Gas Analysis

ModbusTCP

Gas Analyser for maritime emission monitoring

BA 3 MA

Installation and Operation Instructions

Original instructions

BE550027
10/2024

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Read this instruction carefully prior to installation and/or use. Pay attention particularly to all advises and safety instructions to prevent injuries. Bühler Technologies can not be held responsible for misusing the product or unreliable function due to unauthorised modifications.

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Contents

1 Introduction

1.1 Intended Use

The BA 3 MA gas analyser serves the continuous measurement of SO_2 and CO_2 flue gas emissions in maritime applications (marine engines). It can particularly be used to monitor compliance with exhaust emission standards (quotient of SO_2/CO_2 [ppm/Vol.-%] associated with SO_2 pollutant emission control system ships (so-called SO_2 scrubbers). The analyser is therefore DNV certified (Statement of Compliance) according to MEPC259(68).

The device **must not be used**

- To analyse combustible, inflammable or explosive gas mixtures,
- In explosive areas and
- For applications where equipment failure or malfunction puts persons in immediate danger.
- To convey highly toxic gas.

1.2 Equipment configuration

The order key indicates the configuration.

Please refer to the nameplate for your equipment configuration.

1.3 Scope of delivery

- Analyser
- Product documentation
- Connection/mounting accessories (optional)

2 Safety instructions

2.1 Important notices

This unit may only be used if:

- The product is being used under the conditions described in the operating- and system instructions, used according to the nameplate and for applications for which it is intended. Any unauthorized modifications of the device will void the warranty provided by Bühler Technologies GmbH,
- Complying with the specifications and markings in the type plate,
- Complying with the limits specified in the data sheet and the instructions,
- Service and repair work not described in these instructions are performed by Bühler Technologies GmbH,
- Using genuine replacement parts.

These operating instructions are a part of the equipment. The manufacturer reserves the right to change performance-, specification- or technical data without prior notice. Please keep these instructions for future reference.

Please particularly note the following analyser instructions:

- Always transport the equipment diligently and carefully. Strong impact and shock may damage the measuring cells in the analyser or shorten their life!
- Avoid condensation inside the equipment, as the measurement system could be damaged and become defective. If the sample gas contains condensable components, the analyser must have suitable upstream sample gas conditioning. Our customer service will gladly help you select a system.
- Depending on the application, it may be necessary to regard specific regulations and rules when handling with elevated oxygen concentrations. This must be checked by the operator of the device.

Signal words for warnings

DANGER	Signal word for an imminent danger with high risk, resulting in severe injuries or death if not avoided.
WARNING	Signal word for a hazardous situation with medium risk, possibly resulting in severe injuries or death if not avoided.
CAUTION	Signal word for a hazardous situation with low risk, resulting in damaged to the device or the property or minor or medium injuries if not avoided.
NOTICE	Signal word for important information to the product.

Warning signs

These instructions include the following warnings:

	General warning sign		General mandatory sign
	Voltage warning		Unplug from mains
	Warning not to inhale toxic gases		Wear respiratory equipment
	Warning of corrosive substances		Wear a safety mask
	Warning of explosion hazard		Wear gloves
	Warning of hot surfaces		

2.2 General hazard warnings

The equipment must be installed by a professional familiar with the safety requirements and risks.

Be sure to observe the safety regulations and generally applicable rules of technology relevant for the installation site. Prevent malfunctions and avoid personal injuries and property damage.

The operator of the system must ensure:

- Safety notices and operating instructions are available and observed,
- The respective national accident prevention regulations are observed,
- The permissible data and operational conditions are maintained,
- Safety guards are used and mandatory maintenance is performed,
- Legal regulations are observed during disposal,
- compliance with national installation regulations.

Transport

- Always transport the BA 3 MA with care. Strong impact and shock may damage the measuring cells in the analyser or shorten their life!

Sample gas conditioning

- Prevent condensation or particles inside the unit as the measuring system may become defective. If the sample gas contains condensable components, the BA 3 MA must have suitable upstream sample gas conditioning. Suitable filters must be installed ahead of the unit's gas inlet. Our customer service will gladly help you select a sample gas conditioner.

Maintaining the device parameters

- Be sure to maintain the approved operating and ambient temperatures and the technical specifications.

Personnel

- The unit must only be installed, operated and maintained by qualified personnel.

Maintenance, Repair

Please note during maintenance and repairs:

- Repairs to the unit must be performed by Bühler authorised personnel.
- Only perform conversion-, maintenance or installation work described in these operating and installation instructions.
- Always use genuine spare parts.
- Do not install damaged or defective spare part. If necessary, visually inspect prior to installation to determine any obvious damage to the spare parts.

Always observe the applicable safety and operating regulations in the respective country of use when performing any type of maintenance.

DANGER **Electric voltage**

Risk of electric shock

a) Disconnect all poles of the unit from the mains for any maintenance on electric components.

b) Secure the equipment from accidental restarting.

c) The unit may only be opened by trained, competent personnel.

d) Ensure the correct voltages supply.

DANGER **Toxic, corrosive gases**

The measuring gas led through the equipment can be hazardous when breathing or touching it.

a) Check tightness of the measuring system before putting it into operation.

b) Take care that harmful gases are exhausted to a save place.

c) Before maintenance turn off the gas supply and make sure that it cannot be turned on unintentionally.

d) Protect yourself during maintenance against toxic / corrosive gases. Use suitable protective equipment.

DANGER

Potentially explosive atmosphere

Explosion hazard if used in hazardous areas.
The device is not suitable for operation in hazardous areas with potentially explosive atmospheres.
Do not expose the device to combustible or explosive gas mixtures.

3 Technical description

3.1 Configuration

The BA 3 MA is a 19 inch rack device for stationary mounting (IP20 protection class for indoor installation). The core component of the device is a combination of two gas sensors. On one hand it uses an optical NDUV SO_2 sensor (non-dispersive UV spectroscopy). On the other hand, it is equipped with an optical NDIR CO_2 measurement sensor (non-dispersive IR spectroscopy) to measure the CO_2 concentration (also see below: measuring principle). The sensors are connected to hoses in series in a common gas path. Therefore the same sample gas flows through them <0.5 sec apart. The sample gas flow through the device can be between 60 L/h and 120 L/h. Using the internal pump (optional) generates a gas flow of approx. 120 L/h. In both cases, an internal bypass flow regulator down-regulates the input flow through the sensors to approx. 30 L/h. An integrated pressure compensation eliminates the impact of gas pressure variations on the gas concentration measurement. Both gas sensors are located inside a heated thermal box. The device can further be equipped with fine particle filter, flow meter, internal gas pump and 3/2-way auto-calibration solenoid valve.

At the back of the device the user can obtain the SO_2 and CO_2 gas concentrations as 4-20 mA Signal and digital Modbus TCP signal. The measurements are refreshed every second (1 Hz). Status signals (maintenance, fault, operation, calibration, measuring range, limits) are output via relay outputs and Modbus TCP. In addition, maintenance and fault requirements are indicated on the display of the device.

The device further has a maintenance, fault, and a calibration logbook. Here the respective messages (including date and time) can be accessed via the analyser display. Once the specified faults are corrected or the service message actively erased, the service and fault messages are no longer displayed (display, Modbus, relay).

The measuring ranges of the device can be set to any point within a range of 0-500 ppm SO_2 and 0-15 % CO_2.

SO_2 measuring range: Smallest MR = 0-100 vpm SO_2	Largest MR = 0-500 ppm SO_2
CO_2 measuring ranges: Smallest MR = 0-10 Vol.% CO_2	Largest MR = 0-15 Vol.% CO_2

Display and operation

The analyser is standard equipped with a 4.7” touchscreen display. This display is used to show measurements and operate the unit.

Front plate filter

An optional microfilter is available for the front of the housing to filter particles from the sample gas flow. This requires no tools to change. A built-in safety filter is standard on all gas paths without front panel filter.

Flow measurement

The options for having the unit display the gas flow rate are:

– Float flow meters on the front panel and/or
– Bar graph in the display

Gas pumps

A pump conveying the sample gas through the unit can optionally be built in.

Channel markings

The channels on the unit are marked as follows:

Symbol	Explanation
SO_2	SO_2 vpm trace measurement (smallest measuring range 0-100 ppm) via NDUV sensor
CO_2	CO_2 Vol.% measurement (smallest measuring range 0-10 Vol.%) via NDIR sensor
CO_2/SO_2	Operand (quotient) from SO_2 and CO_2 measurements [ppm/Vol.%]

Output signals

All gas concentration measurements necessary for effective monitoring as well as status, limit and alarm messages are output in analogue and/or digital (Modbus TCP) form at the back of the housing (see chapter Signal outputs [> page 17]).

Gas connections

The respective number of gas path PVDF hose fittings are located at the back of the housing. Stainless steel bulkhead couplings are optional.

Gas Flow Control

The analyser is equipped with internal bypass controllers to keep the gas volume flowing through the cells as consistent as possible. This allows a high, stable sample gas flow to the analyser, hence short equipment response times.

Valves for automatic calibration

The unit may optionally be equipped with 3/2-way solenoid valves. These will automatically switch between the sample gas and calibrating gas input on the unit.

Electric supply

The electric supply is located at the back of the housing.

Your equipment configuration

Please refer to the nameplate on the device for the for your specific equipment configuration.

On start-up the unit will further show which measuring cells are installed and the software version. During operation you may view the configuration via Menu > Diagnostics > Status.

3.2 Equipment overview

The following views explain the elements of the analyser.

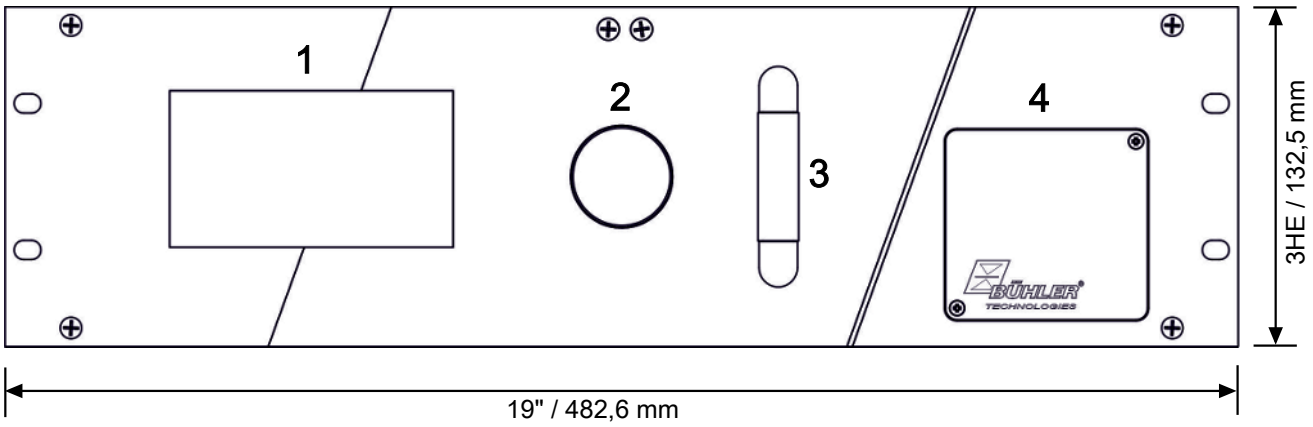


Fig. 1: BA 3 MA, front view

1	Touchscreen and measurement display
2	Sample gas filter (optional)
3	Flow meter, varies by number of channels
4	Maintenance door

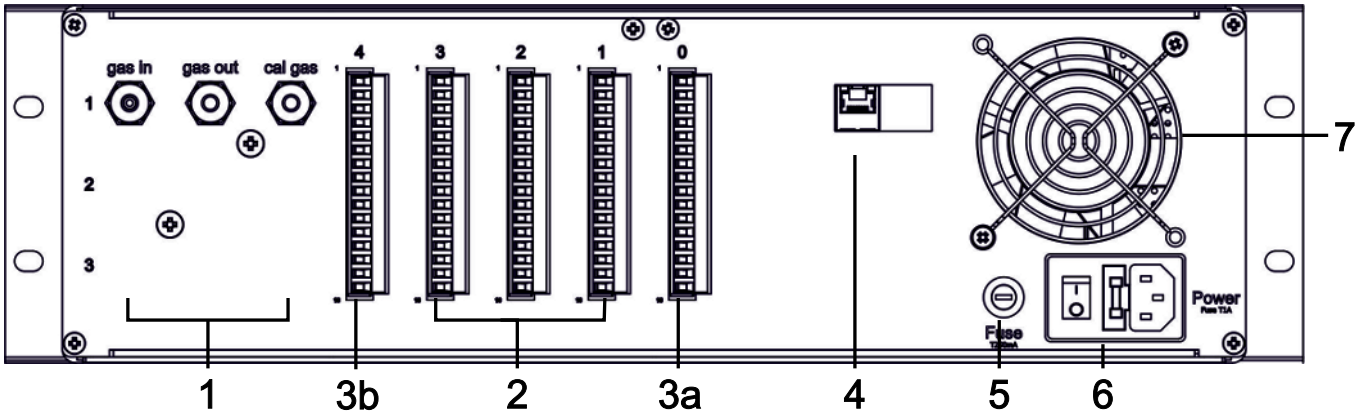


Fig. 2: BA 3 MA, rear view

1	gas in	Sample gas input	4	Modbus-TCP	Modbus interface (optional)
	gas out	Gas outlet	5	Fuse	Fuse 1
	cal. gas	Calibrating gas inlet	6	Power	Power supply with built-in fuse and ON/OFF switch
2	ST1 to ST3	Signal output Ch. 1 to Ch. 3			
3a	ST0	Error/service signal	7		Fan
3b	ST4	Measuring range signal Ch. 1 to 3			

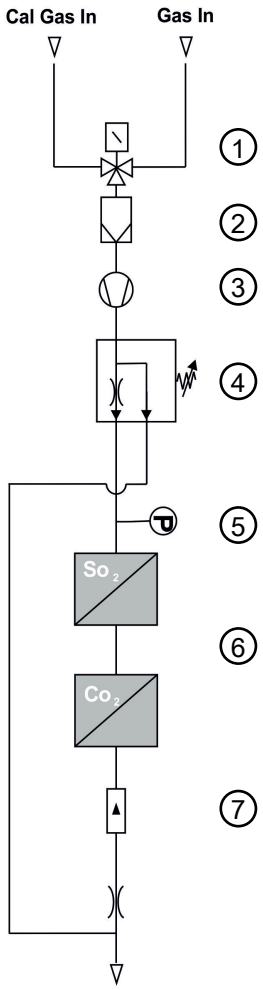
3.3 Gas flow diagrams

The analyser is equipped with an optical NDUV SO_2 sensor and an optical NDIR-CO_2 sensor. The sensors are connected to hoses in series in a common gas path. Therefore the same sample gas flows through them < 0.5 sec. apart.

The flow diagram below shows the equipment base version with one measuring cell or one channel.

	Legend
1	3/2-way solenoid valve (optional with internal auto cal solenoid valve option)
2	Inlet filter
3	Internal pump (optional)
4	Flow regulator
5	Pressure sensor
6	Measuring cells
7	Flow meter (optional)

Flow diagram



Pressure:	With internal pump	max. 1200 mbar absolute
	Without internal pump	max. 1800 mbar absolute
Flow (gas in):		60-120 L/h, or constant via internal pump (approx. 120 L/h)
Cell flow:	SO_2	approx. 30 L/h, internally regulated
	CO_2	approx. 30 L/h, internally regulated
T_{amb}:		5 °C ... 45 °C

Tab. 1: Gas flow diagram for the equipment base version

The solenoid valve (1, optional) adds sample gas or calibrating gas. The maximum pressure permitted at the gas inlet varies by version (see above).

A gas flow between approx. 60-120 L/h can be added via the gas inlet. Using the internal pump (3, optional) generates a gas flow of approx. 120 L/h. The flow regulator (4) keeps the gas flow through the measuring cell (6) at a constant level. Excess gas flows off through the bypass.

The cell flow must not exceed the value permitted for the cell (see above) and should be as consistent as possible.

The barometric pressure sensor (5) compensates the results based on barometric variations. The flow meter (7, optional) or the series bar graph in the display shows the gas flow through the measuring cell.

3.4 Principles of measurement

The gas concentration is measured using non-dispersive (ND) absorption spectroscopy. Here the degree of radiation absorption (in the gas to be measured) is a dimension for the gas concentration. The radiation enters the measuring chamber the sample gas flows through at an intensity of Io. According to the Beer-Lambert law of absorption the intensity of light behind the chamber is reduced to I= Io* exp(-ε c· l). Here, c is the gas concentration and l the length of the measuring chamber. Factor ε is referred to as a so-called extinction coefficient which reflects the specific absorption behaviour of the target gas. The radiation intensity I escaping the chamber is ultimately registered by a detector. The I/Io ratio can be used to infer the concentration of the target gas in the chamber.

The SO_2 or CO_2 concentration is measuring using an NDUV sensor or an NDIR sensor, each with pulsed lamp. This completely eliminates modulating the measurement radiation via chopper susceptible to vibration.

3.5 Technical Data

General		
Housing	Dimensions:	19" rack mount housing, 3 HE
	H x W x D:	132 x 440 x 425 mm
	Protection class:	IP 20
	Weight:	max. 10 kg
	Display and control:	4.7" touchscreen display
Electric supply	Voltage:	230 V AC or 115 V AC *(note nameplate on the unit)*
	Mains frequency:	50/60 Hz
	max. power input:	< 150 W
Ambient parameters	Ambient temperature:	5 °C ... 45 °C
	Relative humidity:	< 75 %
	Ambient pressure:	875 mbar to 1200 mbar
	Transport and storage temperature:	5 °C - 65 °C
AUTO cal. Function	Optional: Zero gas + span gas	
Warm up time	At least 30 min (up to 3 h recommended for high-precision SO_2 measurements in the lower ppm range)	

Sample gas connections		
Gas paths	One gas path (with auto cal. function)	
	Screw-in connection:	6 mm PVDF for 4/6 tube
Inlet parameters	Gas inlet temperature:	5 °C to 50 °C
	Sample gas pressure (absolute):	875 mbar to max. 1800 mbar, reduced to max. 1200 mbar with internal pump
	Sample gas conditioning:	purified/ filtered (< 10 µm filtration) sample gas with dew point < 10 °C (always 5 K below ambient temperature).

Signal inputs and outputs	
Analog output:	4 - 20 mA per channel
Limit relay:	2x per measuring channel (125 V AC, 0.5 A/30 V DC, 1 A)
Status relay:	Error, service, calibration, measuring range (125 V AC, 0.5 A/30 V DC, 1 A)
Binary inlets:	1x per channel + 1x per device
24 Volt output:	1x per channel (to supply binary inputs)
Digital interface:	Modbus TCP

Parts in contact with sample gas

Component	Materials in contact with media	
Pump:	PET, PPS	
Flow regulator:	PTFE, stainless steel (1.4571)	
Gas lines:	FPM (Viton), stainless steel (1.4571)	
Solenoid valves:	PVDF or stainless steel (1.4571)	
Gas ducts:	PVDF or stainless steel (1.4571)	
Flow meter:	PVDF, borosilicate glass	
Measuring cell:	NDUV (SO_2)	NDIR (CO_2)
	Stainless steel (SU316), quartz glass, FKM, PTFE, CaF_2 glass, Nylon 66 GF30 %	

Measuring cells

Measuring cell	NDUV (SO_2)*	NDIR (CO_2)*
Largest measuring range (MR)**:	0 - 500 vpm	0 - 15 Vol.%
Smallest measuring range (MR)**:	0 - 100 vpm	0 - 10 Vol.%
Response time t90:	< 12 sec	< 15 sec
Linearity deviation:	< 2 % MW or 0.3 % FS (depending on greater value)	< 2 % MW or 0.3 % FS (depending on greater value)
Zero point long-term stability:	< 2 ppm/day or < 1 % FS/day (depending on greater value)	< 1 % FS/day
Span long-term stability:	< 2 % FS/week	< 1 % FS /week
Repeatability:	< 1 % FS	< 1 % FS
Detection limit (2.5σ***):	< 0.3 % FS	< 0.3 % FS
Temperature drift:	< 1 % FS/10K	<1 % FS/10K
Thermostatization:	Yes	Yes

* Measurement performance in accordance with IMO regulation MEPC 259(68)

** Measuring ranges configurable between max. and min.

*** σ = standard deviation at zero point

Abbreviations:

FS = Full Scale (upper range value)

MW = measurement value

4 Transport and storage

Transport

The unit is sensitive to shock and vibration. Therefore, where possible, transport in the original packaging or large, sturdy packaging at a minimum consisting of 3 layer carton, plastic or aluminium sheet. Line the inside of the packaging with padding at least 10 cm thick on all sides.

The unit should be marked fragile for shipping.

Removal from service and storage

Purge the unit with dry nitrogen or dry air before removing from service for extended periods. Then close the gas inputs and outputs to prevent dirt, dust and moisture from entering the unit.

Store the unit in a dry, ventilated, dust-free room. Cover the unit with suitable packaging to protect it from liquids and dirt.

Storage temperature: 5 °C ... 65 °C

5 Installation and connection

NOTICE

Unit with specially cleaned gas paths

Protect parts in contact with media, e.g. bulkhead couplings, from recontamination. Use clean work cloves, clothing and clean tools when connecting, particularly when connecting the gas paths. Only charge specially cleaned gas paths with oil-free inert gases or oil-free compressed air apart from the gas for the actual measuring task.

5.1 Installation site requirements

DANGER

Potentially explosive atmosphere

Explosion hazard if used in hazardous areas.
The device is not suitable for operation in hazardous areas with potentially explosive atmospheres.
Do not expose the device to combustible or explosive gas mixtures.

CAUTION

Turbulence in gas paths

Avoid turbulence in the gas paths of the analyser. Place the pressure unit, e.g. Gas cylinder, not too close to the device and install a damping vessel (> 0,5 L) in front of the gas inlet of the analyser.

19" rack or tabletop: The unit is suitable for indoor use mounted in a 19" rack or as a tabletop unit. The unit must rest on support rails when installed in a 19" rack. The mechanical strain is too high when mounted solely via the front panel.

Cooling: The unit is forced-air cooled via a fan at the back. To ensure air can circulate freely, maintain a distance to other objects or walls of at least 3 cm at the top and 10 cm at the back of the analyser.

Dust: The unit must be set up in a low-dust environment. Otherwise dirt can accumulate inside the unit and in the long term result in malfunctions or failure.

Shock: The gas sensor technology in the analyser is mounted so as to tolerate vibration typical on ship. The site should still be as low vibration as possible Strong mechanical oscillation and vibration, particularly low frequency shock (e.g. from heavy equipment or blows) can interfere with measurements, cause equipment errors or permanent damage.

Ambient temperature: The approved ambient temperature of 5 °C to 45 °C must be maintained during operation. The measurement sensors themselves are thermostated. This will largely compensate the effects of temperature fluctuations within the T_{amb} = 5 - 45 °C range.

Disturbance sources: No heat sources or equipment emitting strong magnetic fields (e.g. motors, transformers) may be located near the installation site. Even exposing the unit to sunlight for extended periods and the resulting temperature variations can alter the measurement values.

This also applies to severe temperature variations and barometric variations. Regularly calibrate the unit, including after severe changes in the barometric pressure or temperature.

5.2 Installation

The unit is delivered in cardboard packaging with filler material. The analyser measuring cells are sensitive to shock and vibration. Therefore, if possible, keep the original packaging for future analyser transport. Otherwise dispose of the packaging materials according to local regulations.

Check the unit for any transport damage. Do not install the unit if it shows any type of damage.

19" rack mounting

Place the analyser on support rails and secure the screws to the front face.

5.2.1 Sample gas conditioning

To ensure the least possible interference and low analyser maintenance the gas inlet requirements (Technical Data) must be observed as consistently as possible. Further avoid dirt on any parts the sample gas flows through.

Particularly important sample gas parameters are:

- the gas moisture
- the gas volume flow
- the gas pressure
- the gas temperature
- the particle load in the gas flow
- aggressive and/or gas components altering measurement value

To ensure low maintenance, the analyser typically requires suitable upstream gas conditioning. This greatly affects the quality and correctness of your measurements. The complexity of the required gas conditioning will vary depending on the process and measuring task. The analyser is particularly designed for cold extractive measurement of SO_2 and CO_2. Meaning, the dew point of the sample gas must absolutely be < 10 °C (and always 5 K below the ambient temperature). So-called sample gas coolers are therefore typically upstream from the device.

In this context, it's also important for calibrating gases to flow through the entire gas conditioning system for preferably identical pressure, temperature and flow ratios. This is the only way to compensate the gas conditioning possibly affecting the result. If the gas input and ambient conditions change considerably, always recalibrate the analyser (see chapter Menu > Calibration [> page 34]).

NOTICE

Control valve

We recommend installing a control valve to adjust the gas flow **upstream** from the gas conditioning system. Installation in the sample gas output will increase the pressure in the analyser and possibly result in measuring errors.

Damping vessel

If rapid, high fluctuations of pressure or flow occur in the gas lines (inlet or outlet) we recommend using a damping vessel (> 0.5 L) upstream from the gas inlet.

Please feel free to discuss your specific measuring task with our customer service. Our knowledgeable and experienced staff will be able to recommend modified gas conditioning.

5.2.2 Gas connections

DANGER

Toxic, corrosive gases

The measuring gas led through the equipment can be hazardous when breathing or touching it.

a) Check tightness of the measuring system before putting it into operation.

b) Take care that harmful gases are exhausted to a save place.

c) Before maintenance turn off the gas supply and make sure that it cannot be turned on unintentionally.

d) Protect yourself during maintenance against toxic / corrosive gases. Use suitable protective equipment.

When connecting gas lines to the unit, please note:

- The connection must be made by a qualified professional.
- The substances selected (particularly chemical, thermal and pressure-resistance) must be suitable for the measurement task. Corrosive gases will significantly reduce the life of the measuring cells.
- Limit rapid pressure fluctuations in the gas inlet and outlet pipes to prevent a fluctuation in the measurement values. If rapid, high fluctuations of pressure or flow occur in the gas lines we recommend using a damping vessel (> 0.5 L) upstream from the gas inlet.
- Suitable sample gas conditioning is required upstream from the analyser.
- If the gas inlet or ambient conditions change considerably, always recalibrate the analyser (see chapter "Menu > Calibration").

PVDF hose couplings for tubes with 4 mm inside diameter (6 mm outside diameter) at the back of the analyser are standard. If the analyser is equipped with stainless steel bulkhead couplings (optional), stainless steel tubes with 6 mm outside diameter may be connected gas tight.

The back of the unit will have the respective number of gas connections and terminal strips for signal outputs based on the number of measuring channels.

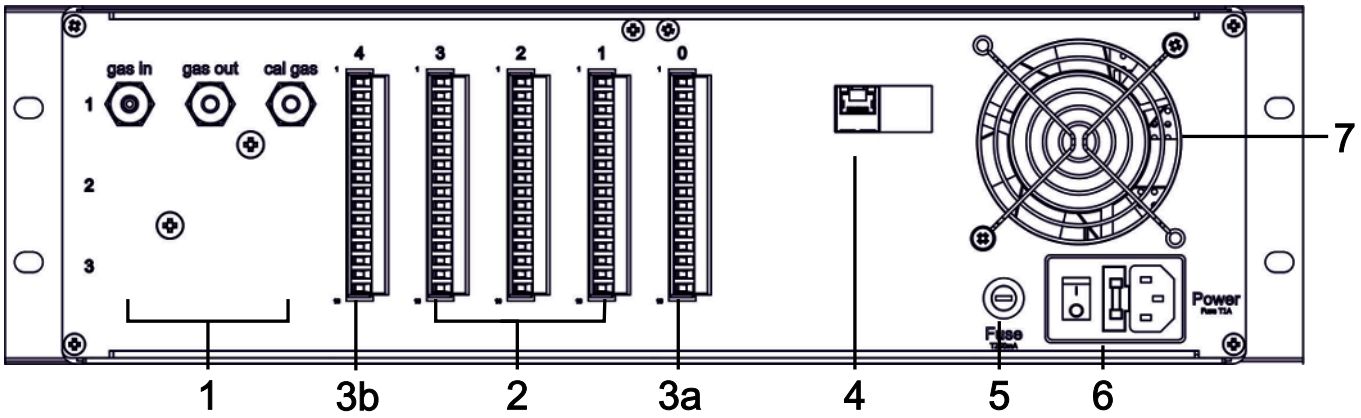


Fig. 3: BA 3 MA, rear view

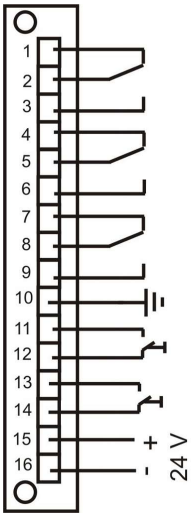
1	gas in	Sample gas input	4	Modbus-TCP	Modbus interface (optional)
	gas out	Gas outlet	5	Fuse	Fuse 1
	cal. gas	Calibrating gas inlet	6	Power	Power supply with built-in fuse and ON/OFF switch
2	ST1 to ST3	Signal output Ch. 1 to Ch. 3			
3a	ST0	Error/service signal	7		Fan
3b	ST4	Measuring range signal Ch. 1 to 3			

5.2.3 Electrical connections

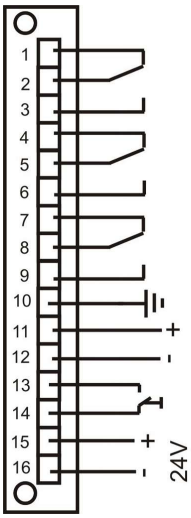
5.2.3.1 Signal outputs

Two or three 16-pin PHÖNIX plugs (ST0 to ST3) are located at the back of the analyser for the input and output signals. Plug ST4 is configured to signal the measuring ranges or the measuring range switchover. To prevent interference, the signal lines should be routed isolated from the power lines.

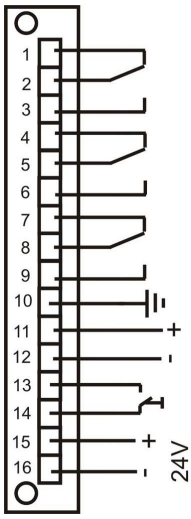
Refer to the tables below for the plug configuration.

Plug 0	Pin	Function	Description / Status	Connection data
	1	NC contact	Operation	Relay, max. switching power 125 V AC/1 A or 60 V DC/1 A
	2	Common	Common	
	3	NO contact	Malfunction	
	4	NC contact	Operation	Relay, max. switching power 125 V AC/1 A or 60 V DC/1 A
	5	Common	Common	
	6	NO contact	Service required	
	7	NC contact	Measurement	Relay, max. switching power 125 V AC/1 A or 60 V DC/1 A
	8	Common	Common	
	9	NO contact	Zero gas calibration	
	10	PE	Protective earth	PE
	11		Switch solenoid valve or pumps (optional)	
	12			
	13		Start calibration (zero gas)	
	14			
	15	+	24 V DC voltage output	
	16	-		

Tab. 2: Plug 0, system connection, 16-pin PHÖNIX connection terminals

Plugs 1-3	Pin	Function	Description / Status	Connection data
	1	NC contact	Limit value 1	Relay, max. switching power 125 V AC/1 A or 60 V DC/1 A
	2	Common		
	3	NO contact		
	4	NC contact	Limit Value 2	Relay, max. switching power 125 V AC/1 A or 60 V DC/1 A
	5	Common		
	6	NO contact		
	7	NC contact	Measurement	Relay, max. switching power 125 V AC/1 A or 60 V DC/1 A
	8	Common		
	9	NO contact	Status range calibration for measuring range 1 (MR 1)	
	10	PE	Protective earth	PE
	11	+	Gas concentration analog output; configured in device menu	4 – 20 mA 0 – 20 mA 0 – 10 V 2 – 10 V
	12	-		
	13		Start calibration (span gas for MR 1)	Controls also see Fig. Control 24 V DC
	14			
	15	+	24 V DC voltage output	
	16	-		

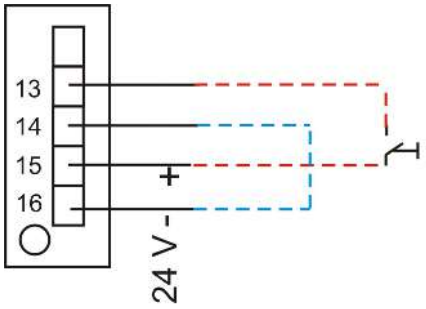
Tab. 3: Plugs ST1 to ST3, measuring channel 1 to 3, 16-pin. PHÖNIX connection terminals

Plug 4	Pin	Function	Description / Status	Connection data
	1	NC contact	Ch. 1 measuring range 1	Relay, max. switching power 125 V AC/1 A or 60 V DC/1 A
	2	Common		
	3	NO contact	Ch. 1 measuring range 2	
	4	NC contact	Ch. 2 measuring range 1	Relay, max. switching power 125 V AC/1 A or 60 V DC/1 A
	5	Common		
	6	NO contact	Ch. 2 measuring range 2	
	7	NC contact	Ch. 3 measuring range 1	Relay, max. switching power 125 V AC/1 A or 60 V DC/1 A
	8	Common		
	9	NO contact	Ch. 3 measuring range 2	
	10	PE	Protective earth	PE
	11			
	12			
	13			
	14			
	15	+	24 V DC voltage output	
	16	-		

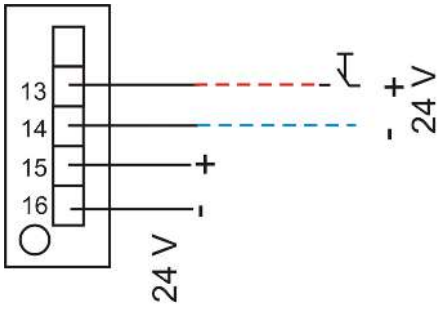
Tab. 4: Plug ST4, measuring channel 1 to 3, 16-pin. PHÖNIX connection terminals

The binary inputs (plug ST0: pin 11/12 and pin 13/14 as well as plug 1-4: pin 13/14) may be controlled internally or externally. The following illustrations show the connection options.

Control 24 V DC internal



Control 24 V DC external



5.2.3.2 Modbus TCP interface

The Modbus interface allows direct access to process and diagnostic data and parameters during operation based on VDI4201.

The analyser takes on the role of the server in communication.

Modbus TCP:

Connects at the back of the device via RJ45 port.

5.2.3.3 Modbus TCP configuration

The settings below are the defaults and can be adjusted.

IP: 192.168.15.168

Subnet: 255.255.254.0

Gateway: 192.168.15.1

DHCP: Enabled

When configuring the address, be sure they are stored in the registers in .hex syntax.

E.g. IP: 192.168.15.168 -> C0 A8 0F A8

After changing a setting, a "1" must be written to address "45500" to apply it. The interface will then automatically restart with the new configuration.

5.2.3.4 Modbus Communication

Communication via Modbus is always initiated by the client (request). The server (typically) responds to the request with a response. A Modbus frame for a request/response always has the following structure:

Address field (A)	Function code (FC)	Data	CRC
1 byte	1 byte	1 ... 252 bytes	2 bytes

Register addresses and data are transferred in Big Endian format.

Every register stands for a 16 bit value, with the information represented in various data types. The data type and required function code are assigned to the respective registers in an attached table.

To read/write data types with sizes larger than an individual register, multiple registers must be addressed.

Supported function codes:

Function code (FC)	FC values
Read Coil Status	1
Read Holding Registers	3
Write Single Coil	5
Write Multiple Coils	15
Write Multiple Registers	16

Data types:

Description	Number of bytes	Number of registers
Bit	1	1
Float	4	2
Int16	2	1
Uint16	2	1
Int32	4	2
Uint32	4	2

For the Modbus manual with the available registers see Chapter Attached documents [> page 49]. There are registers which are read only (R), write only (W), read and write (RW). To write the registers, the respective password based on the password level must be entered. Once the respective password has been entered correctly, the register entries are available until it has been entered incorrectly or the device has been restarted.

By default, the new value will be applied to the write registers during writing without any other interaction. For some registers, simply writing them will not suffice. Once written, the change must be confirmed with another entry in a different register.

After one or more Modbus interface parameters have been changed, a "1" must be written to address "45500" to apply the setting. The interface will then automatically be restarted and the device must be reconnected. Without writing "1" the change will not be applied.

The logbooks can only be read once they have been refreshed. This refresh is triggered by entering a "1" under the addresses "45501" (error), "45502" (service) and "45503" (calibration). Entering "0" will erase the oldest entry from the respective logbook. The respective logbook will then need to be refreshed so it can be read.

5.2.3.5 Power supply

DANGER	**Electric voltage**
	Risk of electric shock if the unit is connected to the supply incorrectly. a) The unit must be connected by trained, expert personnel. b) Ensure the correct supply voltage. c) Only use the included power cord or a power cord with the specifications indicated.

The supply voltage is 230 V AC 50/60 Hz or 115 V AC 50/60 Hz. Verify the available mains voltage matches the required supply voltage per the nameplate.

Use the included power cable to connect the analyser to the DIN EN 60320-2-3 connector at the back marked “power”.

6 Initial operation

CAUTION	**Heating due to turbulences**
	To avoid turbulences, only charge the analyser by slowly opening the fittings. **Adiabatic compression** To avoid potential adiabatic compression, operation with closed gas outputs prohibited.

6.1 Process

Preparation

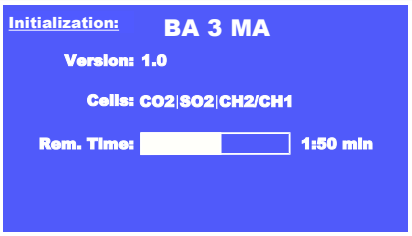
Please ensure

- the unit was assembled and connected properly. Particularly ensure the voltage supply and the gas connection are correct.
- the gas conditioning system is working properly,
- the span gas supplied has the correct concentration (adapted to the measuring range).

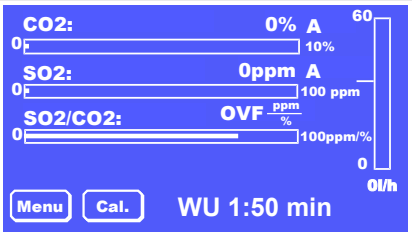
Switching on

Switch on the analyser with the power switch at the back. After the Bühler logo the initialisation screen will display the equipment configuration:

- Software Version
- Installed measuring cells
- as well as the remaining initialization time

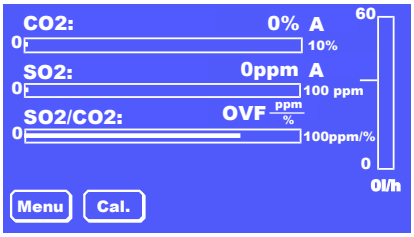


During initialisation you may touch the display to switch to measurement view, e.g. to configure the unit. The initialization progress is also displayed in measurement view: **WU 1:50 min** flashing.



After initialization (**standard 30 min**) the measurement screen will appear.

Here, use **Menu** to open the main menu or **Cal.** to go straight to calibration.



Wait at least **30 minutes** for the unit to warm up, then perform the first calibration. To measure very low concentrations it may be helpful to allow the unit to continue to warm up, **up to 3 h**.

After calibration the unit may be charged with the respective sample gas. Please observe the permissible gas inlet conditions.

To ensure correct operation, the sample gas flow for the respective measuring cell should be set to the values in table Gas Flow diagrams. If the minimal flow rates are underrun, the measurement will be rejected and an error message will appear.

You may now want to configure the analyser settings to your needs. A table with key settings can be found in the next chapter.

If your unit has internal sample gas pumps, these can now be activated under **Menu** > **Base settings** > **Pumps**.

6.2 Overview of key factory settings

Check if the factory settings are suitable for your measurement task. If necessary, change them as described in chapter "Operation and Control".

The following table lists the key parameters:

Check if the factory settings are suitable for your measurement task. If necessary, change these as described in chapter "Menu > Base Settings [> page 28]".

Menu item	Submenu	Factory Setting
Channel settings	Measuring ranges	Meas. range MR1 and MR2 (customer-specific per order) Auto Switchover: OFF
	Limits	No limit presets
	Outputs	– Analog outputs: 4-20 mA/during cal.: current value/on alarm: current value – Modbus TCP (optional)
	Damping	For all measuring cells 1 sec (time constant)
	Units	Custom, as ordered
Base settings	Language	For delivery to Germany "German". For delivery to other countries "English".
	Passwords	Password 1: 111 Password 2: 222
	Pumps	If applicable: Off
	Date/Time	Date: Day.Month.Year, current date Time: hh:mm:ss current time CET (h:min)
	Pressure sensor (optional)	Not set (pressure sensor calibrated prior to delivery)
Calibration	Auto	Off/time period: 24 h
	Manual	No preset
	Deviation	Span gas: 10% from setpoint/zero gas: 1 Vol.% fixed
	Period	– Cal . period: 2 min – Purging Time: 5 min

7 Operation and Control

NOTICE

The device must not be operated beyond its specifications.

7.1 Menu overview and operating principle

The analyser is controlled via the touch display.

NOTICE

Delicate display

The touch display is delicate. Do not use sharp or pointy objects such as pens, screwdrivers, etc. to operate it.

Use the **Menu** button to access the main menu. Use the **Cal.** button to access the calibration submenu directly. Start a submenu by pressing the respective button.

Use the **Meas** button to exit from the menu level and return straight to the measurement display.

All parameters are protected from unauthorised access with a 3 character password. The default passwords at the time of delivery are:

Password 1	111
Password 2	222

The following menus are available for parametrisation and diagnostics:

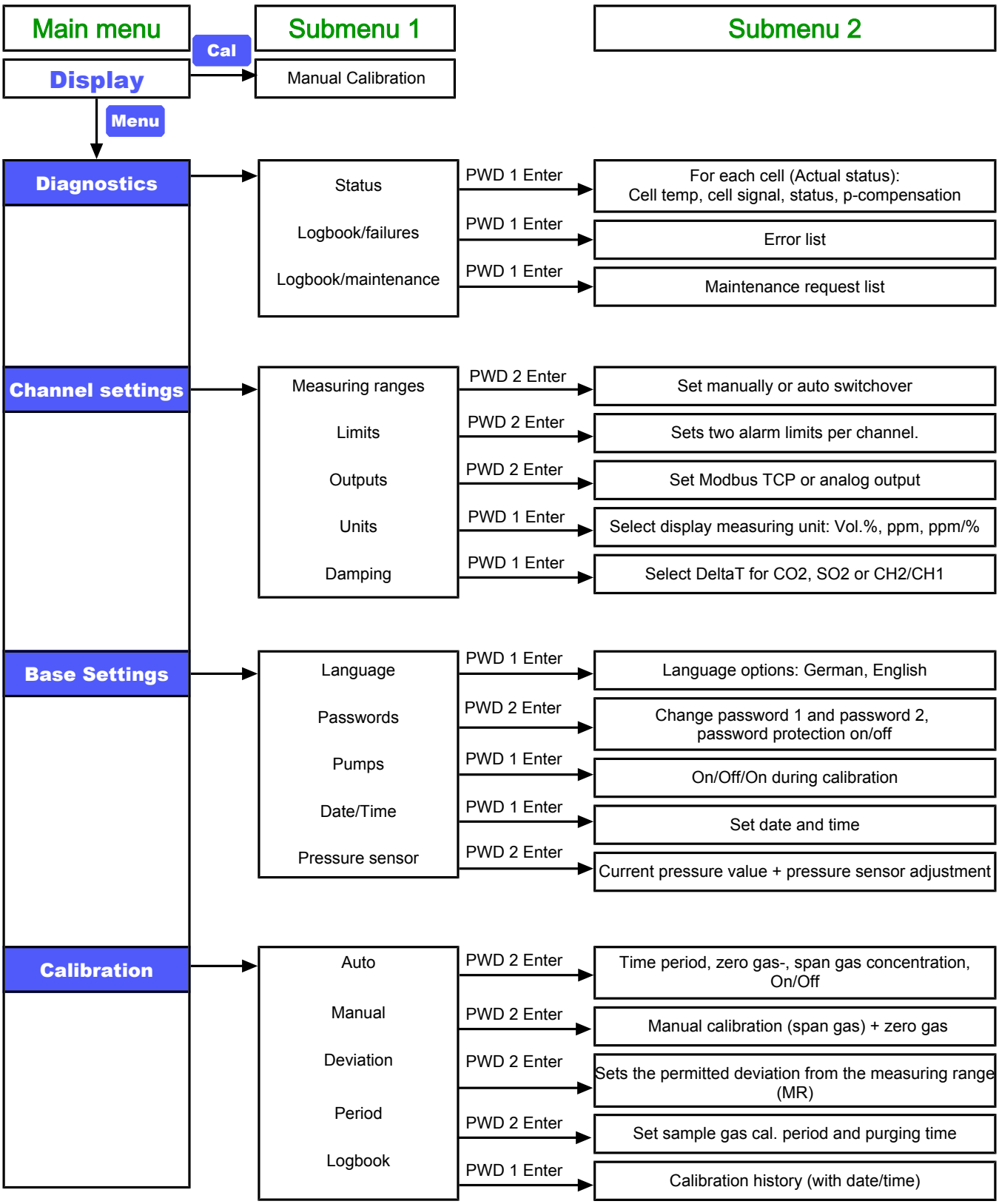


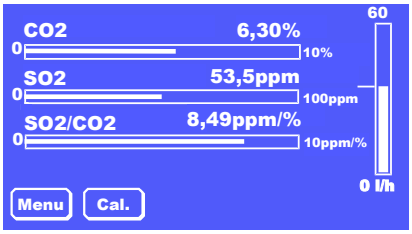
Fig. 4: BA 3 MA Menu overview

7.1.1 General information for navigating the menu

Measurement screen

The normal mode the analyser will show the measurement screen. It will show:

- the current measurement value of each cell as a bar graph and as a measurement value in the specified unit
- the measuring range
- a bar graph of the flow through the unit (optional)
- the keys **Menu** and **Cal.** used to jump directly to the main or calibration menu.



Flashing symbols

A flashing icon in the measurement screen indicates a problem. Where:

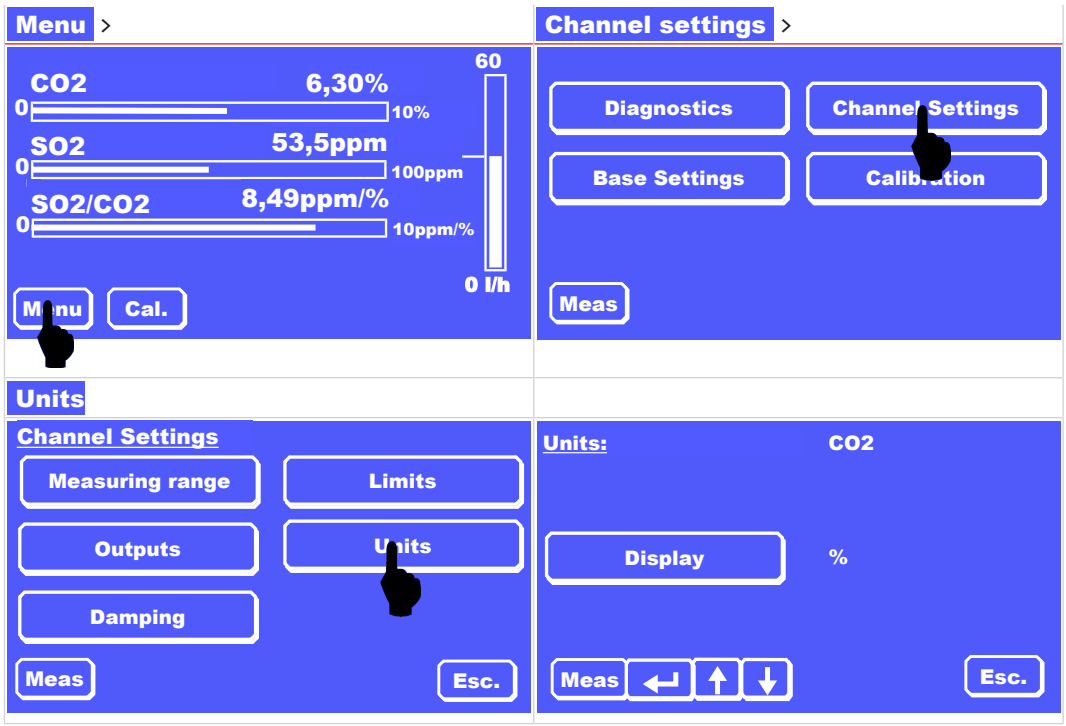
A	An event (alarm or error) was detected and recorded in the "Error" logbook. The event may apply to one channel or the entire unit.
°!°	An event (failure or alarm) occurred but was automatically reset. This is for example the case if a low temperature alarm is temporarily triggered. In this case an entry will be made in the failure logbook.
W	Service is required. A "Service" logbook entry has been generated.

The symbols will remain active until the associated logbook entries have been deleted.

Learn how to open the respective logbook in chapter "Menu > Diagnostics [> page 26]" or "Menu > Calibration [> page 34]".

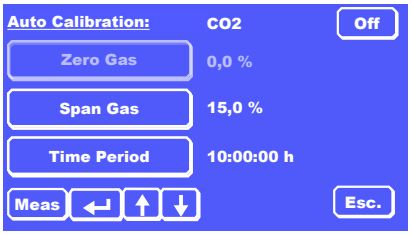
Opening submenus

Navigate the menu with the respective button (key). To e.g. change the unit the gas concentration is displayed in, press



Extra buttons

In addition to the buttons, the menus may also have extra buttons:



The buttons ↑ and ↓ have different functions depending on the context:

- Select measuring cell or **All channels**
- Browsing a list
- Browsing a selection

Pressing a **button**

- will open the respective submenu,
- will open a keyboard to enter values
- selects the button (inverted display).

  With a button highlighted, use the ↑ and ↓ keys to browse the drop-down menu. To change a parameter, you will first need to press again to deselect the button.

Be sure to save the changes with ↵ in the respective menu.

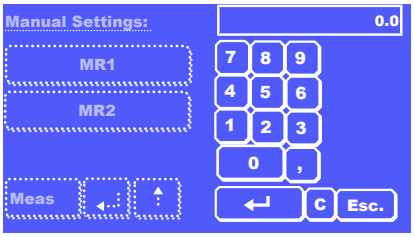
Values are not automatically saved upon exiting.

Use **Esc** to cancel the input at any time. The next higher / previous screen will appear.

Use **Meas** to return directly to the measurement screen. Parameter changes will **not automatically** be saved!

Entering values

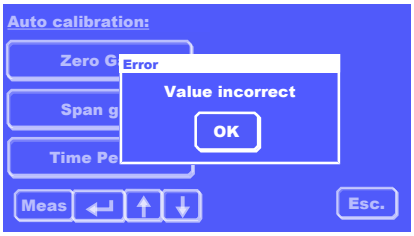
Use the on-screen keyboard to enter a value directly. Here you will see a keypad and context-specific extra keys (e.g. **:**, **,**, **<** or **>**).



You may correct the input with **C** or press **Esc** to cancel.

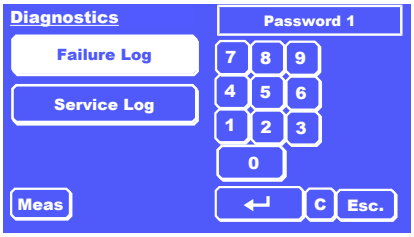
Use the return key ↵ to apply the entry.

When entering an invalid value, an error message will appear (see example) and the respective parameter will not be changed.



Password Protect

With password protect enabled, the analyser will require a password (1 or 2, see chapter "Menu overview and operating principle") before a parameter can be changed.



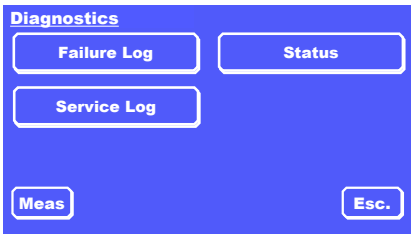
Enter the password with the on-screen keyboard and press ↵ to confirm your input.

Please refer to chapter "Menu > Base Settings > Passwords" for how to enable and disable password protect.

7.2 Menu > Diagnostics

The Diagnostics menu contains the following menu items:

Failure/ logbook	This logbook lists all failures which have occurred including channel number, date, time and error message in plain text.
Maintenance/ logbook	Outstanding service is recorded in the service log. **Note: Not all service will be listed. Please also refer to chapter** Maintenance [> page 41].
Status	This menu shows the status of each measuring cell along with the cell voltage, cell temperature and the compensation type.



NOTICE

Calibration Log

The **Calibration** menu also contains a logbook with records on all calibrations.

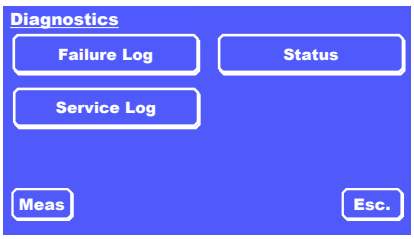
7.2.1 Menu > Diagnostics > Failure Log

This logbook records all alarms and errors. If there is an entry, the measurement display will flash **A** or **!** at the respective channel. Up to 40 messages can be saved. On the 41st entry the oldest message will automatically deleted and overwritten with the new message.

The **!** will appear in the measurement display if the event was reset without user interaction, e.g. for a low temperature alarm.

Failure Log

Open the logbook using **Menu** > **Diagnostics** > **Failure Log** and enter the password.



The screen will show the following information:

- Messages displayed/Total messages
- Current time
- Always 3 messages in plain text

Use the **↓** and **↑** buttons to browse the list.

Take the action required by the respective message. You will find information about this in chapter "Status messages and troubleshooting [> page 45]" and others.

Use the **Del** key to delete the top (oldest) message (always no. 1).

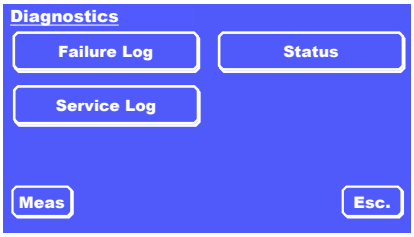
Once all messages have been deleted, the marker **A** or **!** after the respective measurement display will disappear.

7.2.2 Menu > Diagnostics > Service Log

This logbook lists the required service. If an entry exists, the measurement channel will flash **W** at the respective channel.

Service Log

Use **Menu** > **Diagnostics** > **Service Log** to open the logbook and enter the password.



The screen will show the following information:

- Messages displayed/total messages
- Current time
- Always 3 messages in plain text

Use the **↓** and **↑** buttons to browse the list.

Use the **Del** key to delete the top message (always no. 1).

Once all messages have been deleted, the **W** after the respective measurement display will disappear.

For information for any required service, refer to chapter "Maintenance [> page 41]".

NOTICE

Maintenance Schedule

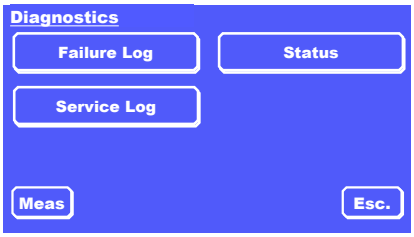
Not all required service is indicated in the logbook. Please also follow the service schedule in chapter "Maintenance [> page 41]".

7.2.3 Menu > Diagnostics > Status

This menu provides an overview with the status of each measuring cell.

Status

Open **Menu** > **Diagnostics** > **Status** and enter the password.



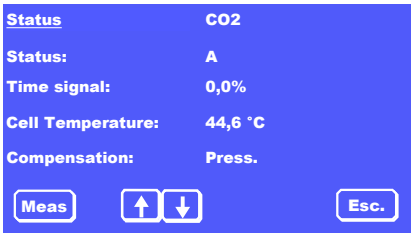
Select the respective channel with the buttons **↑** and **↓**.

It will show:

- the measuring cell,
- the status: **OK**, **A**, **!** or **W**

  Alarm messages will appear before maintenance messages.

  Note: If a status other than **OK** appears, please refer to the respective logbook.
- the cell temperature
- the compensation type



7.3 Menu > Base Settings

Use the base settings menu to configure the device settings.

Menu	Description
Language	Choose from German and English as the menu language.
Passwords	Add passwords 1 and 2 or enable / disable password protect
Pressure sensor	Here enter the current air pressure. This serves as a reference value for adjusting the measurement values.
Date/Time	Set the current date and time.
Pumps	Define the behaviour for the installed pumps.

7.3.1 Menu > Base Settings > Passwords

All parameters are protected from unauthorised access with a 3 character password. The default passwords at the time of delivery are:

Password 1 111
Password 2 222

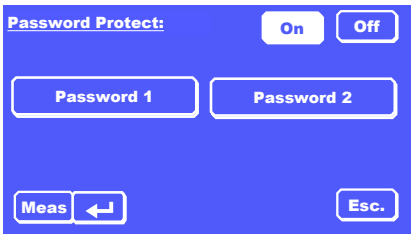
Depending on the parameter relevance these are protected by password 1 or 2.

The passwords may be changed or you can disable/enable password protect.

Passwords

Press **Menu** > **Base Settings** > **Passwords**

Password protect is enabled on delivery (**On** is selected).

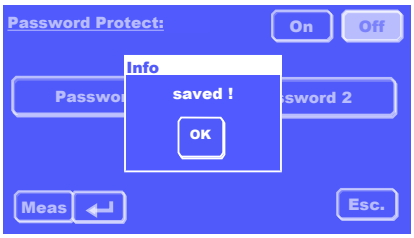


Enable/disable password protect

– To disable the passwords, press **Off** and press ↵ to save this setting.

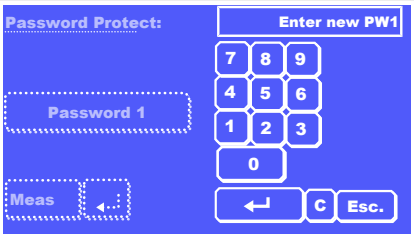
NOTICE! All parameters can now be accessed at all times!

To enable the passwords, press **On** and press ↵ to save this setting.



Change password

– Select **Password 1** or **Password 2** to change.
– Enter a new password (max. 3 characters).
– Press ↵ to confirm your input.
– Repeat the new password.
– Press ↵ to confirm your input.



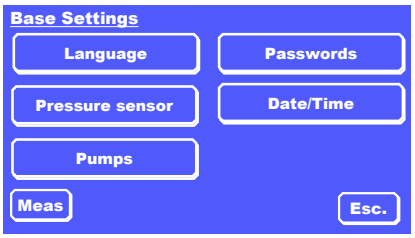
The information will be saved.

NOTICE! Make a note of the new passwords and keep them in a safe location.

7.3.2 Menu > Base Settings > Language

Changing the menu language

Use **Menu** > **Base Settings** > **Language** to open the drop-down menu.



Select the language and press ↵ to confirm your input.

Press **OK** to acknowledge the message "Data saved".

7.3.3 Menu > Base Settings > Pressure Sensor

The analyser can be equipped with pressure sensor for compensating the pressure in the results. This will compute the ideal gas compensation for measurement fluctuations due to barometric or process-related pressure fluctuations.

The drift of the internal pressure measurement is low enough for virtually all measuring tasks that an additional recalibration of the pressure sensor is not necessary.

For high-precision measurements within minimal measuring ranges it may be helpful to recalibrate the pressure sensor. This requires a very accurate pressure gauge (0.1 mbar resolution) to measure the current ambient pressure.

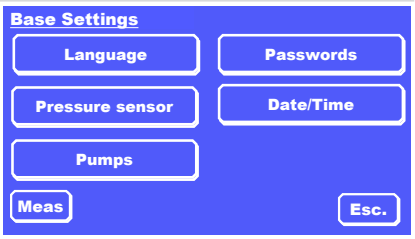
To calibrate the internal pressure sensor:

Preparation

- Shut off the internal and external sample gas pumps and prevent pressure fluctuations in the sample gas line at the process or gas output end (if necessary, disconnect the unit from the sample gas lines)
- Use your external pressure gauge to measure the current ambient pressure and wait for the measurement value to stabilise.

Pressure sensor

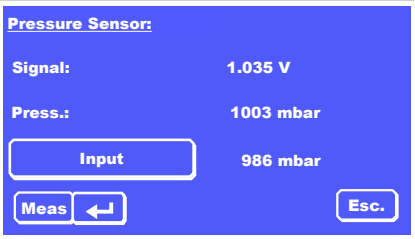
If the pressure output by the analyser significantly deviates from your measurement value, select **Menu** > **Base Setting** > **Pressure Sensor** and enter password 2.



Now select **Input**, enter the value and press ↵ to confirm your input.

- Round your measurement value up or down, enter the new value and press ↵ to confirm your input.

Press ↵ to confirm again and apply the change. Use **Meas** to return to the measurement screen.



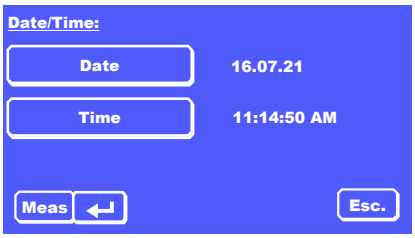
7.3.4 Menu > Base Settings > Date/Time

To set the current date and (local) time:

Setting the date / time

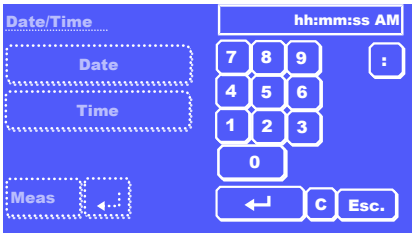
Press **Menu** > **Base settings** > **Date/Time**

Now select **Date** or **Time**.



Enter the current values using the on-screen keyboard. (The example uses **Time**.)

- Time format: hours:minutes:seconds
- Date format: Day.Month.Year (2-digit)
- Press ↵ to confirm your input.



7.3.5 Menu > Base Settings > Pumps

Use this menu to specify the pump behaviour (where applicable) for each channel.

Pumps

Press **Menu** > **Base Settings** > **Pumps**.

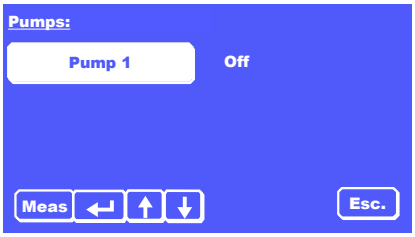
Select the pump for which you wish to change the settings. The selected entry will be displayed inverted.

Now change the setting with the ↑ and ↓ keys.

Off	The pump is always off.
On	The pump is always on.
On Cal	The pump is only on during calibration.

Now select the next pump and define its settings.

Finally, press ↵ to confirm your input. The settings will be saved.



7.4 Menu > Channel Settings

The following settings can be configured for each channel:

Menu	Description
Measuring ranges	Define the measuring range and the switchover points.
Limits	Define the gas concentration limits which will trigger a signal at the relay output.
Outputs	Parametrise the outputs.
Units	Select the unit to display the result in.
Damping	Define the damping constant for the measurement.

7.4.1 Menu > Channel Settings > Meas. Range

You can define measuring range MR1 and MR2 for each channel. The settings will affect the output via the analogue output. The measuring range the unit is in can optionally be indicated via relay outputs.

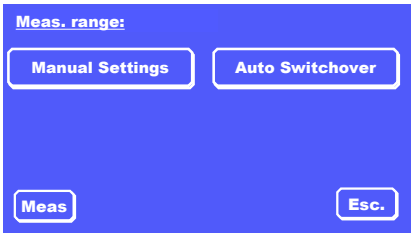
Depending on the setting under **Auto Switchover** two scenarios should be distinguished:

1. **Auto Switchover** is **Off**:
   - The unit will measure in the resolution for measuring range MR1, with arbitrary configuration.
   - The output range of the analogue output corresponds to the range limits of measuring range MR1.
2. **Auto Switchover** is **On**:
   - The unit will now automatically switch between MR1 and MR2 if the current measurement value runs over or under the range limits (switchover points).
   - The output range of the analogue output corresponds to the range limits of the respective active measuring range.
   - The measuring range is displayed based on the **Auto Switchover** settings.

To define the measuring range:

Measuring ranges

Select **Menu** > **Channel Settings** > **Meas. Range**.



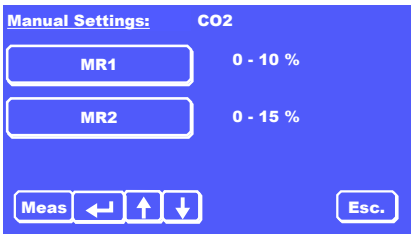
Select **Man. Setting**.

First use the ↑ and ↓ keys to select the channel, then **MR1**.

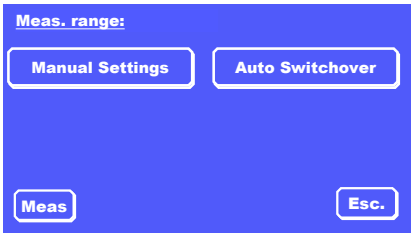
Enter the lower measuring range end value using the on-screen keyboard. Press ↵ to confirm your input. This value will be applied to both measuring ranges.

Then enter the upper measuring range end value for MR1 and press ↵ again to confirm your input.

Now select **MR2**. Press ↵ to confirm the lower value, then enter the upper measuring range end value for MR2.



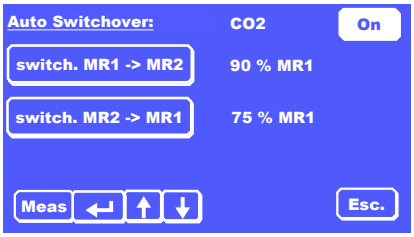
Press ↵ to apply the new parameters and **Esc** to return to the next higher menu.



Auto measuring range switchover

Now under **Auto Switchover** define whether to enable automatic measuring range switchover.

- Selecting **On** will enable automatic switchover of the measuring range. The analogue output signal will automatically be adjusted to the respective measuring range end values when the measuring range is switched over.
- When selecting **Off**, the desired measuring range must then be manually adjusted under **Manual Settings**.
- If necessary, define the switchover points **MR1 -> MR 2** and **MR2 -> MR1**.
- Press ↵ to accept the settings.



7.4.2 Menu > Channel Settings > Limits

You may define two limits per channel and choose whether to signal if the respective limit is overrun or underrun. The signal will be output via the RS232 port, the relay outputs at the back of the unit and with notifications in the unit's display.

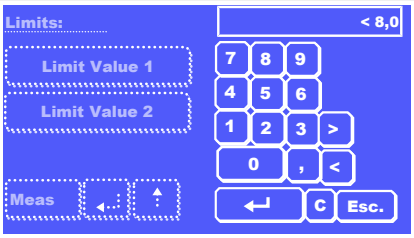
How these signals will be handled is the responsibility of the owner.

Limits

Press **Menu** > **Channel Settings** > **Limits** and select **Limit Value 1** or **Limit Value 2**.

First enter the relational operator **>** or **<**, then the value. (If you only enter one value, the original operator will be used.)

Press **↵** to confirm your input.



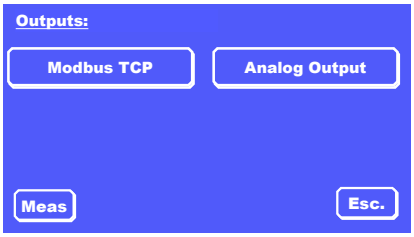
Lastly, press **↵** to apply the new parameters and press **OK** to confirm the message.

7.4.3 Menu > Channel Settings > Outputs

In this menu you can define how the analog output behaves for each channel and the parameters for the Modbus TCP interface.

Analog output

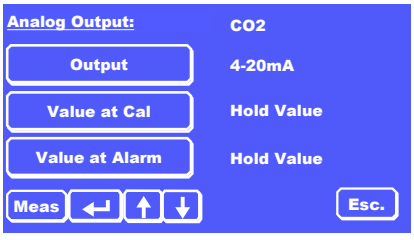
Press **Menu** > **Channel settings** > **Outputs** and select **Analog Output**.



Output

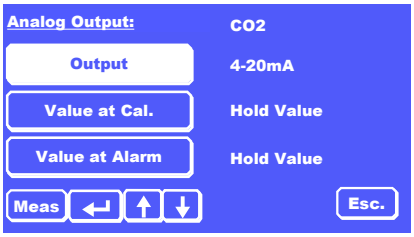
Select the Channel.

Tap to select **Output** and define which signal the measurement output for the channel should output.



Use **↑** and **↓** to browse the list and press **↵** to confirm the respective setting. Choose from

- 4-20 mA (factory setting)
- 0-20 mA
- 2-10 V
- 0-10 V



The analog output scaling varies according to the measuring range MR1 or MR2 settings. The lower value under MR1 is identical with that under MR2 and corresponds with the lower analogue value. The upper analogue value corresponds to the end value of the re-

spective active measuring range. Please note, in automatic switchover the measuring ranges of the end value will automatically be adjusted. This must be considered when analysing the analogue signal.

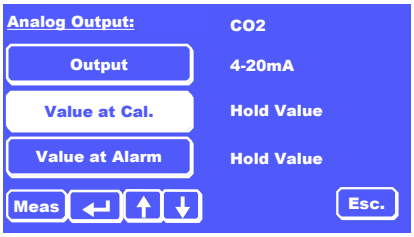
Cal./Error

You can further define the behaviour of the analog output on calibration and failures. The settings can be configured independently.

Mark **Value at Cal.** or **Value at Alarm**, browse through the list using ↑ and ↓, and press ↵ to confirm the respective setting. Choose from

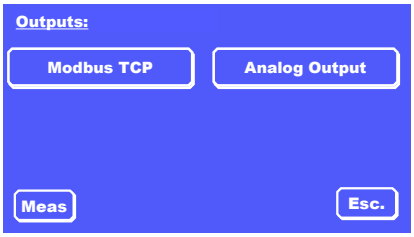
- Hold Value (factory setting)
- Zero
- Current value

Note: With the setting for "Value at Alarm" taking priority over the setting "Value at Cal."; i.e.: If an error occurs during calibration, the measurement will be handled as configured in "Value at Alarm".



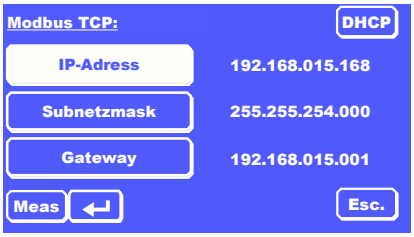
Modbus-TCP

Press **Menu** > **Channel settings** > **Outputs** and select **Modbus-TCP**.



Select the corresponding option:
IP address, **Subnet mask** or **Gateway**

When enabling **DHCP** the router will automatically assign an IP address.



Tap the respective option to go to the input field. Here you can enter and save addresses.

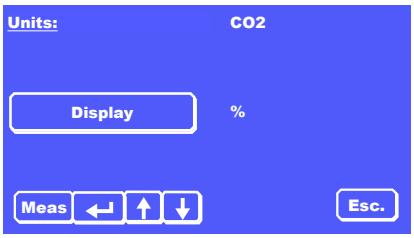
7.4.4 Menu > Channel Settings > Units

Units

Open **Menu** > **Channel Settings** > **Units**.

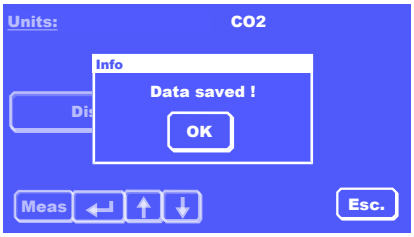
Select the channel using ↑ and ↓.

Now select **Display**.



Now select the unit with ↑ and ↓. Depending on the cell type you will be able to choose from various units.

Press ↵ to apply the new parameter and press **OK** to confirm the message.



7.4.5 Menu > Channel Settings > Damping

This submenu item is used to set the time constant (integration time) for damping the measurement display (moving average value). It represents the amount of time over which the measurement values are averaged before being output to the display. The values are 1 s to 20 s. The time constant factory setting is 1 s.

delta t

Press **Menu** > **Channel Settings** > **Damping**.

Select **delta t** and set the time constant using the ↑ and ↓ buttons.

Press ↵ to accept the setting.

7.5 Menu > Calibration

The following settings can be configured under menu item Calibration:

Menu	Description
Auto	Here you can define whether to regularly auto-calibrate the unit.
Manual	This menu item allows you to start a calibration with defined concentrations of span gas.
Period	Used to define the purging time and calibration period for the calibrating gases.
Deviation	Enter the maximum concentration deviation to maintain during calibration.
Logbook	The logbook records both the calibrations performed and events during calibration.

7.5.1 General information

The properties of measuring instruments change over time due to components ageing or due to changes in ambient or process conditions. The resulting change in the measurement values is referred to as drift.

To be able to measure with adequate accurate the unit regularly needs to be calibrated. This particularly applies when measuring very low gas concentrations. There is no one fit all calibration frequency as it depends on various factors. Important factors could be:

- changes in the unit's ambient conditions (e.g. pressure and temperature),
- Changes in the gas input conditions (e.g. gas temperature, gas flow rate, gas pressure),
- Changes to the gas conditioning system (e.g. filter replacement, replaced devices),
- Changes in the unit’s installation site or the installation position,
- Changes in the composition of the sample gas (e.g. changes in the concentration of carrier gases, sample gas moisture),
- switching measuring ranges.

If the gas inlet and ambient parameters change significantly (reference point approx. > 30 % of the parameter during the last calibration) the analyser should be recalibrated.

Regardless of the above factors, drift will occur due to component ageing (e.g. measurement sensors). Whilst this drift is minimal, we recommend calibrating the device with span gas weekly and with zero gas approx. daily. The influence pressure variations have are largely compensated through the pressure sensor in the gas path. The influence of fluctuations in the ambient temperature is minimised by using the sensor thermostatization.

Procedure

Calibrating gas path: Calibrating gases should preferably flow through the entire upstream gas conditioning system to establish approximately the same pressure, temperature and flow ratios. This is the only way to ensure maximum compensation of the gas conditioning which could affect the result.

Warm up time

Calibration is only sensible once the unit has reached a stable operating temperature (approx. 30 min after first switching on). We recommend generally repeating the initial calibration after 60 min. When measuring very low gas concentrations (< 100 ppm SO_2, < 5 % CO_2), allow the device to warm up approx. 3 h before starting the final calibration.

Maximum optimisation of the calibration result

The best calibration results are achieved if the calibrating gas runs the exact same gas path as the sample gas, so flows to the unit through the entire gas conditioning system. Please also be sure the gas input and ambient conditions during calibration are as close to the same as during measurement as possible.

Factor gas moisture

Measuring SO_2 and CO_2 at a gas dew point range between approx. -20 °C and 10 °C dew point is not very sensitive to water. To completely eliminate the sensitivity to other substances, the calibrating gases should be channeled through the already moistened sample gas cooler. If the heat exchanger was charged with sample gas for > 1 h, the moisture of the heat exchangers will typically suffice. During initial operation, it's advisable to pass ambient air through the heat exchangers over > 6 h. However, on principle some fresh water (approx. 40 ml) can be directly added to the heat exchanger.

NOTICE	**Calibration results**
	The **best calibration results** are achieved if the calibrating gas runs the exact same gas path as the sample gas, so flows to the unit through the entire gas conditioning system. Please also be sure the gas input and ambient conditions during calibration are the same as during measurement.

7.5.1.1 Calibrating gases

In calibration we generally distinguish between zero gas calibration (1st Reference point; zero point of the unit) and range calibration (calibrating a second reference point for greater accuracy. This requires two different gases:

Zero gas

Using inert gases such as N_2 or He as the zero gas is advisable. In addition, dehumidified, purified compressed air (free from oil, grease and particles, H_2O dew point ≤ 5 °C) or equivalent purified and cooled (< 5 °C) ambient air can be used.

Span gas

A span gas concentration of 70 - 90 % of the respective measuring range value of the gas components to be measured is sensible. The best case scenario is a span gas concentration approximately the same as the expected sample gas concentration.

The accuracy of the calibrating gases must be adapted to the respective measuring task. We recommend accuracies of ±1 % of the calibrating gas concentration.

7.5.1.2 Calibration presets

In addition to the settings for calibrating gas concentrations the **Cal. Period**, the **Purging Time** and the acceptable **Deviation** must be defined. Here these parameters are defined as follows:

Cal.Period

The required amount of time for which calibrating gas (zero or span gas) should flow through the analyser for good calibrating results. These should be assessed so the calibrating gas flows through the unit (without supply lines) for at least 1 min. The calibration period factory setting is 3 min.

Purging time

The amount of time for which the analyser is purged with calibrating gas prior to calibration to prevent calibrating gas and sample gas being mixed during calibration. These should be assessed so the calibrating gas flows through the unit (without supply lines) for at least 1 min. Please also remember the amount of time the calibrating gas requires from the sampling point to the analyser. Die purging time factory setting is 3 min.

Deviation

The maximum permissible deviation between the zero gas or span gas setpoint and the actual measurements/readouts during calibration (in % from setpoint). The factory setting for these parameters is 30 % from the measuring range end value.

Time period

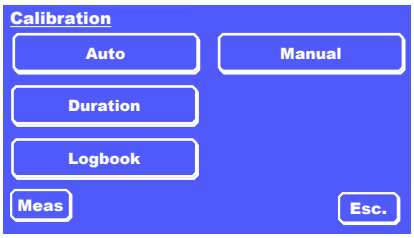
This corresponds to the time period after which automatic calibration should be repeated cyclically. It is only enabled when set to "Auto Calibration ON".

7.5.2 Menu > Calibration > Period

Period

Select **Menu** > **Calibration** > **Duration**.

Enter password 2 and press ↵ to confirm.



You can now set the calibration period and purging time.

The factory setting is 3 min.

First use the ↑ and ↓ keys to select the channel or **All Channels**.

Cal.Period / Purging Time

Select **Cal.Period** or **Purging Time**.

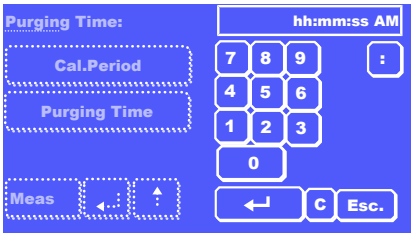
Enter the new time in the format minutes:seconds, e.g. **05 : 30** for 5 min, 30 sec.

Note: A two-digit input is interpreted as “seconds"; e.g. entering **99** ↵ will result in a period of 1:39 min.

Press ↵ to confirm your input.

When setting the period please allow for the length of the lines from the calibrating gas delivery point and the analyser.

– The maximum calibration period or purging time setting is 10:00 minutes.

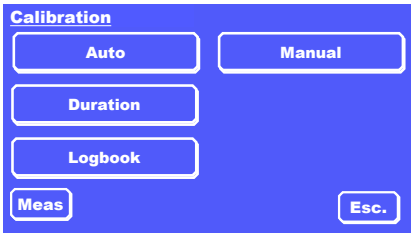


7.5.3 Menu > Calibration > Deviation

Calibration Deviation

Select **Menu** > **Calibration** > **Deviation**.

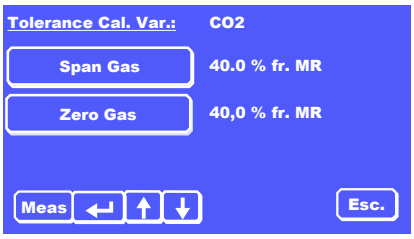
Enter password 2 and press ↵ to confirm.



Now use ↓ and ↑ to select the channel or **All channels**.

Use the ↑ and ↓ keys to select the channel **Span Gas** to define the span gas concentration.

Confirm each input with ↵.

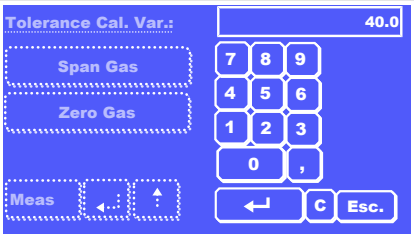


Span Gas

Enter the new limit value as "% from setpoint" under **Span Gas**.

Input range: 0.5 % to 100 % from setpoint

Press ↵ to confirm your input.

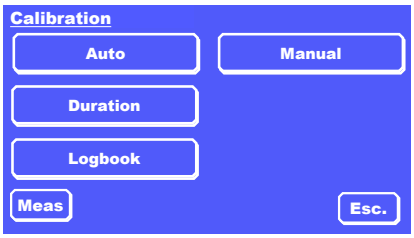


7.5.4 Menu > Calibration > Auto

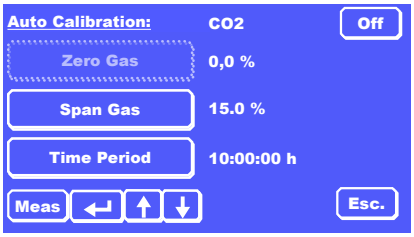
Auto-calibration

Select **Menu** > **Calibration** > **Auto**.

Enter password 2 and press ↵ to confirm.



The correct CO_2 concentration for your application must be set.



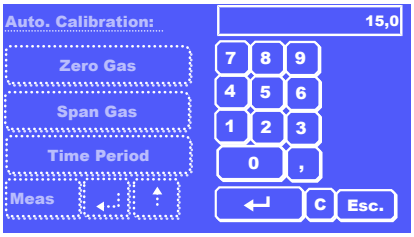
Span Gas

To define the span gas concentration, first select the channel using the keys ↑ and ↓.

Then mark **Span Gas**.

Enter the desired concentration using the on-screen keyboard.

Press ↵ to apply the value.

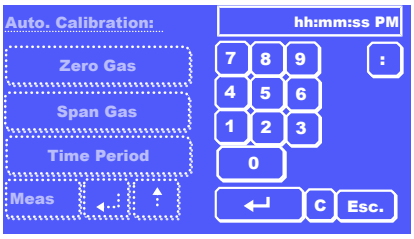


Time Period

Now select **Time Period**.

Enter the auto calibration interval in the format hours:minutes:seconds.

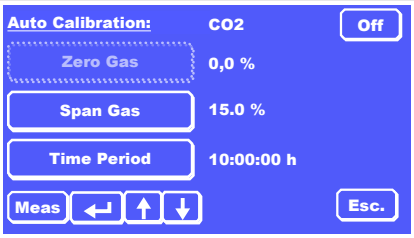
Press ↵ to confirm your input.



Auto. calibration: Off / On

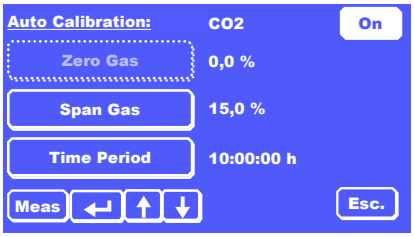
To enable/disable auto calibration, switch the mode with the **Off** or **On** button.

Off - auto calibration is disabled.



On - after applying the settings with ↵ the initial calibration will start and will then be repeated after the defined time period.

Press **Esc.** to return to the next higher menu or **Meas** to return to the measurement screen.



The logbook records both the calibrations performed and events during calibration.

7.5.5 Menu > Calibration > Manual

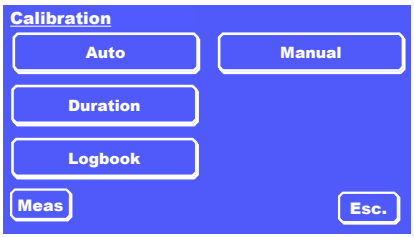
A manual calibration may be performed at any time.

Manual Calibration

Select **Menu** > **Channel settings** > **Manual**.

Enter password 2.

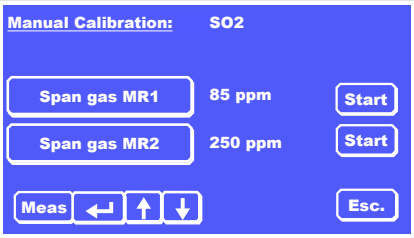
Now select **All channels** or use the arrow keys ↑ and ↓ to navigate to the channel to be calibrated.



Now select either **Span gas MR1** or **Span gas MR2** depending on whether you wish to calibrating within measuring range 1 or measuring range 2. Then enter the concentration for the span gas an and press ↵ to confirm.

Press **Start** to begin the calibration sequence for the span gas.

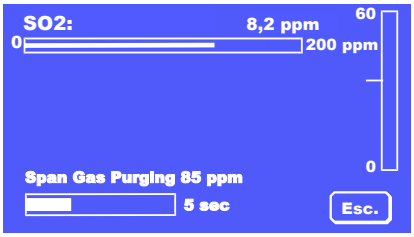
The process may be stopped at any time with **Esc.**.



Purge span gas

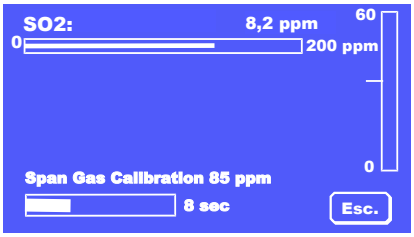
– This process will take the amount of time specified under **Purging Time**. The process may be stopped at any time with **Esc.**.

After the purging time, calibration with span gas will automatically start.



Calibrate span gas

This process will take the amount of time specified under **Cal.Period**. The process may be stopped at any time with **Esc.**.



The logbook records both the calibrations performed and events during calibration.

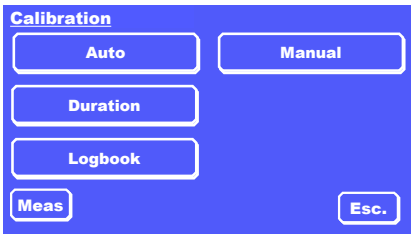
7.5.6 Menu > calibration > Logbook

The logbook records all messages triggered during the calibration sequence. Successful calibrations are also recorded.

View Logbook

– Select the messages with **Menu** > **Calibration** > **Logbook**.

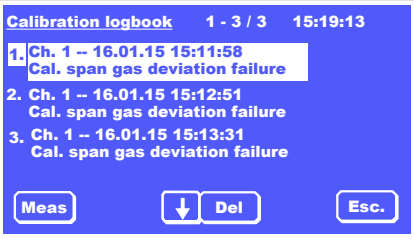
Enter password 1.



Plain text

– Messages are displayed in plain text:
– Channel no., date and time
– Plain text message.

The process may be stopped at any time with **Esc.**.



If an error message is triggered, proceed as follows:

Verify

- the unit had adequate time to warm up (at least 30 min) and stable operating conditions were reached.
- Calibrating gases are loaded in the desired concentration,
- the settings under Auto or Manual are correct and correspond with the respective gases.
- the calibrating gas supply is working properly and the purging time and calibration period settings are adequate.

Delete the respective top message (1st) with the Del button until all messages have been deleted.

Restart calibration.

If calibration fails again, you may be able to find information in chapter "Status messages and troubleshooting [> page 45]" or contact our service (see chapter "Service and repair)".

8 Maintenance

During maintenance, remember:

- The equipment must be maintained by a professional familiar with the safety requirements and risks.
- Only perform maintenance work described in these operating and installation instructions.
- Observe the respective safety regulations and operating specifications when performing any type of maintenance.
- Always use genuine spare parts.

DANGER

Electric voltage

Risk of electric shock

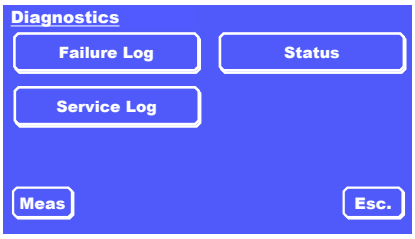
a) Disconnect the unit from the mains when performing any maintenance.

b) Secure the equipment from accidental restarting.

c) The unit may only be maintained and opened by instructed, competent personnel.

Diagnostics

Please also refer to the “Failure” and “Service” logs for information on failure messages and service.



8.1 Service schedule

The service schedule is only a guide for the required service intervals and work. The owner is responsible for defining the service intervals considering the application conditions.

NOTICE

Leaks when using corrosive gases

When using corrosive gases, regularly visually inspect the gas paths for damage. The intervals are based on the gases used, their concentration and their corrosiveness. Please also note the information on parts in contact with media in chapter "".

Further observe the official or company regulations for your application and the failure and service messages output by the unit.

Service	Service interval
Visual inspection	2x per month
Inspect and if necessary replace filter element (if applicable).	2x per month
Calibrate	At least 2x per month (also see General information [> page 35])
Check tightness of gas paths, check built-in gas pump	To be defined by the owner, at least every 6 months

8.2 Measuring the insulation resistance on the complete unit

Never conduct high voltage tests on the unit.

If a insulation resistance must be measured, only test the complete unit using a test voltage of max. 500 VDC.

8.3 Leak test

Interval approx. 6 months (recommended)

Leak test procedure

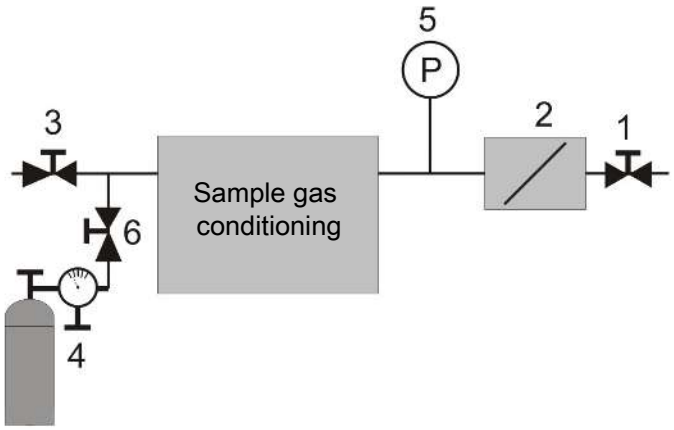


Fig. 5: Leak test set-up

1. Close the sample gas outlet on the analyser (2) and the sample gas inlet of your gas conditioning system gas tight (e.g. using a shut-off cock (1) + (3)).
2. Connect a nitrogen pressure cylinder with pressure reducer and fine control valve (4) between the shut-off cocks anywhere along the sample gas path.
3. Install a pressure gauge (5) in the sample gas path between the two shut-offs. Measuring range approx. 25 kPa = 250 mbar = 250 hPa.
4. Use the fine control valve to carefully set a nitrogen gas pressure of 20 kPa = 200 mbar = 200 hPa and seal the N_2 gas supply gas-tight (e.g. using a shut-off cock (6)).

The leak rate Q for your measuring system is determined from

$Q = (\Delta p \times V) / \Delta t$

Where:

V	Internal volume of your measuring system in litres
Δp	Pressure loss measured in mbar (over period Δt)
Δt	Measurement time in seconds

to ensure high quality CO_2 and SO_2 measurement, we recommend a leak rate of < 3×10^{-4} mbar L/s.

With respect to permitted leak rates please note the standards or legal requirements for your application.

WARNING **Toxic gases**

Conveying toxic gases may require the analyser to be tighter. Please observe the applicable national regulations.
Highly toxic gases must not be used in the unit!

8.4 Replace filter element

Replacement filter elements:

Item no.	Description
411509910	Type FE-E2, 5 count

Replace the filter element (white fibreglass cartridge) at the latest when noticeably discoloured.

– In the case of new applications, check the filter element daily and
– extend the inspection interval until you are able to determine the ideal service interval.

NOTICE

Filter replacement / filter discolouration

Depending on the measuring application the filter will not become discoloured as the dust is colourless. In this case use suitable measures to check the filter.

Changing the filter:

1. Before opening the filter, verify there are no toxic or hazardous gases or components in the sample gas filter. If necessary, purge the unit with air.
2. Switch off the built-in or external sample gas pump and stop the sample gas supply (close valve).
3. Unscrew the filter cover counter-clockwise.
4. Remove the filter cover.
5. Remove the filter cartridge and check the condition.
6. If necessary, install a new filter cartridge. Be sure it is seated correctly.
7. Clean the sealing surfaces and seals and replace, if necessary.
8. Reinstall the filter cover without damaging the filter element.
9. Screw on the filter cover, turning clockwise

8.5 Cleaning

Regularly clean the outside of the housing using a soft, damp cloth.

Only use mild cleaners.

8.6 Replacing fuses

The BA 3 MA has two fuses at the back of the unit, F1 and F2.

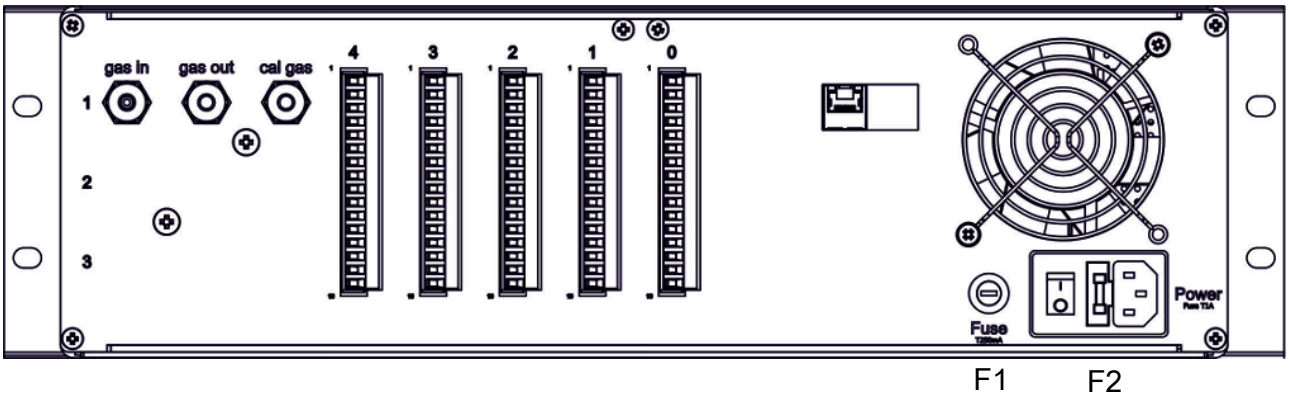


Fig. 6: BA 3 MA, rear view, fuses

F1 is the fuse for the internal 24 V DC supply. F2 is built into the power socket and fuses the mains supply.

– Disconnect the mains plug before replacing the fuses.
– Only replace defective fuses with the same type.

Fuse ratings:

F1: 250 mA, delayed action

F2: 1 A, delayed action

8.7 Service list

Service list	**BA 3 MA**
Serial number	
Location	

Date	Service performed	Name	Signature

9 Service and repair

This chapter contains information on troubleshooting and correction should an error occur during operation.

Repairs to the unit must be performed by Bühler authorised personnel.

Please contact our Service Department with any questions:

Tel.: +49-(0)2102-498955 or your agent

For further information about our services and customised maintenance visit http://www.buehler-technologies.com/service.

If the equipment is not functioning properly after correcting any malfunctions and switching on the power, it must be inspected by the manufacturer. Please send the equipment inside suitable packaging to:

Bühler Technologies GmbH

- Reparatur/Service -

Harkortstraße 29

40880 Ratingen

Germany

Please also attach the completed and signed RMA decontamination statement to the packaging. We will otherwise be unable to process your repair order.

You will find the form in the appendix of these instructions, or simply request it by e-mail:

service@buehler-technologies.com.

9.1 Status messages and troubleshooting

Service notifications and equipment failures are written to the respective logbooks. The event is also indicated by

- flashing icons in the measurement screen,
- a status message from the measuring channel (Plug ST1 – ST4 at the back of the unit) or
- an equipment status message (Plug ST0 at the back of the unit)

Status signals are triggered by the respective relay contact switching over, also see chapter Signal outputs [> page 17].

The following tables provide information on how to handle these messages. Open the respective logbook, take the specified actions and delete the respective logbook entry. Once all messages have been deleted the status signal will reset.

9.1.1 Service Log messages

Information related to the next service is saved to the service logbook.

Open: **Menu** > **Diagnostics** > **Service Logbook**

Logbook message	Symbol	Possible cause	Action
> 25000 h operating hours	W	The unit has been operating for over 25000 hours. The measuring accuracy specified in the technical documentation is no longer guaranteed.	– Equipment service by Bühler Technologies GmbH is recommended. Contact our Service

9.1.2 Failure Log messages

Errors which occur during operation are saved to the failure logbook

Open: **Menu** > **Diagnostics** > **Failure Logbook**

Logbook message	Symbol	Possible cause	Action
<Cell Type> low temp	!	The cell temperature was temporarily below the operating temperature (Alarm was automatically reset)	– Delete the logbook entry – For recurring errors check the ambient and service conditions; if necessary, contact Service
	A	Temperature sensor or measuring cell heater failure	– Take unit out of service, contact Service
Baro pressure comp. out of tolerance	A	negative pressure in the gas path incorrect	– Observe or adjust permissible gas pressure
	A	Internal barometric pressure sensor failure	– Take unit out of service, contact Service
Device temperature out of tolerance	A	Internal device temperature > 55 °C (e.g. due to high ambient temperature)	– Ensure the ambient temperature is below 45 °C
	A	Defective cell heater (if "Heater failure" message also appears)	– Take unit out of service, contact Service
<Cell Type> Limit value over-/underrun	A	Alarm due to over-/underrunning the concentration values set by the customer	– Adjust limits to process conditions
	!	Alarm was automatically cleared	
<Cell Type> Heater failure	A	Measuring cell heater failure	– Take unit out of service, contact Service
<Cell Type> Signal out of tolerance	A	Incorrect measuring cell signal drift or measuring cell failure	– Take unit out of service, contact Service
<Cell Type> T-sensor failure	A	Measuring cell temperature sensor failure	– Take unit out of service, contact Service
IR cell error	A	Measuring cell IR lamp failure	– Take unit out of service, contact Service
UV cell error	A	Measuring cell UV lamp failure	– Take unit out of service, contact Service
Low gas flow	A	The minimum gas flow through the measuring cell is significantly underrun due to – leaks, – gas supply failure, – sample gas pump failure, – clogged gas paths (e.g. filter, lines, etc.)	– Check sample gas lines and unit for leaks – Check gas supply and pump functionality. – Clean clogged filters, lines, etc. – Check any shut-off valves in the gas path
Baro pressure comp. failure	A	Barometric pressure sensor failure	– Take unit out of service, contact Service

9.1.3 Calibration Log messages

Errors which occur during calibration are saved to the calibration logbook.

Open: **Menu** > **Calibration** > **Logbook**

Logbook message	Symbol	Possible cause	Action
Cal. variation failure	A	Excessive variation during calibration.	Maintain a stable calibrating gas concentration during calibration, e.g. by: – Stabilising the sample gas flow. – Avoiding pressure variations in the gas path. – Increase calibrating gas purging times
Cal. span gas deviation failure	A	The deviation between the defined calibration setpoint and the value measured is greater than the limit set by the customer; – Incorrect calibrating gas, – Insufficient gas flow, pressure ratios changed – Permissible cal. deviation set too low	– Increase purging times for calibration – Check calibration gas concentration. – Set the gas flow and gas pressure to permissible values – if necessary, increase permissible cal deviation values under menu item "Calibration"
Cal. zero gas deviation failure	A	See "Cal span gas deviation failure"	
Calibration successful		No error	---
Cal failed	A	Error; calibration was rejected as the display currently shows an equipment error and is listed in the failure logbook.	– Correct or have the equipment error corrected, if necessary contact Service – Delete logbook entries

9.2 Spare parts

Item no.	Description
9148000211	3/2 Solenoid valve
4346067	PVDF bulkhead coupling
9008525	VA bulkhead coupling
9124030115	Brushless pump
4067002	Flow meter 2-20 L/h
55360033	BA 3 Filter KL13, Ø4 mm connection
4115099	AGF-FE–2 front filter
411509910	FE-E2 filter element, 5-pack
9146030235	Plug connector 16 pin
9110000051	Fuse 4 A delayed action for main board
9110000002	Fuse 1 A delayed action for power connector
9110000017	Fuse 250mA delayed action for back of housing

10 Disposal

The applicable national laws must be observed when disposing of the products. Disposal must not result in a danger to health and environment.

The crossed out wheelie bin symbol on Bühler Technologies GmbH electrical and electronic products indicates special disposal notices within the European Union (EU).

The crossed out wheelie bin symbol indicates the electric and electronic products bearing the symbol must be disposed of separate from household waste. They must be properly disposed of as waste electrical and electronic equipment.

Bühler Technologies GmbH will gladly dispose of your device bearing this mark. Please send your device to the address below for this purpose.

We are obligated by law to protect our employees from hazards posed by contaminated devices. Therefore please understand that we can only dispose of your waste equipment if the device is free from any aggressive, corrosive or other operating fluids dangerous to health or environment. **Please complete the "RMA Form and Decontamination Statement", available on our website, for every waste electrical and electronic equipment. The form must be applied to the packaging so it is visible from the outside.**

Please return waste electrical and electronic equipment to the following address:

Bühler Technologies GmbH
WEEE
Harkortstr. 29
40880 Ratingen
Germany

Please also observe data protection regulations and remember you are personally responsible for the returned waste equipment not bearing any personal data. Therefore please be sure to delete your personal data before returning your waste equipment.

11 Attached documents

- Declaration of Conformity KX550012
- Modbus manual BA 3 MA
- RMA - Decontamination Statement

EU-Konformitätserklärung
EU-declaration of conformity

Hiermit erklärt Bühler Technologies GmbH, dass die nachfolgenden Produkte den wesentlichen Anforderungen der Richtlinie

Herewith declares Bühler Technologies GmbH that the following products correspond to the essential requirements of Directive

2014/35/EU
(Niederspannungsrichtlinie / *low voltage directive*)

in ihrer aktuellen Fassung entsprechen.

in its actual version.

Folgende Richtlinien wurden berücksichtigt:

The following directives were regarded:

2014/30/EU (EMV/EMC)

Produkt / products: Mehrkanal Gasanalysator / Multi component gas analyser
Typ / type: BA 3 select, BA 3 MA

Das Betriebsmittel dient zur kontinuierlichen Messung der Gas-Konzentration von industriellen Prozess-Gasen.
The equipment is used to continuously measure the gas concentration in industrial process gas.

Das oben beschriebene Produkt der Erklärung erfüllt die einschlägigen Harmonisierungsrechtsvorschriften der Union:
The object of the declaration described above is in conformity with the relevant Union harmonisation legislation:

EN 61326-1:2013 **EN 61010-1:2010/A1:2019/AC:2019-04**

Die alleinige Verantwortung für die Ausstellung dieser Konformitätserklärung trägt der Hersteller.
This declaration of conformity is issued under the sole responsibility of the manufacturer.

Dokumentationsverantwortlicher für diese Konformitätserklärung ist Herr Stefan Eschweiler mit Anschrift am Firmensitz.
The person authorized to compile the technical file is Mr. Stefan Eschweiler located at the company's address.

Ratingen, den 17.02.2023

Stefan Eschweiler
Geschäftsführer – *Managing Director*

Frank Pospiech
Geschäftsführer – *Managing Director*

Bühler Technologies GmbH, Harkortstr. 29, D-40880 Ratingen,
Tel. +49 (0) 21 02 / 49 89-0, Fax. +49 (0) 21 02 / 49 89-20
Internet: www.buehler-technologies.com

UK Declaration of Conformity

The manufacturer Bühler Technologies GmbH declares, under the sole responsibility, that the product complies with the requirements of the following UK legislation:

Electrical Equipment Safety Regulations 2016

The following legislation were regarded:

Electromagnetic Compatibility Regulations 2016

Product: Multi component gas analyser
Types: BA 3 select
BA 3 MA

The equipment is used to continuously measure the gas concentration in industrial process gas.

The object of the declaration described above is in conformity with the relevant designated standards:

EN 61010-1:2010/A1:2019/AC:2019-04

EN 61326-1:2013

Ratingen in Germany, 17.02.2023

Stefan Eschweiler
Managing Director

Frank Pospiech
Managing Director

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Tel. +49 (0) 21 02 / 49 89-0, Fax. +49 (0) 21 02 / 49 89-20
Internet: www.buehler-technologies.com

BÜHLER TECHNOLOGIES

Gas Analysis

ModbusTCP

Modbus TCP manual BA 3 MA

Bühler Technologies GmbH, Harkortstr. 29, D-40880 Ratingen
Tel. +49 (0) 21 02 / 49 89-0, Fax: +49 (0) 21 02 / 49 89-20
E-Mail: analyse@buehler-technologies.com
Internet: www.buehler-technologies.com

Modbus TCP interface

The Modbus interface allows direct access to process and diagnostic data and parameters during operation based on VDI4201.

The analyser takes on the role of the server in communication.

Modbus TCP:

Connects at the back of the device via RJ45 port.

Modbus TCP configuration

The settings below are the defaults and can be adjusted.

IP: 192.168.15.168

Subnet: 255.255.254.0

Gateway: 192.168.15.1

DHCP: Enabled

When configuring the address, be sure they are stored in the registers in .hex syntax.

E.g. IP: 192.168.15.168 -> C0 A8 0F A8

After changing a setting, a "1" must be written to address "45500" to apply it. The interface will then automatically restart with the new configuration.

Modbus Communication

Communication via Modbus is always initiated by the client (request). The server (typically) responds to the request with a response. A Modbus frame for a request/response always has the following structure:

Address field (A)	Function code (FC)	Data	CRC
1 byte	1 byte	1 ... 252 bytes	2 bytes

Register addresses and data are transferred in Big Endian format.

Every register stands for a 16 bit value, with the information represented in various data types. The data type and required function code are assigned to the respective registers in an attached table.

To read/write data types with sizes larger than an individual register, multiple registers must be addressed.

Supported function codes:

Function code (FC)	FC values
Read Coil Status	1
Read Holding Registers	3
Write Single Coil	5
Write Multiple Coils	15
Write Multiple Registers	16

Data types:

Description	Number of bytes	Number of registers
Bit	1	1
Float	4	2
Int16	2	1
Uint16	2	1
Int32	4	2
Uint32	4	2

For the Modbus manual with the available registers see Chapter Attached documents. There are registers which are read only (R), write only (W), read and write (RW). To write the registers, the respective password based on the password level must be entered. Once the respective password has been entered correctly, the register entries are available until it has been entered incorrectly or the device has been restarted.

By default, the new value will be applied to the write registers during writing without any other interaction. For some registers, simply writing them will not suffice. Once written, the change must be confirmed with another entry in a different register.

After one or more Modbus interface parameters have been changed, a "1" must be written to address "45500" to apply the setting. The interface will then automatically be restarted and the device must be reconnected. Without writing "1" the change will not be applied.

The logbooks can only be read once they have been refreshed. This refresh is triggered by entering a "1" under the addresses "45501" (error), "45502" (service) and "45503" (calibration). Entering "0" will erase the oldest entry from the respective logbook. The respective logbook will then need to be refreshed so it can be read.

Modbus Register

Description	FC	Address	Number of registers	Access	Data type	Default	Min	Max	Selection	Resolution	Unit	Password	Comment
Measurement value channel 1	3	2000	2	R	Float							None	
Measurement value channel 1 - status	3	2002	2	R	Int32							None	
Measurement value channel 2	3	2004	2	R	Float							None	
Measurement value channel 2 -status	3	2006	2	R	Int32							None	
Measurement value channel 3	3	2008	2	R	Float							None	
Measurement value channel 3 -status	3	2010	2	R	Int32							None	
Measurement value channel 4	3	2012	2	R	Float							None	
Measurement value channel 4 -status	3	2014	2	R	Int32							None	
Min. Measuring range 1 channel 1	3, 16	6000	2	R/W	Float							UP2	
Max. Measuring range 1 channel 1	3, 16	6002	2	R/W	Float							UP2	
Min. Measuring range 1 channel 2	3, 16	6004	2	R/W	Float							UP2	
Max. Measuring range 1 channel 2	3, 16	6006	2	R/W	Float							UP2	
Min. Measuring range 1 channel 3	3, 16	6008	2	R/W	Float							UP2	
Max. Measuring range 1 channel 3	3, 16	6010	2	R/W	Float							UP2	
Min. Measuring range 1 channel 4	3, 16	6012	2	R/W	Float							UP2	
Max. Measuring range 1 channel 4	3, 16	6014	2	R/W	Float							UP2	
Min. Measuring range 2 Ch. 1	3, 16	6016	2	R/W	Float							UP2	

Description	FC	Address	Number of registers	Access	Data type	Default	Min	Max	Selection	Resolution	Unit	Password	Comment
Max. Measuring range 2 Ch. 1	3, 16	6018	2	R/W	Float							UP2	
Min. Measuring range 2 Ch. 2	3, 16	6020	2	R/W	Float							UP2	
Max. Measuring range 2 Ch. 2	3, 16	6022	2	R/W	Float							UP2	
Min. Measuring range 2 Ch. 3	3, 16	6024	2	R/W	Float							UP2	
Max. Measuring range 2 Ch. 3	3, 16	6026	2	R/W	Float							UP2	
Min. Measuring range 2 Ch. 4	3, 16	6028	2	R/W	Float							UP2	
Max. Measuring range 2 Ch. 4	3, 16	6030	2	R/W	Float							UP2	
Auto switchover (MR1->MR2) Ch. 1	3, 16	6040	1	R/W	Int16		50	100				UP2	
Auto switchover (MR1->MR2) Ch. 2	3, 16	6041	1	R/W	Int16		0	95				UP2	
Auto switchover (MR1->MR2) Ch. 3	3, 16	6042	1	R/W	Int16		50	100				UP2	
Auto switchover (MR1->MR2) Ch. 4	3, 16	6043	1	R/W	Int16		0	95				UP2	
Auto switchover (MR2->MR1) Ch. 1	3, 16	6044	1	R/W	Int16		50	100				UP2	
Auto switchover (MR2->MR1) Ch. 2	3, 16	6045	1	R/W	Int16		0	95				UP2	
Auto switchover (MR2->MR1) Ch. 3	3, 16	6046	1	R/W	Int16		50	100				UP2	
Auto switchover (MR2->MR1) Ch. 4	3, 16	6047	1	R/W	Int16		0	95				UP2	
Auto switchover EA Ch. 1	3, 16	6048	1	R/W	Int16							UP2	

Description	FC	Address	Number of registers	Access	Data type	Default	Min	Max	Selection	Resolution	Unit	Password	Comment
Auto switchover EA Ch. 2	3, 16	6049	1	R/W	Int16							UP2	
Auto switchover EA Ch. 3	3, 16	6050	1	R/W	Int16							UP2	
Auto switchover EA Ch. 4	3, 16	6051	1	R/W	Int16							UP2	
Limit value 1 Ch. 1	3, 16	6060	2	R/W	Float							UP2	
Limit value 1 Ch. 2	3, 16	6062	2	R/W	Float							UP2	
Limit value 1 Ch. 3	3, 16	6064	2	R/W	Float							UP2	
Limit value 1 Ch. 4	3, 16	6066	2	R/W	Float							UP2	
Limit value 2 Ch. 1	3, 16	6068	2	R/W	Float							UP2	
Limit value 2 Ch. 2	3, 16	6070	2	R/W	Float							UP2	
Limit value 2 Ch. 3	3, 16	6072	2	R/W	Float							UP2	
Limit value 2 Ch. 4	3, 16	6074	2	R/W	Float							UP2	
Limit value 1-function Ch. 1	3, 16	6076	1	R/W	Int16				1 = large 2 = small			UP2	
Limit value 1-function Ch. 2	3, 16	6077	1	R/W	Int16							UP2	
Limit value 1-function Ch. 3	3, 16	6078	1	R/W	Int16							UP2	
Limit value 1-function Ch. 4	3, 16	6079	1	R/W	Int16							UP2	
Limit value 2-function Ch. 1	3, 16	6080	1	R/W	Int16							UP2	
Limit value 2-function Ch. 2	3, 16	6081	1	R/W	Int16							UP2	
Limit value 2-function Ch. 3	3, 16	6082	1	R/W	Int16							UP2	
Limit value 2-function Ch. 4	3, 16	6083	1	R/W	Int16							UP2	
Unit Ch. 1	3, 16	6090	1	R/W	Int16				- 1 = mg/m3 - 2 = ppm - 4 = % - 8 = ppm/%			UP2	
Unit Ch. 2	3, 16	6091	1	R/W	Int16				see above			UP2	
Unit Ch. 3	3, 16	6092	1	R/W	Int16				see above			UP2	
Unit Ch. 4	3, 16	6093	1	R/W	Int16				see above			UP2	
Damping Ch. 1	3, 16	6100	1	R/W	Int16	1	1	20			s	UP2	

Description	FC	Address	Number of registers	Access	Data type	Default	Min	Max	Selection	Resolution	Unit	Password	Comment
Damping Ch. 2	3, 16	6101	1	R/W	Int16	1	1	20			s	UP2	
Damping Ch. 3	3, 16	6102	1	R/W	Int16	1	1	20			s	UP2	
Damping Ch. 4	3, 16	6103	1	R/W	Int16	1	1	20			s	UP2	
Config. analog output Ch. 1	3, 16	6130	1	R/W	Int16				Bit15-Bit12: Value at alarm 1 = Hold value 2 = Current value 4 = Value 0 Bit11-Bit8: Value on calibration 1 = Hold value 2 = Current value 4 = Value 0 Bit7-Bit0: Output types - 1 = 0-20mA - 2 = 4-20mA - 4 = 0-10V - 8 = 2-10V			UP2	
Config. analog output Ch. 2	3, 16	6131	1	R/W	Int16				see above			UP2	
Config. analog output Ch. 3	3, 16	6132	1	R/W	Int16				see above			UP2	
Config. analog output Ch. 4	3, 16	6133	1	R/W	Int16				see above			UP2	
Pumps 1	3, 16	6140	1	R/W	Int16				0 = Off 4 = On 8 = On during Cal			UP1	
Pumps 2	3, 16	6141	1	R/W	Int16				sees above			UP1	
Pumps 3	3, 16	6142	1	R/W	Int16				sees above			UP1	
Zero gas manual calibration Ch. 1	3, 16	6150	2	R/W	Float							UP2	
Zero gas manual calibration Ch. 2	3, 16	6152	2	R/W	Float							UP2	
Zero gas manual calibration Ch. 3	3, 16	6154	2	R/W	Float							UP2	

Description	FC	Address	Number of registers	Access	Data type	Default	Min	Max	Selection	Resolution	Unit	Password	Comment
Zero gas manual calibration Ch. 4	3, 16	6156	2	R/W	Float							UP2	
Zero gas manual calibration all cells	3, 16	6158	2	R/W	Float							UP2	
Span gas manual calibration Ch. 1	3, 16	6160	2	R/W	Float							UP2	
Span gas manual calibration Ch. 2	3, 16	6162	2	R/W	Float							UP2	
Span gas manual calibration Ch. 3	3, 16	6164	2	R/W	Float							UP2	
Span gas manual calibration Ch. 4	3, 16	6166	2	R/W	Float							UP2	
Span gas 2 manual calibration Ch. 1	3, 16	6168	2	R/W	Float							UP2	
Span gas 2 manual calibration Ch. 2	3, 16	6170	2	R/W	Float							UP2	
Span gas 2 manual calibration Ch. 3	3, 16	6172	2	R/W	Float							UP2	
Span gas 2 manual calibration Ch. 4	3, 16	6174	2	R/W	Float							UP2	
Zero gas auto calibration all cells	3, 16	6218	2	R/W	Float							UP2	
Span gas auto calibration Ch. 1	3, 16	6220	2	R/W	Float							UP2	
Span gas auto calibration Ch. 2	3, 16	6222	2	R/W	Float							UP2	
Span gas auto calibration Ch. 3	3, 16	6224	2	R/W	Float							UP2	
Span gas auto calibration Ch. 4	3, 16	6226	2	R/W	Float							UP2	
Zero gas calibration time period Ch. 1-4	3, 16	6236	2	R/W	Uint32		300	86400			s	UP2	
Cal. period Ch. 1	3, 16	6240	1	R/W	Uint16		1	600			s	UP2	
Cal. period Ch. 2	3, 16	6241	1	R/W	Uint16		1	600			s	UP2	
Cal. period Ch. 3	3, 16	6242	1	R/W	Uint16		1	600			s	UP2	
Cal. period Ch. 4	3, 16	6243	1	R/W	Uint16		1	600			s	UP2	

Description	FC	Address	Number of registers	Access	Data type	Default	Min	Max	Selection	Resolution	Unit	Password	Comment
Cal. period all cells	3, 16	6244	1	R/W	Uint16		1	600				UP2	
Purging time Ch. 1	3, 16	6245	1	R/W	Uint16		1	600			s	UP2	
Purging time Ch. 2	3, 16	6246	1	R/W	Uint16		1	600			s	UP2	
Purging time Ch. 3	3, 16	6247	1	R/W	Uint16		1	600			s	UP2	
Purging time Ch. 4	3, 16	6248	1	R/W	Uint16		1	600			s	UP2	
Purging time all cells	3, 16	6249	1	R/W	Uint16		1	600			s	UP2	
Span gas calibration deviation Ch. 1	3, 16	6260	2	R/W	Float		0.5	100				UP2	
Span gas calibration deviation Ch. 2	3, 16	6262	2	R/W	Float		0.5	100				UP2	
Span gas calibration deviation Ch. 3	3, 16	6264	2	R/W	Float		0.5	100				UP2	
Span gas calibration deviation Ch. 4	3, 16	6266	2	R/W	Float		0.5	100				UP2	
Zero gas calibration deviation Ch. 1	3, 16	6268	2	R/W	Float		0.2	100				UP2	
Zero gas calibration deviation Ch. 2	3, 16	6270	2	R/W	Float		0.2	100				UP2	
Zero gas calibration deviation Ch. 3	3, 16	6272	2	R/W	Float		0.2	100				UP2	
Zero gas calibration deviation Ch. 4	3, 16	6274	2	R/W	Float		0.2	100				UP2	
Authenticate (user level 1)	16	6280	1	W	Int16		0	999				None	
Authenticate (user level 2)	16	6285	1	W	Int16		0	999				None	
Temperature Ch. 1	3	6500	2	R	Float							None	
Temperature Ch. 2	3	6502	2	R	Float							None	
Temperature Ch. 3	3	6504	2	R	Float							None	
Temperature Ch. 4	3	6506	2	R	Float							None	
Flow Ch. 1	3	6508	2	R	Float							None	
Flow Ch. 2	3	6510	2	R	Float							None	
Flow Ch. 3	3	6512	2	R	Float							None	
Flow Ch. 4	3	6514	2	R	Float							None	
Pressure Ch. 1	3	6516	2	R	Float							None	

Description	FC	Address	Number of registers	Access	Data type	Default	Min	Max	Selection	Resolution	Unit	Password	Comment
Pressure Ch. 2	3	6518	2	R	Float							None	
Pressure Ch. 3	3	6520	2	R	Float							None	
Pressure Ch. 4	3	6522	2	R	Float							None	
Alarm logbook entry number	3	6550	1	R	Struct							UP1	
Alarm logbook entry 1	3	6551	3	R	Struct				Register 1 = channel and error code Bit15-Bit8: Channel number 0 to 3 same as 1 to 4 Bit7-Bit0: Error code registers 2 + 3 = time (unix timestamp)			UP1	
Alarm logbook entry 2	3	6554	3	R	Struct							UP1	
Alarm logbook entry 3	3	6557	3	R	Struct							UP1	
Alarm logbook entry 4	3	6560	3	R	Struct							UP1	
Alarm logbook entry 5	3	6563	3	R	Struct							UP1	
Alarm logbook entry 6	3	6566	3	R	Struct							UP1	
Alarm logbook entry 7	3	6569	3	R	Struct							UP1	
Alarm logbook entry 8	3	6572	3	R	Struct							UP1	
Alarm logbook entry 9	3	6575	3	R	Struct							UP1	
Alarm logbook entry 10	3	6578	3	R	Struct							UP1	
Alarm logbook entry 11	3	6581	3	R	Struct							UP1	
Alarm logbook entry 12	3	6584	3	R	Struct							UP1	
Alarm logbook entry 13	3	6587	3	R	Struct							UP1	
Alarm logbook entry 14	3	6590	3	R	Struct							UP1	
Alarm logbook entry 15	3	6593	3	R	Struct							UP1	
Alarm logbook entry 16	3	6596	3	R	Struct							UP1	
Alarm logbook entry 17	3	6599	3	R	Struct							UP1	
Alarm logbook entry 18	3	6602	3	R	Struct							UP1	
Alarm logbook entry 19	3	6605	3	R	Struct							UP1	
Alarm logbook entry 20	3	6608	3	R	Struct							UP1	
Alarm logbook entry 21	3	6611	3	R	Struct							UP1	
Alarm logbook entry 22	3	6614	3	R	Struct							UP1	
Alarm logbook entry 23	3	6617	3	R	Struct							UP1	

Description	FC	Address	Number of registers	Access	Data type	Default	Min	Max	Selection	Resolution	Unit	Password	Comment
Alarm logbook entry 24	3	6620	3	R	Struct							UP1	
Alarm logbook entry 25	3	6623	3	R	Struct							UP1	
Alarm logbook entry 26	3	6626	3	R	Struct							UP1	
Alarm logbook entry 27	3	6629	3	R	Struct							UP1	
Alarm logbook entry 28	3	6632	3	R	Struct							UP1	
Alarm logbook entry 29	3	6635	3	R	Struct							UP1	
Alarm logbook entry 30	3	6638	3	R	Struct							UP1	
Alarm logbook entry 31	3	6641	3	R	Struct							UP1	
Alarm logbook entry 32	3	6644	3	R	Struct							UP1	
Alarm logbook entry 33	3	6647	3	R	Struct							UP1	
Alarm logbook entry 34	3	6650	3	R	Struct							UP1	
Alarm logbook entry 35	3	6653	3	R	Struct							UP1	
Alarm logbook entry 36	3	6656	3	R	Struct							UP1	
Alarm logbook entry 37	3	6659	3	R	Struct							UP1	
Alarm logbook entry 38	3	6662	3	R	Struct							UP1	
Alarm logbook entry 39	3	6665	3	R	Struct							UP1	
Alarm logbook entry 40	3	6668	3	R	Struct							UP1	
Service logbook entry number	3	6680	1	R	Struct							UP1	
Service logbook entry 1	3	6681	3	R	Struct				Register 1 = Channel and error code Bit15-Bit8: Channel number 0 to 3 same as 1 to 4 Bit7-Bit0: Error code registers 2 + 3 = time (unix timestamp)			UP1	
Service logbook entry 2	3	6684	3	R	Struct							UP1	
Service logbook entry 3	3	6687	3	R	Struct							UP1	
Service logbook entry 4	3	6690	3	R	Struct							UP1	
Service logbook entry 5	3	6693	3	R	Struct							UP1	
Service logbook entry 6	3	6696	3	R	Struct							UP1	
Service logbook entry 7	3	6699	3	R	Struct							UP1	
Service logbook entry 8	3	6702	3	R	Struct							UP1	
Service logbook entry 9	3	6705	3	R	Struct							UP1	

Description	FC	Address	Number of registers	Access	Data type	Default	Min	Max	Selection	Resol-ution	Unit	Pass-word	Comment
Service logbook entry 10	3	6708	3	R	Struct							UP1	
Service logbook entry 11	3	6711	3	R	Struct							UP1	
Service logbook entry 12	3	6714	3	R	Struct							UP1	
Service logbook entry 13	3	6717	3	R	Struct							UP1	
Service logbook entry 14	3	6720	3	R	Struct							UP1	
Service logbook entry 15	3	6723	3	R	Struct							UP1	
Service logbook entry 16	3	6726	3	R	Struct							UP1	
Service logbook entry 17	3	6729	3	R	Struct							UP1	
Service logbook entry 18	3	6732	3	R	Struct							UP1	
Service logbook entry 19	3	6735	3	R	Struct							UP1	
Service logbook entry 20	3	6738	3	R	Struct							UP1	
Service logbook entry 21	3	6741	3	R	Struct							UP1	
Service logbook entry 22	3	6744	3	R	Struct							UP1	
Service logbook entry 23	3	6747	3	R	Struct							UP1	
Service logbook entry 24	3	6750	3	R	Struct							UP1	
Service logbook entry 25	3	6753	3	R	Struct							UP1	
Service logbook entry 26	3	6756	3	R	Struct							UP1	
Service logbook entry 27	3	6759	3	R	Struct							UP1	
Service logbook entry 28	3	6762	3	R	Struct							UP1	
Service logbook entry 29	3	6765	3	R	Struct							UP1	
Service logbook entry 30	3	6768	3	R	Struct							UP1	
Service logbook entry 31	3	6771	3	R	Struct							UP1	
Service logbook entry 32	3	6774	3	R	Struct							UP1	
Service logbook entry 33	3	6777	3	R	Struct							UP1	
Service logbook entry 34	3	6780	3	R	Struct							UP1	
Service logbook entry 35	3	6783	3	R	Struct							UP1	
Service logbook entry 36	3	6786	3	R	Struct							UP1	
Service logbook entry 37	3	6789	3	R	Struct							UP1	
Service logbook entry 38	3	6792	3	R	Struct							UP1	
Service logbook entry 39	3	6795	3	R	Struct							UP1	
Service logbook entry 40	3	6798	3	R	Struct							UP1	
Calibration logbook entry number	3	6810	1	R	Struct							UP1	

Description	FC	Address	Number of registers	Access	Data type	Default	Min	Max	Selection	Resolution	Unit	Password	Comment
Calibration logbook 1	3	6811	3	R	Struct				Register 1 = Channel and error code Bit15-Bit8: Channel number 0 to 3 same as 1 to 4 Bit7-Bit0: Error code registers 2 + 3 = time (unix timestamp)			UP1	
Calibration logbook 2	3	6814	3	R	Struct							UP1	
Calibration logbook 3	3	6817	3	R	Struct							UP1	
Calibration logbook 4	3	6820	3	R	Struct							UP1	
Calibration logbook 5	3	6823	3	R	Struct							UP1	
Calibration logbook 6	3	6826	3	R	Struct							UP1	
Calibration logbook 7	3	6829	3	R	Struct							UP1	
Calibration logbook 9	3	6832	3	R	Struct							UP1	
Calibration logbook 8	3	6835	3	R	Struct							UP1	
Calibration logbook 10	3	6838	3	R	Struct							UP1	
IP address	3, 16	9950	2	R/W	Uint32	0xC0A80FA8	0x00	0xffffffff				UP2	
Subnet	3, 16	9952	2	R/W	Uint32	0xffffffe00	0x00	0xffffffff				UP2	
IP gateway	3, 16	9954	2	R/W	Uint32	0xC0A80F01	0x00	0xffffffff				UP2	
DHCP	3, 16	9956	1	R/W	Int16							UP2	
Date/time (Linux time)	3, 16	9960	2	R/W	Int32							UP1	
TEST	3	9990	2	R	Uint32	12648430	-	-	-	1	-	None	
TEST_UINT16	3, 16	9992	1	R/W	Uint16	206	0	65535	-	1	-	None	
TEST_INT16	3, 16	9993	1	R/W	Int16	-206	-32768	32767	-	1	-	None	
TEST_UINT32	3, 16	9994	2	R/W	Uint32	2766	0	4294967295	-	1	-	None	
TEST_INT32	3, 16	9996	2	R/W	Int32	-2766	0x80000000	0x7fffffff	-	1	-	None	
TEST_Float	3, 16	9998	2	R/W	Float	-10.5			-	-	-	None	
Enable limit value 1 Ch. 1	1, 5, 15	45010		R/W	Bit				1 = Enable 0 = Disable			UP2	
Enable limit value 2 Ch. 1	1, 5, 15	45011		R/W	Bit				1 = Enable 0 = Disable			UP2	
Enable limit value 1 Ch. 2	1, 5, 15	45012		R/W	Bit				1 = Enable 0 = Disable			UP2	

Description	FC	Address	Number of registers	Access	Data type	Default	Min	Max	Selection	Resolution	Unit	Password	Comment
Enable limit value 2 Ch. 2	1, 5, 15	45013		R/W	Bit				1 = Enable 0 = Disable			UP2	
Enable limit value 1 Ch. 3	1, 5, 15	45014		R/W	Bit				1 = Enable 0 = Disable			UP2	
Enable limit value 2 Ch. 3	1, 5, 15	45015		R/W	Bit				1 = Enable 0 = Disable			UP2	
Enable limit value 1 Ch. 4	1, 5, 15	45016		R/W	Bit				1 = Enable 0 = Disable			UP2	
Enable limit value 2 Ch. 4	1, 5, 15	45017		R/W	Bit				1 = Enable 0 = Disable			UP2	
Autocal enabled/disabled Ch. 1	1, 5, 15	45024		R/W	Bit				1 = Enable 0 = Disable			UP2	
Apply new IP address	5, 15*	45500		W	Bit				1 = Apply network setting 0 = Reserved			UP2	Write with function code 15 only with quantity = 1
Alarm logbook (update&refresh)	5, 15*	45501		W	Bit				1 = Update logbook 0 = Erase oldest entry			UP1	Write with function code 15 only with quantity = 1
Service logbook (update&erase)	5, 15*	45502		W	Bit				1 = Update logbook 0 = Erase oldest entry			UP1	Write with function code 15 only with quantity = 1
Cal. Logbook (update&erase)	5, 15*	45503		W	Bit				1 = Update logbook 0 = Erase oldest entry			UP1	Write with function code 15 only with quantity = 1
Calibrate zero gas (all)	5, 15*	45504		W	Bit				1 = Start calibration 0 = Cancel calibration			UP2	Write with function code 15 only with quantity = 1
Calibrate zero gas Ch. 1	5, 15*	45505		W	Bit				1 = Start calibration 0 = Cancel calibration			UP2	Write with function code 15 only with quantity = 1
Calibrate zero gas Ch. 2	5, 15*	45506		W	Bit				1 = Start calibration 0 = Cancel calibration			UP2	Write with function code 15 only with quantity = 1
Calibrate zero gas Ch. 3	5, 15*	45507		W	Bit				1 = Start calibration 0 = Cancel calibration			UP2	Write with function code 15 only with quantity = 1

Description	FC	Address	Number of registers	Access	Data type	Default	Min	Max	Selection	Resolution	Unit	Password	Comment
Calibrate zero gas Ch. 4	5, 15*	45508		W	Bit				1 = Start calibration 0 = Cancel calibration			UP2	Write with function code 15 only with quantity = 1
Calibrate span gas Ch. 1	5, 15*	45509		W	Bit				1 = Start calibration 0 = Cancel calibration			UP2	Write with function code 15 only with quantity = 1
Calibrate span gas Ch. 2	5, 15*	45510		W	Bit				1 = Start calibration 0 = Cancel calibration			UP2	Write with function code 15 only with quantity = 1
Calibrate span gas Ch. 3	5, 15*	45511		W	Bit				1 = Start calibration 0 = Cancel calibration			UP2	Write with function code 15 only with quantity = 1
Calibrate span gas Ch. 4	5, 15*	45512		W	Bit				1 = Start calibration 0 = Cancel calibration			UP2	Write with function code 15 only with quantity = 1
Calibrate span gas 2 Ch. 1	5, 15*	45513		W	Bit				1 = Start calibration 0 = Cancel calibration			UP2	Write with function code 15 only with quantity = 1
Calibrate span gas 2 Ch. 2	5, 15*	45514		W	Bit				1 = Start calibration 0 = Cancel calibration			UP2	Write with function code 15 only with quantity = 1
Calibrate span gas 2 Ch. 3	5, 15*	45515		W	Bit				1 = Start calibration 0 = Cancel calibration			UP2	Write with function code 15 only with quantity = 1
Calibrate span gas 2 Ch. 4	5, 15*	45516		W	Bit				1 = Start calibration 0 = Cancel calibration			UP2	Write with function code 15 only with quantity = 1
IR_temperature_low	1	47000		R	Bit							None	
IR_error_cell	1	47001		R	Bit							None	
IR_heater_defective	1	47002		R	Bit							None	
IR_T-sensor_defective	1	47003		R	Bit							None	
reserved	1	47004		R	Bit							None	
reserved	1	47005		R	Bit							None	
reserved	1	47006		R	Bit							None	
reserved	1	47007		R	Bit							None	
UV_temperature_low	1	47024		R	Bit							None	

Description	FC	Address	Number of registers	Access	Data type	Default	Min	Max	Selection	Resolution	Unit	Password	Comment
UV_error_cell	1	47025		R	Bit							None	
UV_heater_defective	1	47026		R	Bit							None	
UV_T-sensor_defective	1	47027		R	Bit							None	
reserved	1	47028		R	Bit							None	
reserved	1	47029		R	Bit							None	
reserved	1	47030		R	Bit							None	
reserved	1	47031		R	Bit							None	
CO2_limit_1_exceeded	1	47056		R	Bit							None	
CO2_limit_1_underrun	1	47057		R	Bit							None	
CO2_limit_2_exceeded	1	47058		R	Bit							None	
CO2_limit_2_underrun	1	47059		R	Bit							None	
reserved	1	47060		R	Bit							None	
reserved	1	47061		R	Bit							None	
reserved	1	47062		R	Bit							None	
reserved	1	47063		R	Bit							None	
SO2_limit_1_exceeded	1	47096		R	Bit							None	
SO2_limit_1_underrun	1	47097		R	Bit							None	
SO2_limit_2_exceeded	1	47098		R	Bit							None	
SO2_limit_2_underrrun	1	47099		R	Bit							None	
reserved	1	47100		R	Bit							None	
reserved	1	47101		R	Bit							None	
reserved	1	47102		R	Bit							None	
reserved	1	47103		R	Bit							None	
Baro_pressure_compensation_out_of_tolerance	1	47104		R	Bit							None	
Baro_pressure_compensation_defective	1	47105		R	Bit							None	
Device_temperature_out_of_tolerance	1	47106		R	Bit							None	
reserved	1	47107		R	Bit							None	
reserved	1	47108		R	Bit							None	
reserved	1	47109		R	Bit							None	
reserved	1	47110		R	Bit							None	

Description	FC	Address	Number of registers	Access	Data type	Default	Min	Max	Selection	Resolution	Unit	Password	Comment
reserved	1	47111		R	Bit							None	
Cal_variation_high	1	47112		R	Bit							None	
Cal_deviation_span_gas_high	1	47113		R	Bit							None	
Cal_deviation_zero_gas_high	1	47114		R	Bit							None	
Cal_successful	1	47115		R	Bit							None	
Cal_invalid_error	1	47116		R	Bit							None	
reserved	1	47117		R	Bit							None	
reserved	1	47118		R	Bit							None	
reserved	1	47119		R	Bit							None	
reserved	1	47120		R	Bit							None	
reserved	1	47121		R	Bit							None	
reserved	1	47122		R	Bit							None	
reserved	1	47123		R	Bit							None	
reserved	1	47124		R	Bit							None	
reserved	1	47125		R	Bit							None	
reserved	1	47126		R	Bit							None	
reserved	1	47127		R	Bit							None	
Gas_flow_low	1	47128		R	Bit							None	
high_T-Drift	1	47129		R	Bit							None	
Reorder_EC	1	47130		R	Bit							None	
>_20000h_operating_hours	1	47131		R	Bit							None	
reserved	1	47132		R	Bit							None	
reserved	1	47133		R	Bit							None	
reserved	1	47134		R	Bit							None	
reserved	1	47135		R	Bit							None	
Measuring range status Ch. 1	1	47136		R	Bit	0			0 = Measuring range 1 1 = Measuring range 2			None	
Measuring range status Ch. 2	1	47137		R	Bit	0						None	

Description	FC	Address	Number of registers	Access	Data type	Default	Min	Max	Selection	Resol-ution	Unit	Pass-word	Comment
Measuring range status Ch. 3	1	47138		R	Bit	0						None	
Measuring range status Ch. 0	1	47139		R	Bit	0						None	
reserved	1	47140		R	Bit							None	
reserved	1	47141		R	Bit							None	
reserved	1	47142		R	Bit							None	
reserved	1	47143		R	Bit							None	

RMA-Formular und Erklärung über Dekontaminierung
RMA-Form and explanation for decontamination

RMA-Nr./ RMA-No.

Die RMA-Nr. bekommen Sie von Ihrem Ansprechpartner im Vertrieb oder Service. Bei Rücksendung eines Altgeräts zur Entsorgung tragen Sie bitte in das Feld der RMA-Nr. "WEEE" ein./ You may obtain the RMA number from your sales or service representative. When returning an old appliance for disposal, please enter "WEEE" in the RMA number box.

Zu diesem Rücksendeschein gehört eine Dekontaminierungserklärung. Die gesetzlichen Vorschriften schreiben vor, dass Sie uns diese Dekontaminierungserklärung ausgefüllt und unterschrieben zurücksenden müssen. Bitte füllen Sie auch diese im Sinne der Gesundheit unserer Mitarbeiter vollständig aus./ This return form includes a decontamination statement. The law requires you to submit this completed and signed decontamination statement to us. Please complete the entire form, also in the interest of our employee health.

Firma/ Company

Firma/ Company	
Straße/ Street	
PLZ, Ort/ Zip, City	
Land/ Country	

Ansprechpartner/ Person in charge

Name/ Name	
Abt./ Dept.	
Tel./ Phone	
E-Mail	

Gerät/ Device	
Anzahl/ Quantity	
Auftragsnr./ Order No.	

Serien-Nr./ Serial No.	
Artikel-Nr./ Item No.	

Grund der Rücksendung/ Reason for return

- ☐ Kalibrierung/ Calibration
- ☐ Modifikation/ Modification
- ☐ Reklamation/ Claim
- ☐ Reparatur/ Repair
- ☐ Elektroaltgerät/ Waste Electrical & Electronic Equipment (WEEE)
- ☐ andere/ other

bitte spezifizieren/ please specify

Ist das Gerät möglicherweise kontaminiert?/ Could the equipment be contaminated?

☐ Nein, da das Gerät nicht mit gesundheitsgefährdenden Stoffen betrieben wurde./ No, because the device was not operated with hazardous substances.

☐ Nein, da das Gerät ordnungsgemäß gereinigt und dekontaminiert wurde./ No, because the device has been properly cleaned and decontaminated.

☐ Ja, kontaminiert mit:/ Yes, contaminated with:

☐ explosiv/ explosive	☐ entzündlich/ flammable	☐ brandfördernd/ oxidizing	☐ komprimierte Gase/ compressed gases	☐ ätzend/ caustic	☐ giftig, Lebensgefahr/ poisonous, risk of death	☐ gesundheitsgefährdend/ harmful to health	☐ gesundheitsschädlich/ health hazard	☐ umweltgefährdend/ environmental hazard

Bitte Sicherheitsdatenblatt beilegen!/ Please enclose safety data sheet!

Das Gerät wurde gespült mit:/ The equipment was purged with:

Diese Erklärung wurde korrekt und vollständig ausgefüllt und von einer dazu befugten Person unterschrieben. Der Versand der (dekontaminierten) Geräte und Komponenten erfolgt gemäß den gesetzlichen Bestimmungen.

This declaration has been filled out correctly and completely, and signed by an authorized person. The dispatch of the (decontaminated) devices and components takes place according to the legal regulations.

Falls die Ware nicht gereinigt, also kontaminiert bei uns eintrifft, muss die Firma Bühler sich vorbehalten, diese durch einen externen Dienstleister reinigen zu lassen und Ihnen dies in Rechnung zu stellen.

Should the goods not arrive clean, but contaminated, Bühler reserves the right, to comission an external service provider to clean the goods and invoice it to your account.

Firmenstempel/ Company Sign

Datum/ Date

rechtsverbindliche Unterschrift/ Legally binding signature

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Internet: www.buehler-technologies.com

Vermeiden von Veränderung und Beschädigung der einzusendenden Baugruppe

Die Analyse defekter Baugruppen ist ein wesentlicher Bestandteil der Qualitätssicherung der Firma Bühler Technologies GmbH. Um eine aussagekräftige Analyse zu gewährleisten muss die Ware möglichst unverändert untersucht werden. Es dürfen keine Veränderungen oder weitere Beschädigungen auftreten, die Ursachen verdecken oder eine Analyse unmöglich machen.

Umgang mit elektrostatisch sensiblen Baugruppen

Bei elektronischen Baugruppen kann es sich um elektrostatisch sensible Baugruppen handeln. Es ist darauf zu achten, diese Baugruppen ESD-gerecht zu behandeln. Nach Möglichkeit sollten die Baugruppen an einem ESD-gerechten Arbeitsplatz getauscht werden. Ist dies nicht möglich sollten ESD-gerechte Maßnahmen beim Austausch getroffen werden. Der Transport darf nur in ESD-gerechten Behältnissen durchgeführt werden. Die Verpackung der Baugruppen muss ESD-konform sein. Verwenden Sie nach Möglichkeit die Verpackung des Ersatzteils oder wählen Sie selber eine ESD-gerechte Verpackung.

Einbau von Ersatzteilen

Beachten Sie beim Einbau des Ersatzteils die gleichen Vorgaben wie oben beschrieben. Achten Sie auf die ordnungsgemäße Montage des Bauteils und aller Komponenten. Versetzen Sie vor der Inbetriebnahme die Verkabelung wieder in den ursprünglichen Zustand. Fragen Sie im Zweifel beim Hersteller nach weiteren Informationen.

Einsenden von Elektroaltgeräten zur Entsorgung

Wollen Sie ein von Bühler Technologies GmbH stammendes Elektroprodukt zur fachgerechten Entsorgung einsenden, dann tragen Sie bitte in das Feld der RMA-Nr. „WEEE“ ein. Legen Sie dem Altgerät die vollständig ausgefüllte Dekontaminierungserklärung für den Transport von außen sichtbar bei. Weitere Informationen zur Entsorgung von Elektroaltgeräten finden Sie auf der Webseite unseres Unternehmens.

Avoiding alterations and damage to the components to be returned

Analysing defective assemblies is an essential part of quality assurance at Bühler Technologies GmbH. To ensure conclusive analysis the goods must be inspected unaltered, if possible. Modifications or other damages which may hide the cause or render it impossible to analyse are prohibited.

Handling electrostatically conductive components

Electronic assemblies may be sensitive to static electricity. Be sure to handle these assemblies in an ESD-safe manner. Where possible, the assembles should be replaced in an ESD-safe location. If unable to do so, take ESD-safe precautions when replacing these. Must be transported in ESD-safe containers. The packaging of the assemblies must be ESD-safe. If possible, use the packaging of the spare part or use ESD-safe packaging.

Fitting of spare parts

Observe the above specifications when installing the spare part. Ensure the part and all components are properly installed. Return the cables to the original state before putting into service. When in doubt, contact the manufacturer for additional information.

Returning old electrical appliances for disposal

If you wish to return an electrical product from Bühler Technologies GmbH for proper disposal, please enter "WEEE" in the RMA number box. Please attach the fully completed decontamination declaration form for transport to the old appliance so that it is visible from the outside. You can find more information on the disposal of old electrical appliances on our company’s website.

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