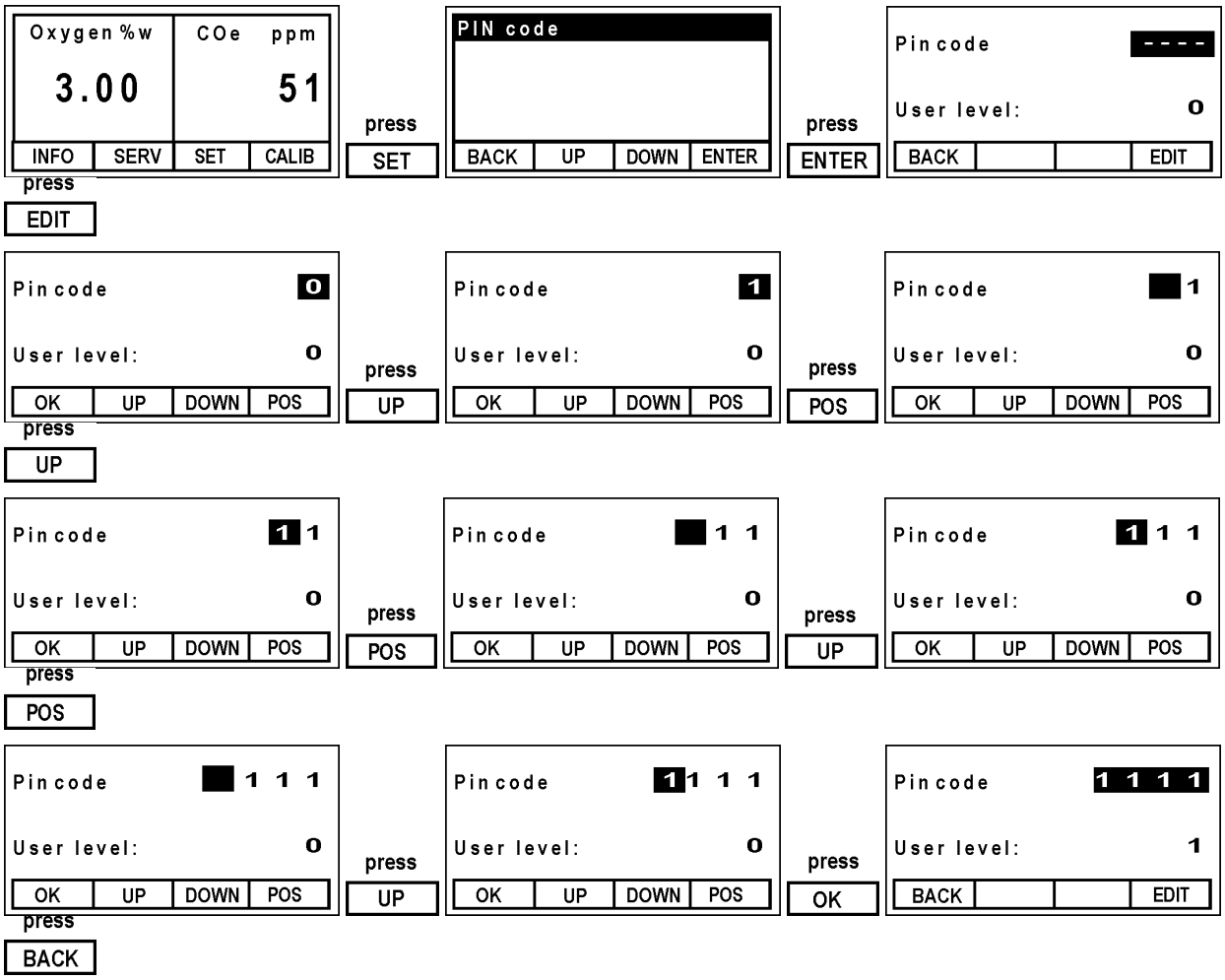
9.6 Settings menu

This menu is protected by a user level 1 PIN code. Changing the pin code is described in following chapter.

9.6.1 PIN code level 1



Entering the factory default PIN code 1111 (user level 1), gains access to the SET main menu and the above settings.

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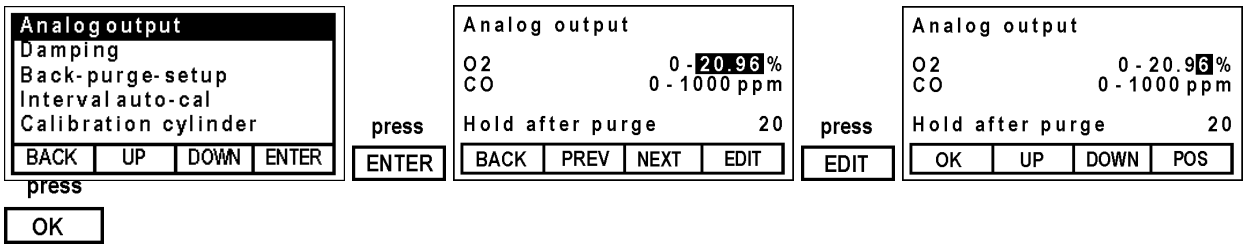
9.6.2 Set analog output



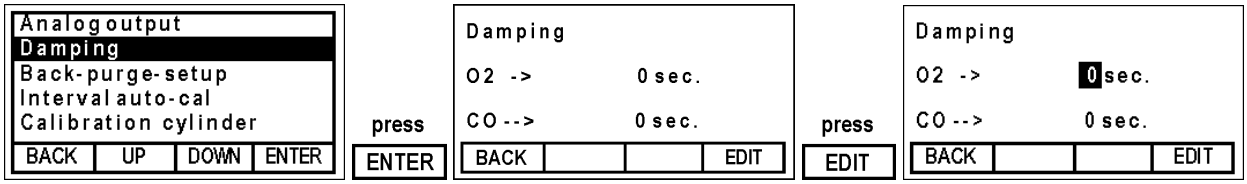
PREV or NEXT	move cursor to values which can be changed
EDIT	change value by means of UP/DOWN and POS
OK	save values
BACK	return to main menu

Factory defaults are:	20mA: O_2	0 – 21.00 %
	20mA: CO	0 – 1.000 ppm
	Hold after purge	typical 20 sec. (from 5 to max 200 seconds)

Notice: The last measured value on analog output 4-20mA after back-purge is hold even after back-purge cycle is finished.

9.6.3 Damping

This function allows user to set a damping (averaging the measurement over a period of time) of measurement, in the display as well in the analog output.



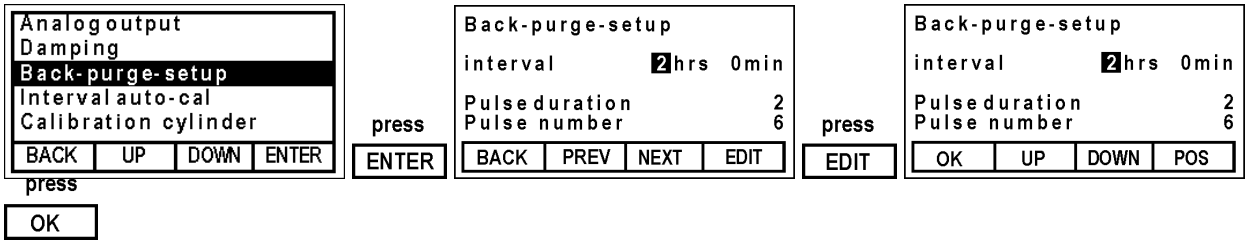
PREV or NEXT	move cursor to values which can be changed
EDIT	change value by means of UP/DOWN and POS
OK	save values
BACK	return to main menu

Integration times from 0 to 30 seconds are settable, where 0 seconds means no damping.

9.6.4 Back-purge setup

This function allows setup of the optional back-purge solenoid valve to control:

- interval time between back purges (hours and minutes)
- pulse duration or interval time for energizing the solenoid valve (opening the valve)
- number of pulses during one back purge cycle



PREV or NEXT	move cursor to values which can be changed
EDIT	change value by means of UP/DOWN and POS
OK	save values
BACK	return to main menu

If hours and minutes are 0, the back purge function is deactivated. The delivery state of this function is off.

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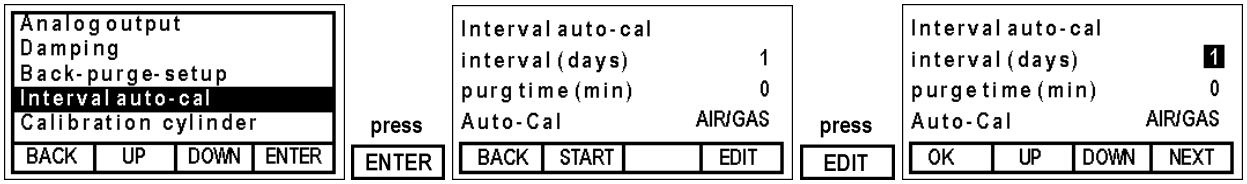
9.6.5 Interval auto-calibration

This function allows setting the interval of auto calibration



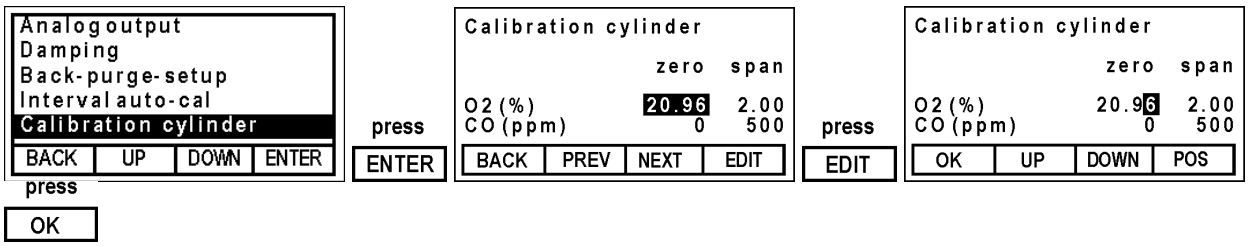
PREV or NEXT	move cursor to values which can be changed
EDIT	change value by means of UP/DOWN and NEXT
BACK	return to main menu
START	Starts the auto cal immediately

Interval:	0 – 99 days .**<u>Note:</u> If "interval" is 0, the auto cal. function is deactivated!**
Purge time:	1 – 10 minutes
Auto-cal:	AIR or AIR and Gas
	AIR: 1 point calibration with AIR (zero gas)
	AIR/GAS: 2 points calibration with combined AIR an GAS (zero gas and span gas)
	First calibration must always be the zero calibration with AIR".

The delivery state of this function is off.

9.6.6 Set calibration cylinder values

This function allows setting the values of span gas cylinders used for calibration.

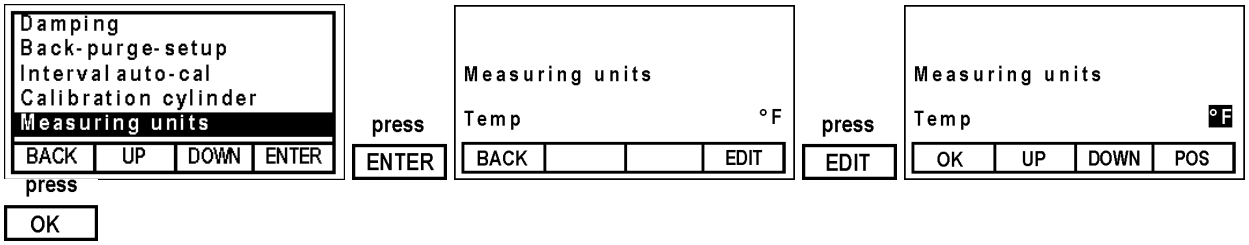


PREV or NEXT	move cursor to values which can be changed
EDIT	change value by means of UP/DOWN and POS
OK	save values
BACK	return to main menu

The set values for "zero" are fixed values, programmed into the unit's firmware.

The values for the calibration gas cylinder setting have to be set to the correct cylinder values for both O_2 and CO.

9.6.7 Set temperature measuring unit



EDIT	change value by means of UP/DOWN
OK	save values
BACK	return to main menu

Set the temperature units to °C or °F

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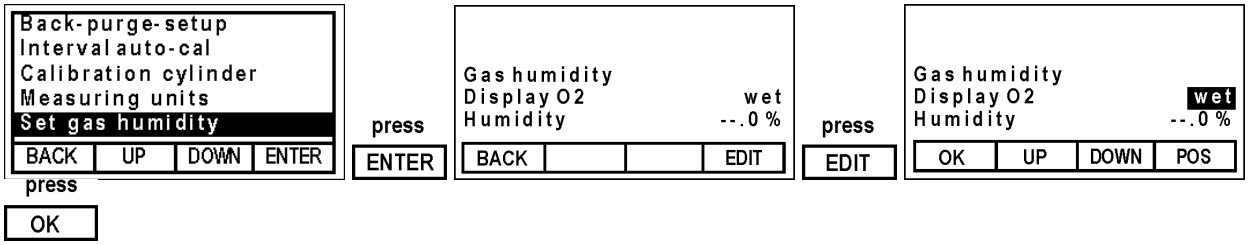
9.6.8 Set gas humidity

This function allows setting the value of gas humidity (if known) and selection of either wet oxygen measurement or dry oxygen calculation.



NEXT	move cursor to values which can be changed
EDIT	change value by means of UP/DOWN
OK	save values
BACK	return to main menu

Change value of gas humidity (XX.X %) if this is known.

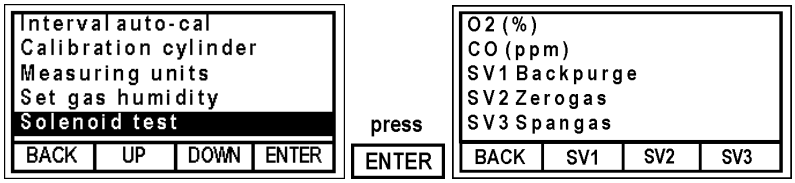
Using the formula: Humidity H % = (1 - O2wet/O2dry) x 100 the dry oxygen is calculated and displayed.

Default value for humidity = disabled

In the main menu the readings are w → wet oxygen measurement and d → dry oxygen calculation

9.6.9 Solenoid test

With the menu option "Solenoid test" allows to test each individual solenoid valve (if installed)



A manual switch ON or OFF of all 3 individual solenoid valves is possible.

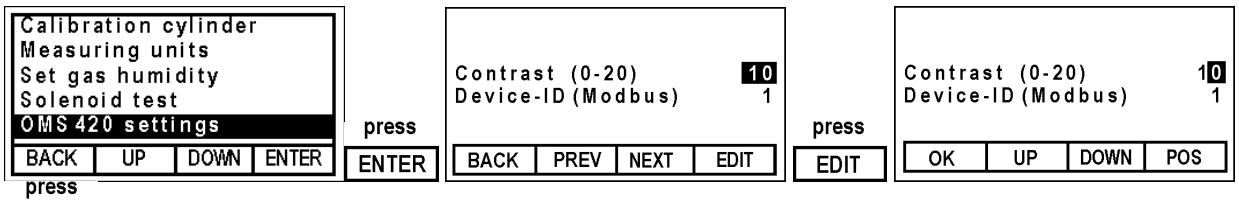
By means of the key F1 the solenoid valve SV1 is switched ON or OFF, key F2 the solenoid valve SV2 is switched ON or OFF and with the key F3 the single solenoid valve SV3 is switched ON or OFF.

The display shows the current O2 and/or CO value(s).

Warning: All valves can be switched at the same time. It does not take place monitoring on a meaningful position of the single solenoid valves. This operation is only for authorized technical personal!

9.6.10 OMS420 settings

This function allows change of display contrast and set of transmitter address for multiple transmitter connection on the same RS485 data bus.



OK to get back to main settings menu

PREV or NEXT	move cursor to values which can be changed
EDIT	change value by means of UP/DOWN and POS
OK	save values
BACK	return to main menu

LCD – Contrast	0-20	(10 for default)
Device-ID (Modbus)	Slave address (RS 485-Modbus RTU)	

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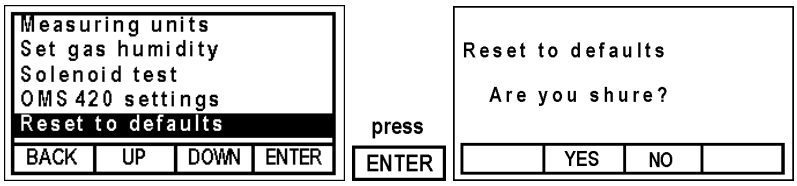
9.6.11 Reset to (factory) defaults



YES System parameters will be reset to factory defaults
NO Function will be aborted

Factory defaults

Auto-calibration		OFF	
Back-purge		OFF	
4 – 20 mA Range O_2		20,96 %	
4 – 20 mA range CO		1.000 ppm	
O_2 cylinder1		21,00 %	
O_2 cylinder2		2,00 %	
CO cylinder1		0 ppm	
CO cylinder2		1.000 ppm (mixture gas with additional 50 ppm H_2 gas is expected!)	
Pulse duration		2 sec.	
Numb. of pulses		6	
Hold after purge		20 sec.	
Unit temp.		°F	
Display O_2		wet	
Humidity	--.- %	(without)	
Interval (days)		0	(autocalibration = OFF)
Purge time (min.)		0	
Auto-Cal.		AIR	(only 1 point calibration)

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9.7 Calibration

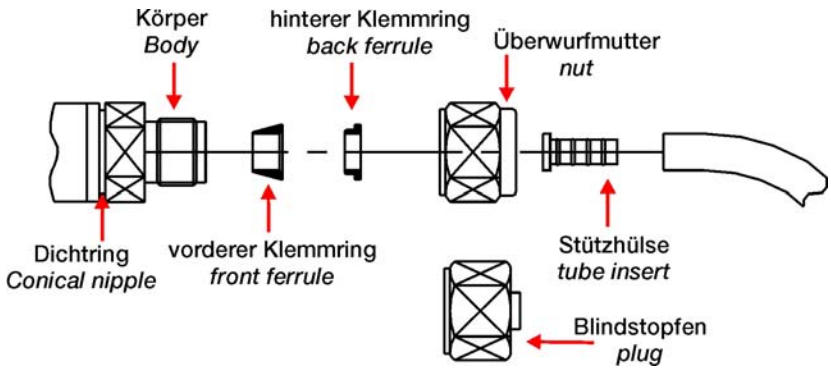
The transmitter should be powered up for at least 2 … 3 hours before calibration.
A test (calibration) gas cylinder is connected to the calibration gas inlet port for calibration.

Adjustment can be done manually or automatically using the solenoid valves of the optional pneumatic unit PU420.

The test gas (clean fresh air/instrument air or calibration gas) flows through the hole inside the small flange (sensor manifold), purges the sensors and exits through the filter screen to the inside probe tube mounted on the stack.

On site calibration is done without removing the probe from the stack.

After calibration, tighten the calibration inlet port plug with a 14 mm wrench for 1/6 of a turn.



Perform adjustment:

1 Purge sensor with ambient air (40 l/h using the calibration gas inlet port).

2 When being purged with fresh air, the analog output signal should be 17.37 mA (for 0 – 25 % O_2 measuring range).

3 With calibration gas (2% O_2 in N_2), the analog output should be 5.28mA (for 0 - 25% O_2 measuring range).

4 The transmitter is now ready for operation.

Use calibration gas cylinder at least every 3 - 6 months.

Calibration with ambient clean air can be done automatically on a daily basis using the pneumatic option PU420.

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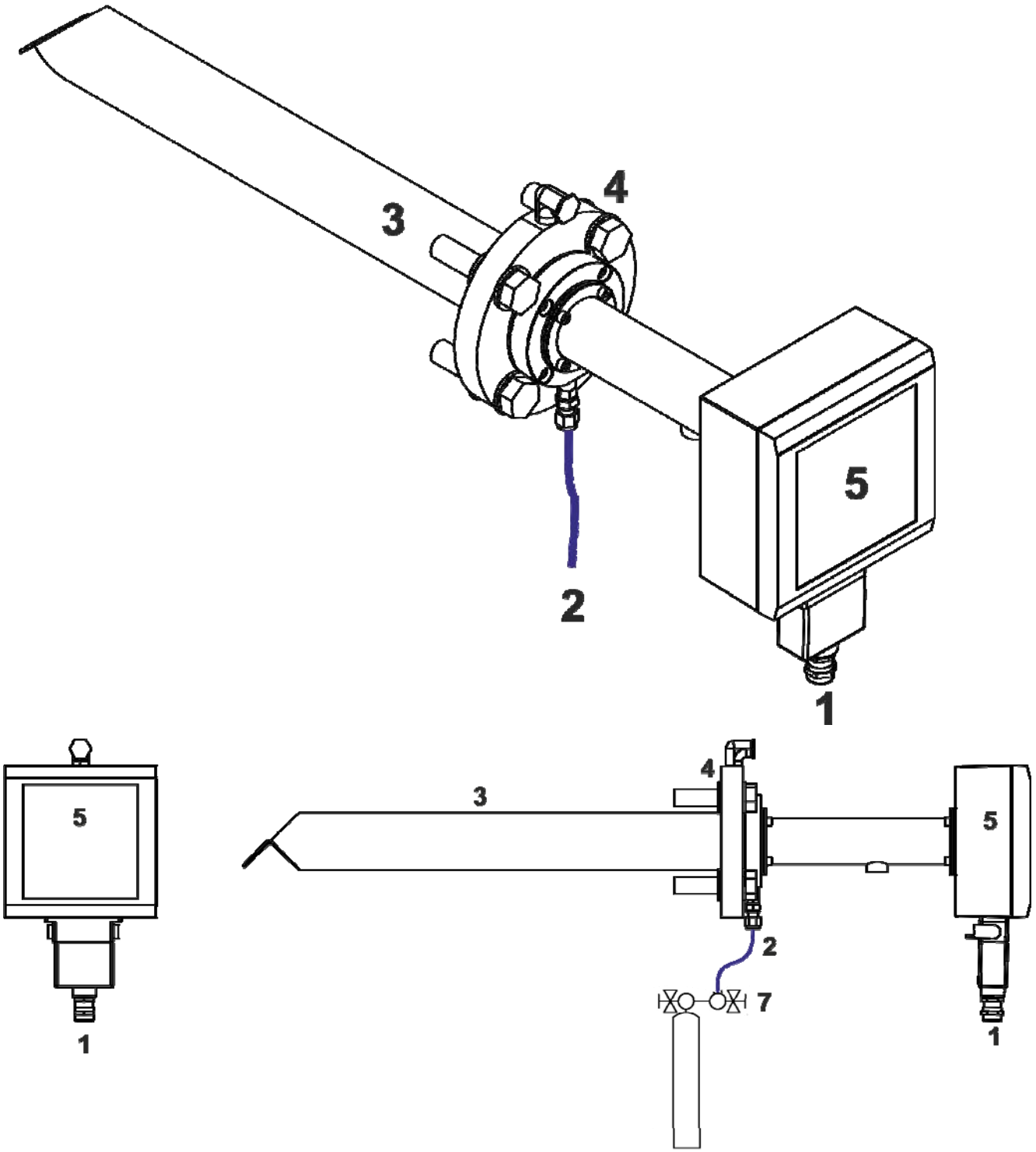
9.7.1 OMS420HT model compact probe (# 61417)



Pos.	Description
1	Electrical connector
2	Hose connection cal gas
3	Probe tube (stainless steel)
4	Flange 4”ANSI 150 or DN65PN6
5	Probe head (transmitter)
6	Calibration gas cylinder
7	Pressure regulator with flow volume control

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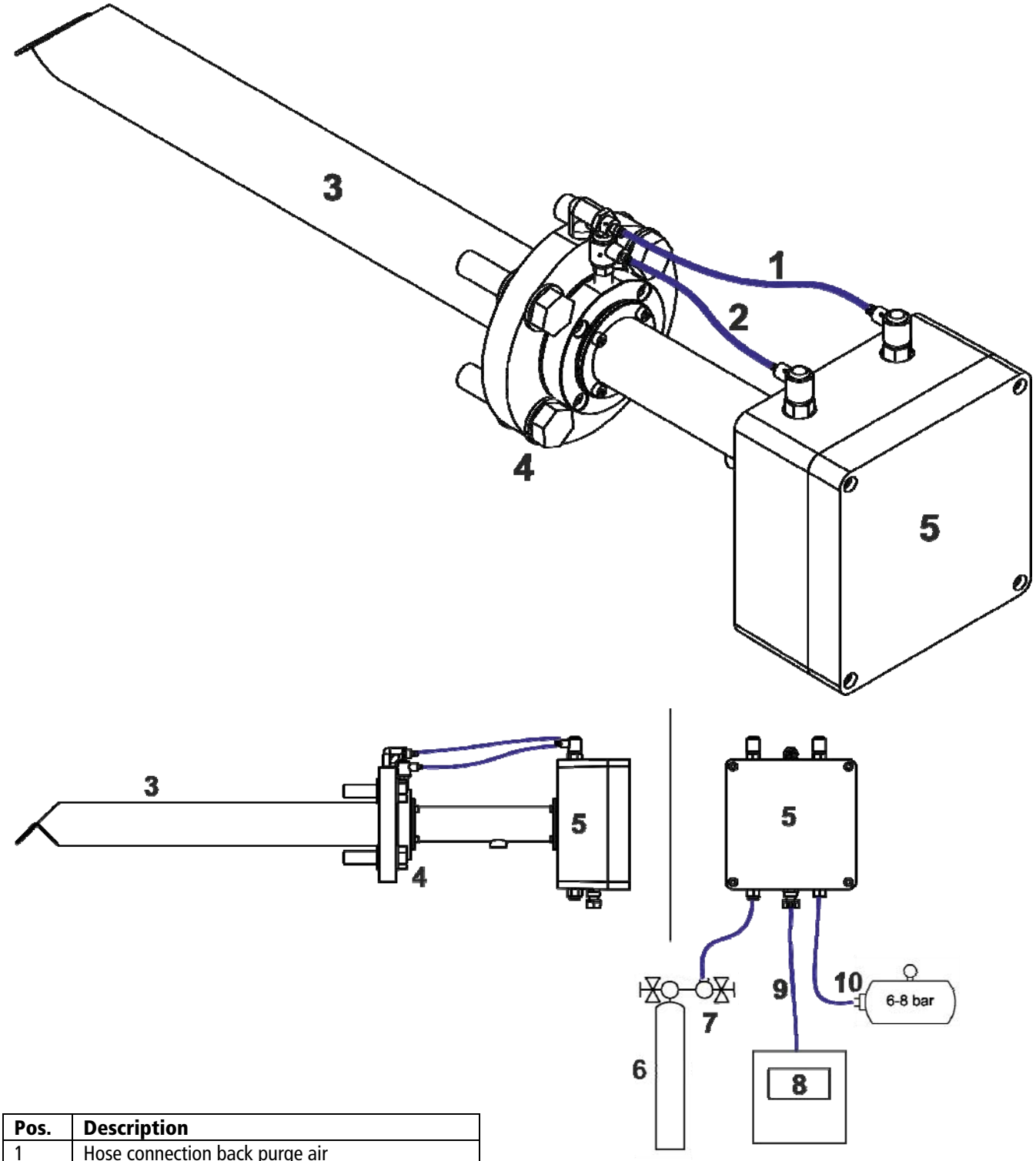
9.7.2 OMS420RT model remote transmitter (# 63467RT)



Pos.	Description
1	Hose connection back purge air
2	Hose connection cal gas and back purge air
3	Probe tube (stainless or Inconel steel)
4	Flange DN65 PN6 or 4" ANSI 150
5	Probe head
6	Calibration gas cylinder
7	Pressure regulator with flow volume control
8	Transmitter
9	Special connection cable (10 m or 30 m)
10	Compressed air or Nitrogen N2 (6 – 8 bar) supply

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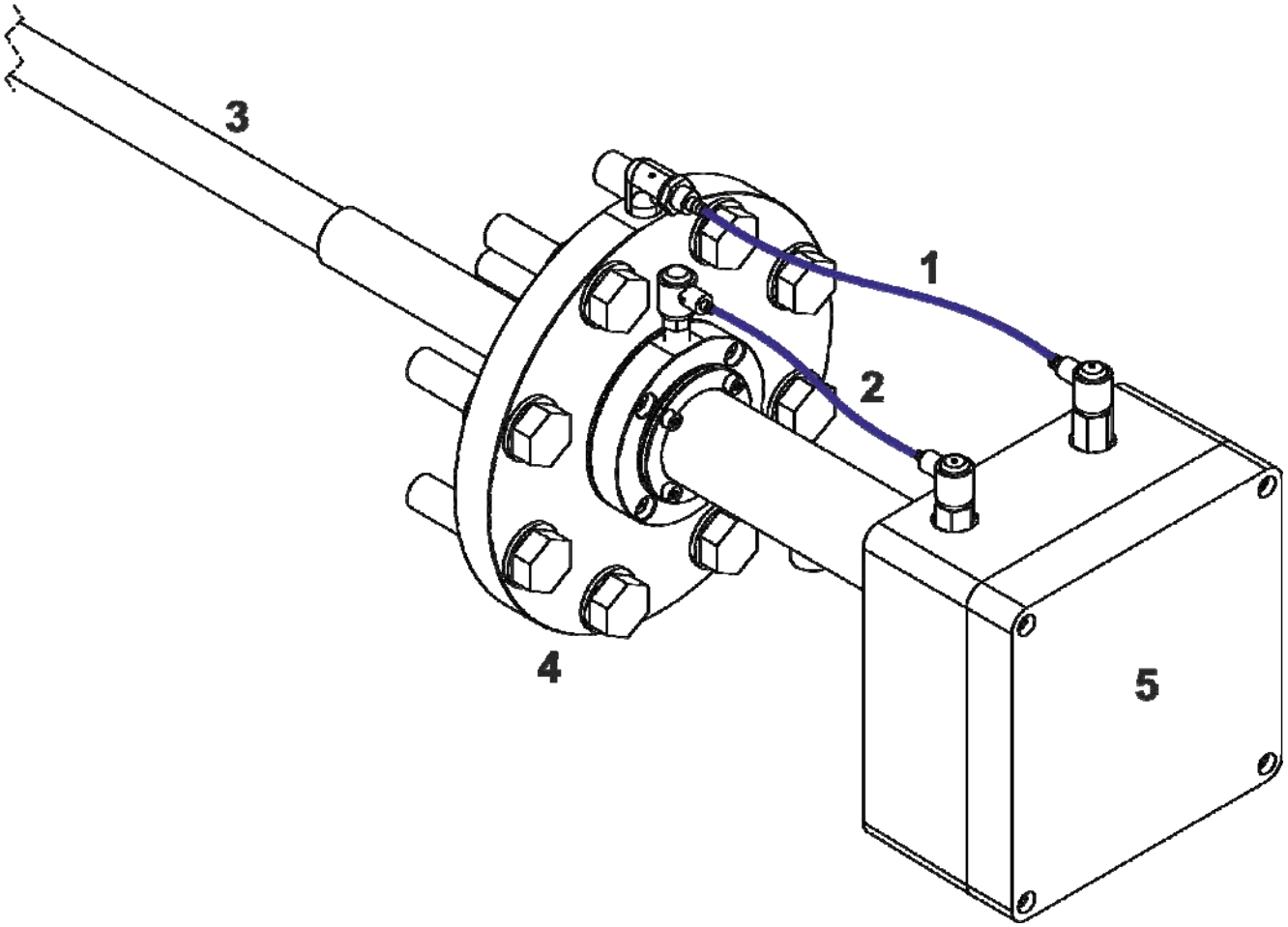
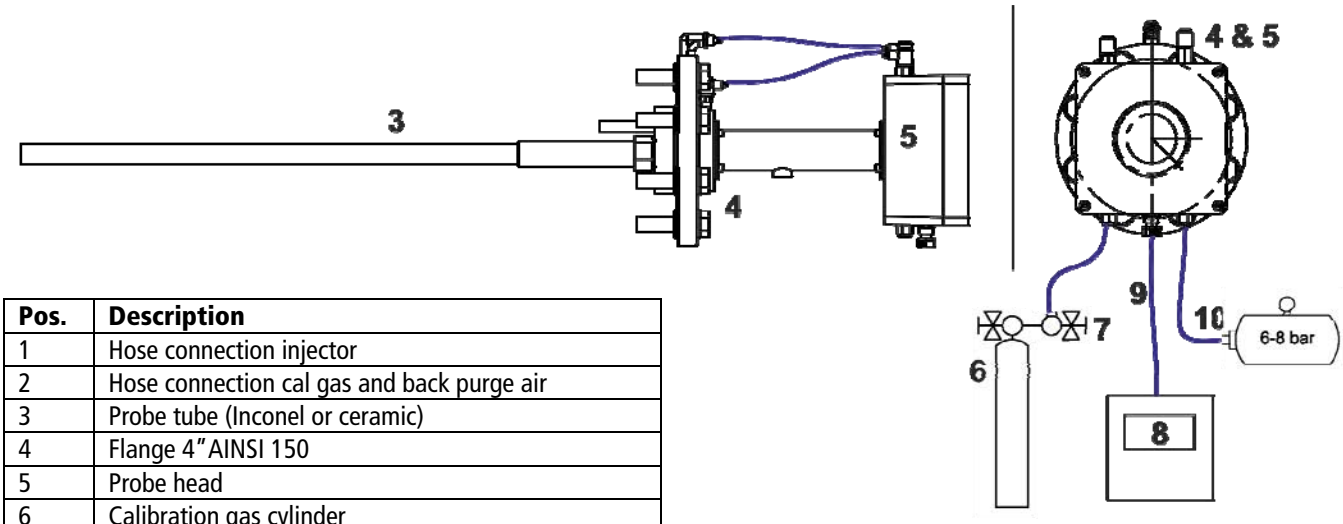
9.7.3 OMS420HT model high temperature (# 63467HT)





Pos.	Description
1	Hose connection injector
2	Hose connection cal gas and back purge air
3	Probe tube (Inconel or ceramic)
4	Flange 4"AINSI 150
5	Probe head
6	Calibration gas cylinder
7	Pressure regulator with flow volume control
8	Transmitter
9	Special connection cable (10 m or 30 m)
10	Compressed air or Nitrogen N2 (6 – 8 bar) supply

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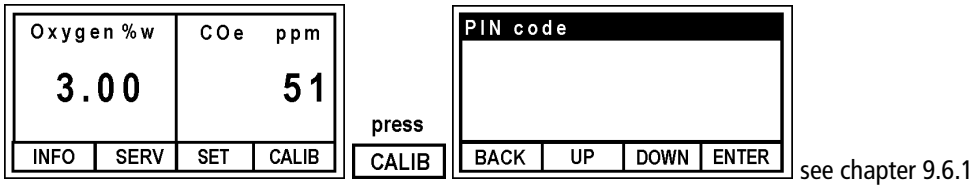
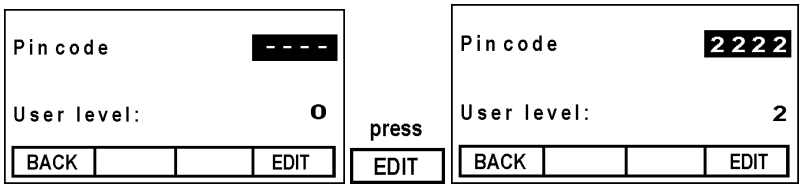
IMPORTANT: Only authorized persons or manufacturer's trained technicians are authorized to perform calibration adjustments on the OMS420.

9.7.4 Pin Code level 2

Calibration with AIR (zero gas) or GAS (span gas) requires the use of level 2 pin code



see chapter 9.6.1



POS **position**
UP / DOWN **to change the numbers**

NOTE:

Below displayed values e.g. O2 factor and offset values are examples!

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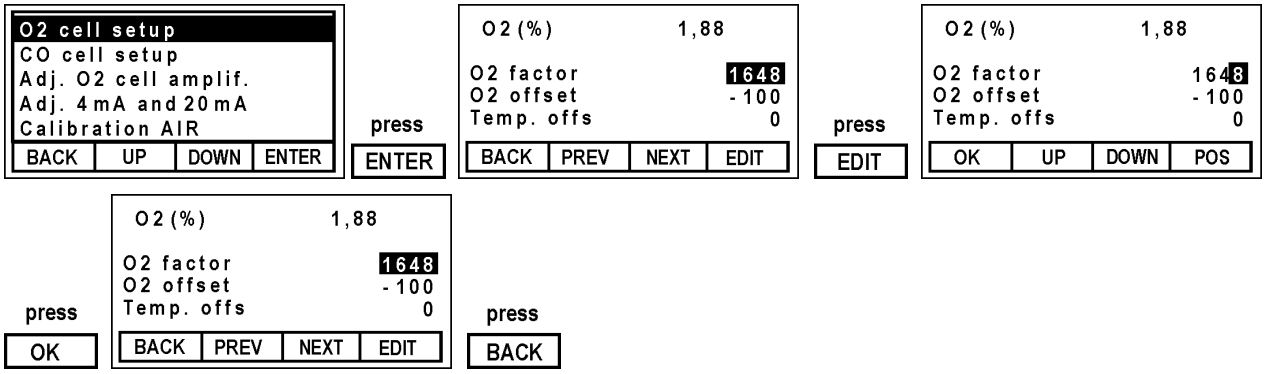
9.7.5 O2 cell setup (by factory only)

If there is no calibration gas available and the cell must be replaced, this function permits changing a cell without calibration. This can only be done if the cell factors have been measured at MRU and delivered together with the spare sensor.



PREV or NEXT	move cursor
EDIT	change value by means of UP/DOWN and POS
OK	save values
BACK	return to calibration menu

1) O2 cell setup requires input (edit function) of O2 factor and O2 offset values delivered with the spare sensor

2) Temperature compensation of 20.9 % O_2 is required when oxygen value at air is changed too much because of gas or flange temperature change. The difference of air oxygen measurement at lower temperature to measurement at higher temperature will be edit as "Temp.offs" value.

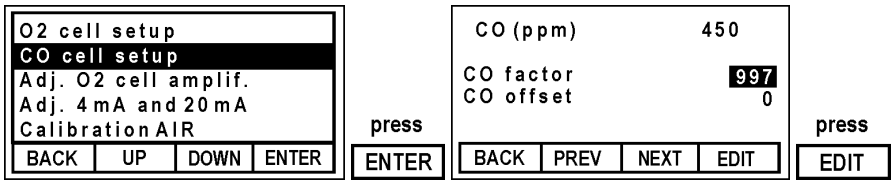
NOTE:

This procedure should be followed by new calibration using calibration gas cylinder.

Only authorized persons or manufacturer's trained technicians are authorized to perform adjustments on the OMS420.

9.7.6 CO cell setup (by factory only)

If there is no calibration gas available and the cell must be replaced, this function permits changing a cell without calibration. This can only be done if the cell factors have been measured at MRU and delivered together with the spare sensor.



PREV or NEXT	move cursor
EDIT	change value by means of UP/DOWN and POS
OK	save values
BACK	return to calibration menu

CO cell setup factor and CO offset setup factor will be edit using the values delivered together with the spare sensor.

Set point of heat resistor [Ohm] must be also carried out according to § 6.7.12
NOTE:

This procedure should be followed by new calibration using calibration gas cylinder.

Only authorized persons or manufacturers trained staff are allowed to perform adjustments on the OMS420!

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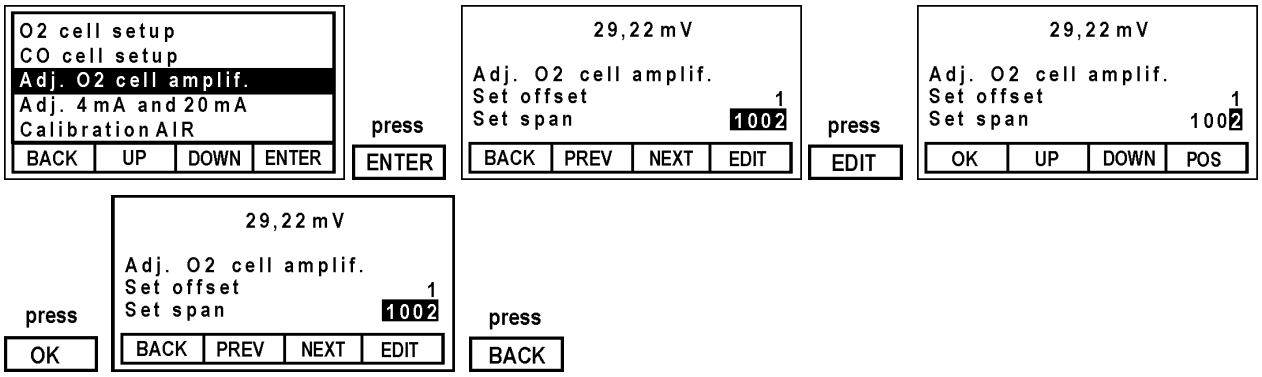
9.7.7 Adjustment O2 cell amplifier (by factory only)



PREV or NEXT	move cursor
EDIT	change value by means of UP/DOWN and POS
OK	save values
BACK	return to calibration menu

This procedure is required only when a new O_2 cell is installed.

Source a precision voltage device to the input connectors of the O_2 cell signal (see picture below) and select

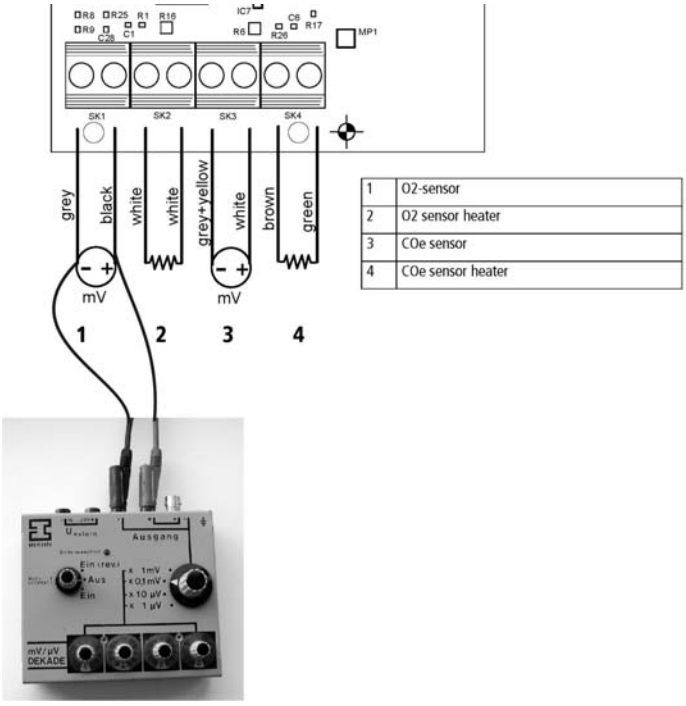
-10mV for offset trim and +100mV for span trim.

If actual values displayed are other than -10mV to +100mV setting can be adjusted by selecting "Set offset" or "Set span" and editing and replacing the displayed numbers with the actual numbers.

Factory default = factory adjusted values

ATTENTION:

Changes of these factors require new gas calibration. Only authorized persons or manufacturer's trained technicians are authorized to perform adjustments on the OMS420.



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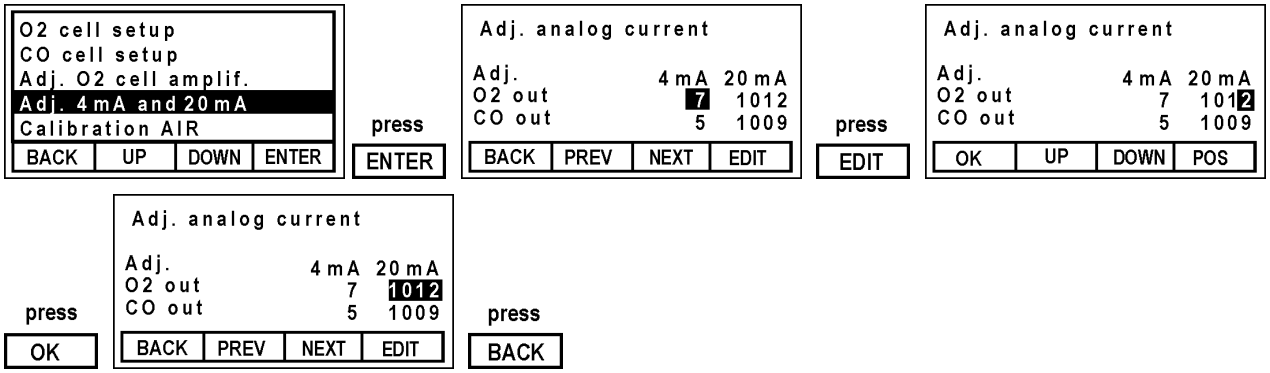
9.7.8 Adjustment 4 mA – 20 mA (factory only)

Connect precision 100 Ohm resistor (0.1% tolerance) to both analog outputs of O_2 and CO measurements.

Measure the voltage across the resistors using a precision digital multi-meter.

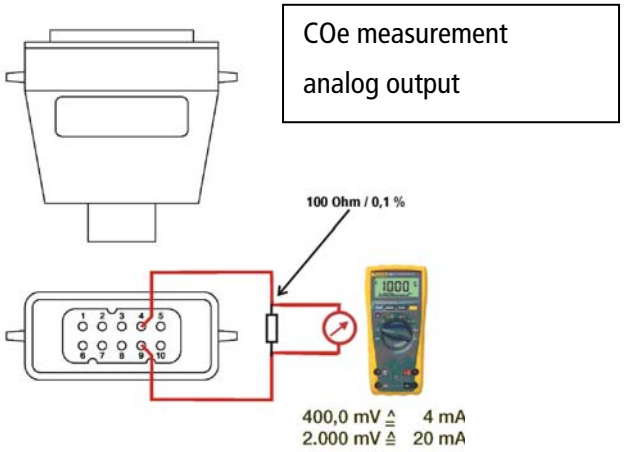


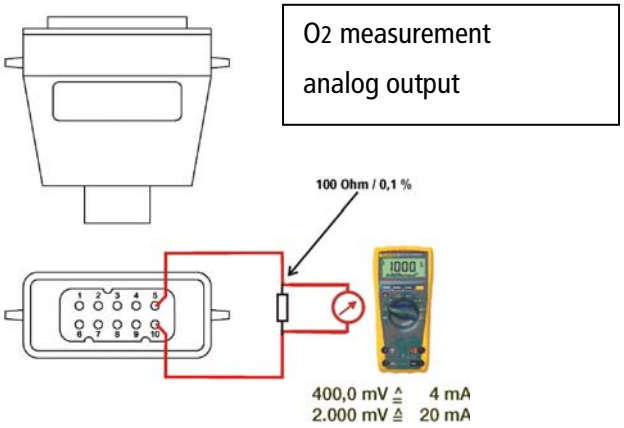
PREV or NEXT	move cursor
EDIT	change value by means of UP/DOWN, until you read 400mV, up to2000mV on the multi-meter
OK	save values
BACK	return to calibration menu

Note:

The 4 – 20mA analog output factory adjustment can deteriorate over time, so measured values must be verified occasionally.

Only authorized persons or manufacturers trained staff are allowed to perform adjustments on the OMS420.





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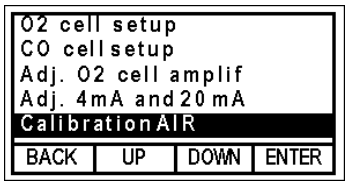
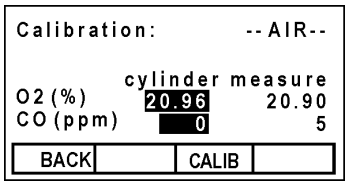
9.7.9 Calibration AIR

This menu performs the 1 point calibration with AIR (zero gas).



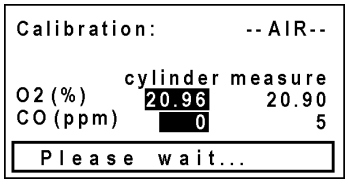
press ENTER



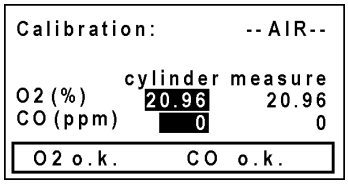
press CALIB

Wait approximately 5 minutes while instrument air is being supplied to sensors to allow signals to stabilize.

Press "CALIB" key

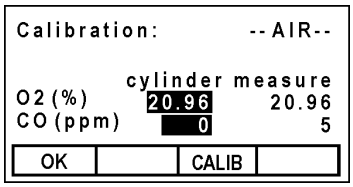


Wait for approximately 3 seconds.



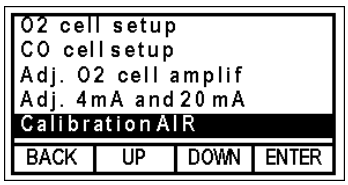
Zero gas (AIR) calibration was successful.

If calibration fails, an error message will be displayed.



press OK

Return to setting menu.



O_2 OK. CO OK or O_2 failed! CO failed!

If calibration fails, an error message will be displayed.

9.7.10 Calibration AIR & GAS

This menu performs the 2 points calibration with combined AIR and GAS (zero gas and span gas).

For the calibration, the use of moistured mixture gas (O_2, CO and H_2) is mandatory.
Moisturing the span gas requires the use of water bubblier!

With single component gas CO the calibration is not possible.

If no mixture gas is available, then see chapter 9.7.11.

Calibration of O2 only: set CO cylinder (value) = 0 → no calibration
Calibration of CO only: set O2 cylinder (value) = 0 → no calibration

First calibration must always be the zero calibration with "AIR"

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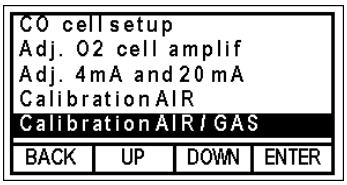
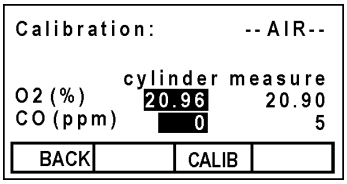


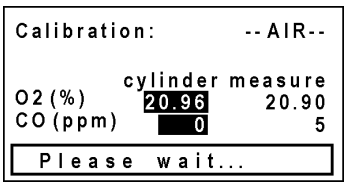
press ENTER



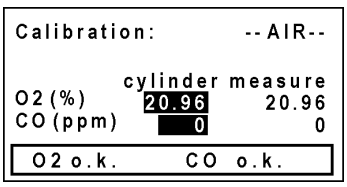
press CALIB

Wait approximately 5 minutes while instrument air is being supplied to sensors to allow signals to stabilize.

Press "CALIB" key

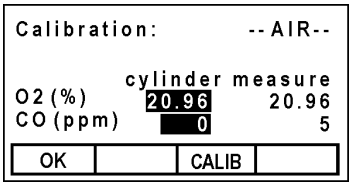


Wait for approximately 3 seconds!.



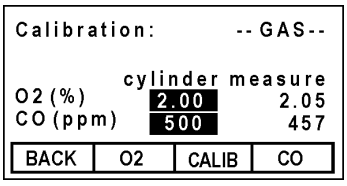
Zero gas (AIR) calibration was successful.

If calibration fails, an error message will be displayed.



press OK

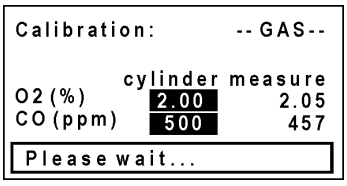
Second calibration shall be the span calibration with "GAS"



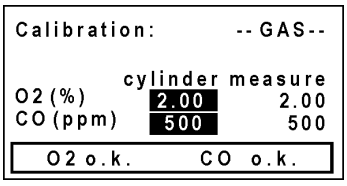
press CALIB

Read calibration gas cylinder values and if any change is required (other cylinder values) then edit O_2 and CO in the display by pressing "O_2" then the "CO" key.

Wait approximately 5 minutes while calibration gas is being supplied to sensors to allow signals to stabilize, then press "CALIB" key.

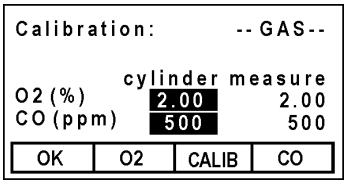


Wait for approximately 3 seconds.



Span gas (GAS) calibration was successful.

If calibration fails, an error message will be displayed.

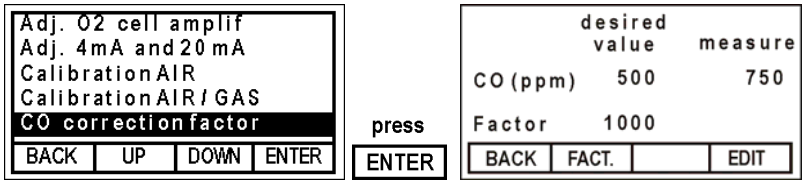


press OK

Return to previous setting menu.

9.7.11 CO correction factor

This function allows user to perform site calibration of combustibles measurement with a comparative selective CO measurement, using **portable CO analyzer** (e.g. Delta65). This will make the equivalency to CO and is recommended to be carried out at stable, constant combustion process.



Because sensor is measuring all combustibles in the flue gas, a difference to selective CO measurement will occur.

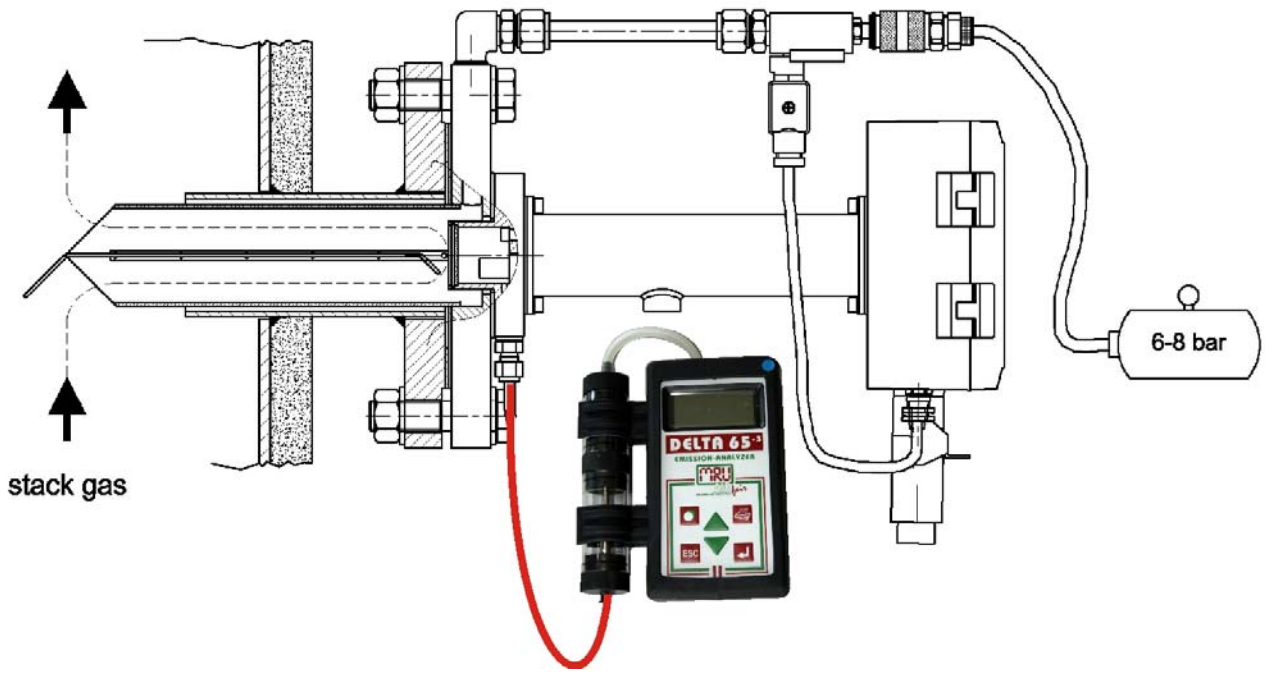
By using the correction factor, this difference will be minimized, the instrument will display same value as the comparing CO selective measuring instrument.

1) The measured value by means of Delta65 can be set ("desired value") by pressing "EDIT" key.

2) Using the"UP" and "DOWN" keys will change this value until it corresponds to Delta65 measurement of CO.

3) Then press "OK" key to correct the combustibles measurement to selective CO measured value.

> **NOTE:** by pressing the key "FACT." the CO correction factor will be set to 1000 (amplification is 1)!!!!
>
> In that case, adjustment of COe reading according to measurement by means of Delta65 is out of order!



Use a portable analyzer to measure CO in the flue gas and to adjust accordingly the "desired value".

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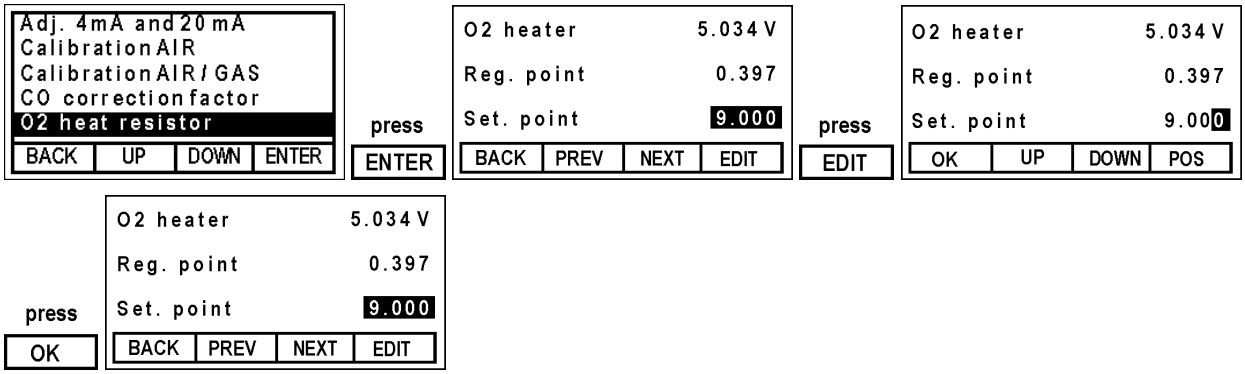
9.7.12 O2 heat resistor regulation (factory only)



PREV or NEXT	move cursor
EDIT	change value by means of UP/DOWN and POS
OK	save values
BACK	return to calibration menu

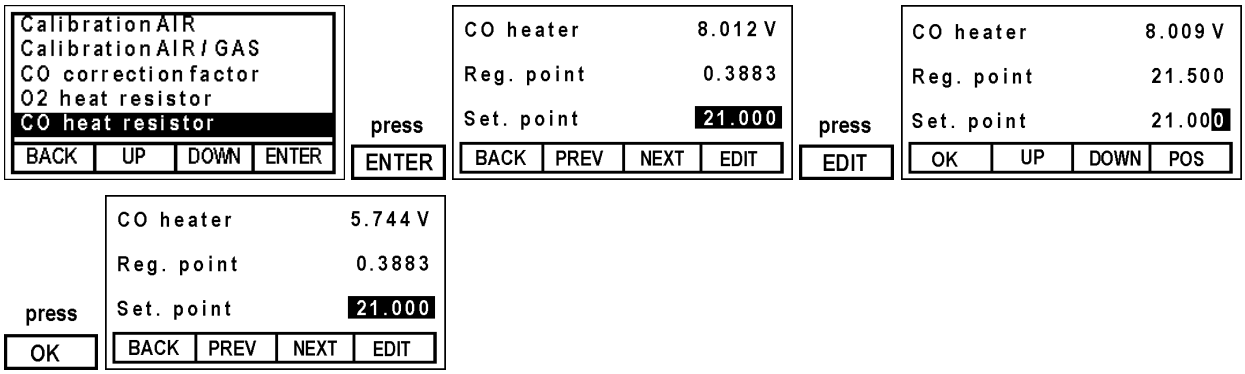
First line: regulation point actual (O_2)

Second line: new set point (Heat resistor [Ohm]}

ATTENTION:

Changes of these parameters require new calibration.
Only authorized persons or manufacturer's trained technicians are authorized to perform adjustments on the OMS420

9.7.13 CO heat resistor regulation (factory only)



PREV or NEXT	move cursor
EDIT	change value by means of UP/DOWN and POS
OK	save values
BACK	return to calibration menu

First line: regulation point actual (CO)

Second line: new set point (Heat resistor [Ohm]}

Heat resistor [Ohm]
CO: R 25 °C * (2.35 up to 2.6)

R higher → higher temperature → lower offset signal, faster response time, low CO response signal
R lower → lower temperature → larger CO response signal, and lower response time

ATTENTION:

Changes of these parameters require new calibration.
Only authorized persons or manufacturer's trained technicians are authorized to perform adjustments on the OMS420

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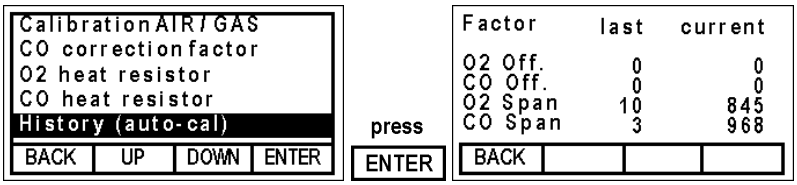
9.7.14 History auto-calibration

This function allows the user to see the last auto calibration values.



10 Troubleshooting

If the system detects an error, the plain text will be displayed after pressing the "Error" key in the service menu.

Malfunction:	**Corrective action:**
No display	Check power supply, check cables and connectors
Display: Heating current<0.5A Sensor element defect	O_2 sensor element defect Check heater resistance of sensor Replace sensor
Display: Configuration not ok Checksum wrong	New adjustment required
Display: Flash error!	New adjustment required Please contact your dealer (manufacturer).
Display: Unit to warm Hot environment	Ambient temperature too high! Use heat shield or attach a compressed air based Vortec cooler
Transmitter does not react with sample gas from stack	Clean the filter screen.
Calibration error	Calibration factor cannot be set. Test gas cylinder is empty, filter screen dirty or clogged Calibration offset value cannot be set. Instrument air supply is not available,
Transmitter does not react with test gas	Please contact your dealer (manufacturer).

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11 Technical specifications

Measurements	Oxygen and combustibles (equivalent CO_e) contained in flue gas
Measurement principle	Heated zirconium oxide cell for O_2,
	Heated solid electrolyte cell for CO_e
Lifetime of cells	more than 5 years under normal conditions (*)
Warm-up time	minimum 30 minutes
Measurement range	0 – 25.0 % for O_2
	0 – 1,000 ppm for CO_e
Resolution	0.01 % for O_2 and 1 ppm for CO_e.
Repeatability	within ± 1 % of full scale for O_2
Linearity	better than ± 1 % of full scale for O_2
Accuracy	O2: ± 0.2 % O_2 or ± 5 % of reading (whichever is larger)
	COe: not selective measurement, accuracy is not an issue
Response time	< 10 seconds
Electronics	micro-controlled based, on board graphic backlit LCD
Output signals	2 x 4 – 20 mA, galvanic isolated, max. 500 R (for direct transfer to process PLC)
	RS 485, galvanic isolated digital data transfer (Modbus protocol RTU)
Power supply	18 Vdc to max. 24 Vdc, 100 W for compact probe model OMS420
	100…240Vac / 50-60Hz, 100W for all other models
Ambient temperature	- 4° F … 140° F (-20°C …+ 65°C)
Ambient humidity	5 – 95 %, non condensing
Protection	IP 65 (NEMA 4)

(*) in the absence of heavy metals, silicones, silicates, aggressive and/or corrosive gases

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12 Appendix

12.1 Error codes

02 Configuration Error, new adjustment required

04 Flash Error, new adjustment required Please contact your dealer (manufacturer).

08 Unit to warm, ambient temperature too high!

01 Heating current<0.5A, O2 sensor not o.k.

32 Heating current<0.1A, CO sensor not o.k.

64 Heating current<0.1A, CO sensor not o.k.

128 Calibration error, calibration factor cannot be set.
Test gas cylinder is empty, filter dirty or clogged.
Calibration offset value cannot be set.
Instrument air supply is not available.

At the same time if several errors line up, then the error codes are to be added.
Her one example:

33 Heating current<0.5A, O2 sensor not o.k. and
Heating current<0.1A, CO sensor not o.k.

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12.2 Modbus Slave specification

General information

- supports only the binary Modbus protocol (RTU)
- the slave modbus address is user definable from 1 to 49
- communication parameter are user definable as follows:
  - 9600 baud
  - 8-Bit
  - even parity and 1 stop bit
- data types (used in table below):
  - U 16 bit unsigned integer value (0…65535)
  - I 16 bit signed integer value (-32768...32767)
  - UL 32 bit unsigned integer value (0…4.294.967.295)
  - L 32 bit signed integer value (-2.147.483.648…2.147.483.647)
  - F 3 32 bit floating point value (reads -1E38, when not available)

Defined registers

Available data with modbus command 4 READ INPUT REGISTERS:

PLC address	Protocol address	Data type	Number of registers	Register content
				Device info / status
40001	0	U	1	Error-Flags
40002	1	U	1	Reserved for further flags
40003	2	U	1	Status
40004	3	I	1	O2 [%] 1152 -> 11,52 %
40005	4	I	1	CO [ppm] 123 -> 123 ppm

Error Flags

Bit 0 Heating current<0.5A, O2 sensor not o.k.
Bit 1 Config error
Bit 2 Flash error
Bit 3 Unit to warm
Bit 4
Bit 5 Heating current<0.1A, CO sensor not o.k.
Bit 6
Bit 7 Calibration error

Status

Status 0 Busy
Status 2 Measurement active
Status 5 Backpurge active
Status 6 Calibration active

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12.3 Declaration of confirmity

Messgeräte für Rauchgase
und Umweltschutz GmbH

Fuchshalde 8
74172 Neckarsulm - Obereisesheim
Tel 07132 / 9962-0
Fax 07132 / 9962-20

EG - Konformitätserklärung
Declaration of confirmity

Hiermit bescheinigt das Unternehmen / The company

**MRU Messgeräte für Rauchgase
und Umweltschutz GmbH
74172 NSU - Obereisesheim**

die Konformität des Produkts / herewith declares confirmity of the product

Bezeichnung / Designation **OMS 420**

Mit folgenden einschlägigen Bestimmungen/ with applicable regulations below

EG-Richtlinie / EC directive **73/23/EWG**

89/336/EWG

angewendete harmonisierte Normen/ Harmonized standards applied

a) Niederspannungsrichtlinie: **2006/95/EG**

b) EMV-Richtlinie: **2004/108/EG**

Angewendete nationale technische Spezifikationen /
National technical specifications applied

Gemeldete Stelle, EG Baumusterprüfung / Notified body, type test
Eigenerklärung

Neckarsulm - Obereisesheim, den 09.08.2010

MRU GmbH Geschäftsleitung

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**Messgeräte für Rauchgase
und Umweltschutz GmbH**

Fuchshalde 8
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Tel 07132 / 9962-0
Fax 07132 / 9962-20

EG - Konformitätserklärung
Declaration of confirmity

Hiermit bescheinigt das Unternehmen / The company

**MRU Messgeräte für Rauchgase
und Umweltschutz GmbH
74172 NSU - Obereisesheim**

die Konformität des Produkts / herewith declares confirmity of the product

Bezeichnung / Designation **OMS 420 RT-PU**

Mit folgenden einschlägigen Bestimmungen/ with applicable regulations below

EG-Richtlinie / EC directive **73/23/EWG**

89/336/EWG

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Gemeldete Stelle, EG Baumusterprüfung / Notified body, type test
Eigenerklärung

Neckarsulm - Obereisesheim, den 09.08.2010

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