SWG 100
bioEX

USER MANUAL

MRU® AIR *fair*
since 1984
EMISSION MONITORING SYSTEMS

9512GB-BIOEX

Die leeren Seiten der Bedienungsanleitung sind kein Fehler sondern herstellungsbedingt erforderlich!

The blank pages of the operating instructions are not a mistake but due to manufacturing required!

Пустые страницы в инструкции по эксплуатации не ошибка, а требуется производством!

Les pages vides sont pas fauses, mais dûs à la production requise!

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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.

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.

Please forward all comments or suggestions to the Customer Feedback Department at the following address:

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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. General Information

1.1. Weather and environmental conditions

The SWG100BIOGAS analyser is designed for operating ambient temperatures of +5°C to +45°C (without cabinet heater) resp. -20°C to +45°C (with cabinet heater).
The SWG100BIO-Ex. is for designed for use in hazardous Zone 2, see the conformity marking in the corresponding section.

In case of outdoor mounting it is important that the analyser is protected against rain and sun.
For extreme environmental conditions like high humidity, salty sea air, etc. further protective measures are necessary. These should be clarified with the manufacturer (MRU).

Any additional protective measures for outdoor mounting have to be provided by the plant operator. The manufacturer (MRU) is supporting the plant operator in choosing appropriate protective measures.

1.2. Installation instructions

Installation instructions, which are described in chapter 17 of the operation manual, have to be strictly carried out.

⚠ WARNING
Please check correct installation before powering up the analyzer! Please operate the analyzer only in upright position!

1.3. General important instructions for the plant operator

To guarantee continuous operation of the SWG100 BIOGAS analyser, the functions, processes and operation of the analyser have to be monitored regularly by the plant operator – especially in case of any initial installation. Thus, it will be possible to take suitable measures to improve the availability and life time of the analyser.

As the plant operator gains more experience concerning the maintenance requirements of the analyser, the monitoring frequency may be reduced to more extended periods of time.

It is important that the filter-units, listed in chapter 10 of the operation manual, are checked regularly and, if necessary, service parts are changed.

ATTENTION
In case of not intended use the guarantee will void. Regular controls, inspections and the exchange from polluted and exhausted filters by the operator are also an important part of the determination "not determined use". See chapter 9 regular maintenance work.

2.1. Important information about the user's operation manual

The users/operation manual is an important part of this delivery. It will explain how to use this analyzer properly and sets forth safety and environmentally friendly procedures.

It is the responsibility of all users to read and familiarize themselves with this manual, paying particular attention to the safety instructions.

The most important safety details are clearly marked with an attention sign.

Safety declarations

In this document the safety hints will be declared as follow:

	⚠ DANGER
	Identifies an immediate, impending hazard that, if ignored, will result in severe bodily injuries or death.

	⚠ WARNING
	Identifies an immediate, impending hazard that, if ignored, may result in severe bodily injuries, material damage or death.

	⚠ CAUTION
	Identifies a possibly dangerous situation that, if ignored, may result in minor injuries.

	ATTENTION
	Identifies a possibly harmful situation that, if ignored, may result in damages to the device or its surroundings.

	NOTE
	Identifies user tips and other especially important information.

11.1. General warning

	⚠ DANGER
	Any maintenance action must be done only, when the atmosphere is verified to be not explosive.

11.2. Safety Information

The following safety procedures must be followed at all times. They are significant and essential part of this manual. Failure to follow safety procedures can result in the loss of your warranty claims.

Biogas or other similar gases (landfill gas, bio-methane, coal seam gas etc) is containing flammable gas component CH_4 and toxic gas component as well (H_2S and CO_2).

Analyzers is continuously sampling a certain volume (approx 50l/h) of the sample gas, and is venting it to ambient air.

For this reason, there are two aspects which must be considered:

1)   toxicity danger of sample gas

2)   flammable (explosion) danger of sample gas

1) Inhaling toxic gases is harmful to health and can even cause death in some cases.
- It is the responsibility of analyzer user to ensure that person is skilled and trained in safety aspects of gases being analyzed and procedures to follow while using this instrument.
- Local regulations for possible exposition to toxic gases have to be known and obeyed by the user of the analyzer
- Using a personal gas detector inside the biogas plant is highly recommended since H2S in higher (very dangerous) concentration cannot be detected by human nose. Only small concentrations around few ppm can be detected by human nose
- CO2 gas is heavier than air and therefore operator shall avoid working at underground or confined spaces. Beside of that CO2 is also odorless!
- It is not allowed using the biogas analyzer in confined space or rooms without forced ventilation.
- Sample gas exiting the analyzer will flow in the ambient air and only outdoor use or forced ventilation rooms are suitable for using the biogas analyzer

2) Regarding flammable gases (e.g. CH4 methane) and hazardous area of operating the instruments, user must also be able to recognize the area classification and be aware of using the instrument there. This area classification is country specific, please observe and notice it.
- Stationary analyzers are allowed to be mounted in hazardous area zone 2 only if they have the certificate of compliance. These instruments shall never be located in confined places or rooms without forced ventilation.

Only trained personnel should carry out installation of stationary instrument and/or maintenance, service and repair. Opening the stationary analyzer cabinet can expose personnel to injuries and shocks from mains voltage!

Safety regulations

The analyzer may only be used as indicated in this manual. Our analyzers are checked according to the following regulations:

VDE 0411 (EN61010) and DIN VDE 0701 before they leave the MRU GmbH factory.

MRU technical products are designed and manufactured according to DIN 31000/ VDE 1000 and UVV = VBG 4 of the professional guilds for fine mechanics and electrical engineering.

MRU GmbH assures that the analyzer complies to the essential requirements of the legal regulations of the member states of the electro-magnetic compatibility (89/336/EWG) and to the low-voltage regulations (3/23/EWG).

Specific safety regulations

No part of the analyzer, or any other metal parts & accessories shall be used as electric conductors.

The analyzer shall not be used in or under water.

The analyzer shall not be placed near or directly exposed to open fire or heat.

The analyzer shall avoid dropping.

⚠ CAUTION
Moisture or condensate, being pumped out of the condensate outlet port can be slightly acidic.
In case of skin contact IMMEDIATELY: clean affected parts of the body.
Avoid getting liquid in eyes.
Please carefully clean all parts that come into contact with the condensate.

11.3. Packing

Packing regulation of 12.07.1991

If your local waste facility does not accept 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.

11.4. Return of hazardous waste

Waste Disposal/Returns/Warranty -

MRU GmbH is required to accept the return of hazardous waste such as electro-chemical sensors that cannot be disposed of locally. Hazardous waste must be returned to MRU prepaid.

11.5. Return of analyzer

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.

11.6. MRU guarantee conditions

MRU granted of the analyzer SWG100 BIOGAS a guarantee of 12 month.

1. 6 month on MRU spare parts.
2. The term of the guarantee conditions starts as of the invoice date.
3. Excluded from the guarantee conditions are damages, which occurred by:
- Improper use.
- Improper application.
- Improper mounting.
- Deliberate or negligent destructions.
- External influence for example fall, hits, solvents, acids, gases, by normal wear or transport damages. This applies also for defects, which are caused from high pollution and/or moisture (condensate) in the gas route or on the sensors.

4. As well excluded from the guarantee conditions are typical consumable- and spare parts.
5. The guarantee condition denatured immediately, if no original consumable parts are installed. The guarantee is only for original MRU consumable parts and sensors.
6. With the replacement of the type plate or the serial- number of the devices all guarantee conditions will be invalid.
7. The service of a guarantee conditions will not enlarge the guarantee time. Demands because of consequential damages are excluded.
8. The transport costs for round trip takes the consignor or the warrantee.
9. MRU reserves the right, to determine individual conditions or exceptions. These will be separated informed.

12. Analyzer Description

12.1. Intended use

The instrument is intended for analyzing the composition of biogases / biomethane / landfill gases and determine the concentration of several components like CH4, CO2, O2 and H2S. The instrument may optionally be equipped to monitor several sites in time sharing technique (cyclical one by one sampling).

In particular, the instrument is not foreseen to serve as a gas detector or as a safety device.

In case of not intended use the guarantee will void. Regular controls, inspections and the exchange from polluted and exhausted filters by the operator are also an important part of the determinations "not determined use"- see chapter 9 regular maintenance work.

The SWG-100BIO Ex. is an extractive measuring system. It has maximal 4 sample gas inlets, to measure the gas concentration from 4 different sample points, one by one. It has an internal gas pump to suck the sample gas from the sampling points. After the measurement, the sample gas is vented through the sample gas outlet (Vent).

All sample points are equipped with a flow restrictor orifice, which allows also sampling the gas from the higher-pressure gas pipe of the engine, while limiting the maximum amount of gas in case of internal cabinet piping leakage.

12.2. Principle of operation

- Sample gas from one or more sampling points is fed into the analyzer by dedicated ports. Internally mounted electric valves select one point at a time to feed sample gas to the analysis unit.
- The instrument is equipped with a non-dispersive infrared (NDIR) bench for analysis of CO2 and CH4. Two separate infrared detectors for each CO2 and CH4 are included, each operating with a different optical path length and stabilized by referring to a reference detector. The IR source is a highly efficient and stable IR emitter, pulsed at a frequency of several Hertz. By design NDIR technique offers good stability and selectivity together with long life time of sensor (only limited by corrosion or dust, which can be prevented or removed by regular servicing the instrument).
- The instrument is optionally equipped with a number of electro-chemical sensors ECS in order to detect gas components like oxygen O2 or H2S. Those sensors offer a reliable and effective way to detect the target gases. They are typically of limited life time (several years) but may be easily replaced once the end-of-life is reached.
- In regular time intervals (user settable), the instrument automatically switches to purge the sensors with fresh (ambient) air for re-adjust the zero point.
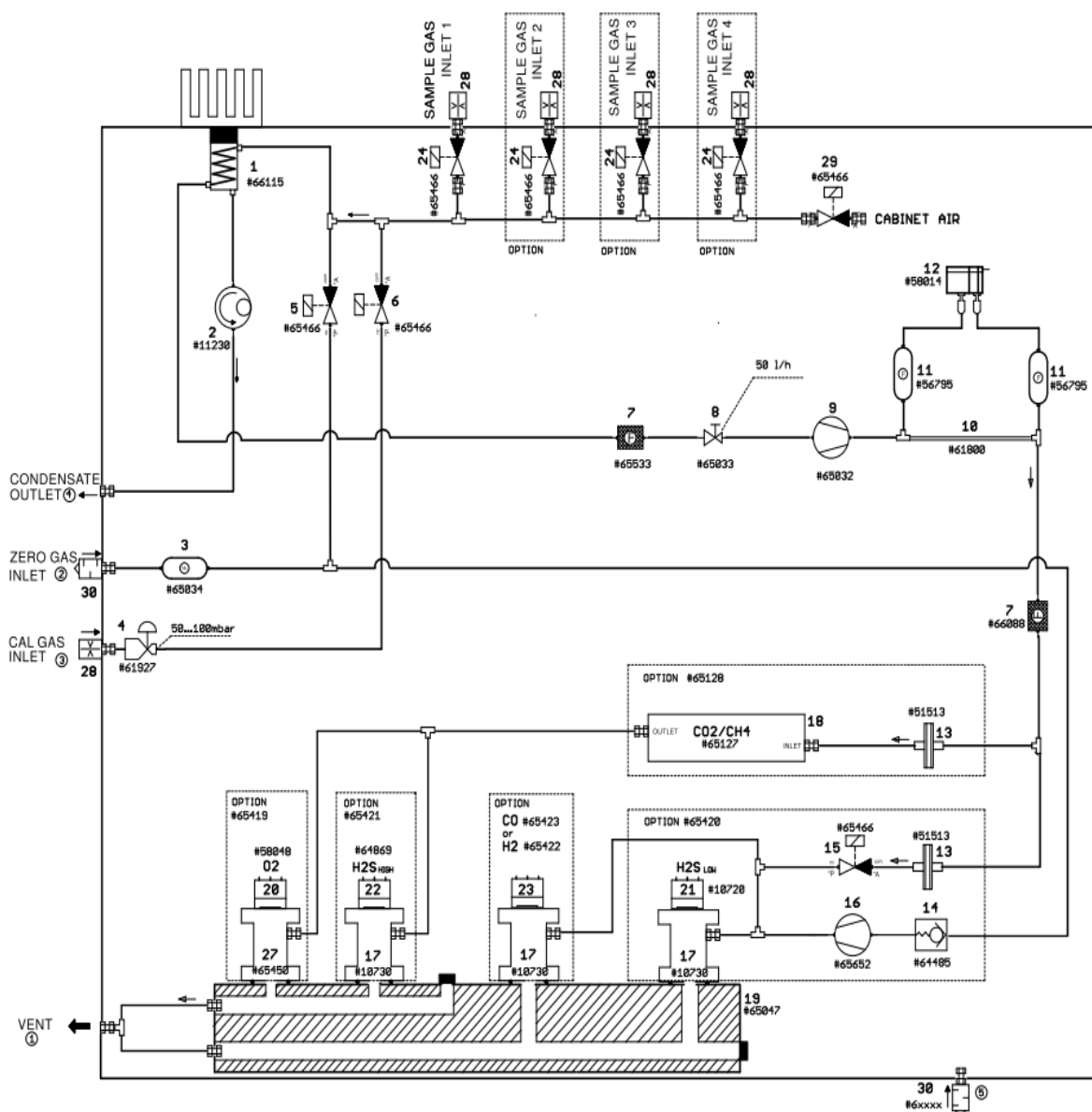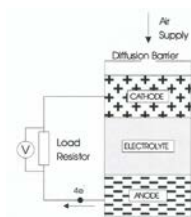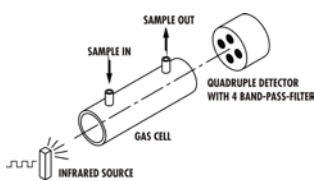
12.3. Marking and range of application

The SWG100BIO-EX was designed for use in hazardous area with potentially explosive atmosphere and was certificated by ATEX directive:

EX-Protection: **[EX] II 3G Ex nA nC IIC T3 Gc**
Certification no.:   **EPS 16 ATEX 1xxx X**

The SWG100BIO-EX is operating in a temperature range of -20°C … +45°C with intern cabinet heater.

The specifications of the analyzer are:

Main power supply:	*230 VAC / 50 Hz*
Power consumption:	*36 VA*
Protection class:	*IP65*
Fuses:	*230 VAC/ 50Hz / 6 A*
Data output interface:	*4…20 mA / analog outputs* *RS485 Modbus RTU*

12.4. Possible applications and analyzer options

The biogas analyzer SWG100 is the industrial measuring solution to be used at all hazardous zone 2 areas of::
• biogas (anaerobic digestion) plants
• cogeneration heat and power engines (CHP)
• municipal or industrial waste water treatment sites
• coal seam gas sites (coal bed methane)
• food and animal waste processing plants
• biomethane (gas to grid) plants
• landfill sites

12.5. Features

This analyzer can be equipped with additional options and/or additional accessories to full fill multiple other measuring tasks such as
• $H2S_{low}$ measurement with protected EC cell using cutoff solenoid valve and air purge pump
• $H2S_{high}$ measurement with EC cell
• H2 measurement with EC cell
• CO measurement with EC cell
• Multiple sampling point switchover from 2x up to maximum 4x sites
• Module with 4 channel analog outputs/inputs 4-20mA, with 2x "fail safe" alarm relays
• Converter module of RS485 into Profibus
• Cabinet heater for freeze protection

Ask our sales representatives for available options and accessories or check out our MRU website.

13. Overview of the SWG-100BIO Ex

13.1. Scope of supply and delivery

The delivery contains the follow components:

- SWG-100BIO Ex analyser, with a stainless steel case.
- A stainless-steel thread filter for the zero gas inlet, with a G1/8 inch male thread.
- Flow restrictor orifices for the sample gas inlets, with a G1/8 inch female thread. The number of flow restrictors is depended from the number of gas sample inlets.
- A fitting for the gas outlet (vent), with a G1/4 inch male thread.
- Mounting material.
- Optional: Flame arresters for the sample gas inlets, with a G1/4 inch male thread.

13.2. Material required for the installation (not scope of supply)

Material for tubing or hosing the sample gas inlets and outlet.

- ***For the sample gas inlets:*** Flexible PTFE tube or stainless steel tubing with a diameter of 4/6 mm. It could be necessary to install a heated sample line on the tubes, to protect the sample gas from freezing.
- ***For the sample gas outlet (Vent):*** Flexible PTFE tube with a diameter of 8/10 mm. It could be necessary to install a heated sample line on the flexible tube, to protect the vent gas pipe for freezing.
- ***For the condensate outlet:*** Flexible tube with a diameter of 4/6 mm. It could be necessary to heat the condensate tube to prevent that the condensate for freezing.

Power supply lines and signal lines

- Cable for power supply: Cable type: H 07 RN-F 5 G 0,75 mm²
- Signal lines for 4…20 mA analog outputs.
- Signal lines for Modbus RTU digital transfer.

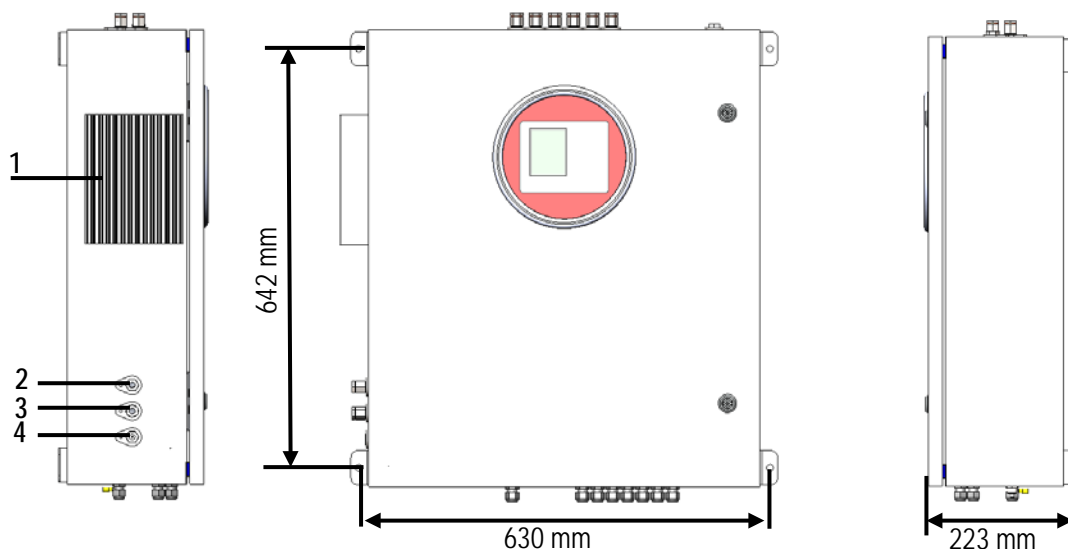## 13.3. Dimensions and views of the analyser

Top view:

Reference:
1. Sample gas inlets G1/8 inch female thread.
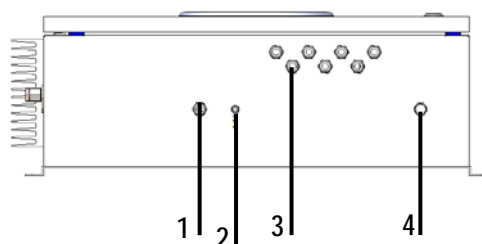2. Sample gas outlet G1/4 inch female thread

Front view / left view / right view

Reference:
1. Heat sink of gas cooler unit
2. Calibration gas inlet G1/8 inch female thread
3. Zero gas inlet G1/8 inch female thread
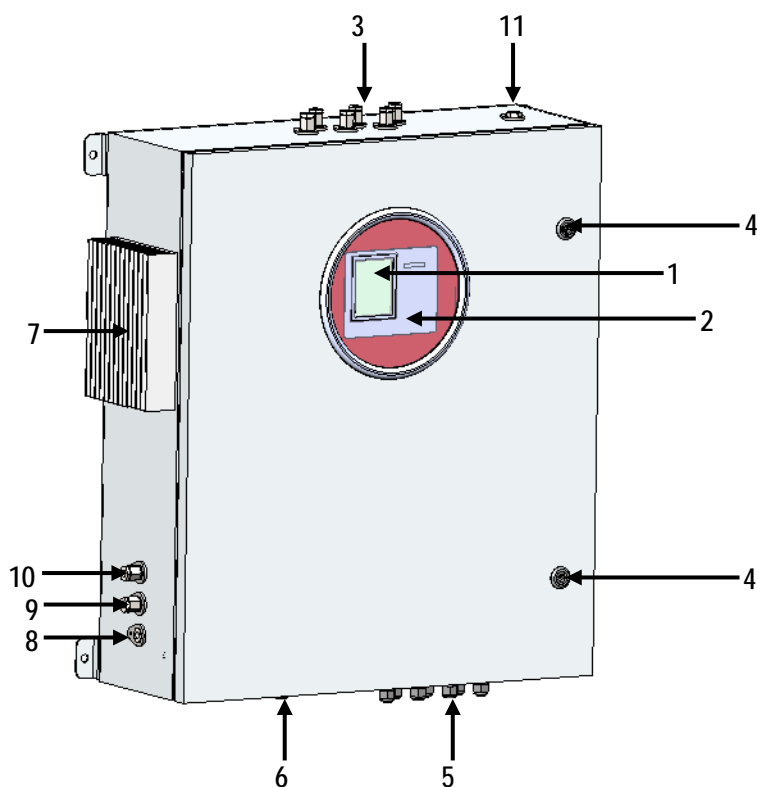4. Condensate outlet G1/8 inch female thread

Bottom view

Reference:
1. Cable gland M16 for power supply
2. PE bolt for earthing cable
3. Cable gland M16 for I/O modules
4. Breather drain

13.4.   Position of the gas in and outlets

1	Display (color, with backlight)
2	Keypad
3	Sample biogas inlet ports (1 to max 4), female G1/8″ threads
4	Cabinet lock
5	Inlet cable glands M16 for I/O modules
6	Inlet cable gland M16 for mains power supply
7	Heat sink for gas cooler unit
8	Condensate outlet port, female G1/8″ thread
9	Zero gas inlet port, female G1/8″ thread
10	Calibration gas inlet port, female G1/8″ thread
11	Vent outlet port, female G1/4″ thread

13.5. Operating unit: Display and keypad

	NOTE
ℹ️	Operation of the keypad is intrinsically safe.

All commissioning can be carried out with the control-unit.
The operating-unit can only be operated when the cabinet door is open.
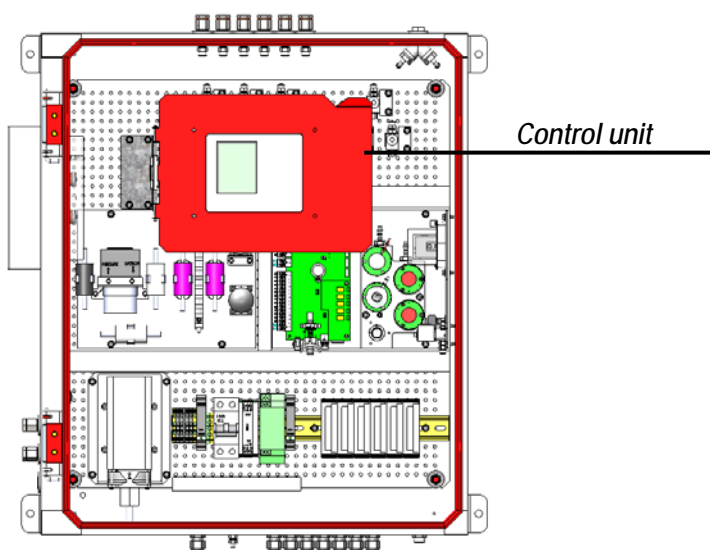
Control unit

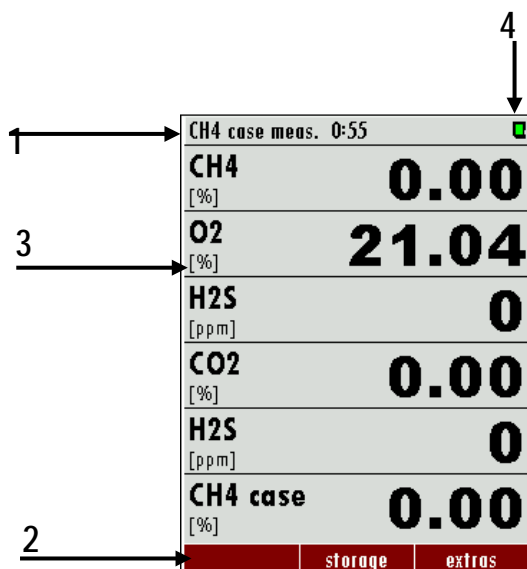|	⚠ DANGER
⚠️	**Explosion hazard** In case of system alarm, after analyser has auto-shut-off itself, the cabinet might contain an explosive atmosphere. Any ignition source must be avoided when opening the door.

Keypad for operation of control unit.
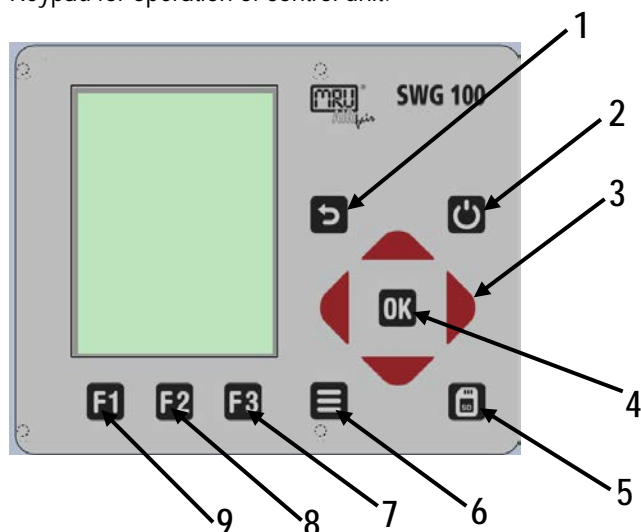
All information required to operate the analyser is displayed as shown below.

Number	Symbol	Description
1	↩	**ESC :** abort or return to the menu above
2	⏻	**Prepare Power-Down**: Press this key before you disconnect mains. The analyser will store changed user settings and other operational data and will purge the sensors
3	◀▶ , ▼ , ▲	**Arrow keys**: context dependent functions, e.g. scroll in between lines, change values, change view.
4	OK	**OK :** confirmation key, select a marked menu point.
5	🖭SD	**Screen shot :** press this key in order to store a screen shot of the current display contents onto the SD card.
6	☰	**Menu key**: Will show all available functions in the window that is currently in use – also those which have an individual key on the key pad like the printer and the three function keys.
7-9	F1 F2 F3	**Function Keys :** Activates the functions seen on the display (2 function key bar)

All information required to operate the analyser is displayed as shown below.

Number	Function
1	Menu bar
2	Function key bar
3	Display panel - Menu - Measurement value,
4	SD-Card in the slot - Indication green → read- and write access - Indication yellow → only read access (SD-Card write protected)

14.1. Measurement menu

The measurement menu is the main root of the menus. Here you can see the current measurement values, the current sampling point number and the status of the zeroing process while it's active. Via pressing the function keys F1-F2-F3 you can reach other menus:
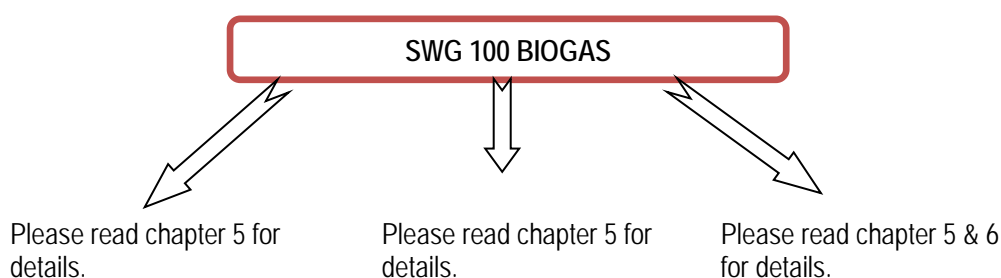
- F1: Menu Sample Point Switching
- F2: Menu Storage
- F3: Menu Extras

Menu Memory   all tasks for the management of the data memory available.
Menu Extras   all the other available tasks – for management and customizing your analyzer.

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              ┌──────────────────────────────┐
              │       SWG 100 BIOGAS          │
              └──────────────────────────────┘
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Please read chapter 5 for details.   Please read chapter 5 for details.   Please read chapter 5 & 6 for details.

Measurement configuration	SP3
Zeroing time	0:01:30
Response time	0:01:30
Temperature unit	°C
	return

Storage menu	SP4
Sample point 1	8
Sample point 2	8
Sample point 3	8
Sample point 4	4
All sample points	28
Available memory	99.9 %
delete	view	export » SD

Extras menu	SP4
General settings	
Measurement configuration	
Analog output configuration	
Alarm output configuration	
Sample point configuration	
Service menu	
Default settings	
Contents SD card	
Device info	

No matter which menu is currently active you will return to the measurement menu by pressing the ESC key several times.

15.   Explosion protection systems of SWG100BIO-EX

The explosion protection of SWG100 Bio-EX is based on the nA and nC type of protection as indicated in the ATEX declaration. Following aspects have to be followed.

Any action not in line with the guidelines below may violate the explosion protection of the SWG100 BIO-Ex and may results in danger and explosion hazard

⚠ WARNING
The following chapter explains with which protection systems the SWG100BIO-Ex. is equipped. If one of the explained protection systems is triggered, the user must do the following actions to prevent an ignition inside the analyser cabinet.

- Only staffs with a "hot permit" are allowed to restart the analyser in service.

- The staff must have a certified flammable gas detector to monitor the ambient atmosphere.

- The cabinet door shall not be opened by force in order to prevent ignition sparks.

- The entire cabinet must be checked for absence of flammable gas with a certified combustible gas detector.

- It is not allowed to restart the analyser in service, until the cause of system alarm is remedied.

- Exchange disconnected flexible tubes. Never use exhausted tubes again.

15.1.   Electrical components

All components in the SWG100 BIO-EX are selected and qualified to meet the requirements of the given type of protection (nA or nC). Make sure that any change to the instrument during it's life time are in line with the requirements of this type of protection. No change to the wiring or change of components are allowed without prior information about the impact on the type of protection of these changes. Always ask feedback of MRU for the intended changes.

15.2.   IP 65 cabinet

The SWG100BIO-Ex. has an IP 65 cabinet. The cabinet prevents explosive gases and dust to penetrate inside. Prevention from dust is a basic requirement to the type of protection. Therefore, it is required to always operate the instrument with the door being closed. Perform a visual inspection in regular time intervals to verify the housing and the seals of the door and window are not damaged.

15.3.   CH$_4$ measurement of inside cabinet

While the components internal to the instrument are verified to meet the type of protection, it is nevertheless required to monitor the cabinet to prevent explosive atmosphere being present. Therefore SWG100 BIO-EX implements a regular monitoring of the CH4 content inside the cabinet with the help of the CH4-NDIR bench used for biogas measurement.

In case an explosive atmosphere is detected inside the cabinet, the SWG100BIO-EX outputs an alarm signal to the remote power supply box, which interrupts the power supply of the full instrument.

Desciption of the CH4 cabinet monitoring

The main parts of the system are following:

- The CH4/CO2 NDIR- bench.
- A solenoid valve, which feeds the atmosphere inside the case to the CH4/CO2 NDIR bench.

The figure below shows the position of the two components.

Solenoid valve for CH4 monitoring

CH4 / CO2 NDIR-bench
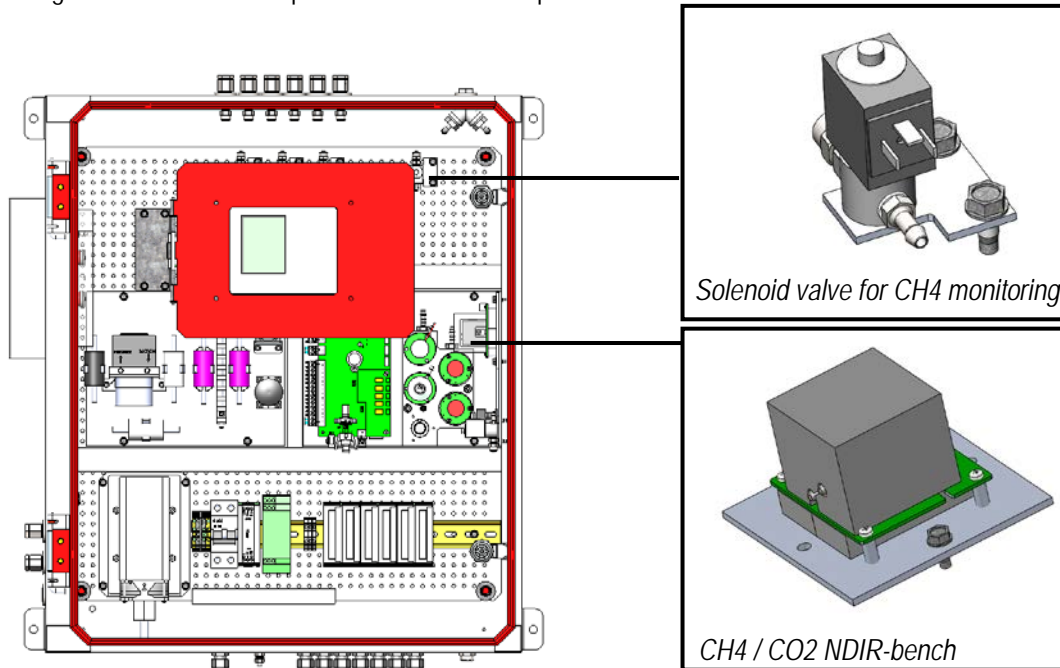
- The CH4 cabinet measurement is inforced after each air purging phase / zero point. This phase takes 2 minutes and is called 'CH4 case measurement'. During this phase the menu indication bar will indicate '*CH4 case meas.'* and a count-down starts.
- During this phase, all solenoid valves are closed and the solenoid valve, which feeds the gas from inside the cabinet, will open. The first 90 seconds of the CH4 monitoring is used to feed the inside cabinet atmosphere to the NDIR bench. *Only in the last 30 seconds the CH4/CO2 NDIR- bench detects the CH4 concentration*. During this time the measured CH4 values will be shown also as life values.
- The CH4 concentration is displayed as CH4 % concentration as well as CH4 concentration in % LEL in the measurement menu (see screenshots below).
- If the CH4 concentration rises over an user defined value, an alarm will be triggered for 2 minutes. After the 2 minutes the analyser will power down to prevent an explosion.
- The CH4 alarm threshold can be set in the general menu (find on the path: EXTRAS / GENERAL MENU).
- If the user must perform maintenance works on the analyser and the alarm appears, it is possible to delay the power down for 1 hour to max 2 hours. The alarm menu can be closed with the key *F1* or *ESC*. The alarm is still active, the user will see a flashing red 'OFF' on the menu indication bar.
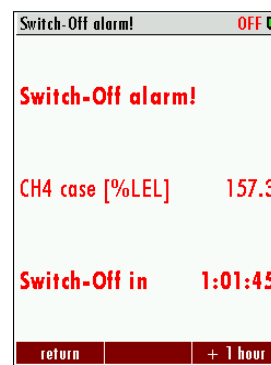

Menu screen in the „CH4 case meas." mode

•
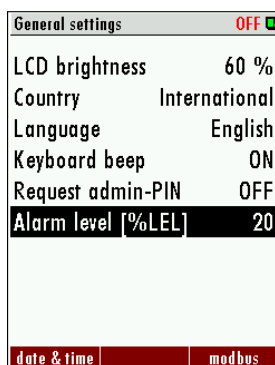
General menu: Menu-point to set the LEL Level
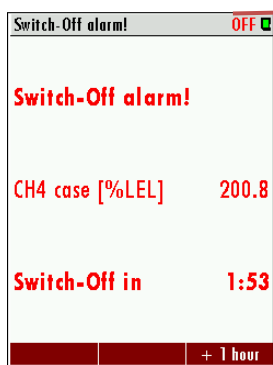
Switch off alarm. The user has 2 minutes before the SWG100BIO-Ex power down.


Screen after a delay was added

Self test of the CH4/CO2 NDIR- bench

The *CH4/CO2 NDIR-bench* being a part of the SWG100BIO-EX protection system, is required to be monitoring itself. In case the bench is supposed to be not working correctly, the alarm output is activated as well, which will lead to a power down of the instrument.

This self test is performed regularly and intrinsically by the biogas sample gas measurement itself. The analyser detects the CH4 concentration on all installed sample gas inlets. If the CH4 concentrations of all inlets are below 5 Vol.%, the alarm is triggered. The user has the possibility to manually delay the power-down in 1 hour intervals (max. 24 hours), in case the missing CH4 is known to be due to the sample gas composition. Do not delay the alarm if there is any doubt on the NDIR bench's performance. The alarm is still active, the user will see a flashing red 'OFF' on the menu indication bar.

In case the user needs to pause the self test supervision for a limited time interval, this can be done for a couple of hours (min.2:00:00 max.24:00:00) in order to prevent a switch-off alarm. To pause the function, select to the path: EXTRAS / CH4 SENSOR SUPERVISION. The following menu will appear. With F3 the supervision function can be switched off and on. In the screen a countdown appears. This countdown shows when the paused CH4 sensor supervision will restart. With the right/ left arrow keys the countdown can be set up until 24 hours.
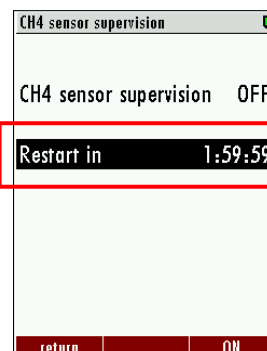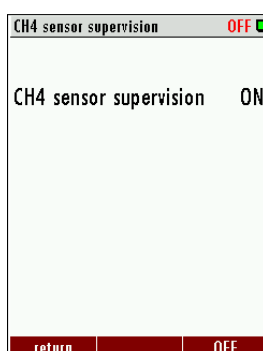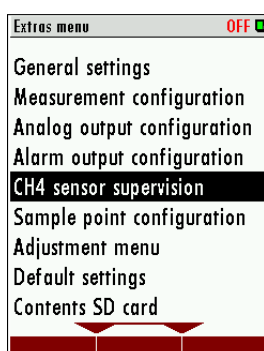
*Right / left arrow keys to set the countdown up or down.*

After power-on the CH4 sensor supervision will start as soon as all sample gas inlets have been measured once and not earlier than 1 hour operation.

15.4. Remote Power Supply Box

When the SWG100BIO-EX outputs an alarm (due to internal CH4 detected or due to failed self test) it is required to switch off the instrument completely by means of an external power supply box, which shall be located in safe area, in the power supply distribution cabinet.

The Remote Power Supply Box as optionally supplied by MRU, has a switch-off contactor **(K1)**, with 3 make contacts (normally open). The power contactor K1 is activated after the analyser is powered on by pushing the power-on button until the green LED is light-on. In case of an SWG100BIO-EX alarm, the power contactor K1 is deenergized. The circuit diagram shows the correct wiring of the power contactor installed in the remote power supply box.
For more information see chapter 20.3
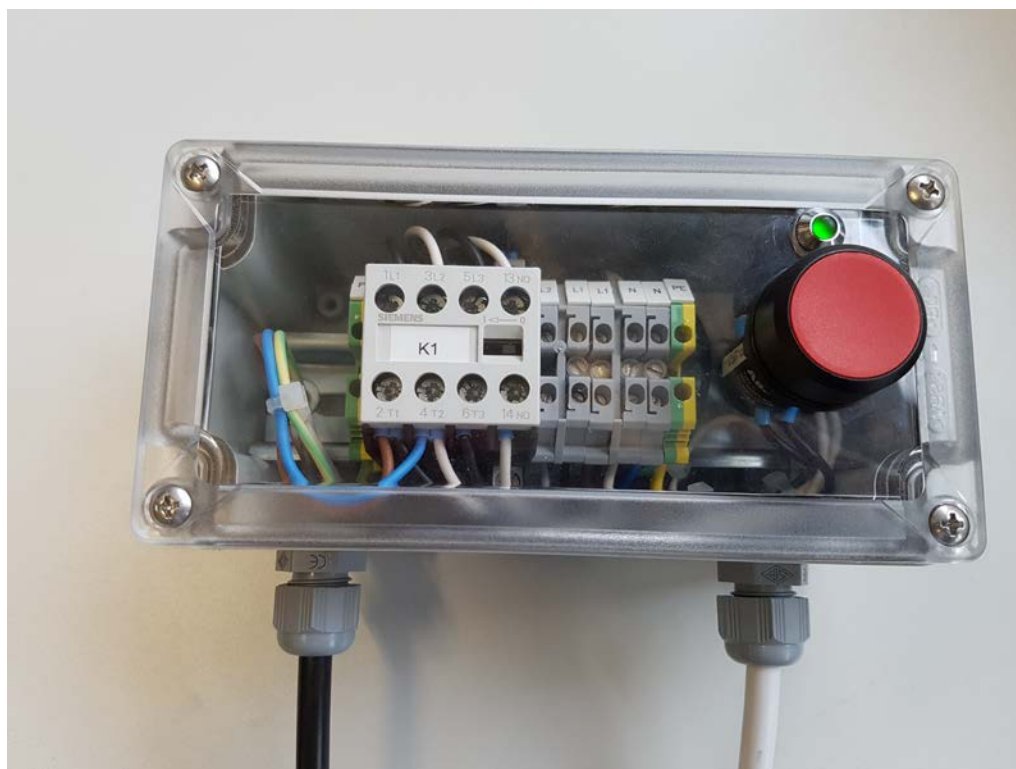
The circuit diagram of above pictured device <u>must be implemented</u> by user as part of the safety concept.
User can either use the remote power supply box as offered by MRU, or install inside the power distribution cabinet a similar circuit (see diagram in chapter 20.3) using a power contactor and push-start button.
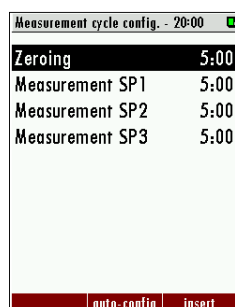
16. Sample Gas measurement

16.1. Cycle configuration

Path and default setting

EXTRA/ MEASUREMENT CYCLE CONFIG.
When the menu "MEASUREMENT CYCLE CONFIG." is selected the user definable setting for the measurement cycle will appear (see screenshot below).

Measurement cycle config. - 20:00	
Zeroing	5:00
Measurement SP1	5:00
Measurement SP2	5:00
Measurement SP3	5:00
auto-config	insert

Screenshot shows default setting, when the „MEASUREMENT CYCLE CONFIG." will be started the first time.

General information

The menu point "CYCLE CONFIGURATION" allows the user to configure an individual measurement cycle. Every installed sample point can be configured. For the configuration the user has the following phases, which can be selected:

- Zeroing.
- Purging.
- Stand-by.
- Measurement SPx (SPx stands for Sample point 1, 2…).

The configuration is performed with the three function keys *F1*, *F2* and *F3*.

- *F1*:   Delete a phase.
- *F2*:   Make an Auto-config.
- *F3*:   Insert a new phase.
- *OK*:   View/change phase details
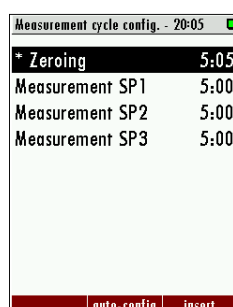- *Left/right*:   Change the phase type.

Auto configuration

With *F2* the "Auto-config." can be selected. The user can select one of two default cycle configurations.

- One zeroing / cycle.
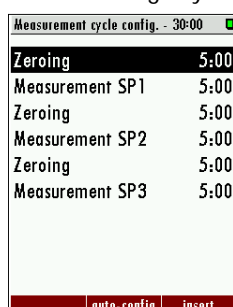- One zeroing / sample point.

The first program is for applications where the different measurement points have almost the same gas concentrations. The zeroing is not necessary at every change of the measurement SPX.
The second program is for applications where the different measurement points have different gas concentrations. A zeroing is recommended after every measurement point change.
The screenshots below show the "One zeroing / cycle" and "One zeroing / sample point" in comparison.

Measurement cycle config. - 20:05		Measurement cycle config. - 30:00	
* Zeroing	5:05	Zeroing	5:00
Measurement SP1	5:00	Measurement SP1	5:00
Measurement SP2	5:00	Zeroing	5:00
Measurement SP3	5:00	Measurement SP2	5:00
		Zeroing	5:00
		Measurement SP3	5:00
auto-config	insert	auto-config	insert

The two auto-configurations, which can be selected.

Depending on the analyser type, the first or the first and second phase cannot be deleted, deactivated or moved to another position.

Delete a phase

With *F1* a phase can be deleted. To do this, select the phase, which should be deleted and press *F1*.

Screenshot shows how a phase can be deleted. In this example the last phase "Measurement SP3" is deleted.

Insert a phase

With *F3* a new phase is inserted in the measurement cycle. With the *right/left arrow keys* the different phase types can be selected.

In the title-bar the entire cycle time is shown. It is called "Measurement cycle config."
With *OK* the "Cycle phase details" can be shown and changed.

Configuration of the phase details

In this chapter the different cycle phase details will be explained.

Zeroing (Cycle phase details): In the cycle phase detail "ZEROING" the zeroing time can be configured.

ZEROING	
Measuring site valves	Valves closed
Zeroing valve	Valve open
Duration	2min to 1 h
Recommendation	5min., in general not to be changed by user as depending only on analyzer internal setup

Measurement SPX (Cycle phase details): In the cycle phase details of "Sample point X" the measurement time and the suction delay can be configured. Each sample point can be configured individually. In the cycle phase details the following times can be set:

MEASUREMENT SPx	
Measuring site valves	Valve of selected site is open, others closed
Zeroing valve	Valve closed
Duration	Phase duration: 2 min. to 24 h Suction/response time: 30 sec. to 1h Pure measurement: calculated H2S-low: Activated/protect (Optional)

Stand-by (cycle phase details): In the cycle phase details "Stand-by" the sleep mode time can be configured. In the cycle phase details the following times can be set:

- _Phase duration:_ Entire Stand-by time (Purging time + Quiet time = Phase time).
- _Purging time:_ The time, to purge the analyser with ambient air, through the zero gas inlet.
- _Quiet time:_ The time, where the analyser is in the pure stand-by mode.

STAND-BY	
Measuring site valves	Valves closed
Zeroing valve	Valve closed
Duration	Phase duration: 2 min to 24h Purging time: 30 sec. to 1h Quiet time: calculated

- _Purging (cycle phase details):_ The purging is a separate configuration point to purge the analyser with ambient air through the zero gas inlet. It can be helpful, if the analyser must switch between a sample point with different sample gas concentrations.

PURGING	
Measuring site valves	Valves closed
Zeroing valve	Valve open
Duration	30 sec. to 1 h

Activated/deactivated a phase

The user has the opportunity to deactivate a phase in the measurement configuration cycle. This could be necessary for example if a sample point is temporarily not in use. The activation and deactivation of a phase can be done in the cycle phase details of the concerning phase.

Example for the deactivation of a phase

In this example the "Measurement SP2" will be deactivated. The deactivated phase is grey out.

Example for a measurement cycle configuration

In this chapter an individual measurement cycle should be created with the features described at the chapters below.

The measurement cycle should have the following sequence:

Following points must be done to configure the individual measurement cycle:

1. Open the measurement cycle config. menu: Path: EXTRA/ MEASUREMENT CYCLE CONFIG.
2. The default measurement cycle will appear. Open the cycle phase detail of the first zeroing and adjust the phase duration at 25 min.
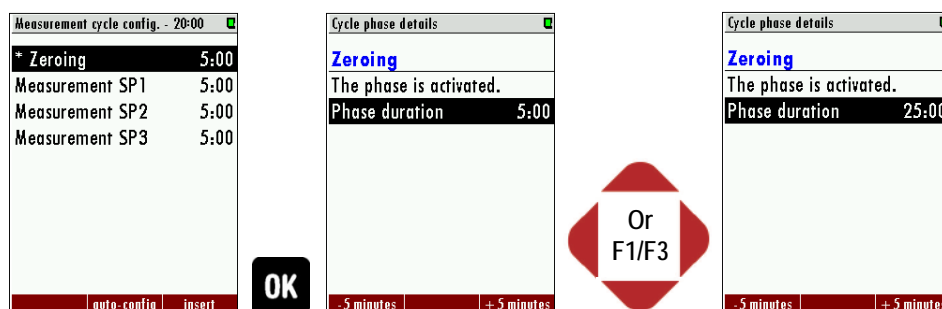
3. Leave the cycle phase detail and select the second point. Switch with the *left/right arrow keys* until the measurement SP2 is selected.
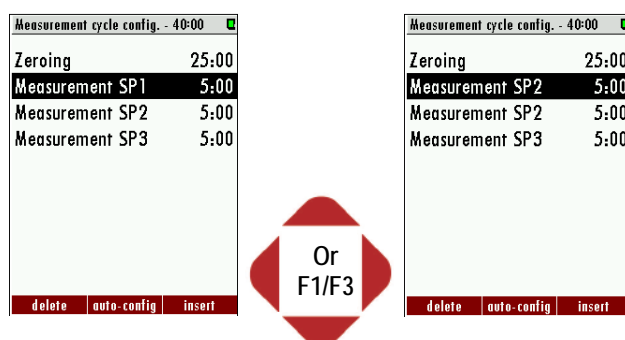
4. Open with the *OK* key the cycle phase detail of the measurement SP2. Adjust the duration-phase at 15 min. and the suction/response time until the pure meas. time has the value of 3 min. Use for this operation the *arrow keys*.
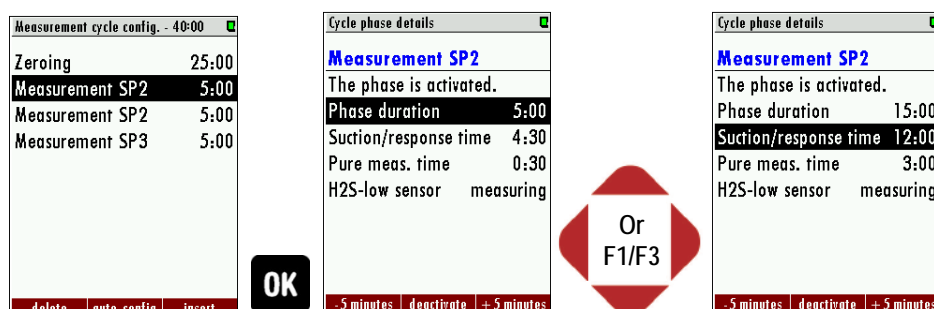
5. Leave the cycle phase detail and select the next phase. Select with the *left/right arrow keys* the phase "zeroing" and go in the cycle phase detail. Adjust the phase-duration at 15 min. and leave the cycle phase detail.

6. Switch to the next point and select with the *left/right arrow key* the measurement SP1. Go in the cycle phase detail of the measurement SP1. Here adjust the duration-phase 10 min. and the pure measurement time: 5 min.

7. At last push *F3* key for insert a new phase and select with the *left/right arrow* key the "Stand-by" phase. Go into the cycle phase detail and adjust the Purging time at 3 min. and the Quiet-time at 10 min.

Leave the menu and safe the adjustments. The individual configuration is done.

16.2.   H2Slow sensor protection (optional)

The instrument may be optionally equipped with a H_2S_{low} sensor. As this sensor typically shows limited life time when experiencing high H2S concentrations, some precautions are taken to protect the sensor:

- The instrument is equipped with a cut-off solenoid valve and air purge pump to protect the H_2S_{low} sensor, without impacting the results of all other sensors.
- The purge unit is always activated after 3-10 minutes of active sensor measuring time.

- The measuring time of the H_2S_{low} sensor may be limited to less than 10 minutes by user setting
- The H_2S_{low} sensor may optionally not be included in all measuring cycles of sampling points. Instead the user may configure that the H_2S_{low} sensor is active only added at some of the measurement cycles.

17. Analyzer mounting and installation

17.1. Content of your order
Your analyzer is delivered in a carton box and is protected with special edged protectors. Please do preserve the packing of your analyzer, for possible back shipment.

17.2. Installation rules to guarantee explosion protection
The SWG100BIO-Ex. has an ATEX Class 2 certification. To guarantee, that the analyser can be operated safely in this area, please follow the rules during the mounting and the operation of the analyser.

17.3. Prerequisites for installation

⚠ DANGER
Explosion hazard Before start the mounting and installation work, detect the atmosphere with a certificate gas detector.

⚠ CAUTION
Only educated staff should mounting the analyzer on the stack.

NOTE
Important The mounting should be done in pairs.

A measurement point must conform some criterions:

- The measurement place must be safeguarding and easily accessible.
- The measurement place must have enough space for installation and maintenance works.
- The place should be protected for direct sunlight, rain and squalls.
- The area around the analyzer must have enough space.

17.4. Steps for the mechanical mounting and installation

The graphic below shows the single steps, which must be done to mount the SWG100BIO Ex. analyser correctly into the application

```
┌─────────────────────────────────────────────────────┐
│      Mounting the analyser on a wall or a steel rack  │
└─────────────────────────────────────────────────────┘
                          │
                          ▼
┌─────────────────────────────────────────────────────┐
│            Installation of the power supply           │
└─────────────────────────────────────────────────────┘
                          │
                          ▼
┌─────────────────────────────────────────────────────┐
│       Installation of the external switch-off circuit │
└─────────────────────────────────────────────────────┘
                          │
                          ▼
┌─────────────────────────────────────────────────────┐
│            Installation of the sample gas tubing      │
└─────────────────────────────────────────────────────┘
                          │
                          ▼
┌─────────────────────────────────────────────────────┐
│         Installation of the Modbus RTU (optional)     │
└─────────────────────────────────────────────────────┘
                          │
                          ▼
┌─────────────────────────────────────────────────────┐
│             Installation of the I/O modules           │
└─────────────────────────────────────────────────────┘
```
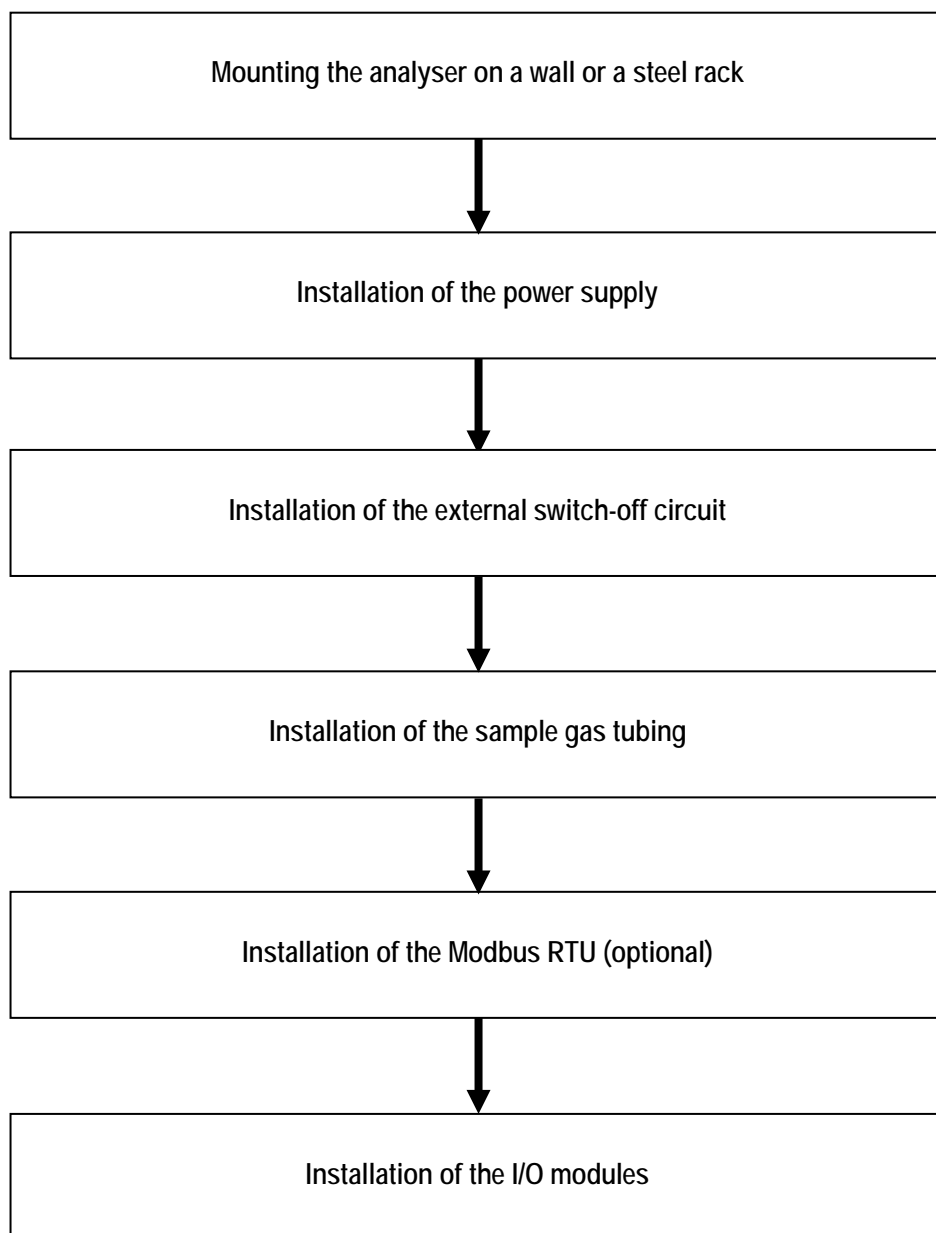
17.5. Mounting the analyser on a wall or steel rack

The analyzer can be mounted indoor or outdoor. The device is designed for the mounting on wall or on steel rack. The follow sketch shows the dimensions, which the analyzer needs for the correct mounting.

⚠ DANGER

Explosion hazard

Before start the mounting and installation work, make sure to have a "hot permit" and monitor at all time the ambient atmosphere with a certified flammable gas detector.

⚠ CAUTION

Only operate the analyzer in an upright position. Only power the device up after it is correctly mounted.
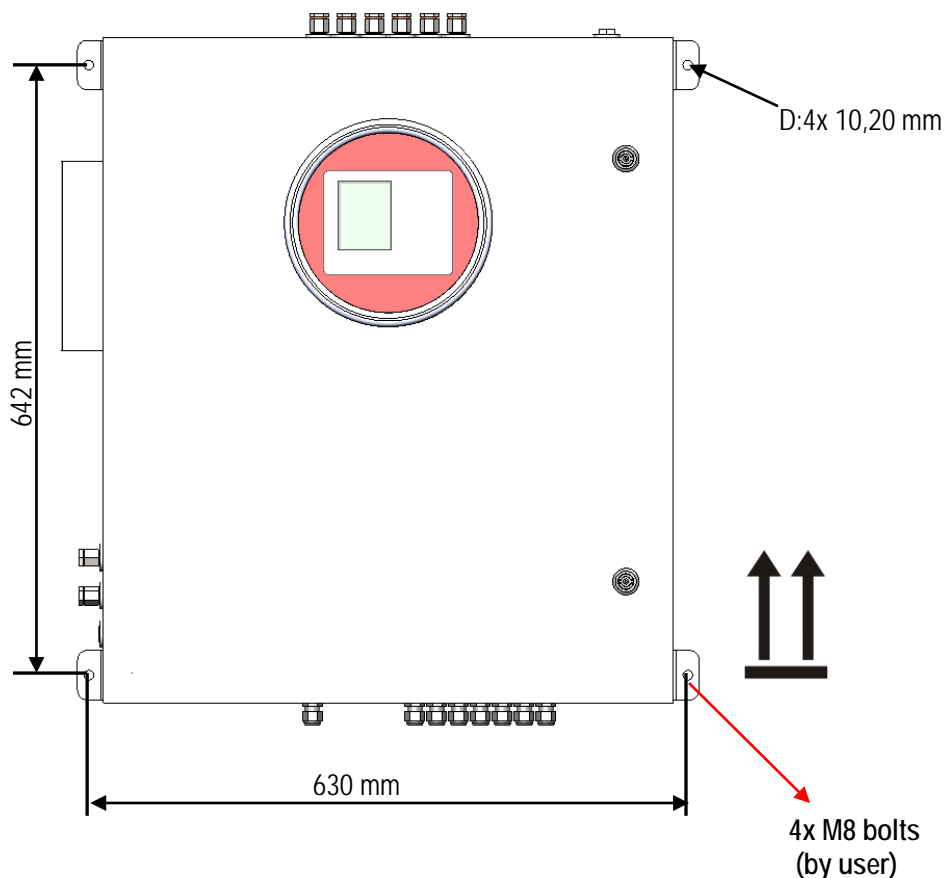
General installation rules

- Mount the device on a solid wall or steel rack.
- Be sure, that the air circulation is not obstructed.
- Let enough room for the tubing or piping.

For outdoor installation
Ensure that the analyzer is mounted on a rain and sun protected place (weather shade).

For indoor installation:

Ensure that the analyzer is installed on a dry and clean place. Be sure that the room is permanently vented with fresh air (forced ventilation).
Connect the VENT gas-outlet of the device to ambient by using adequate tube with min Ø8mm ID.

17.6. Correct tubing of the SWG100BIO-Ex

The analyzer uses two different fitting diameters. The position and the diameters of the different connectors will be shown in the sketch below:

⚠ DANGER
Explosion hazard Before start the mounting and installation work, make sure to have a "hot permit" and monitor at all time the ambient atmosphere with a certified flammable gas detector.

⚠ CAUTION
Do not cover the breather drain!

NOTE
All connectors of the analyzer use female threads.The analyzer may be connected by tubing or piping.

Distance, which should be fulfilled

Do not cover the breather drain.
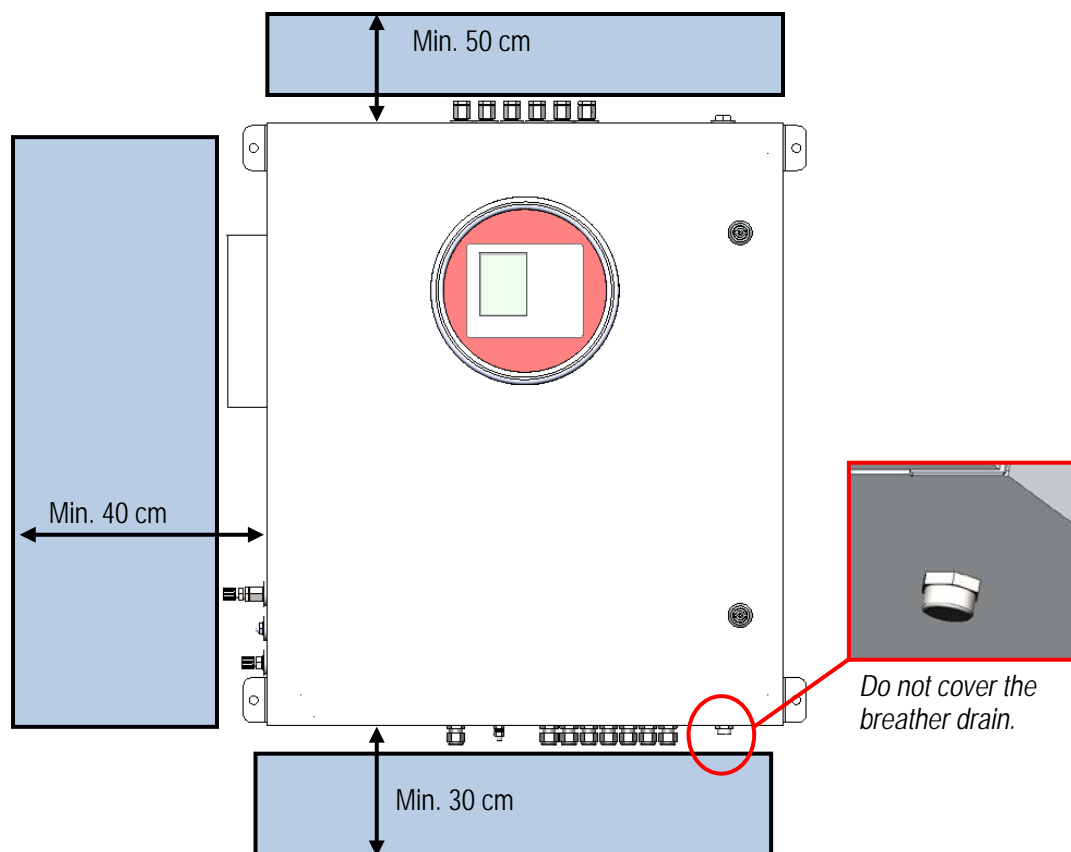
Top-side

On the top of the analyzer are the sample gas-inlets. Sample gas inlet 1 is the default gas inlet port. The analyzer may be equipped with up to 3 additional sample gas inlet ports from different sampling sites. The following sketch shows the position of the different sample gas inlets.
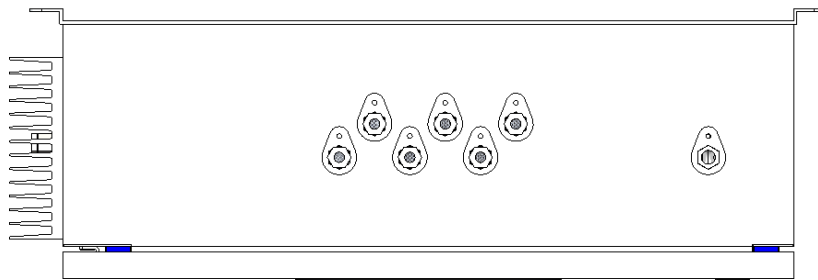
18.1.   Flow restrictor orifice (#65114)

To measure any biogas applications, the analyzer can be equipped with a flow restrictor orifice (see picture).
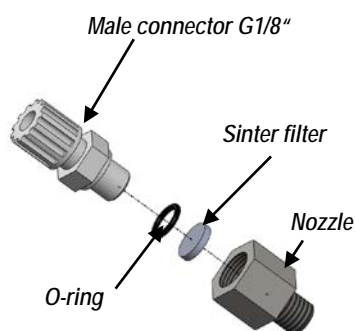
Picture: Flow restrictor orifice with intern filter.

Information
The copper seal of the nozzle is intended only for single use.

Connection the flow restrictor orifice with the gas inlets

Fitting type: G 1/8 inner ISO parallel thread for tubing with 6/4 mm flexible tube.

Information
Use PTFE strips to tighten the fitting inside the thread!

G1/8" out ISO parallel thread

G1/8" ISO parallel thread
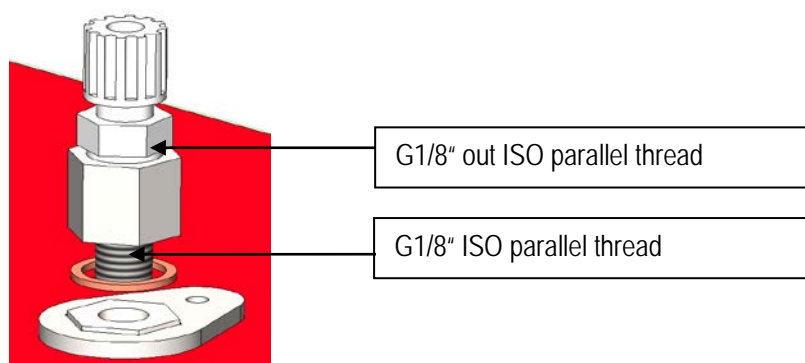
The flow restrictor orifices are installed on the sample gas inlets and on the calibration gas inlet.

Left-side

⚠ CAUTION
Be sure, that the heat sink has enough distance to the next wall.

⚠ CAUTION
Be sure that the Zero gas inlet feeds fresh, clean air.

Heat sink:
Do not cover the heat sink from the gas cooling- unit.

Calibration gas inlet
Fitting: 1/8 in. ISO parallel thread.

Zero gas inlet:
Fitting: 1/8 in. ISO parallel thread.

Condensate outlet (Option: 65408)
Fitting: 1/8 in. ISO parallel thread.
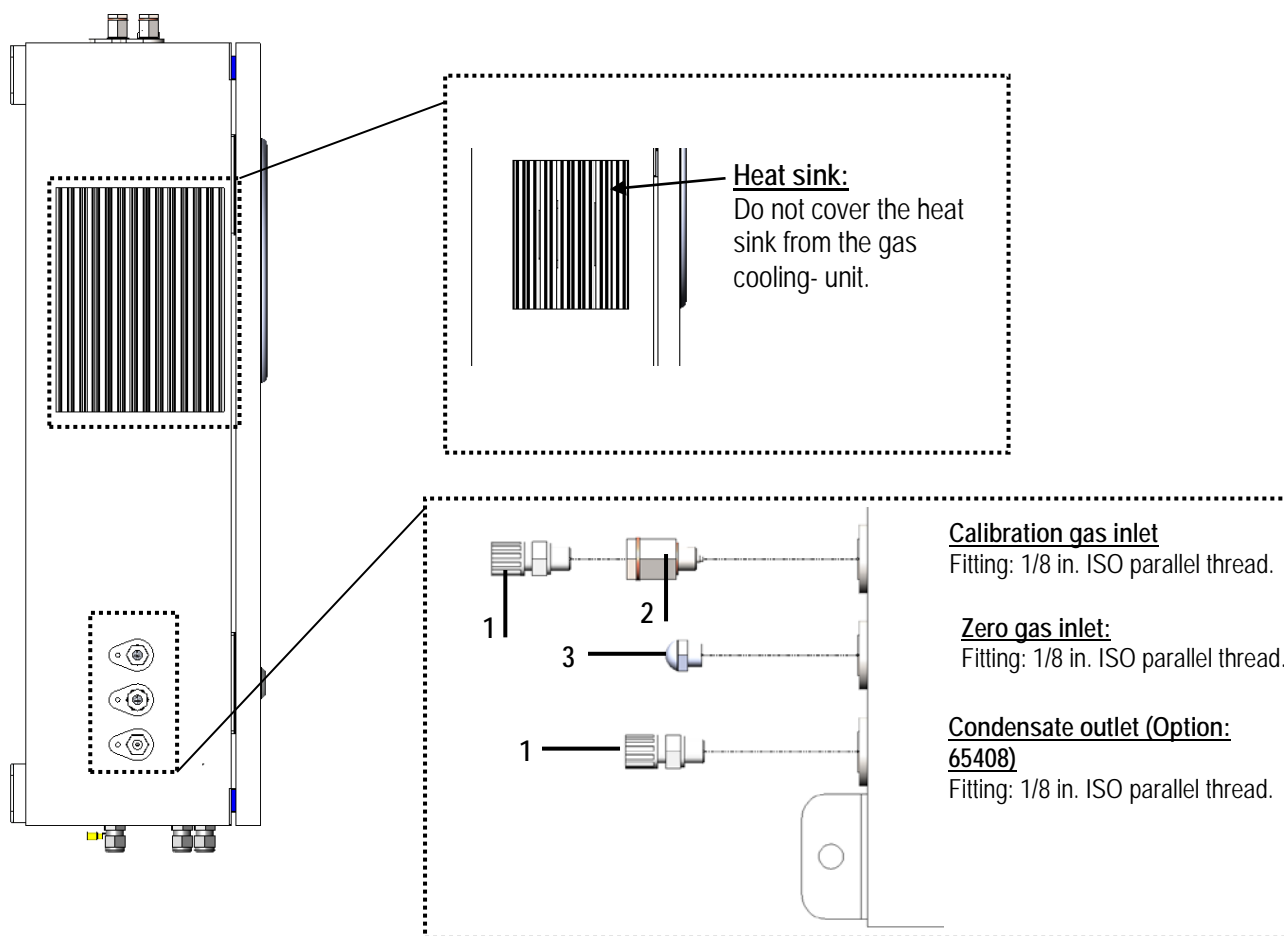
Reference:
1. Fitting for PTFE tubing 4/6 mm G1/8″ thread
2. Flow restrictor orifice G1/8″ thread.
3. Zero gas filter G1/8″ thread

18.2. Installation of the power supply

⚠ DANGER

Explosion hazard

Before start the mounting and installation work, make sure to have a "hot permit" and monitor at all time the ambient atmosphere with a certified flammable gas detector.

⚠ DANGER

Electric shock.
Electricity may cause death. Only educated staff should be allowed for mounting and installation job.

K2 switch off relay

Cable gland (M16):
For cables with Ø 3,5-10 mm.

G5

Pre-fuse

N
L
PE

100-230 Vac/ 47-60 Hz/ 300W
Fuse 4A slow (by user)

Remote power supply circuit
to guarantee power down the analyser in
case of hazard. (See chapter 20.3)

18.3. Installation of the external switch-off circuit

The remote power supply box itself is not explosion protected at all. Therefore it must be installed in safe area.

⚠ WARNING
Safety installation
The external electric contactor K1 is a part of the safety installation. It is required to be installed by user when power supplying the analyser.
The circuit diagram below shows the correct wiring of the remote power supply box.
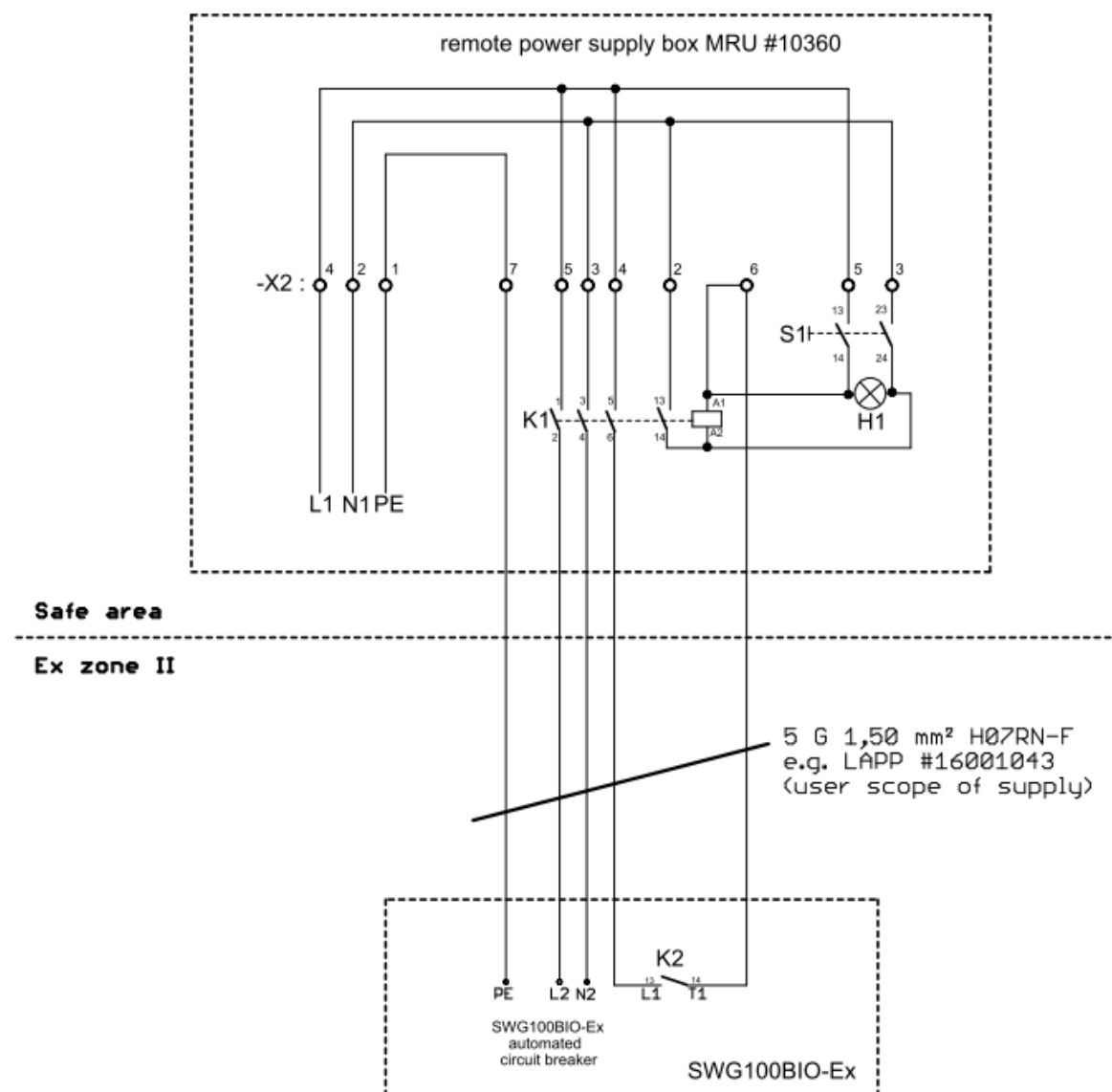
terminal connection table
terminal block: -X2

terminal or element	label	bridge	MRU #	width	object	note
1_1	PE		64768	0,75	PE mains	mains cable (user scope of supply)
1_2	PE			0,75	X1 : 7	
2_1	N1		61848	0,75	N mains	mains cable (user scope of supply)
2_2	N1	▓		0,75	K1 : 13	main contactor
3_1	N1		61848	0,75	S1 : 23	power-on switch
3_2	N1			0,75	K1 : 3	main contactor
4_1	L1		61848	0,75	L mains	mains cable (user scope of supply)
4_2	L1	▓		0,75	K1 : 5	main contactor
5_1	L1		61848	0,75	S1 : 13	power-on switch
5_2	L1			0,75	K1 : 1	main contactor
6_1	L2		61848	**0,75**	K2 : 14	connection cable to SWG 100BIO-EX
6_2	L2		62733	**0,75**	K1 : A1	main contactor
K1	contactor			0,75		main contactor
7_1	PE		64768	0,75	SWG100BIO-Ex mains PE	connection cable to SWG 100BIO-EX
7_2	PE		64768	0,75	X1 : 1_2	

terminals and elements placed from right to left

overview terminal

n_2
n_1

n_2
n_1

18.4. Connection of the I/O module
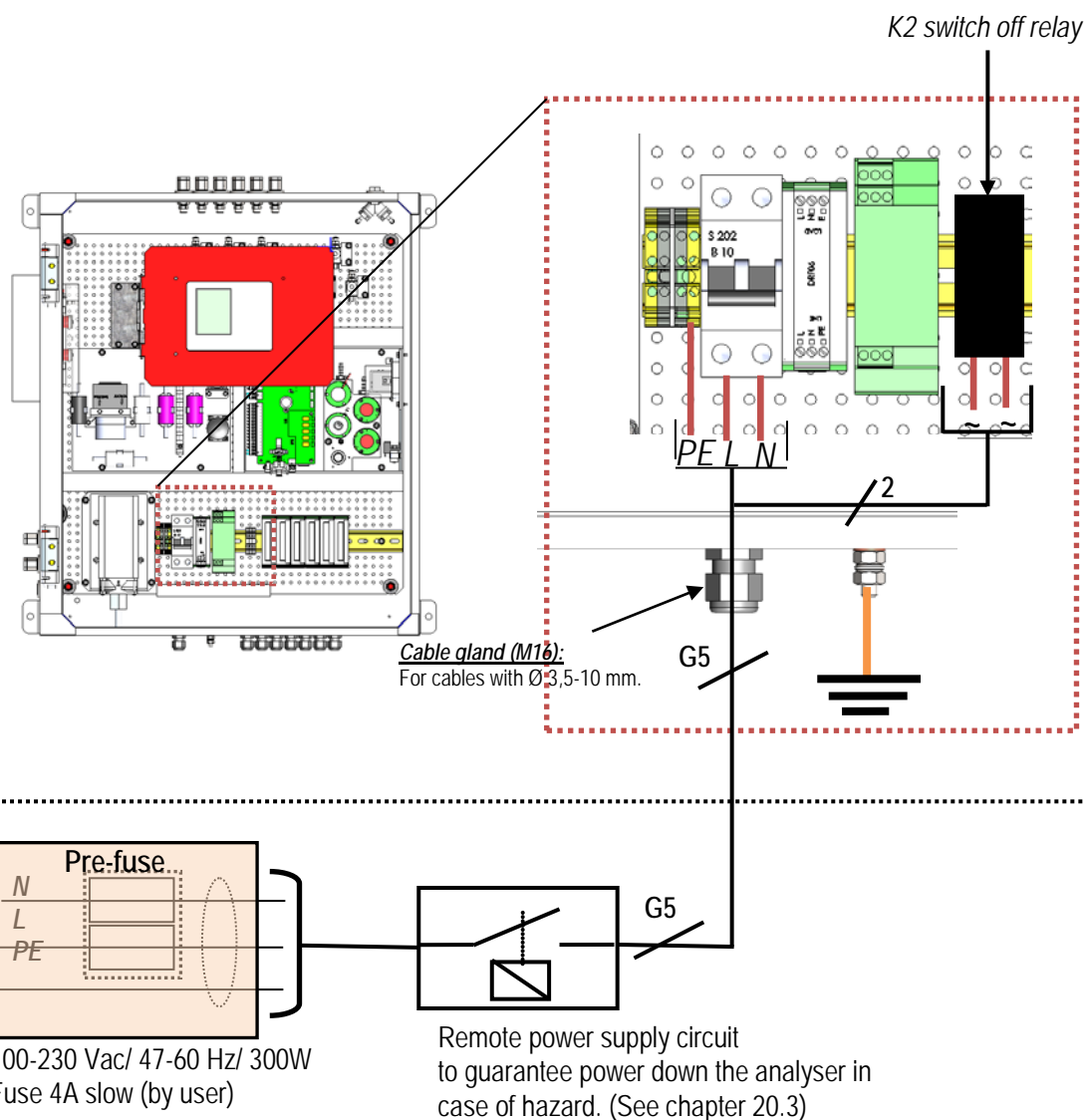
⚠ DANGER

Explosion hazard

Before start the mounting and installation work, make sure to have a "hot permit" and monitor at all time the ambient atmosphere with a certified flammable gas detector.

⚠ DANGER

Electric shock.
Electricity may cause death. Only educated staff should be allowed for mounting and installation job.

Cable glands (M16):
For cables with
Ø 3,5-10 mm.

*Signal cable
for I/O modul*
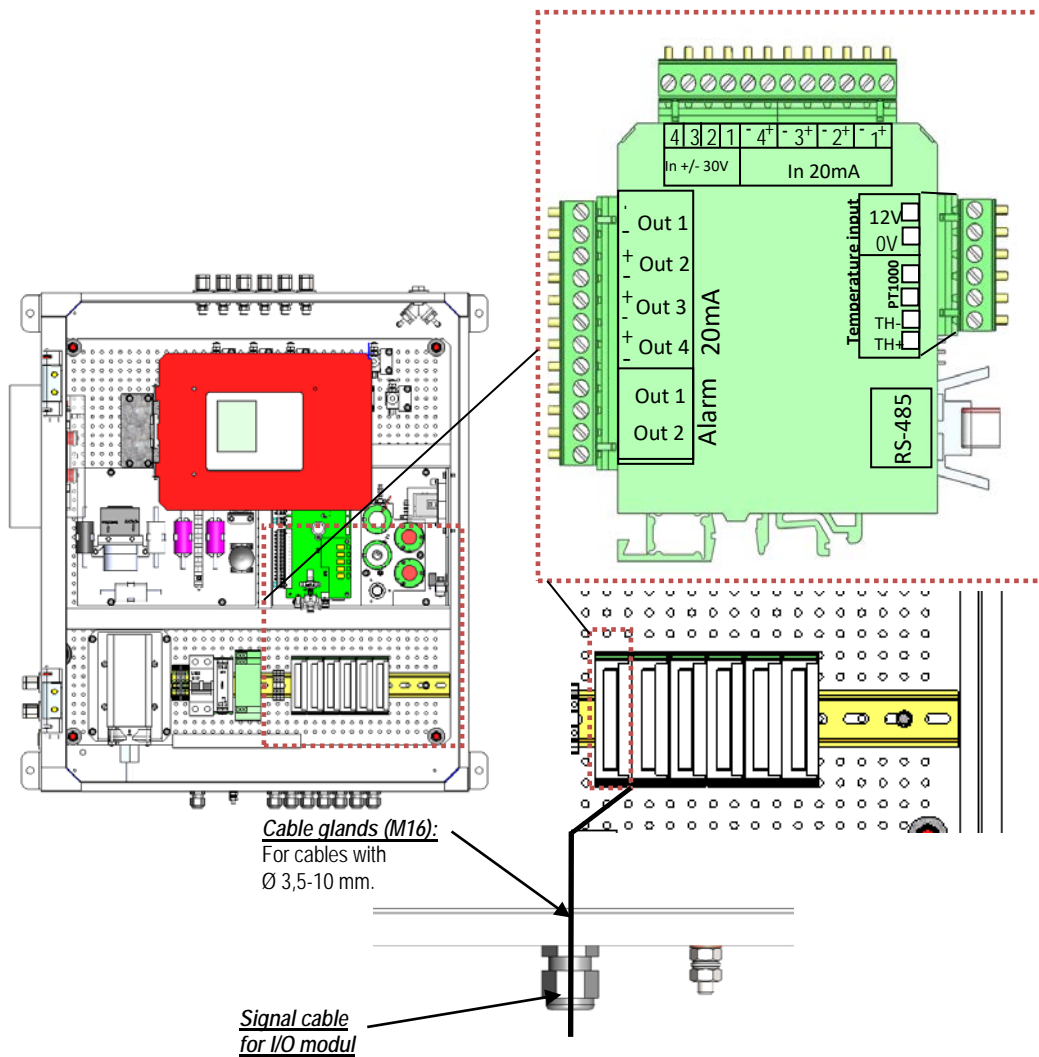
NOTE: analog output current 4-20mA load resistor is max. 500Ohm
          analog output does not require power supply since it is sourcing the current
          alarm relays Out1 and Out2 contacts are "fail safe" type:
          ▪ open contact in case of alarm or power failure
          ▪ closed contact for normal operation

Plug connector definition:

⚠ WARNING
Electric voltage   Power the system down and protect for reconnecting, before start maintenance work.

Slit screws
Stripping length: 7 mm
Tightening torque min.-max.:   0,5-0,6 Nm

Conductor cross sections, which can be used:

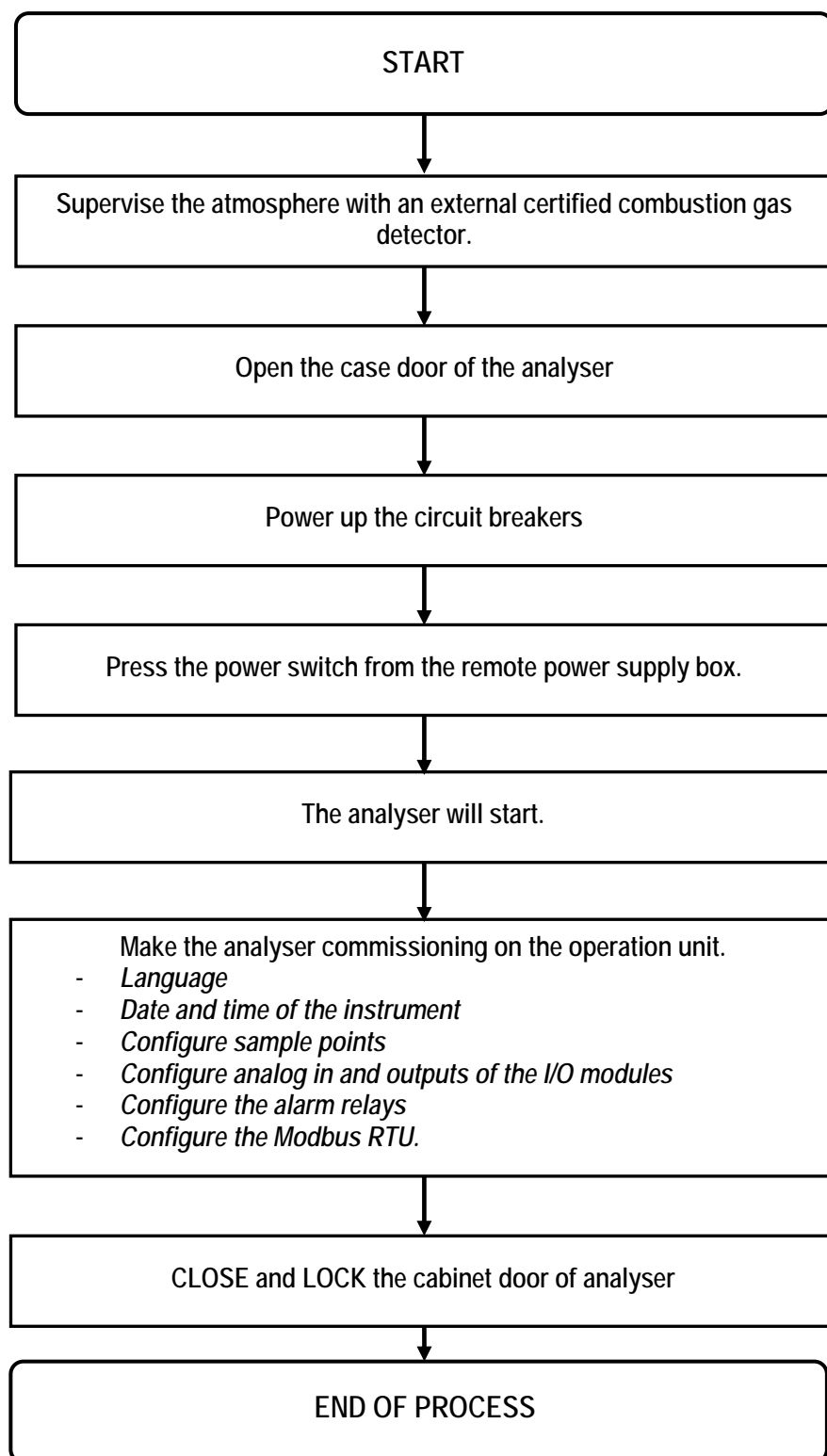| Type of electric line	Conductor cross section min.-max.
Solid	0,2-2,5 mm² (30-12 AWG)
Stranded	0,2-2,5 mm² (30-12 AWG)
Solid with ferrule (with/ or without plastic)	0,25-2,5 mm²

Information for cables, which go through the cable gland M16:

It is recommended to use only electric lines with ferrules.

19. Power up and commissioning the analyser

After installation of the analyzer few steps should be processed in order to operate the instrument properly.

The graphic below shows the few steps, which should be done, to power up the analyser correctly.

```
┌─────────────────────────────────────────────┐
│                    START                      │
└───────────────────────┬───────────────────────┘
                        │
                        ▼
┌─────────────────────────────────────────────┐
│ Supervise the atmosphere with an external     │
│ certified combustion gas detector.            │
└───────────────────────┬───────────────────────┘
                        │
                        ▼
┌─────────────────────────────────────────────┐
│        Open the case door of the analyser     │
└───────────────────────┬───────────────────────┘
                        │
                        ▼
┌─────────────────────────────────────────────┐
│           Power up the circuit breakers        │
└───────────────────────┬───────────────────────┘
                        │
                        ▼
┌─────────────────────────────────────────────┐
│ Press the power switch from the remote power   │
│ supply box.                                    │
└───────────────────────┬───────────────────────┘
                        │
                        ▼
┌─────────────────────────────────────────────┐
│            The analyser will start.            │
└───────────────────────┬───────────────────────┘
                        │
                        ▼
┌─────────────────────────────────────────────┐
│ Make the analyser commissioning on the         │
│ operation unit.                                │
│  - Language                                    │
│  - Date and time of the instrument             │
│  - Configure sample points                     │
│  - Configure analog in and outputs of the      │
│    I/O modules                                 │
│  - Configure the alarm relays                  │
│  - Configure the Modbus RTU.                   │
└───────────────────────┬───────────────────────┘
                        │
                        ▼
┌─────────────────────────────────────────────┐
│ CLOSE and LOCK the cabinet door of analyser    │
└───────────────────────┬───────────────────────┘
                        │
                        ▼
┌─────────────────────────────────────────────┐
│                END OF PROCESS                  │
└─────────────────────────────────────────────┘
```

19.1. Power up the analyser

1. Open the case door of the analyser.

2. Power up the circuit breaker. See figure below.

Power up the circuit breaker.
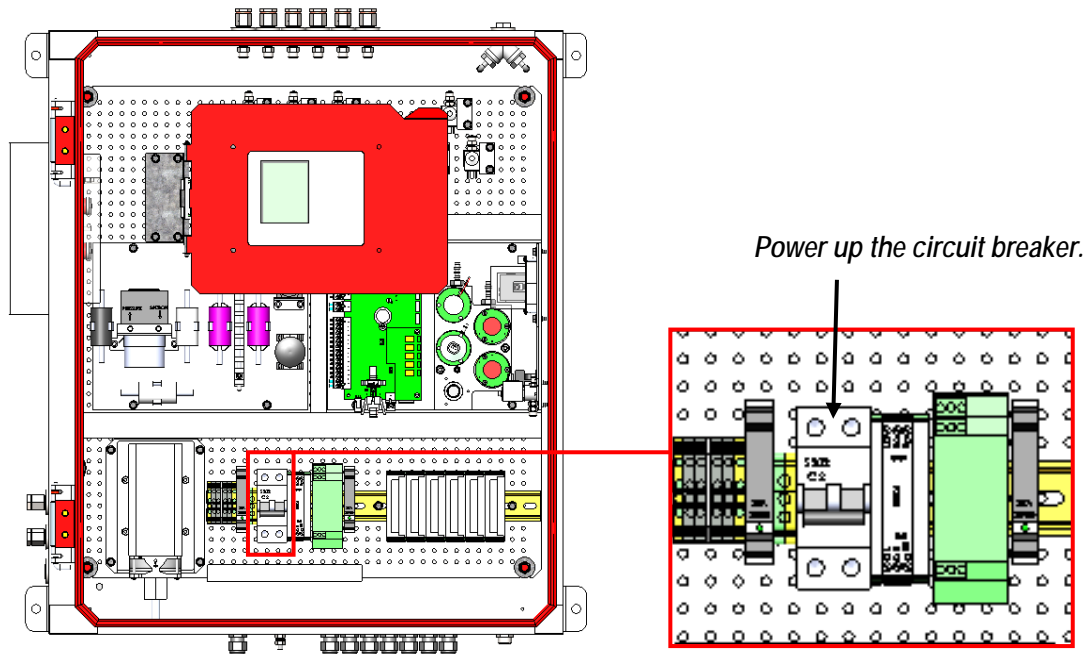
3. Press the power switch of the remote power supply box. Wait until the system is ready for operation. The green LED on the remote power supply box will glow.

Press for 3 sec.
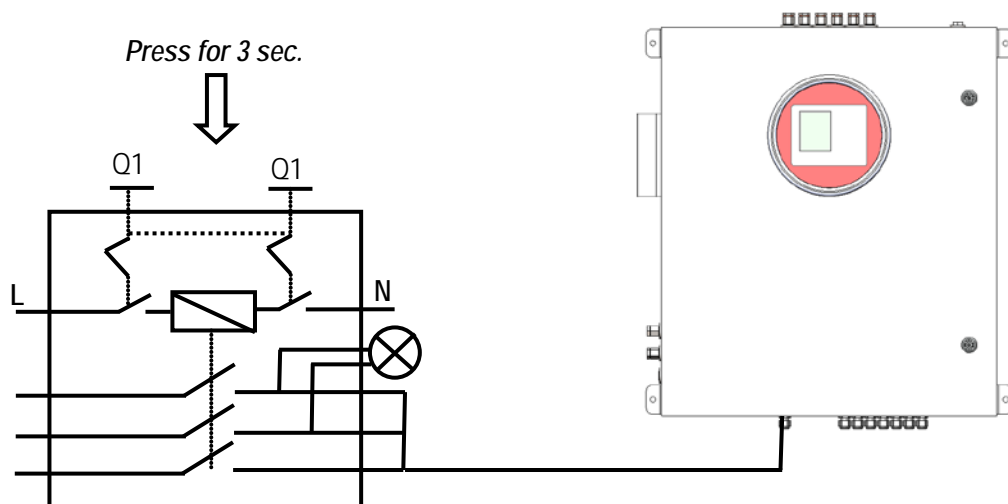
4. The analyser will start and firmware will boot. Wait until the first Self-Test is completed.

19.2.   Check country and language

Important note:
In case the analyzer shows a language, you don't understand, you may swap the language to English by pressing the menu key and selecting the function 'Set English language'.

Use the menu EXTRAS – GENERAL SETTINGS.

The analyzer will automatically set some country-typical things like the language, the date format, the temperature unit, the daylight-saving time function and the CSV-export settings.

19.3.   Check date and time of the instrument

The analyzer stores automatically measurement values including timestamps. Therefore, the instruments' system clock should be set correctly.

Use the menu EXTRAS – GENERAL SETTINGS – DATE & TIME.

In case the date & time is not correct, press the key F2=modify, change date & time and then press the key F2=store.

Note:
According to the selected country (see previous chapter) the analyzer automatically switch the daylight-saving time in spring and autumn. This function is active for most European countries. Whenever the daylight-saving time is currently active, then you'll see a '*' in the time line of the menu, thus 'Time *' instead of 'Time'.

19.4.   Configure sampling points

The analyzer measures at least one sample point. Optional it can measure up to 10 sample points automatically or manually. Remote sample switching is also possible by using 4 relays contacts connected to the 1-st I/O module

Use the F1 key in the main measurement menu   SAMPLE POINT CONFIGURATION

Set suction delay and measuring time for each sample point according to your needs.

Note:
You may use the function 'auto-config', which will install typical settings. Then check the settings and modify them if needed.

19.5. Configuration of the alarm relays

On the main PCB there is one "system alarm" relay with "fail safe" NC contact. The following errors will turn the relay from NC to NO.

1. Main board is offline (internal RS485 bus communication failure)
2. Main board is in the "bootloader" phase
3. Gas leakage inside analyzer cabinet (CH4 > 20% to 50% LEL)
4. Condensate alarm (contacts resistance < 35kΩ)
5. Low fan rotation (speed rotation < 900U/min)
6. Sample flow alarm (sample flow < 20 l/hr)
7. Gas cooler high alarm (temperature > +10°C)
8. Gas cooler low alarm (temperature < +2°C)
9. Cabinet high temperature (> +55°C)
10. Cabinet low temperature (< +5°C)

Errors 1 to 5 alarm will force a measurement stop (all analog outputs are on hold or at 2mA, depending on configuration).
Errors 5 to 10 will be displayed as warning message only; analog outputs of active sampling point are live, all others are on hold.

ATTENTION

Analyzer system alarm relay is a potential-free contact, which max. 24VDC/VAC and a current of 1A (max.)

Connection of the alarm relay: Potential-free Max. 24VDC/VAC, 1 A (max.)

Plug connector definition for the system alarm relay
Slit screws
Stripping length: 7 mm
Tightening torque min.-max.:   0,5-0,6 Nm

Conductor cross sections, which can be used:

Type of electric line	Conductor cross section min.-max.
Solid	0,2-2,5 mm² (30-12 AWG)
Stranded	0,2-2,5 mm² (30-12 AWG)
Solid with ferrule (with/ or without plastic)	0,25-2,5 mm²

Information for cables, which go through the cable gland M16:

It is recommended to use only electric lines with ferrules.

Following analyzer errors will produce a system alarm (open contact of System Alarm relay)

19.6.   Configuration of the Modbus

The Mobdbus connector can be found on the PCB-mainboard (see sketch below).
NOTE: for specification of Modbus (RTU) data transfer over RS485, please observe appendix.

User RS-485 (Modbus RTU)

Plug connector definition for the system alarm relay

Slit screws
Stripping length: 7 mm
Tightening torque min.-max.:   0,5-0,6 Nm

Conductor cross sections, which can be used:

Type of electric line	Conductor cross section min.-max.
Solid	0,2-2,5 mm² (30-12 AWG)
Stranded	0,2-2,5 mm² (30-12 AWG)
Solid with ferrule (with/ or without plastic)	0,25-2,5 mm²

Information for cables, which go through the cable gland M16:
It is recommended to use only electric lines with ferrules.
Configuration at the analyzer

1. Open the path EXTRAS/ GENERAL SETTINGS.
2. Press *F3* "Modbus".
3. The Modbus store settings will be open. The user can commission the slaves settings.

General settings	
LCD brightness	60 %
Country	International
Language	English
Keyboard beep	ON
Request admin-PIN	ON
Service message	OFF
Alarm level [%LEL]	50

date & time   modbus

modbus

F3

Modbus slave settings	
Modbus slave settings	
Baud rate	9600
Slave address	238
Parity & stop bits	even / 1

return

19.7. Configuration of the external control (Option: IO module)

This feature requires an I/O module (optional) and the function must be activated.

This feature can be used for the external control of the analyzer. With the help of the external control follow operations can be done:

- Externally controlled sampling point selection,
- Stand-by.

The commands will be given by a 4-bit binary number, which will be built through four external signals. The pins for the signal are shown in the sketch below. It exists two different types to set the four pins:

- Potential free relay contacts.
- 4-20 mA signal inputs.
- Through one 4...20mA input.

The settings-menu can be found at the path: EXTRAS/GENERAL SETTINGS-> EXTERNAL CONTROL.

The user can set three different types for the external control. The types can be found at the sketch below.
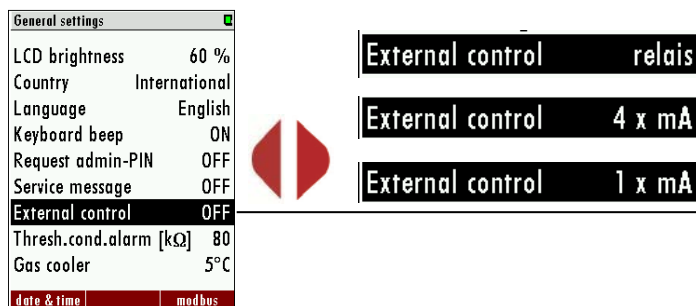
Connection of the external control via relay contact

This feature can be used for externally controlled sampling point selection, zeroing and stand-by, using external potential free relay contacts, see also diagram in $4.4
The relay contacts build a 4-bit binary number: RC4 - RC3 - RC2 - RC1 open=0, closed=1.
Let us tell this number 'status number'.
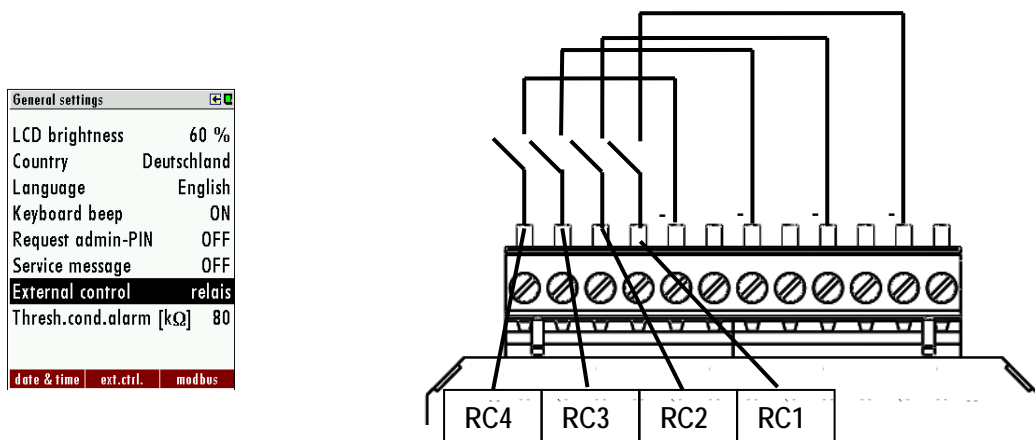
Connection of the external control via 4-20 mA input signals
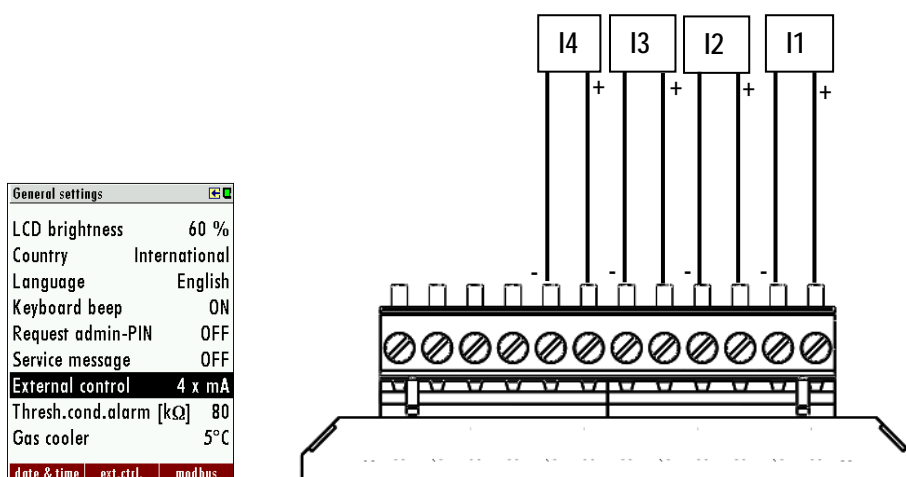
The signal inputs built a 4-bit binary number: **I4 – I3 – I2 – I1: 0-11 mA=open=0; 11/12-20 mA=closed=1.**

Connection of the external control via one 4-20 mA input signal

The user has the opportunity to control the analyzer with only the first 4-20mA input (see sketch below). The different commands will be given by the changing of the current signal. The offset-signal is 4 mA. Every 1 mA step describes a condition of for the external control. Overall the analyzer can take 16 different statuses. The first status is by 5 mA (4 mA+1 mA) the second is by 6 mA (4 mA + 2 mA) and so on until the 20 mA signal is reached.
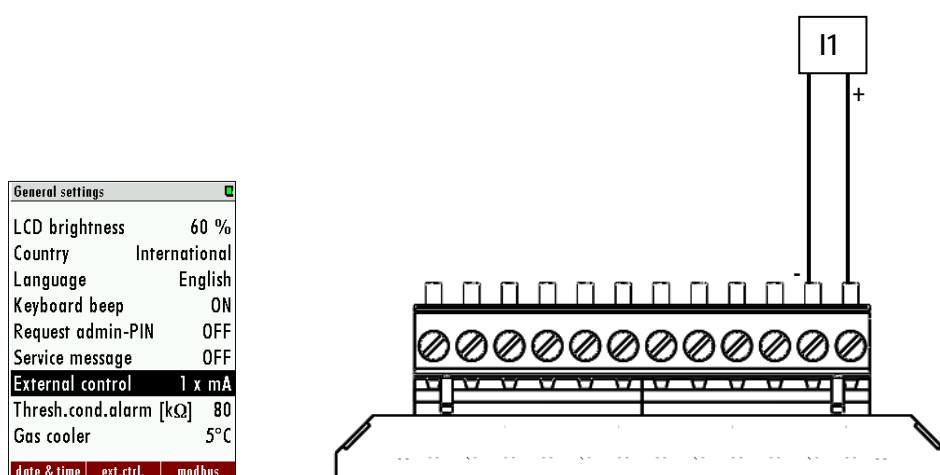
The connection of the one 4-20 mA signal is a two-wire connection.

Configuration at the analyzer

1. Open the path: EXTRAS/GENERAL SETTINGS.
2. Switch the menu-point "External control" from "*OFF*" to "*Relais*"/"*4x mA*" or *"1 x mA"* (dependent from the connected signal input.). When the external control is activated an arrow symbol will appear at the title line.

3. If a valid input state (>0) is present, an arrow in the title line will appear. The analyzer is now slave and will perform the measurement until it gets another command from the master unit. Some external control settings can be configured. This can be found at the path: EXTRA/GENERAL SETTINGS then *F2*= ext.crtl.
The user has the opportunity to set the zeroing time, suction/response time and stand-by purge time.
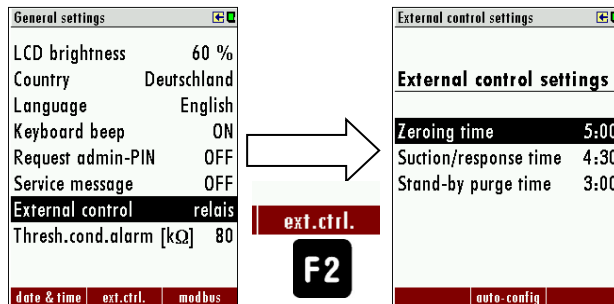
Case 1: Stand-by

The Stand-by modus will be activated if the input state is higher than the number of sample points (example: 4 sample points and input state 5…15). The Stand-by modus has the following pass:

- Purging with zero gas (for the configured duration)
- Standby until the input state is below or equal the number of sample points (e.g. 4 sample points and input state 1.4)

Case 2: External control of a sample point

-Zeroing: First the zeroing will be done. The duration of the zeropoint can be set at the menu ext. crtl. (see point "*configurated at the analyzer*" in the same chapter).
-Gas sampling: The gas sampling is for purging the entire system and give the analyzer enough time for response. (Response time). To set the suction/ response time, see point "*configurated at the analyzer*" in the same chapter.
-Measurement: The measurement will be started after the response/ suction time is finished. It will be only abort, if the user changes the status of the external signal sources. The chart below shows the possible statues, which can be set at the analyzer:

Status of external signal source					Status number	Description
RC4/I4	RC3/I3	RC2/I2	RC1/I1	I [mA]	-	-
0	0	0	0	4	0	Automatic sampling point switching
0	0	0	1	5	1	Analyzer is sampling the point SP1 (*1, *2)
0	0	1	0	6	2	Analyzer is sampling the point SP2 (*1, *2)
0	0	1	1	7	3	Analyzer is sampling the point SP3 (*1, *2)
0	1	0	0	8	4	Analyzer is sampling the point SP3 (*1, *2)
0	1	0	1	9	5	Analyzer is sampling the point SP4 (*1, *2)
0	1	1	0	10	6	Analyzer is sampling the point SP5 (*1, *2)
0	1	1	1	11	7	Analyzer is sampling the point SP6 (*1, *2)
1	0	0	0	12	8	Analyzer is sampling the point SP7 (*1, *2)
1	0	0	1	13	9	Analyzer is sampling the point SP8 (*1, *2)
1	0	1	0	14	10	Analyzer is sampling the point SP9 (*1, *2)
1	0	1	1	15	11	Analyzer is sampling the point SP10 (*1, *2)
1	1	0	0	16	12	Analyzer is "stand-by" (*3)
1	1	0	1	17	13	Analyzer is "stand-by" (*3)
1	1	1	0	18	14	Analyzer is "stand-by" (*3)
1	1	1	1	19	15	Analyzer is "stand-by" (*3)

(*1): Whenever the selected sample point will be changed, then the analyzer will start a zeroing before measuring the new sample point.

(*2): Not only status numbers 4 to 15, but all status numbers larger than the number of installed sample points will start the "stand-by" (example: when you have 4 sample points, then status numbers 5 to 15 will trigger "stand-by").

(*3): When the status number changes to a "stand-by" number, then the analyzer will purge the sensors, then it will close all solenoid valves and switch off the gas pump. When the status number changes back to a value less or equal to the number of installed sample points, then a "set to zero" cycle will start and afterwards the selected sample point will be measured.
Note: The "stand-by" status can easily be used to initiate just a zeroing without any "stand-by" and without changing the sample point.
Example :   - status number=1 (for any time period, recommended max. 1 hour)
                   - status number=15 (for a few seconds, recommended min. 10 seconds)
   - status number=1 (for any time period, recommended max. 1 hour)

After installation and power-up of the analyzer few steps should be processed in order to operate the instrument properly.

19.8. Configuration of the analog outputs at the I/O module

Each I/O module provides 4 channel analog 4-20mA outputs, which are able to provide the measuring values via 8 wire cable to a remote PLC or DCS.
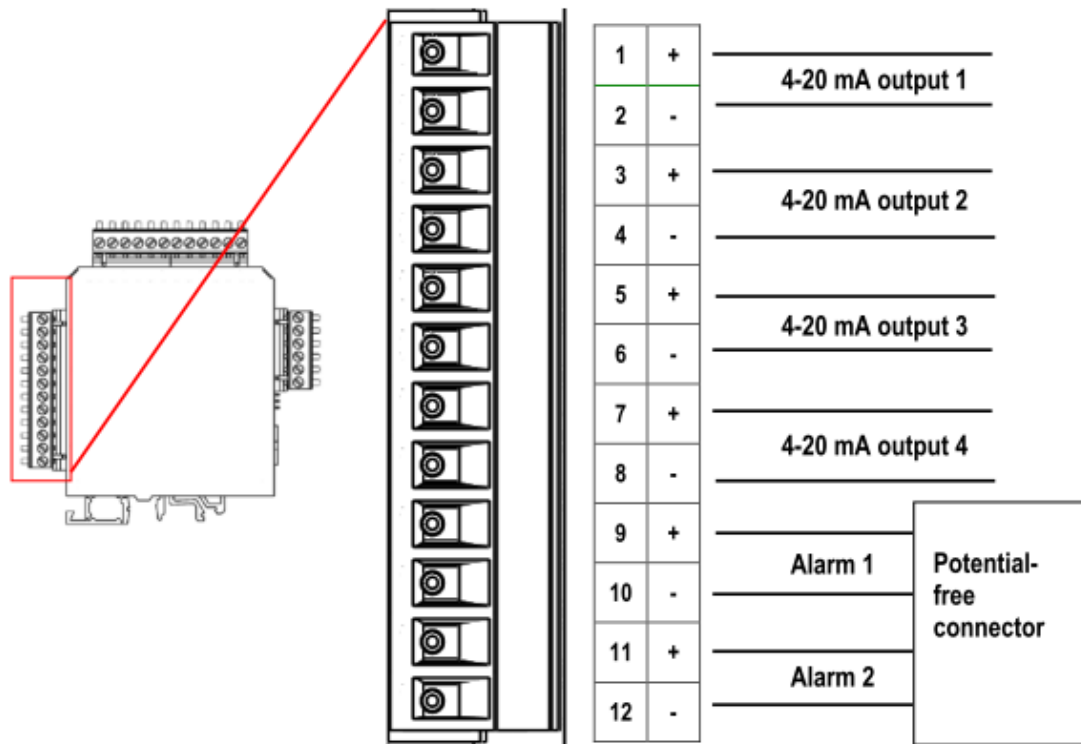
1. Use the menu EXTRAS – ANALOG OUTPUT CONFIGURATION.
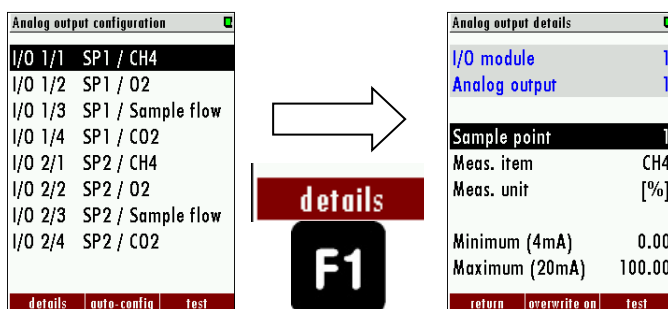
2. At the menu the user can:
   a. Select the sample point.
   b. The measurement item.
   c. The measurement unit.
   d. The equivalent concentration for 4 mA and for 20 mA.

Assign measuring value and the min and max value to each analog output channel.

Note:
You may use the function 'auto-config', which will install typical settings. Then check the settings and modify them if needed.

19.9. Configure alarm output of I/O module

Each I/O module provides 2 alarm relay contacts (see previous page) normally open contacts (fail safe type) which will send alarm status via 4 wire cable to a remote PLC or DCS.
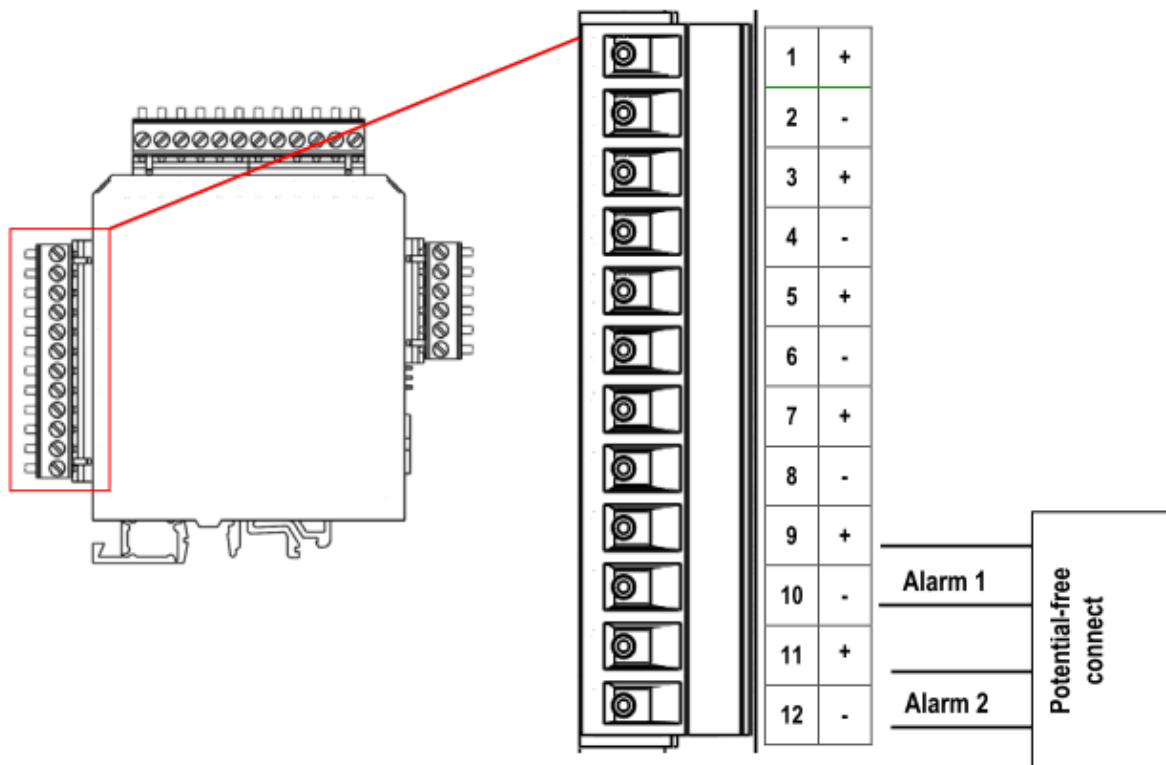
Use the menu EXTRAS – ALARM OUTPUT CONFIGURATION.

The screenshot below, shows how the menu looks like:

Assign sampling point, measuring value, threshold value and the alarm direction (LO alarm, when below threshold or HIGH alarm when above threshold).

ATTENTION
You may use the fuction 'auto-config', which will install typical settings. Then check the settings and modify them if needed.

Test the alarm outputs of the IO module

Use the menu EXTRAS/ ALARM OUTPUT CONFIGURATION
Open the submenu TEST (*F2*).
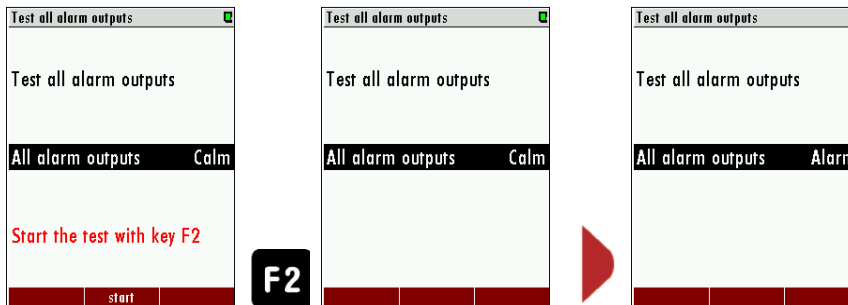
The following screenshot will appear. With *F2* all alarm outputs in the entire analyzer can be activated.

With the help of a multimeter, it is possible to test the different alarm outlets. The sketch below shows how to measure the alarm outputs.
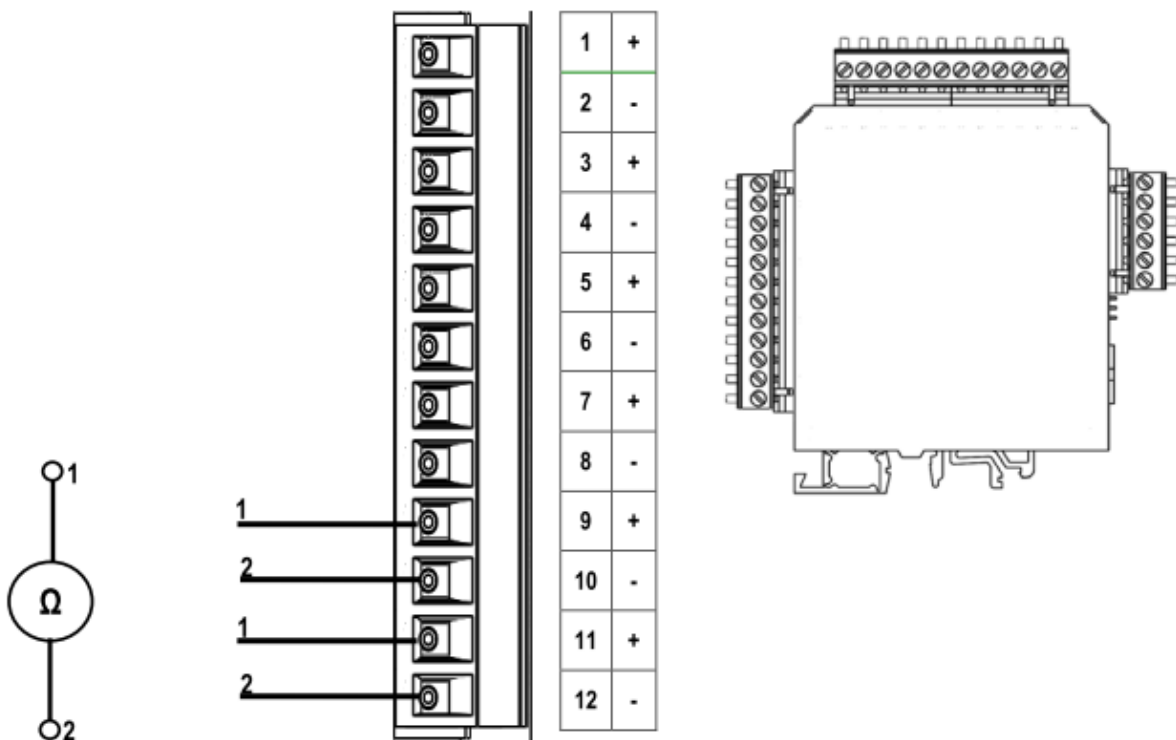
#	Calm	Alarm
1	NC	NO

ATTENTION
With the test modus for the alarm outputs of the IO module, the alarm relays at the IO modules and the relay at the PCB mainboard can be activated.

19.10. Configure the AUX-input on software-side:
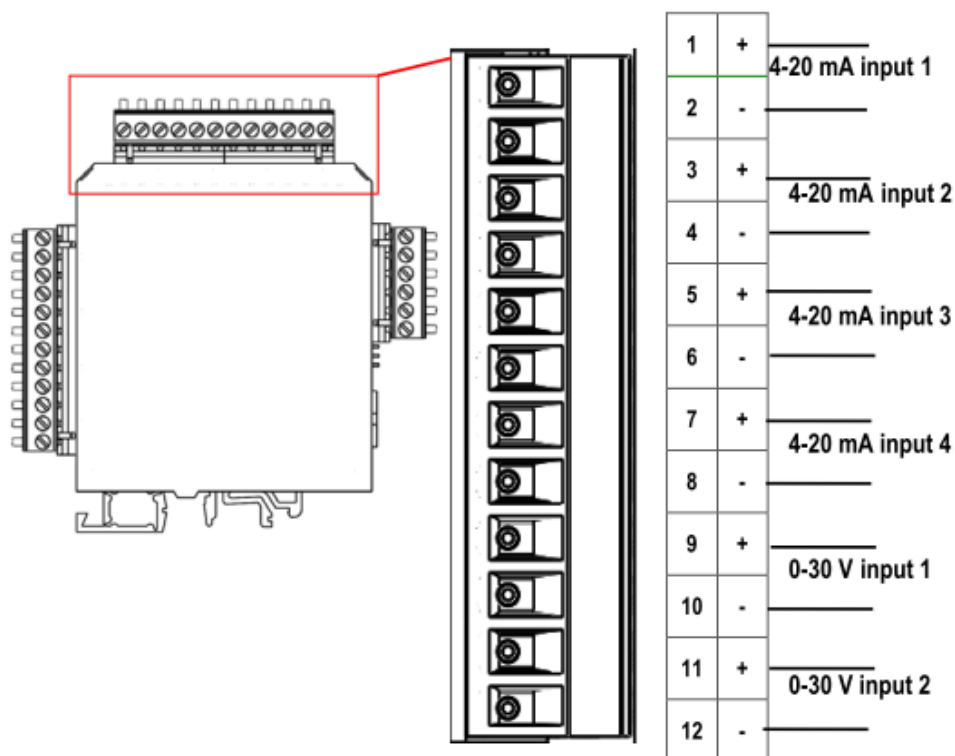
1. Open the menu point AUX input configuration which can be found under the path: EXTRAS/ AUX INPUT CONFIGURATION.

2. All possible inputs are listed in the following screen. Every IO module is able to load four signals.

3. To configure an AUX input on the software side, select an AUX-input with the arrow keys and confirm it with *OK*.

4. The screen AUX INPUT DETAILS appears. In this menu the AUX-input can be given a name (Meas. item) and a unit (under Meas. unit) which can be selected with the arrow keys. The measurement item can be named by the user. To set the measurement unit rotates with the left/ right arrow keys.

5. Important for the AUX-inputs is the measurement range. The range is set with the two points "Minimum 4 mA" and "Maximum 20 mA".

6. Before the menu is left, a request to safe the configuration will appear.

20. Operating the analyser

20.1. Administrator PIN code

All functions and menus which may disturb the analyser's normal measurement can be protected against unauthorized access by activating the administrator PIN code request.

We highly recommend activating this function, when unauthorized persons could access the analyzer.

The PIN code is: F1 - F1 - F3 - F2 - Up - Down
The PIN code request can be activated and deactivated in the menu Extras/General settings:
The deactivation of the PIN code request requires at least one time PIN code input.

Once the user has input the correct administrator PIN code the analyser will stay in administrator mode (password free) for 10min after last time key acting. Each key acting will trigger another 10min password free operation.

20.2. Power-On of analyser

When the analyser is connected with mains (Power-On) it will start the system boot process which usually takes very few seconds. Then the display will show the self-test menu.

20.3. Self-Test

The first menu to be displayed after Power-On is the self-test menu. The analyser won't leave this menu before all sub-systems will be connected and the gas cooler (option) has reached the target operation temperature.

During the self-test phase
- the gas pump is switched off
- all analog outputs will deliver 2mA
- all alarm outputs will have alarm status (open contacts)

Usually the self-test will be left automatically as soon as all conditions for measurement are satisfied. Then the first zeroing will be started.

If one of the internal RS485 bus participants are issuing alarm (faulty) status, the user can still leave the self-test manually by pressing F2='forward' (PIN code requested), even if not all sub-systems or the gas cooler are ready.
NOTE: this is for service purpose only!

20.4.   Main menu measurement

This menu is the root of all menus and will be shown automatically as soon as the self-test is finished. The title bar you can see on the left the current measurement cycle status and how long it lasts and the actual sampling point number. In the middle section of the actual measurement values are displayed.

Representation during the status "measurement"

The title bar you can see on the left "measurement" and the remaining measurement duration, and the right **light blue highlighted** sampling point number SPx (x = 1 to 4) that is being measured. In the middle section of the menu, the current (live) values are displayed.

Representation outside the status of "measurement"

The title bar you can see on the left "air purging" or "gas sampling SPx" and the remaining duration of the current status. On the top right you can see the **yellow highlighted** sampling point number SPx previously measured or that you have selected for display and their measuring values are hold until it is measured again. In the middle section of the menu hold measured values of these measurement sites are displayed.

Change the Display Zoom / Standard

Two display modes are available:
- standard view mode with 6 values per page, up to 4 pages (indicating up to 24 values)
- zoom view mode with 2 values per page, up to 6 pages (indicating up to 12 values)

The indication mode can be swapped with the menu key and the selection of zoom view or standard view.
For devices with just one measuring point the switching is additional possible with the arrow keys up / down.

Change the displayed page

Use the arrow keys left / right can be changed in both display modes the page. The new page number is displayed in the title bar for a moment just after the successful change.

Change sampling point displayed

For analyzers with several measuring points can used the arrow keys up / down the displayed (not measured) measuring point can be changed. In this way you can get an overview very quickly over the last measured values for all points. In the background, the analyzer uses the measurement cycle continues uninterrupted. However, once a measurement phase is completed, the display automatically switches to the actual measurement location.

Manual zeroing and selection of measurement points

For analyzers with just one measuring point, the status of "measuring" by pressing the F1 key = "zero" will be canceled and the next manual zeroing be initiated.

For analyzers with several sampling points can by pressing the F1 key = "number" manually the next sampling point can be selected. This is then measured as soon as possible.

Configuration of the measurement window (display content)

The measuring values selection and arrangement is user free configurable in both display modes.

Press the content menu key and select the function 'Define measuring window'. A cursor (inverted line) will appear. The cursor can be moved with the arrow keys up and down. The arrow keys left and right will change the measuring value in the selected line. When the cursor is moved over the top or under the bottom line, then the next definable page will show up.

As soon as you have finished the configuration, press the ESC key (or press again the menu key and select the function 'Save measuring window'). You will be asked, whether the changed settings shall be stored or discarded. Select 'keep them' in order to store your changes.

MRU GmbH, D-74172 Neckarsulm
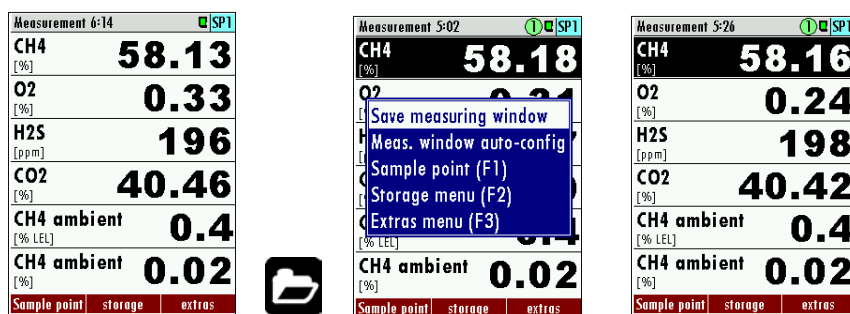
20.5. Data Storage

The analyser makes use of an internal flash memory to store measurement values automatically.

Data storage strategy is as follows:
- The analyser may store up to 20,000 measurement points (including all relevant data).
- At the end of each measurement cycle (per sampling point) the current values will be stored.
- The memory is used as a ring buffer. As soon as the memory is completely occupied, the latest measurements will replace the oldest measurements.

Specifically:

If the used memory is 99%, then the oldest 20% of the measurements will automatically be exported to SD card in CSV format and then deleted from the memory. In case the SD card export doesn't succeed (SD Card missing or read-only), then only the oldest 4% of the measurements will be deleted. The file names reflect the date of the most recent measurement contained in the export file, e.g. "20141031.csv".

Example:

An analyser with 2 sample points and a total configured cycle time of 32 minutes saves 2 * 24 * 60/32 = 90 measurements per day (45 of each sample point). So the ring buffer will provide measurements of the last 20000/90 = 222 days (more than 7 months).

Data Storage Menu

The data storage menu can be reached by pressing F2='storage' in the measurement menu:
The menu provides an overview of stored measurements of each sample point and of the memory usage.

View stored measurements in text mode

This function can be reached from the Data Storage Menu by selecting one or all sample points and by pressing F1='view text':

When entering the menu the latest stored measurement will be displayed. With the keys F1='previous' and F3='next' the measurements can be browsed (F3 will lead to the oldest measurement when the latest was displayed before - wrap-around).

You may delete a single measurement here, usually you won't need this function. The arrow keys have the same function than in the measurement menu.

View stored measurements in graphic mode

This function can be reached from the Data Storage Menu by selecting one sample point (not all) and by pressing F3='view graph':
Two curves for one pair of data are shown at the same time in one diagram. The used scales are determined automatically and can't be changed by the user.

The offered pairs of data are determined by the setting of the zoom values in the measurement menu. The displayed pair of data can be changed by pressing the arrow keys up or down.
When entering the menu the measurements of the last 24 hours will be displayed. This interval can be changed by pressing the keys F1=more or F3='less'.
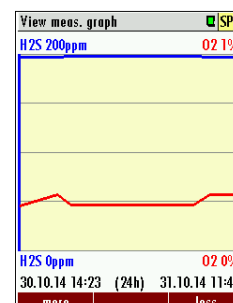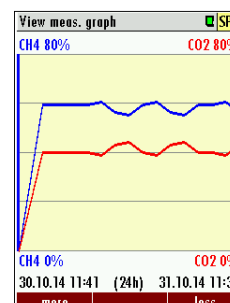
Export of measurements to SD card

This function is used to export the measurements from the analyzer to a PC. The used format is CSV (comma-separated values). Many computer programs are able to read this format, e.g. spread sheet calculation programs.

The CSV format is not exactly the same in all countries. The analyser selects a fitting format variation according to the selected country. Nevertheless, the CSV output can be changed individually by the function 'CSV settings', which can be found using the content menu key in the Data Storage Menu.

This function is only available, when a SD card is inserted and is not write protected. The export can be started in the Data Storage Menu by selecting one or all sample points and by pressing F2='export >> SD'.

The created files have names like 'BIOxxxxx.csv', in which the xxxxx are continuing 5 digit numbers with leading zeros.

The 1st line of the created file is a column header with the following information: Sample point number, Date, Time and all measurements. The following lines contain the data.

20.6. Power-Down of analyzer

Before the analyzer is disconnected from mains, it should be prepared for the Power-Down, because
- operational data should be stored
- eventually changed user settings should be stored
- the sensors should be purged with fresh air

Press the OFF key in any menu in order to prepare the analyser for the Power-Down. The analyser will store operational data and user settings and will offer to start a sensor purge cycle:
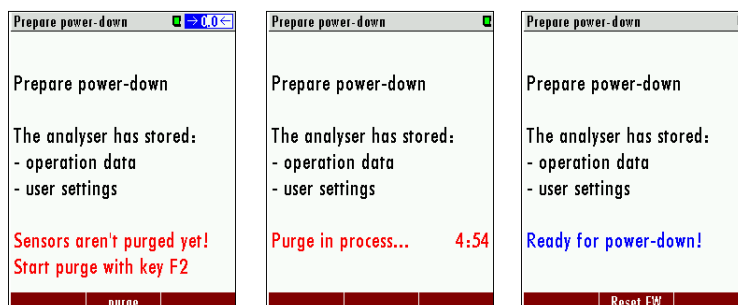
Start the purge cycle with the F2 key (PIN code requested). The analyser will purge the sensors with fresh air and will indicate a count-down. Then the analyser will be ready for power-down.

Now it's not possible anymore to continue directly the ordinary measurement process. Only power-down by disconnecting mains or a software restart by pressing F2='Reset FW' is offered.

Note:
You also may enter this menu by pressing the OFF key and leave it by pressing the ESC key (without starting the purge cycle) , when you just want to store operational data and user settings.

20.7.   Backup/restore all individual user-settings

It's a quite amount of work to configure the analyzer, especially when the analyzer provides several sample points and several IO-modules and when the analog ouputs are used. Therefore, we recommend to backup all your found settings on the SD card.

In order to backup the settings, do the following:
- use the menu EXTRAS.
- insert an SD card (without write-protection)
- press the menu key and select the function 'Export user settings'

The analyzer will write the backup file 'settings.usr' to the SD card.

In order to restore the settings, do the following:
- use the menu EXTRAS.
- insert an SD card containing the backup file 'settings.usr'
- press the menu key and select the function 'Import user settings'

The analyzer will replace the current settings by the settings from the backup file.

20.8.   Default configuration

Use the menu MEASUREMENT -> EXTRAS –> DEFAULT SETTINGS for the default configuration:

DEFAULT CONFIGURATION				
Parameter	Analog output 4-20mA		Alarm output relay contact	
	4mA	20mA	open	
CH4 [%]	0	100	less than	50
O2 [%]	0	25	more than	1
H2S [ppm]	0	1000	more than	300
CO2 [%]	0	100	more than	50
H2 [ppm]	0	500	more than	500
	0	500	more than	500
CH4 ambient [%]	0	5	more than	1
CH4 ambient [%LEL]	0	100	more than	20
Temperature sensor [°C]	0	50	more than	50
Fan rotation [rpm]	0	2000	less than	1200
Pump rotation [rpm]	0	5000	less than	1500
Sample flow [l/hr]	0	60	less than	30
Temperature cooler [°C]	0	20	more than	10
Net calorific value [MJ/kg]	0	40	less than	30
Gross calorific value [MJ/kg]	0	40	less than	30
Net calorific value [MJ/m3]	0	40	less than	30
Gross calorific value [MJ/m3]	0	40	less than	30

20.9. Update the firmware

| ⚠ DANGER |
|---|

Explosion hazard

Before update the firmware, make sure to have a "hot permit" and monitor at all time the ambient atmosphere with a certified flammable gas detector.

The analyzer and different installed options can be updated, if it is necessary. Following options can be updated:

- The firmware from the analyzer.
- The firmware from the pcb- mainboard.
- The firmware from the NDIR-bench.
- The firmware from the installed I/O modules.

General steps for the firmware-update

1. Copy the actual firmware for the analyzer or the firmware from the option on a SD-card. Be sure, that the firmware is in the mean root of the SD-card. All firmware updates have the ending "fwb".
2. Put the SD-card on the card slot on the operation unit. The card slot can be found inside the door (see sketch below).

BEEP!!
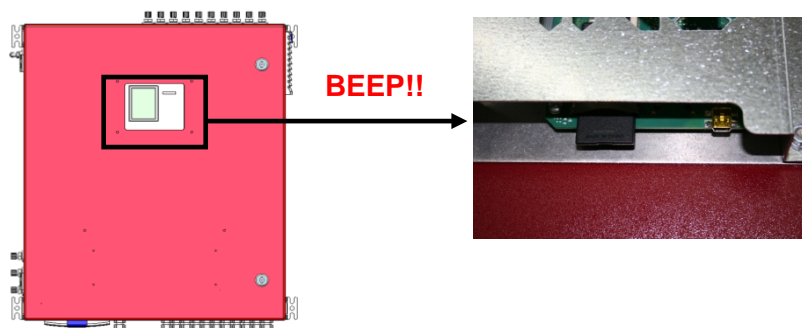
3. If the SD-card is recognized, the analyzer will make a noise.
4. Open the path: EXTRA/DEVICE INFO. Dependent from the firmware update it can be necessary to open the different submenus.

Update the analyzer (Firmware-Updates with filename "1106.fwb")

1. Open the path: EXTRA/DEVICE INFO

2. Press *F2 = details* to open the details for the main device menu.
3. Press *F2 = FW update*. The analyzer will start the update from the SD-card.

Update the pcb-mainboard (Firmware-Update with filename "1106mb.fwb")

1. Open the path: EXTRA/DEVICE INFO

2. Press *F3 = sub.syst*. to open the menu "SUB SYSTEMS INFO".
3. Press *F2 = details*, to open the details from the mainboard. Be sure, that the device is "Mainboard" to update the pcb-mainboard.
4. The Update will start from the SD-card, if a firmware with the filename "1106mb.fwb" is at the SD-card.

Update the NDIR-bench (Firmware-Update with filename "1106ndir.fwb")
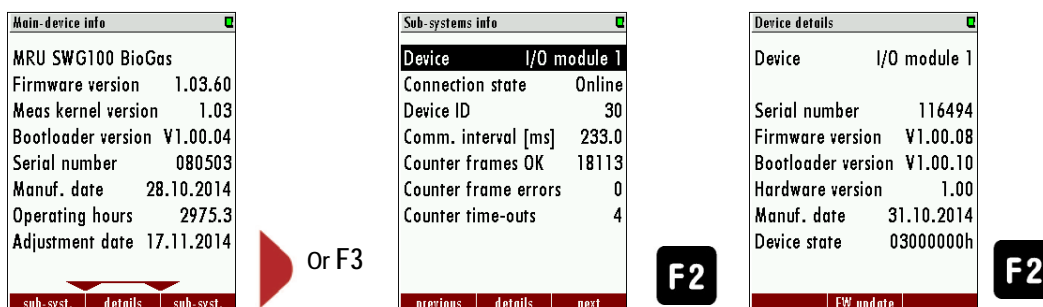
1. Open the path: EXTRA/DEVICE INFO

2. Press *F3 = sub.syst*. to open the menu "SUB SYSTEMS INFO".
3. Press *F2 = details*, to open the details from the NDIR bench. Be sure, that the device is "NDIR bench" to update the NDIR-bench.
4. The Update will start from the SD-card, if a firmware with the filename "1106ndir.fwb" is at the SD-card.

Update the IO modules (Firmware-Update with filename "1106iom.fwb")

1. Open the path: EXTRA/DEVICE INFO

2. Press *F3 = sub.syst*. to open the menu "SUB SYSTEMS INFO".
3. Press *F2 = details*, to open the details from the I/O module. Be sure, that the device is "Mainboard" to update the I/O module.
4. The Update will start from the SD-card, if a firmware with the filename "1106iom.fwb" is at the SD-card.

21. Service and maintenance

⚠ DANGER

Explosion hazard

Before start the maintenance make sure to have a "hot permit" and monitor at all time the ambient atmosphere with a certified flammable gas detector.

⚠ CAUTION

The maintenance part is important to guarantee, that the analyser works correctly and the entire system is safely.

For a reliable function and high measurement quality it is necessary to inspect and service the analyzer regularly.

Besides the regular routine control by the operator (see chapter 8.1.) the producer recommends a regular half year maintenance, which must carried by a qualified specialist.

21.1. Preparing and information about the maintenance

It is important to power off the mains supply before the maintenance can be started. Even if the main fuse is powered off, dangerous voltage is present.

It can be required to cut off the electric supply and safe this from an accidental switch-on.

By maintenance works on the gas analyzer dangerous and toxic gases may leak. The gas supply must be cut-off.

It is important to comply with the national directives, which are the country specific.

## 21.2. Regular maintenance works by the operator

All inspections- and maintenance works are dependent from individual operating conditions, and site. The specified intervals below are only benchmarks.

Review	Recommended intervals	Actions
Moisture in the analyzer.	Weekly	Remove the moisture. Call vendor specialist.
Dirt and depositions in analyzer.	Weekly	Remove the dirt, prevent further penetration of dirt. Inform vendor.
Dirt and moisture in the filter- unit	Weekly	Exchange the filter-unit.
Testing the gas pipes of leakage with "sniffer".	Weekly	Tighten or exchange the gas pipe if it is necessary
Inspecting the conditions of the gas filters	Every month	Exchange if is necessary
Cleaning the surface and window of the analyzer, to prevent a electrostatic loading of the cabinet.	Weekly.	Clean the surface and the window with an antistatic cloth.
Check the switch-off relay and the cabinet ambient solenoid valve.	Every month	See chapter 9.2.
Look if all flexible tubes are tight. Exchange flexible tubes, which are	Weekly	Exchange the tubes to new one.

exhausted or not tight enough		

In the follow chapters, there will be introduced some service parts, which are important for the reliable operation. These parts are independent from the regular checks and must be replaced in a regular interval of minimum 6 month.

21.3.   Position and overview of the service-parts
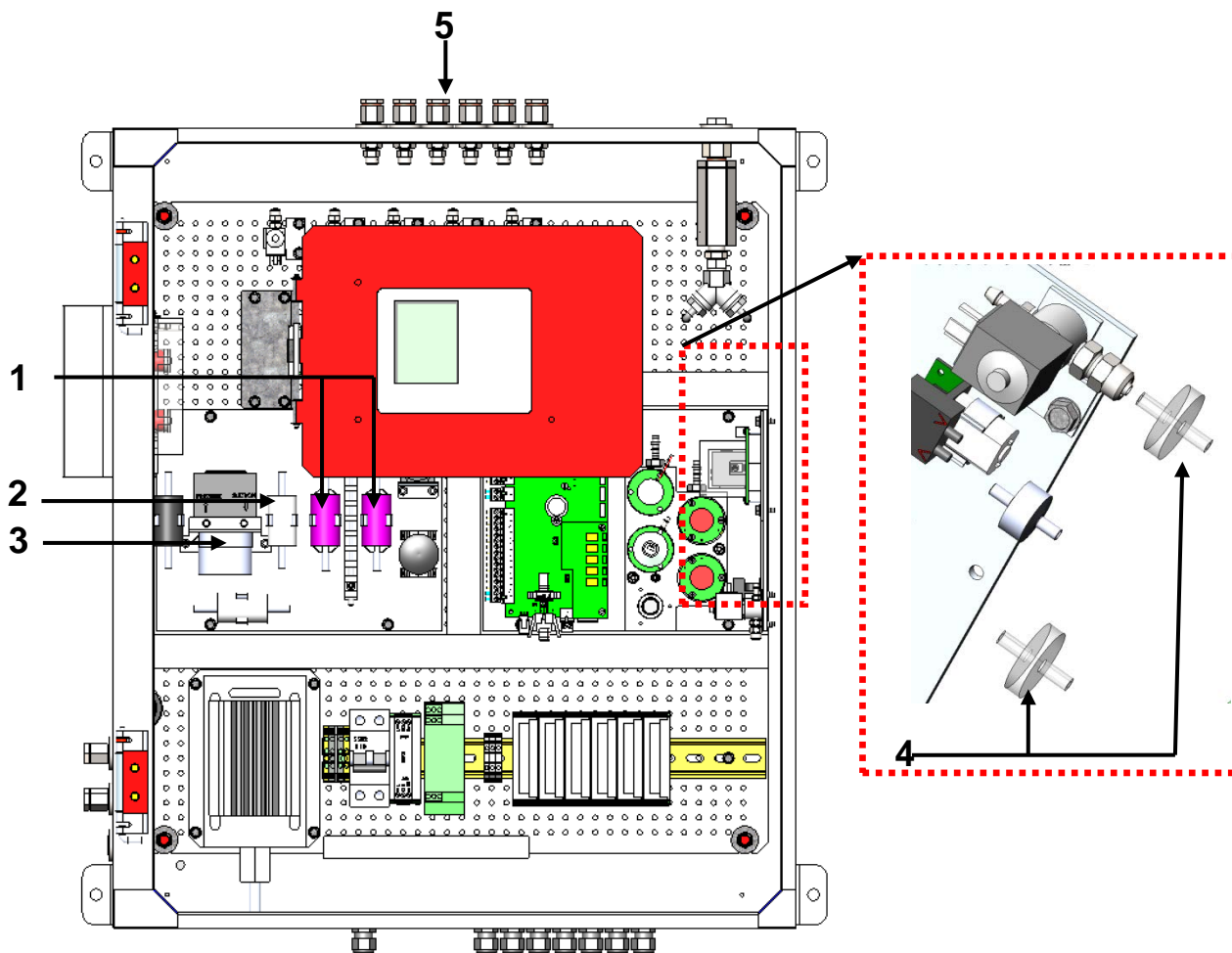
<u>Content of the service-set (offer-number: 66174)</u>
Single components can be offered under their article number directly.

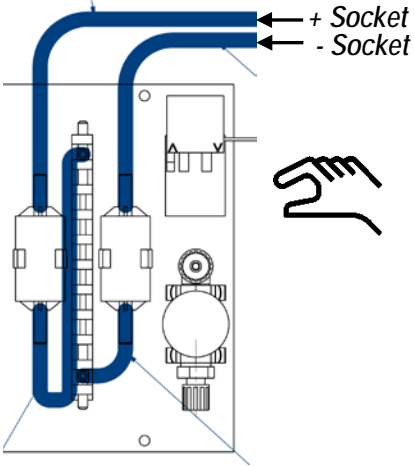| #	Image	name	Interval	Quantity	Offer-number
1		Acid-gas filter	New state: purple beads Used: white beads Life time: 2-6 month, dependend from gas concentration. Visual inspection is necessary.	2 pieces	56795
2		Dust- and particle filter	New state: white Used: dark/black Life time: 6 month, dependend from the dust- and dirt concentration. Visual inspection is necessary.	1 piece	65533
3		Dust- and particle filter (fine filter)	New state: white Used: dark/black Life time: 12 month, dependend from the dust- and dirt concentration. Visual inspection is necessary.	1 piece	66088
4		PTFE-filer	New state: white Must be changed, if the PTFE filter is blocked. The analyzer shows the warning *"Gas flow is too low"*.	2 pieces	51513
5		Sinterfilter	New state: sintered surface Must be changed, if the PTFE filter is blocked. The analyzer shows the warning *"Gas flow is too low"*.	2 pieces	65988

Position 1: Acid-gas filter (#56795)

Required materials 2x Acid gas filter (#56795), contained in the service- set.
Required tools: Needle-nose pliers.
Exchange interval: Exchange necessary, if filter turns from purple to white.

Steps:

1. Remove exhausted acid gas filter from the clips. 2. Pull the viton tubes from the exhausted acid gas filter. If it is necessary, use needle- nose pliers. 3. Plug the viton tubes on the new acid gas filters. Be sure, that the tubing is correct. (The single tubes are signed with "+" and "-", see sketch on the right side.)	*+ Socket* *- Socket*

Steps:
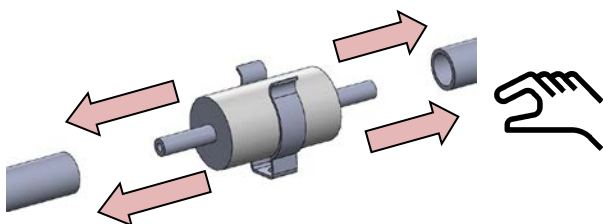
Pull the viton-tubes from the filter unit. If it is necessary, pliers can be used to solve the tubes from the filter unit.
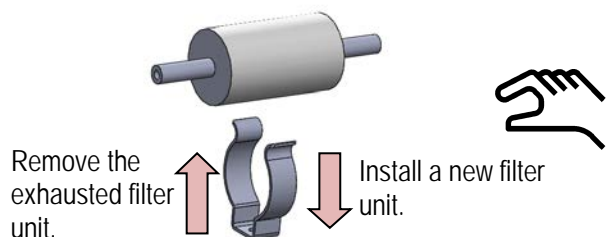
Remove the exhausted filter unit.

Install a new filter unit.

Remove the exhausted filter unit from the clip.
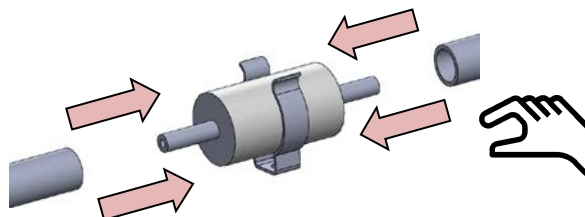
Plug the viton tubes on the filter unit. Push the filter unit on the clip.

Position 2 and 3: Dust- and particle filter (#65533 and #66088)

Required materials: Dust- and particle filter (#65533 and #66088) contained in the service set.
Required tools: needle-nose pliers.
Exchange interval: Exchange necessary, if the filter gets dark or black.

Steps:

Pull the viton-tubes from the filter unit with the hand. If it is necessary, pliers can be used to solve the tubes from the filter unit.
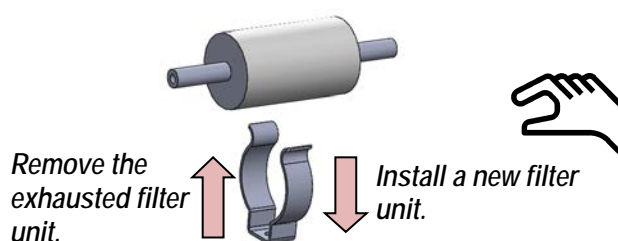
Remove the exhausted filter unit.   *Install a new filter unit.*

Remove the exhausted filter unit from the clip.

Plug the viton tubes on the filter unit. Push the filter unit on the clip.

Position 4: PTFE Filter (#51513)

Required materials: PTFE filter (#51513) contained in the service set.
Required tools: needle-nose pliers.
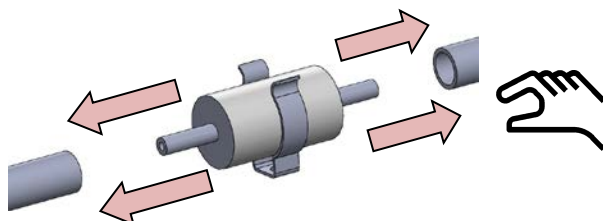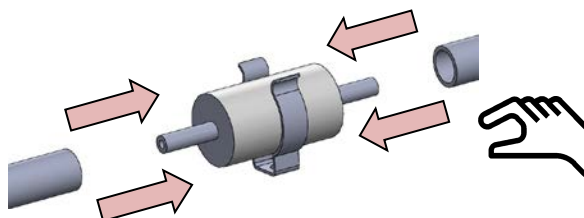Exchange interval: Exchange necessary, if gas flow is too low.

Steps:

Pull the exhausted filter-unit from the viton tube and exchange it with a new one. If it necessary, the tube can be solved from the tube with a needle-nose pliers.	
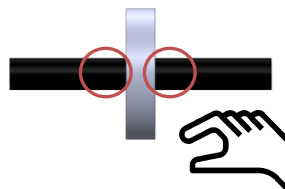
Position 5: Sinter filters (#65988)

Required materials: Sinter filters (65988), contained in the service-set.
Required tools: Spanner (range:17)
Exchange interval: Every 2 month, dependent from the dust- and pollution load.

Steps:

1. Remove the gas tube. Be sure, that no process gas emits in the environment. The upper part from the nozzle can be removed with a spanner (range 17). 2. Inside of the nozzle is a sinter filter tablet with an o-ring. Remove the exhausted sinter filter tablet and the o-ring and exchange both parts to a new one. The compensation parts can be found in the service-set. 3. The gas tube can now connect with the nozzle again.	O-ring (#64798) Sinterfilter (#65988) Copper seal (#61947)
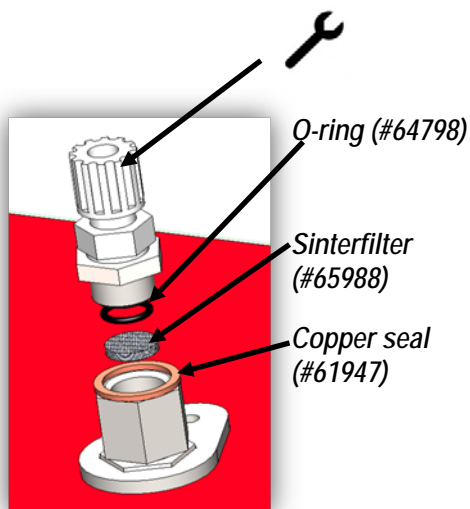
21.4.   Cleaning the surface of SWG100BIO-Ex.

⚠ DANGER

Explosion hazard

For cleaning the cabinet uses a wet and antistatic cloth to prevent electrostatic charge.
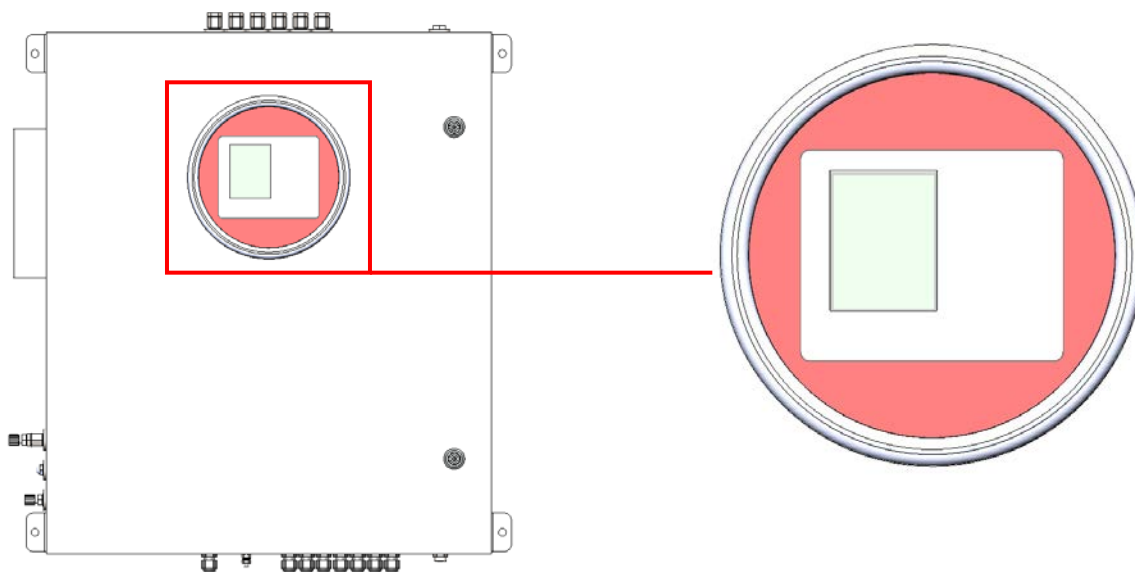
The SWG100BIO-Ex is designed for explosive atmosphere class 2. If the cabinet and the window must be cleaned, it is necessary to use a wet and antistatic cloth to prevent an electrostatic charge of the cabinet.

Use an antistatic cloth to clean the surface.

21.5.   Maintenance of the switch-off relay (K2) and the solenoid valve for CH4 supervision

The relay (K2) and the solenoid valve, which feeds the cabinet air in the NDIR-bench, are safety parts. The two components can be checked in the Self-Test menu. The menu can be found on the path: *Extras / Adjustment menu / Hardware state & tests*.

Check the following points:

- S. valve CH4 case from OFF to ON. The solenoid CH4 valve will make a noise.
- Safety switch-off from ON to OFF. The analyser will power down.

22.   Exchange of electrochemical sensors

The position of the electrochemical sensor in the SWG-100 BIOGAS is shown in the sketch below.
Depending form the design of the electrochemical sensors design, there are different ways to exchange the sensor.
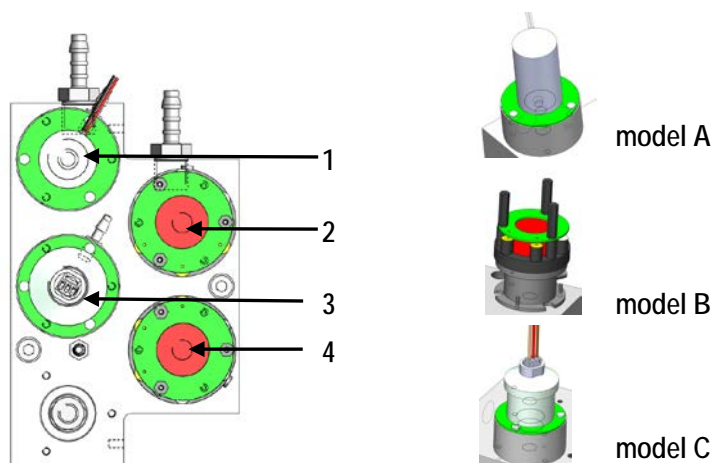
The chart below shows the article numbers where the replace can be offered.

Article number	Position number	Sensor	Range	Model
65824	1	O_2-Sensor	0-25 Vol.%	A
65825	2	H_2S-Sensor $_{low\ 200ppm}$	0-200ppm	B
66060	2	H_2S-Sensor $_{low\ 2.000ppm}$	0-2.000ppm	C
65826	3	H_2S -Sensor$_{high10000ppm}$	0-10.000ppm	C
65828	3	CO-Sensor	0-4000ppm	B
65827	4	H_2-Sensor$_{low}$	0-1.000ppm	B

It is important to consider, that only sensors can be replaced! The costumer has the opportunity to upgrade a new sensor type, it is necessary.

Exchange the sensors of the model A

Required sensor: O2-Sensor (65824 position 1)

⚠ CAUTION
Do not disposal the sensor in the domestic waste! Exhausted chemical sensors are special waste!

To exchange the sensor, following steps must be done:

Unplug the sensor connection cable here

- Remove the sensor from the main pcb (see sketch above).

- Unscrew the sensor, by hand from the sensor manifold.

New sensor

- Screw the new sensor hand tight in the sensor- manifold. Plug the sensor cable on the main pcb.

Exchange the sensors of the model B

Affected sensors: H2S low Sensor (65825 position 2)
H2 low sensor (65827 position 4).

⚠ *Caution*
Do not disposal the sensor in the domestic waste! Exhausted chemical sensors are special waste!

To exchange the sensors, following steps must be done:

- Remove all 3 plastic nuts from the sensor.
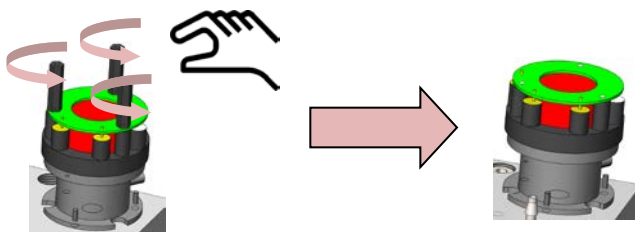
- Remove the round circuit board from the sensor. It is not necessary to unplug the circuit board from the main board.

Remove

- Pull off the "old" sensor from the sensor manifold.

Remove

- Put the "new" sensor in the same position like the old one.
- Push the round circuit board on the pins of the sensor. Be sure, that the pins of the circuit board has same designation with the pins from the sensor (for example: A-A, C-C...)
- Mount the three fixing nuts hand-tight on the sensor.

New sensor   *Circuit board*

Exchange the sensors from the model C
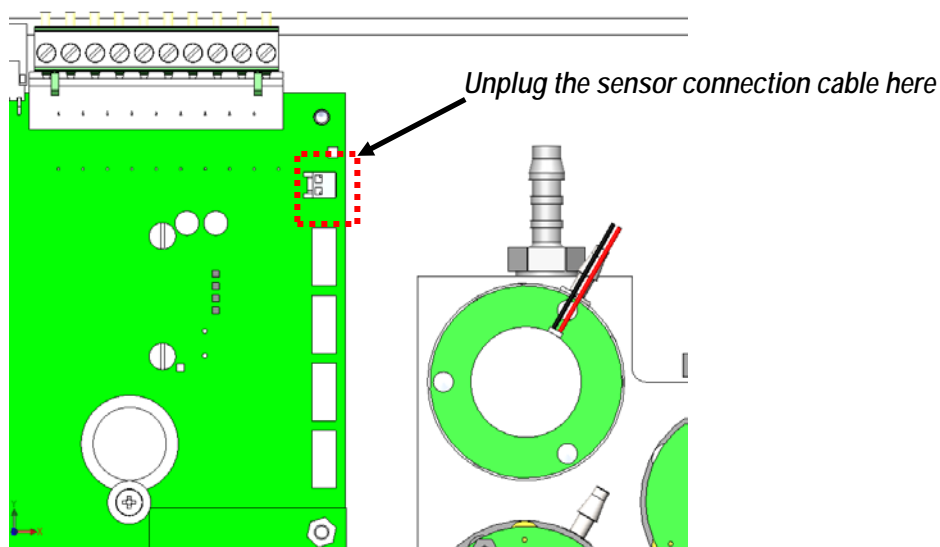
Affected sensors: H2S high sensor (65826 position 2)
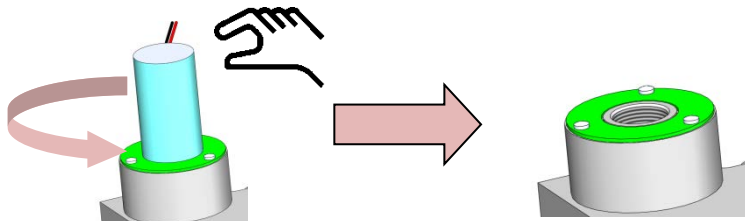H2S sensor (66060 position 4).

⚠ **CAUTION**

Do not disposal the sensor in the domestic waste! Exhausted chemical sensors are special waste!

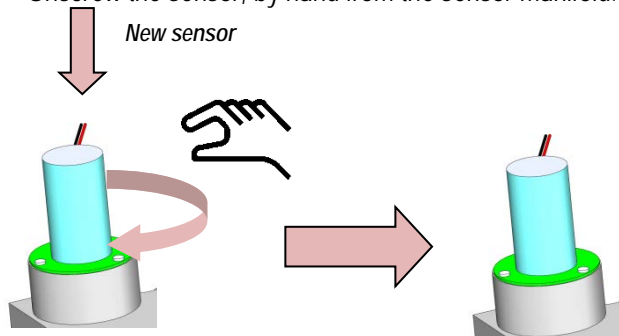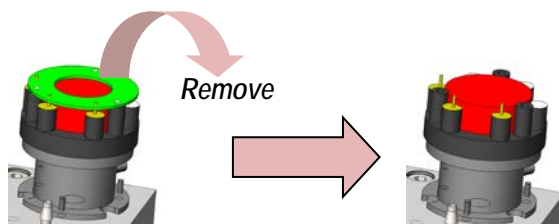
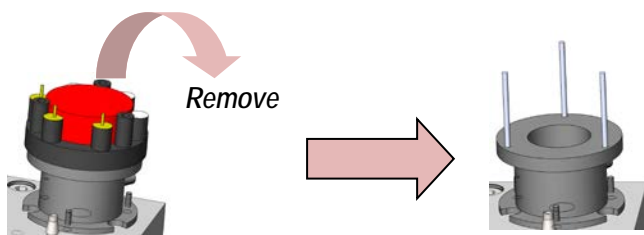To exchange the sensors, following steps must be done:
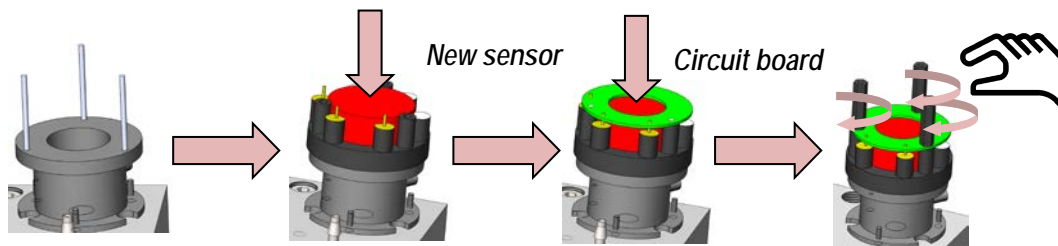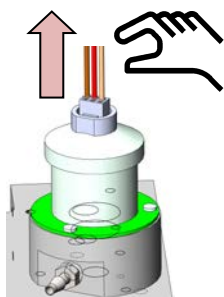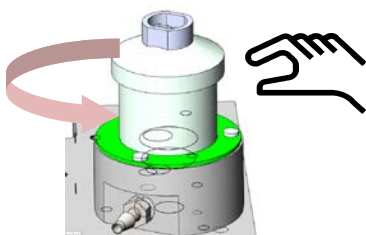
• Remove the cable form the sensor.

• Remove the old sensor.

• Mount the new sensor hand-tight to the sensor module.
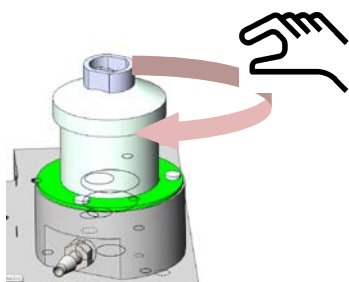
• Plug the cable to its previous position.
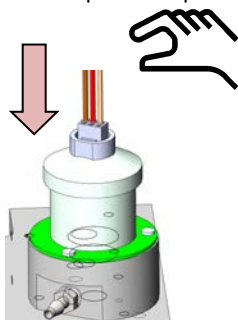
22.1. Analyzer calibration

Once in a while it is necessary to recalibrate the analyzer. The exact interval time depends on the biogas condition (gas concentration, total measuring time) and shall be determined by the user. MRU recommends at least half yearly calibration.

Calibration is carried out by connecting certified gas cylinder to the analyzer. As those cylinders, typically are under high pressure (150 to 200 bar) and they contain toxic and/or flammable gases, make sure that only qualified personal is involved in this calibration procedure. Every gas cylinder must be equipped with a proper pressure reducing manifold with flow regulating needle valve.

Applying calibration gas

Depending on the options installed there are two ways of connecting calibration gas:

Flow meter to ambient.

SWG
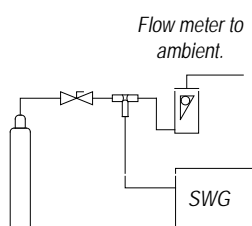
◆ *Analyzer without calibration gas inlet port*:
after zeroing the instrument with clean, free of pollutants ambient air, connect the calibration gas to the zero gas inlet port. Make sure that between the calibration gas cylinder pressure reducing manifold and the SWG100 zero gas inlet port, a flow regulating needle valve and a bypass to ambient air is installed, see sketch at left.
After the calibration procedure, the gas cylinder shall be removed; zero gas inlet port is used for regular zeroing of the analyzer.

• *Analyzer with calibration gas inlet port*:
the analyzer equipped with separate calibration inlet port, is internally equipped with a pressure reducing device which will limit the calibration gas pressure to 50mbar. Therefore the gas cylinder including a pressure reducing manifold (100 mbar … 1 bar) may be permanently connected to this calibration inlet port to perform automatic calibration (user free settable interval time).

Performing the calibration

• Perform always first a zeroing of the analyzer. Be sure, that the ambient air is clean and free of pollutants.
During calibration gas supply, please make sure that at all time there is a 5 to 10 l/hr surplus (bypass) of gas flowing through the flow-meter.
Total consumption of calibration gas is then:
  60 l/hr (analyzer) + 10 l/hr (bypass) = 70 l/hr
Generally the calibration time per each gas cylinder is not more than 5 minutes.

• Use the menu EXTRAS CALIBRATION to set the span factor accordingly to align the analyzer's measurement to the values of the calibration gas.

Mounting and installation of the gas cylinders for the auto calibration function

The auto calibration function allows the calibration of the analyzer. To use the auto calibration function, it is necessary to install the calibration gas bottles on the analyzer.

⚠ DANGER
Only educated staff is allowed to install the gas cylinders! Gas cylinders stand under extreme pressure and may cause material and personal damage!

⚠ CAUTION
All gas cylinders must be equipped with a pressure reducer! The pressure must be set to 500 mbar!

Cal inlet port (scope of supply)

(1)

(1) Primary pressure: 500mbar
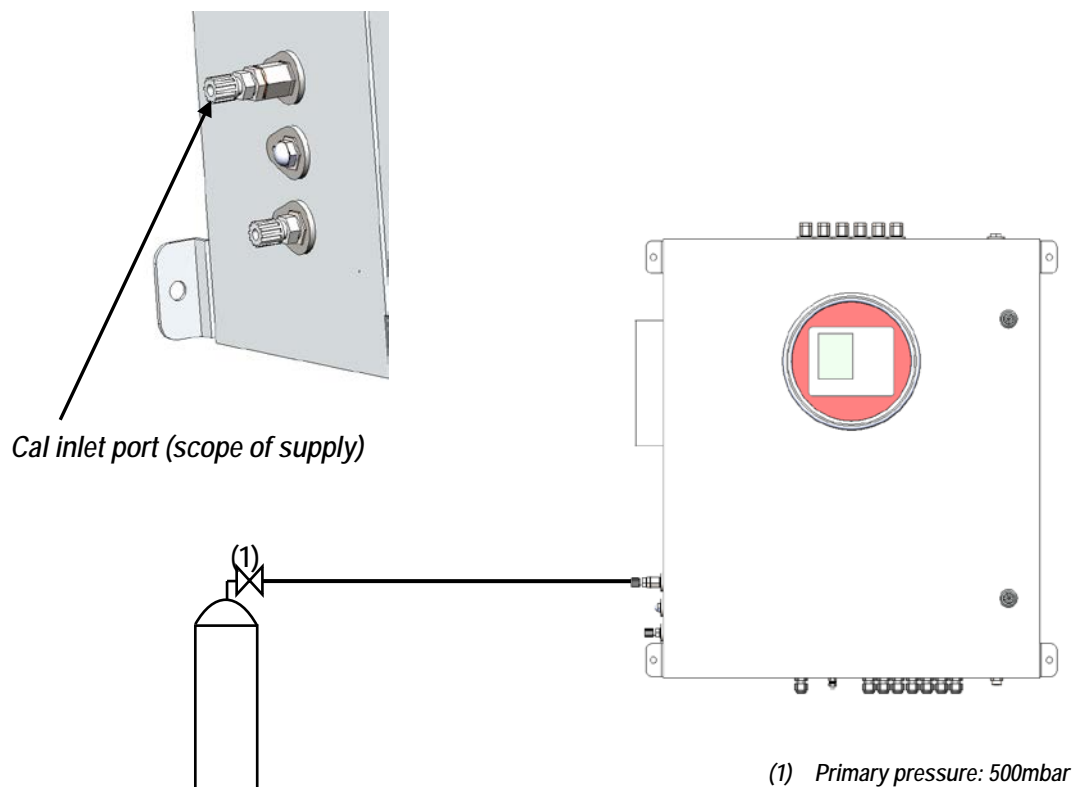
The sketch above shows the necessary installations for the auto calibration. The mixed gas bottle is installed on the left side of the analyzer. Before the gas bottle can be installed the *gas nozzle* must be mounted on the calibration gas inlet. The *gas nozzle* reduces the incoming gas flow in the analyzer.

Software side: **Adjustment for the option auto-calibration:**

1. Open the menu "Setup auto-calibration". It from: "EXTRAS/ ADJUSTMENT MENU/ SETUP-AUTO.-CALIBRATION".

2. Select menu point "test gas composition" to set the gas composition from the calibration gas cylinder. With the arrow keys "up/ down" an empty area can be chosen. With the arrow keys "left/ right" the different gas compositions can be set.
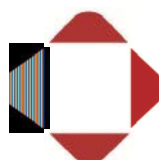
Arrow keys left/ right: With these keys the gas composition can be set.

Arrow keys up/ down: Single positions for the different gas compositions can be selected.

3. With *OK* the user is able to set the gas concentrations for the different gas compositions. First select the gas component, than press *OK*. A blue screen will show up appeared. With the arrow keys the gas concentration can be set.

4. After the gas composition is set, the interval for the calibration can be set, too.

	NOTE
i	**All gas concentrations are in percent! The factor from percent to ppm is: 1% = 10.000 ppm!**

5. The user has the following options:
- leave the menu: The set gas concentrations are stored and the auto calibration will start after the interval is reached.
- Start the auto- calibration immediately: Press *F2* (start now).

6. During the auto calibration the stored gas concentrations are compared with the measure gas concentrations. If the gas concentrations are not differing too much, the measured values will be shown "green" on the display.

7. The new gas factors will be stored, after successful calibration.

23.1. Troubleshooting

Error	Possible causes	Solutions
Display does not work.	- System is not power-up.	- connect main power supply. - power up automatic fuse. - contact customer support.
Analyzer powers down by itself.	- The fan is defect. - Filter mat from the fan is clogged. - The protect switch has been triggered.	- exchange the fan. - exchange the filter mat. - Internal short circuit. Contact an electrician to determine cause of defect.
Gas cooler unit does not work.	- The device is not ready, after a new start of the analyzer. - The ambient temperature is too hot. - The gas cooler unit is defect.	- wait until the gas cooler-unit is ready. - be sure, that ambient temperature is within operating range. -Contact the customer support.

24. Technical specification

Allgemein		General
Deutsch	**Angabe**	**English**
Betriebstemperatur (ohne Frostschutzheizung)	+5°C ... +45 °C / 41 °F ... 113 °F	Operating temperature (without heating)
Betriebstemperatur (mit optionaler Frostschutzheizung)	-20 °C ... +45°C / 14 °F ... 113 °F	Operating temperature (with internal heating, option)
Rel. Luftfeuchtigkeit bei Betrieb, nicht-kondensierend	95%	Rel. Humidity, non-condensing
Lagertemperatur	-20°C ... +50°C / -4°F ... 122°F	Storage Temperature
Schutzart	IP65	Protection Class
Aufstellbedingungen	geschützt vor direkter Sonneneinstrahlung und Regen	Installation Requirements
	do not expose to direct sun light or rain	
Akku intern, Pufferzeit für Sensor Bias	NiMH, 3 Monate / 3 months	Internal Battery Pack, buffer time for sensor bias
Stromversorgung (mit Frostschutzheizung)	100 - 240 V, 236 W	Power supply (with cabinet heater)
Gewicht	25 kg / 55 lbs	Weight
Maße	600x700x210 mm	Size
	23.6x 27.6 x8.3 in	
Gehäusematerial	Stainless steel	Cabinet material
max. Unterdruckbereich der Gaspumpe	300 hPa	Max suction of gas pump
typischer Gasdurchfluss	50 l/h	Typical gas flow

Schnittstellen		Interfaces
Deutsch	**Angabe**	**English**
Benutzerschittstelle	**Angabe**	**User Interface**
Anzeigetyp	3,5TFT	Display type
Anzahl gleichzeitig angezeigter Messwerte	6	Number of simultaneously displayed values
Tastatur mit Anzahl Tasten	12	Keyboard with qty of keys

Elektrische Aus-/Eingänge			Electrical I/O
Serielle Schnittstelle	RS485		Serial interface
Protokoll	Modbus RTU		Protocol
Typ Analogausgang	4 ... 20 mA		Type of analog output
Anzahl Ausgangskanäle pro I/O-Modul (optional)	4		Number of output channels per I/ modul (optional)
Typ Analogeingang	4 ... 20 mA		Typ of analog input
Anzahl Eingangskanäle pro I/O - Modul (optional)	4		Number of input channels per I/ modul (optional)
Anzahl Alarmausgänge pro I/O - Modul (über Relais)	2		Number of alarm ouput signal via relays
maximal mögliche Anzahl I/O - Module	4		Max number of I/O modules to be equipped
Systemalarm-Ausgang	Relaiskontakt relay contact		system alarm output
Gas Ein- und Ausgänge			**Gas input and ouput**
Anzahl parallel zu überwachender Messstellen	1		Number of simultaneously monitored sampling points
Anzahl Messgaseingänge (serielle Umschaltung)	4		Number of sampling points (serial sampling point switching)
Gehäuseverschraubung Messgaseingang	G1/8"		Screw joint sampling point
Gasausgang	G1/8"		gas output
Frischluft (für Nullpunktnahme)	G1/8"		Fresh air (for zeroing)
Kalibriergas	optional, G1/8"		Calibration gas

Messwerte

Meas. values

Deutsch	Angaben zur Messgenauigkeit	English
Elektrochemischer Sensor	**O2 Long Life**	**Electrochemical Sensor**
Messbereich	0 .. 21 %	Measuring Range
Auflösung	0,01 %	Resolution
Genauigkeit abs.	± 0,2 Vol%	Abs. Accuracy
Ansprechzeit T90	< 20s	Response Time T90
Jahre erwartete Lebensdauer an Luft	2	Years expected lifetime (@air)

Elektrochemischer Sensor	H2S low200	Electrochemical Sensor
Messbereich	0-200 ppm	Measuring Range
Auflösung	1 ppm	Resolution
Überlastbereich	< 1000 ppm	Overload Range
Genauigkeit abs.	±5 ppm / 5% (0 … 200 ppm) 10% (> 200 ppm)	Abs. Accuracy
Ansprechzeit T90	< 40s	Response Time T90
Jahre erwartete Lebensdauer an Luft	2	Years expected lifetime (@air)
Elektrochemischer Sensor	H2S high10.000	Electrochemical Sensor
Messbereich	0-10000 ppm	Measuring Range
Auflösung	1 ppm	Resolution
Überlastbereich	< 50000 ppm	Overload Range
Genauigkeit abs.	± 50 ppm / 5% (0 … 10000 ppm) 10% (> 10000 ppm)	Abs. Accuracy
Ansprechzeit T90	< 90s	Response Time T90
Jahre erwartete Lebensdauer an Luft (abhängig von gewähltem Sensor)	2	Years expected lifetime (@air) (Depending on chosen sensor)
Elektrochemischer Sensor	H2S low2000	Electrochemical Sensor
Messbereich	0-2000 ppm	Measuring Range
Auflösung	1 ppm	Resolution
Überlastbereich	< 5000 ppm	Overload Range
Genauigkeit abs.	< 5% (0…500 ppm) <15% (501…2500 ppm)	Abs. Accuracy
Ansprechzeit T90	< 35s	Response Time T90
Jahre erwartete Lebensdauer an Luft (abhängig von gewähltem Sensor)		Years expected lifetime (@air) (Depending on chosen sensor)
Elektrochemischer Sensor	CO	Electrochemical Sensor
Messbereich	0-4000 ppm	Measuring Range
Auflösung	1 ppm	Resolution
Überlastbereich	< 10000 ppm	Overload Range
Genauigkeit abs.		Abs. Accuracy
Ansprechzeit T90	< 40s	Response Time T90
Jahre erwartete Lebensdauer an Luft (abhängig von gewähltem Sensor)	3	Years expected lifetime (@air) (Depending on chosen sensor)
Elektrochemischer Sensor	H2	Electrochemical Sensor
Nominaler Messbereich	0-1000 ppm	Nom. Measuring Range

Überlastbereich	< 2000 ppm	Overload Range
Auflösung	1 ppm	Resolution
Genauigkeit absolut / vom Messwert	5% (0 … 1000 ppm) 10% (> 1000 ppm)	Accuracy abs. / reading
Ansprechzeit T90	< 50s	Response Time T90
Nicht-dispersive Infrarotmessung (NDIR)	CH_4	**Non-dispersive Infrared Measurement (NDIR)**
Nominaler Messbereich	0 .. 100 Vol%	Nom. Measuring Range
Auflösung	0,1 Vol%	Resolution
Genauigkeit abs. /vom Messwert	± 0,3 Vol% / 3%	Accuracy abs./reading
Ansprechzeit T90	< 35 s	Response Time T90

Berechnete Werte		Calculated values
Deutsch	Angabe	English
	CO_2	
Messbereich (brennstoffabhängig)	0 - CO_2max	Measuring range (fuel type dependant)

25. Declaration of conformity

(1) **Certificate of Conformity**

(2) Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres – **Directive 2014/34/EU**

(3) Certificate Number:

EPS 16 ATEX 1 182 X   Revision 0

(4) Equipment: SWG100BIO-Ex

(5) Manufacturer: MRU GmbH

(6) Address: Fuchshalde 8, 74172 Neckarsulm-Obereisesheim, Germany

(7) This equipment and any acceptable variation thereto are specified in the schedule to this Certificate of Conformity and the documents therein referred to.

(8) Bureau Veritas Consumer Products Services Germany GmbH certifies based on a voluntary assessment that this equipment has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of equipment and protective systems intended for use in potentially explosive atmospheres, given in Annex II of the Directive 2014/34/EU. The examination and test results are recorded in the confidential documentation under the reference number 16TH0283.

(9) Compliance with the Essential Health and Safety Requirements has been assured by compliance with:

EN 60079-0:2012 + A11:2013   EN 60079-15:2010

(10) If the sign "X" is placed after the certificate number, it indicates that the equipment is subject to special conditions for safe use specified in the schedule to this certificate.

(11) This Certificate of Conformity relates only to the design and the construction of the specified equipment in accordance with Directive 2014/34/EU. Further requirements of this Directive apply to the manufacture and supply of this equipment. Those requirements are not covered by this certificate.

(12) The marking of the equipment shall include the following:

⟨Ex⟩ II 3G Ex nA nC IIC T3 Gc

Certification department of explosion protection   Nuernberg, 2016-12-16

D. Zitzmann
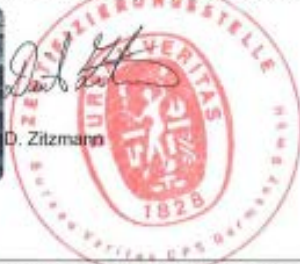
Page 1 of 2

Certificates without signature and seal are void. This certificate is allowed to be distributed only if not modified. Extracts or modifications must be authorized by Bureau Veritas Consumer Products Services Germany GmbH. EPS 16 ATEX 1 182 X, Revision 0.

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Annexe

(13)

(14) Certificate of Conformity EPS 16 ATEX 1 182 X

Revision 0

(15) Description of equipment:

Stationary Biogas-measuring system for continuous measurements

Electrical data:

230 V; 50 Hz; 10 A

(16) Reference number: 16TH0283

(17) Schedule of Limitations:

The device must be protected against excessive UV light emission.
The installation is intended to minimize the risk from electrostatic discharge.
Ambient temperature range +5 °C to +45 °C (without internal heater)
Ambient temperature range -20 °C to + 45 °C (with internal heater)

(18) Essential health and safety requirements:

Met by standards.

Certification department of explosion protection

Nuernberg, 2016-12-16

D. Zitzmann

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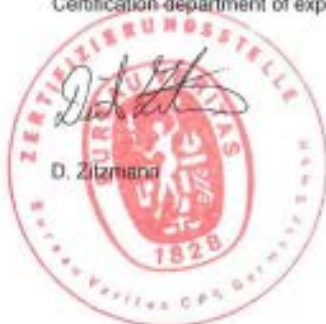
26.   APPENDIX

27. General information

The Modbus/Profibus Slave function requires the analyser firmware version V1.11.00 dated 12.07.2016 or later.
Multi byte values are transmitted in Motorola® byte order (Big-Endian). Only the CRC16 at the end of each frame is transmitted in Intel® byte order (Little-Endian).
In case you need Little-Endian byte order in the master's system:
- 16bit values (occurs only in the frame): swap bytes 0<=>1
- 32bit values (occurs only in the data): swap bytes 0<=>3 and swap bytes 1<=>2
All addresses written in this document are decimal (not hexa-decimal)
All readable data are 32bit values, therefore the analyser only accepts even addresses end even number of registers to be read.
Data types (used in table below):
U32   32 bit unsigned integer value (0…4.294.967.295)
FL   32 bit floating point value (reads -1E38, when not available)
Some values are optional (e.g. gas-cooler).

27.1.   Special informationen about the Modbus Slave function

- The analysers are able to work as modbus slave using the RS232 or RS485 port (possibly with external RS232/RS485 adapter)

- supports RS485 interface with 2/4 wires (half/full duplex)

- supports only the binary Modbus protocol (RTU)

- supports modbus command *Read Holding Register* (command no 3)

- supports modbus command *Read Input Register* (command no 4)

- the slave modbus address is user definable from 1 to 238

- communication parameter are user definable as follows:
  - 9600 baud or 19200 baud (recommended)
  - odd, even or none parity
  - 1 or 2 stop bits

- The maximal number of 32bit-values to be read with one single read command is 63
  (126 modbus registers)

27.2. Special informationen about the Profibus Slave function

- The Profibus Slave function requires a modbus/profibus-converter "Seneca HD67561", which is configured and installed in the analyser.

- Usually MRU sets the Profibus ID to 84.

28. Defined registers to be read by the master

modbus address	profibus address	data type	register content
Status & Device info			
0	0	U32	Analyser Status (more details read below)
2	4	U32	System Alarm (more details read below)
4	8	U32	Serial number
6	12	U32	Analyser type (11060 = SWG100biogas)
8	16	U32	Firmware version (e.g. 12345 = V1.23.45)
10	20	U32	Elapsed seconds since Power-On
12	24	U32	Counter Modbus Frame Error
14	28	FL	CH4 amb. [%]
16	32	FL	CH4 amb. [% LEL]
18	36	FL	T-sensor [°C/°F] (unit depends on user settings)
20	40	FL	Sample Flow [l/h]
22	44	FL	T-gascooler [°C/°F] (unit depends on user settings)
24	48	FL	Case fan rotations [rpm]
26	52	FL	Gas pump rotations [rpm]
28	56	FL	P-absolute [hPa] (=[mbar])
30	60	FL	P-absolute [inchHG]
32		U32	not (yet) defined (reads zero)
34		U32	not (yet) defined (reads zero)
36		U32	not (yet) defined (reads zero)
38		U32	not (yet) defined (reads zero)
Status & current measurement values (live values!)			
40		U32	Analyser Status (more details read below)
42		U32	System Alarm (more details read below)
44		FL	O2 [%]
46		FL	CO2 [%] (or CO2 [ppm], if CO2 [%] isn't available)
48		FL	CH4 [%] (or CH4 [ppm], if CH4 [%] isn't available)
50		FL	H2S [ppm] (optional)
52		FL	H2 [ppm] (optional)
54		FL	Net calorific value [MJ/kg]
56		FL	Gross calorific value [MJ/kg]
modbus address	profibus address	data type	register content
58		FL	Net calorific value [MJ/m³]
60		FL	Gross calorific value [MJ/m³]

62		FL	CO [ppm] (optional)
64		FL	CH4 [ppm] (optional, when CH4 [%] also available)
66		FL	CO2 [ppm] (optional, when CO2 [%] also available)
68		U32	not (yet) defined (reads zero)
Status & measurement values of sample point 1			
70		U32	Analyser Status (more details read below)
72		U32	System Alarm (more details read below)
74	64	FL	O2 [%]
76	68	FL	CO2 [%] (or CO2 [ppm], if CO2 [%] isn't available)
78	72	FL	CH4 [%] (or CH4 [ppm], if CH4 [%] isn't available)
80	76	FL	H2S [ppm] (optional)
82	80	FL	H2 [ppm] (optional)
84	84	FL	Net calorific value [MJ/kg]
86	88	FL	Gross calorific value [MJ/kg]
88	92	FL	Net calorific value [MJ/m³]
90	96	FL	Gross calorific value [MJ/m³]
92	100	FL	CO [ppm] (optional)
94	104	FL	CH4 [ppm] (optional, when CH4 [%] also available)
96		FL	CO2 [ppm] (optional, when CO2 [%] also available)
98		U32	not (yet) defined (reads zero)
Status & measurement values of sample point 2 (optional)			
100		U32	Analyser Status (more details read below)
102		U32	System Alarm (more details read below)
104	108	FL	O2 [%]
106	112	FL	CO2 [%] (or CO2 [ppm], if CO2 [%] isn't available)
108	116	FL	CH4 [%] (or CH4 [ppm], if CH4 [%] isn't available)
110	120	FL	H2S [ppm] (optional)
112	124	FL	H2 [ppm] (optional)
114	128	FL	Net calorific value [MJ/kg]
116	132	FL	Gross calorific value [MJ/kg]
118	136	FL	Net calorific value [MJ/m³]
120	140	FL	Gross calorific value [MJ/m³]
122	144	FL	CO [ppm] (optional)
124	148	FL	CH4 [ppm] (optional, when CH4 [%] also available)
126		FL	CO2 [ppm] (optional, when CO2 [%] also available)
128		U32	not (yet) defined (reads zero)
Status & measurement values of sample point 3-10 (optional)			
130-369	152...	...	add 30/44 to the addresses for each sample point

Optional AUX values are not available via Profibus.

protocol address	data type	numb. of registers	register content
AUX-values (read by up to 10 IO-modules)			
370	FL	2	AUX-value read by IO-module 1 - Input 1
372	FL	2	AUX-value read by IO-module 1 - Input 2
374	FL	2	AUX-value read by IO-module 1 - Input 3
376	FL	2	AUX-value read by IO-module 1 - Input 4
378	FL	2	AUX-value read by IO-module 2 - Input 1
380	FL	2	AUX-value read by IO-module 2 - Input 2
382	FL	2	AUX-value read by IO-module 2 - Input 3
384	FL	2	AUX-value read by IO-module 2 - Input 4
386	FL	2	AUX-value read by IO-module 3 - Input 1
388	FL	2	AUX-value read by IO-module 3 - Input 2
390	FL	2	AUX-value read by IO-module 3 - Input 3
392	FL	2	AUX-value read by IO-module 3 - Input 4
394	FL	2	AUX-value read by IO-module 4 - Input 1
396	FL	2	AUX-value read by IO-module 4 - Input 2
398	FL	2	AUX-value read by IO-module 4 - Input 3
400	FL	2	AUX-value read by IO-module 4 - Input 4
402	FL	2	AUX-value read by IO-module 5 - Input 1
404	FL	2	AUX-value read by IO-module 5 - Input 2
406	FL	2	AUX-value read by IO-module 5 - Input 3
408	FL	2	AUX-value read by IO-module 5 - Input 4
410	FL	2	AUX-value read by IO-module 6 - Input 1
412	FL	2	AUX-value read by IO-module 6 - Input 2
414	FL	2	AUX-value read by IO-module 6 - Input 3
416	FL	2	AUX-value read by IO-module 6 - Input 4
418	FL	2	AUX-value read by IO-module 7 - Input 1
420	FL	2	AUX-value read by IO-module 7 - Input 2
422	FL	2	AUX-value read by IO-module 7 - Input 3
424	FL	2	AUX-value read by IO-module 7 - Input 4
426-241	FL	16	8 AUX-values read by IO-modules 8 & 9
442	FL	2	AUX-value read by IO-module 10 - Input 1
444	FL	2	AUX-value read by IO-module 10 - Input 2
446	FL	2	AUX-value read by IO-module 10 - Input 3
448	FL	2	AUX-value read by IO-module 10 - Input 4

28.1. Analyser Status (address 0 and some mirror addresses)

The Analyser Status is a 32bit-word and must be interpreted bitwise.

Bit	Description
0	Power-On (until the first zeroing has been done)
1	System-Alarm, see table below
2	Air Purging (zeroing)
3	Gas Sampling (preparing measurement, not measurement!)
4-7	Currently sampled sample point number (1..10, reads 0 while air purging)
8	One sensor (e.g. CO or H2S) is currently purged
9	One sensor (e.g. CO or H2S) is currently cut-off the sample gas
10-31	reserved for later applications (reads zero)

Some status examples:

Decimal	Hexadecimal	Binary	state description
1	0001h	0000 0001	Power-On (self-test)
5	0005h	0000 0101	First Air Purging (Power-On + Air Purging)
24	0018h	0001 1000	Preparing meas. smp.pt.1 (Gas Sampling + smp.pt.1)
16	0010h	0001 0000	Measuring sample point 1
40	0028h	0010 1000	Preparing meas. smp.pt.2 (Gas Sampling + smp.pt.2)
32	0020h	0010 0000	Measuring sample point 2
48	0030h	0011 0000	Measuring sample point 3
18	0012h	0001 0010	Measuring sample point 1 + System-Alarm
0	0000h	0000 0000	Adjustment (user interaction at the analyser)

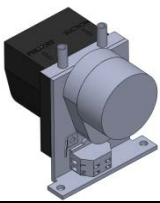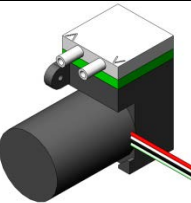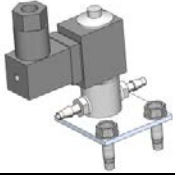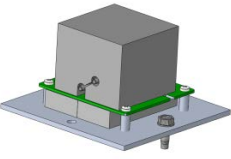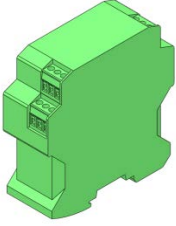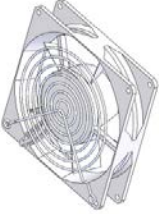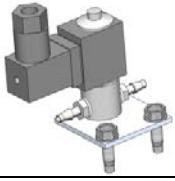## 28.2. Analyser System Alarm (address 2 and some mirror addresses)

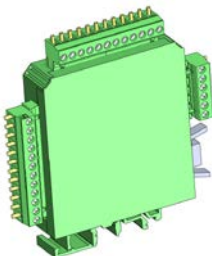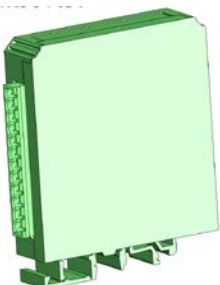The Analyser System Alarm is a 32bit-word and must be interpreted bitwise.

Bit	Description	Meas. halted
0	Mainboard Offline (some communication problems)	YES
1	Mainboard is in bootloader mode	YES
2	CH4 ambient > threshold value	YES
3	Condensate	YES
4	Sample flow < 20 l/h	-
5	Case fan rotations < 900 rpm	-
6	T-gascooler > 10°C	-
7	T-gascooler < 2°C	-
8	T-Sensor > 55°C	-
9	T-Sensor < 5°C	-
10-31	reserved for later applications (reads zero)	

Some system alarm examples:

Decimal	Hexadecimal	Binary	state description
1	0001h	0000 0001	Mainboard is offline, measurement is halted
8	0008h	0000 1000	Condensate Alarm, measurement is halted
80	0050h	0101 0000	Sample flow < 20 l/h and T-gascooler > 10°C

28.3. Spare parts list

Article	Description – Serial number
	Condensate pump - #11230 *Required to drain the condensate*
	Sample gas pump - #65032 *Used for sample gas pumping*
	H2S solenoid valve - #65470 *Required for cut-off sample gas supply to H2Slow sensor.*
	NDIR CH4/CO2 - #65128 *Infrared measuring device of CH4 and CO2*
	Power supply - #65325
	Axial fan - #65097 *For ventilation of analyzer cabinet*
	Solenoid valve - #65470 *Used for sampling point switching.*
	Heater - #65425 *Used for freeze protection of analyzer cabinet*

	Display and operation unit *#65133* *Control unit for the user.*
	I/O-Module #65179 + #65430 *Used for analog output* *data transfer and sample point switching.* *-*
	I/O Module - #65179 *Used for analog output* *data transfer*

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