Embracing Challenge

GENTWO®

Multigas Analyzer V2.2

Instruction Manual

Version 1.02.03

Software Version: 2.24

Embracing Challenge

Quick support

If you have any questions about this product regarding commissioning, handling or technical service - feel free to contact us. We will support you directly, quickly and of course free of charge with our experience and product knowledge.

Please contact our service center in Ratingen, Germany,

for US Service Ventura, California

Please help us by providing this information about the device, if possible:

- Product model
- Product serial number
- M&C order or invoice number

- Germany service center:
  +49 2102 935 - 888
  service@mc-techgroup.com
- US service:
  +1 805-654-6970
  info-usa@mc-techgroup.com

In addition, we are continuously working on providing further assistance for many of our products online on our webpage:

- www.mc-techgroup.com

Table of Contents

1 About this instruction manual

Welcome to the M&C instruction manual. The goal of this document is to give a broad overview of the main functions of the Multigas Analyzer V2.2. It will help you to get started with using the GENTWO analyzer.

If you have any questions about this instruction manual, please contact M&C or one of our official distributors.

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	40885 Ratingen, Deutschland

This instruction manual does not claim to be complete and it may be subject to technical modifications. We appreciate any feedback you may have to this document .

The German instruction manual is the original instruction manual.

With the release of this version all older manual versions will no longer be valid.

Registered trademarks

GENTWO®	is a registered trademark of M&C Techgroup Germany GmbH.
Viton®	is a registered trademark of Dupont Performance Elastomers L.L.C.
ULTRA.sens® INFRA.sens®	ULTRA.sens® and INFRA.sens® are trademarks of Wi.Tec - Sensorik GmbH

2 Important safety information

Read this important safety information carefully before installing the Multigas Analyzer V2.2. Follow these safety precautions during commissioning, start-up and regular operation.

2.1 Intended use

This Multigas Analyzer V2.2 gas analyzer is intended for use in general purpose areas (non-hazardous environments). It may only be operated in compliance with the information on page 26 chapter 'Technical data basic instrument' . Particularly you must meet the requirements of the ambient temperature and characteristics.

Do not use this product for any other purpose. Improper use and handling can create hazards and cause damage. For more information, please refer to the safety information in this instruction manual.

2.2 Personal safety

Read this instruction manual carefully before commissioning and operating the device. If you have any questions regarding the product or the application, please don't hesitate to contact M&C or an M&C authorized distributor.

Follow all instructions and warnings closely.

The product described in this instruction manual has been built and tested in our production facility. All analyzers are packed to be shipped safely. To ensure the safe operation and to maintain the safe condition, all instructions and regulations stated in this manual need to be followed.

This instruction manual includes all information regarding proper transportation, storage, installation, operation and maintenance of this product by qualified personnel.

2.3 Warning signs and definitions

DANGER DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE	NOTICE is used to address practices not related to physical injury.
 **High Voltage!**	Caution, risk of electric shock!
 **High Pressure!**	Caution, system might be under pressure.
 **Hot Surface!**	Caution, hot surface! Do not touch!
 **Hazardous Gas!**	Caution, hazardous and toxic gas! Do not inhale!
 **Qualified personnel**	"Qualified personnel" are experts who are familiar with the installation, mounting, commissioning and operation of these types of products.
 **Safety Gloves!**	Put on safety gloves for your protection.
 **Pull Main Plug!**	Unplug power supply before opening!
 **Note**	"Note" indicates important information relating to the product or highlights parts of the documentation for special attention.
 **Do you need help?**	Please contact M&C!

2.4 Safety instructions

Follow these safety directions and instructions regarding installation, commissioning and operation of the Multigas Analyzer V2.2.

Qualified personnel	Installation, commissioning, maintenance, inspections and any repairs of all M&C products and components must be carried out by qualified personnel in compliance with the current regulations.

Install the device only in protected areas, sheltered from sun, rain and moisture.

Operate the device only in the permitted temperature and pressure ranges. For details please refer to the technical data on page 26 chapter 'Technical data basic instrument' .

Don't repair or maintain this product without M&C's specific maintenance- and service instructions.

When replacing parts, use only original M&C spare parts.

Pull Main Plug!	If there is any indication that safe operation of the Multigas Analyzer V2.2 is no longer possible, turn off the power and disconnect the device from the power supply immediately.

Then protect the defective device against accidental switch-on and mark it clearly as defective.

2.5 Working on electrical and electronic devices

Only qualified and authorized personnel are permitted to work on equipment which operates on 115 or 230 V AC supply voltage. Observe the generally accepted engineering standards and all of your national and local regulations.

Note	Before connecting the device, please make sure that the supply voltage matches the specified voltage on the product label.

High Voltage!	Protect yourself and others against damages which might be caused by high voltages. Disconnect the power supply before opening the device for access. Make sure that all external power supplies are disconnected.

Make sure to take appropriate precautions even by working on unplugged or low-voltage devices. Unplugged devices need to be properly grounded to prevent damage to internal electronics from electrostatic discharges (ESD).

2.6 Not certified in hazardous areas

This device is NOT certified to be installed or operated in hazardous areas.

WARNING	Explosion hazard! For general purpose areas ONLY. Don't use the Multigas Analyzer V2.2 in hazardous areas.

3 Introduction

Congratulations on your purchase of the Multigas Analyzer V2.2 analyzer. We know from experience that you surely will enjoy this reliable and durable M&C product.

M&C is one of the premium and performance-driven companies in the business. With this in mind, our customers benefit from a number of significant advantages. We offer proven, durable and advanced products and solutions. We have listened to our customers needs, when designing our products, allowing M&C to provide premium products at a comparatively lower cost over the entire life cycle.

Our products and special systems are designed and tested in our own facilities by our highly skilled staff that are always quality-oriented. We carefully package our goods and send them to our customers worldwide.

With our 30-years of experience in customer specific solutions for almost 30 different industries and applications, it is our goal to supply you with an excellent product. Our products offer fast commissioning, safe and reliable day-to-day operation and low maintenance.

We expect that our products fully meet your expectations. If you have any question regarding the product or the application, please don't hesitate to contact M&C or your M&C authorized distributor. Our service does not end with delivery of the products.

Thanks again for your purchase.

We appreciate your business.

4 Product overview

The Multigas Analyzer of the GENTWO® series is suitable for continuous measurements of gases in gas mixtures.

Areas of application are in particular combustion control, process optimisation, inertization monitoring, environmental protection or laboratory measurements, each in non-explosive environments.

The Multigas Analyzer is characterized by its modular design and innovative navigation concept. This enables fast intuitive understanding and adaptation of the analyzer to a wide variety of applications. Display and functions can be set according to the operator's requirements.

The basic design of the analyzer is mounted in a 19" rack housing and it is connected using FKM (Viton®) tubing. It has a universal power supply, a 7" color touch screen and can be equipped with up to 6 sensors for various applications including the corresponding sensor and I/O electronics. Pressure sensors for process pressure compensation, optional humidity compensation, temperature monitoring and flow indicator are also available. The measured value is available as mA signal, as well as status, alarm and switching outputs. Two limit values per measuring channel can be user-programmed in the analyzer. All measured values are simultaneously available via Modbus and AK communication protocol at the Ethernet connection. A special feature is the integrated data logger function for time-resolved display and long-term recording of measurement, warning and alarm messages. The Multigas Analyzer offers the user convenient calibration functions for zero point and full scale calibration.

4.1 Sensor overview

- **Paramagnetic oxygen sensor**

The M&C oxygen transmitter uses the paramagnetic properties of oxygen.

The dumbbell principle implemented here represents a physical, wear-free and proven measuring method. It is suitable for low-drift, long-term stable measurements in the range from 0 to 100 vol%.

- **ZrO_2 oxygen sensor**

This sensor type uses the diffusion properties of oxygen ions on a high-temperature doped ceramic solid electrolyte. An electrical potential known as the Nernst voltage is established between a Pt working electrode and a reference electrode. This allows a robust in-situ oxygen measurement from 0 to 21 vol%. Mounted in M&C gas sample probes, it can be used for control tasks in combustion processes.

- **Electrochemical oxygen sensor**

This compact, fast-response, long-life sensor measures the oxygen content in a gas mixture, typically up to 25 vol% over an electrochemically generated voltage. It is RoHS- compliant (lead-free), fully CO_2-resistant and non-toxic.

- **Thermal conductivity detector (TCD)**

This type of sensor uses the thermal properties of gases. In the design implemented here, the thermal conductivity of hydrogen in a binary gas mixture is used to determine the H_2 concentration.

- **NDIR/NDUV/UVRAS measuring benches**

With this technique, the concentration of multiatomic gases, i.e. molecules with permanent or induced electrical dipole moment, can be determined. The measuring cuvettes are available in different lengths for different measuring ranges. The measuring benches are characterized by wide dynamic ranges and fast response times. Optionally, a sensor for water vapor correction can be used for NDIR measurements.

5 Receiving the analyzer

The Multigas Analyzer V2.2 is usually delivered in one package. You will find the following items in the box:

- Multigas Analyzer V2.2
- Instruction Manual
- 230 V AC power supply or 24 V DC connector (depending on your order)
- Digital/analog connectors (depending on your order)

Note	Please note, that there are no materials or tools included in the package you might need for assembly or installation.

5.1 Product label and serial number

The product label with the serial number is located on the back of the analyzer.

Please refer to this serial number if you have any questions about your device or if you need to order spare parts.

Thanks for your help!

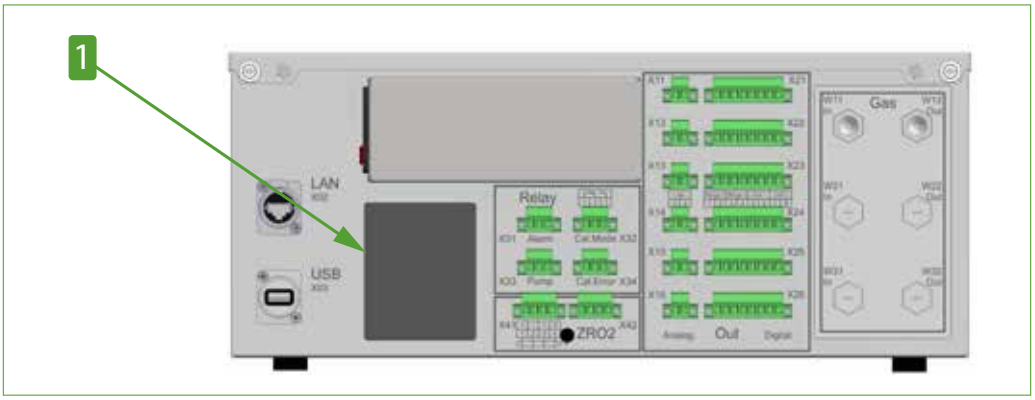

Fig. 1: Product label is on the back of the Multigas Analyzer V2.2

1 *Product label*

6 Measuring principles

Depending on the configuration of the analyzer, there may be more than one measuring principle in use.

Note The configuration of the device is shown on the type plate.

6.1 Paramagnetic oxygen sensor (PMA)

With this sensor the concentration of oxygen (O_2) can be determined. The measuring principle uses the magnetic properties of gases. Oxygen is characterised by a significant paramagnetic behaviour. Most other gases compared to oxygen show a paramagnetic behaviour reduced by several orders of magnitude combined with a diamagnetic behaviour. The molecules of oxygen are thus most strongly influenced by magnetic fields.

The measuring cell consists of two hollow spheres filled with nitrogen, which are formed into a dumbbell. In the center of rotation of the dumbbell is a small mirror as part of the optical scanning system. The dumbbell is surrounded by a wire loop, which is needed to generate a compensation magnetic field. The dumbbell system is fixed rotationally symmetrically in a glass tube with a platinum strap and screwed to two pole pieces. Two permanent magnets generate an inhomogeneous magnetic field in the zero position of the dumbbell. If there is oxygen in the sample gas, it is pulled into the area between the magnetic pole pieces and tries to displace the dumbbell from the zero position. This is counteracted by a current through the loop wire and the resulting compensating magnetic field. The dumbbell thus remains in its zero position, the compensation current applied represents the measurement signal.

This wear-free physical measuring principle is linear, low-drift and long-term stable. It is largely selective to oxygen, and only notable cross-sensitive to nitrogen oxides. All cross-sensitivity correction values can be taken from a table.

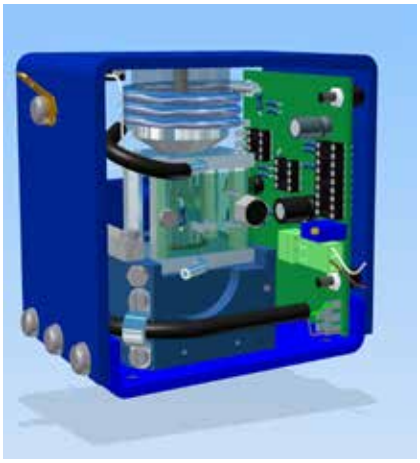

Fig. 2: Heated PMA transmitter with measuring cell

6.1.1 PMA flow chart

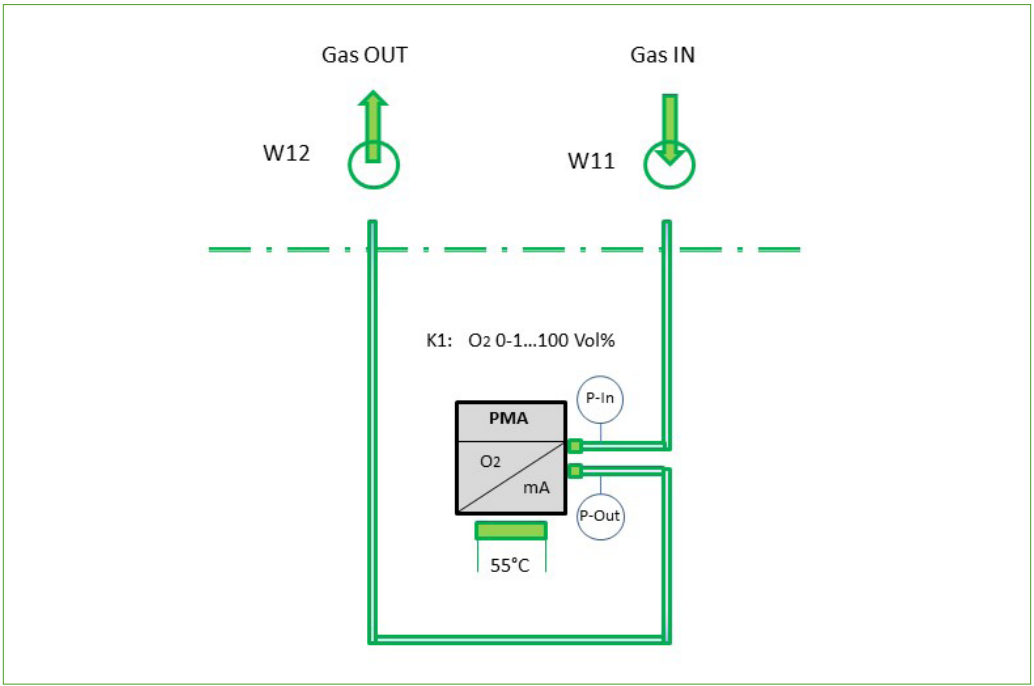

Fig. 3: PMA flow chart: heated transmitter with measuring cell

Two pressure sensors before and behind the PMA cell are installed for determination of the flow being calculated from the differential pressure.

6.1.2 Technical data PMA sensor

PMA sensor	
Gas measured	O_2
Measuring ranges	0-1…100 vol% O_2
Limit of detection (LOD)[1]	0.02 vol%
Response time for 90 % value	<3 s for measuring cell at 60 Nl/h
Noise	0.2 % of full scale value
Linearity	< ±0.1 vol%
Accuracy after calibration[1]	±1 % of full scale value or 0.02 vol% O_2, depending on which value is greater
Zero drift	< 0,06 vol% in 72 hours
Sample gas flow	25-60 Nl/h
Sample gas pressure	0.8 to 1.2 bar absolute
Sample gas temperature	3 to + 50 °C [37.4 to 122 °F] dry, particle-free gas
Ambient temperature	5 to + 35 °C [41 to 95 °F]
O_2-Transmitter temperature	55 °C [131 °F]
Storage temperature	20 to 60 °C [68 to 140 °F], relative humidity 0 - 90 % R.H.
Wetted material	Glass, platinum, FKM (Viton®)*, SS 316Ti, Epoxy resin

** Viton® is a registered trademark of DuPont Performance Elastomere*

[1] Calibration and determination of measurement accuracy under constant ambient conditions in the compensated temperature and pressure range (±0.015 %/mbar)

6.2 Elektrochemical oxygen sensor

This compact, fast-response, long-life sensor measures the oxygen content in a gas mixture, typically up to 25 % by volume over an electrochemically generated voltage. It is RoHS compliant (lead-free), fully CO_2 resistant and non-toxic. This sensor shows a negligible cross-sensitivity < 20 ppm for most gases occurring in combustion processes.

Fig. 4: Elektrochemical oxygen sensor with flow chamber

6.2.1 Flow chart elektrochemical oxygen sensor

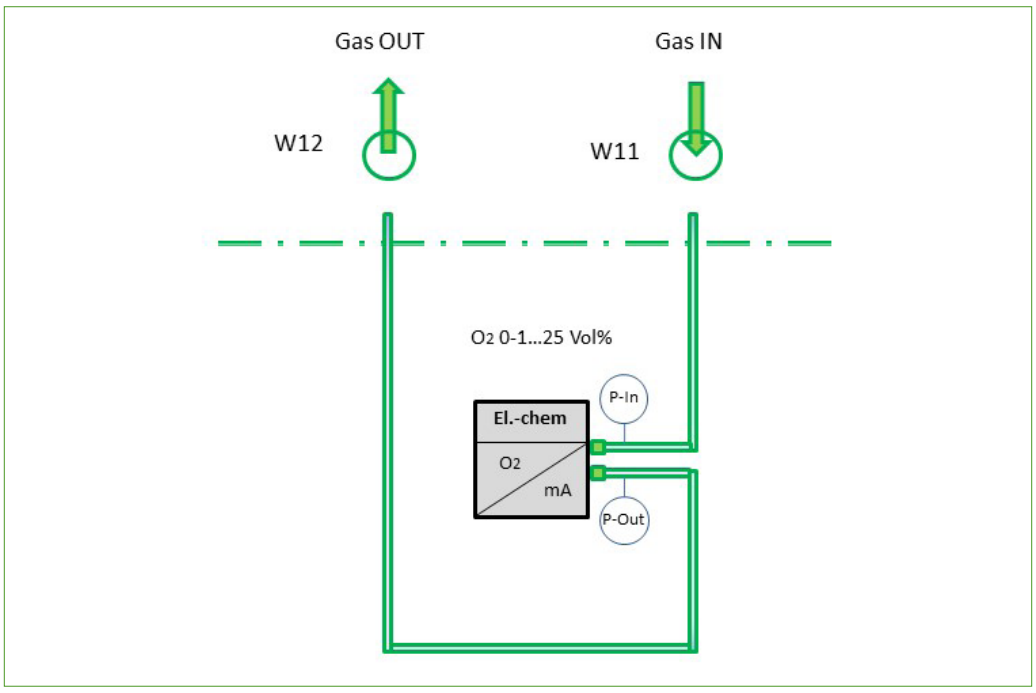

Fig. 5: Flow chart of the electrochemical oxygen sensor

6.2.2 Technical data of the electrochemical oxygen sensor

Elektrochemical oxygen sensor	
Gas measured	O_2
Measuring range	0 - 25 vol%
Limit of detection (LOD)[1]	0.1 vol%
Response time for 90 % value	< 5 s for the measuring cell at 60 Nl/h
Noise	0.2 % of full scale value
Linearity	< ±0.5 vol% of full scale value
Zero drift	< 1 % of full scale value per month
Accuracy after calibration[1]	±1 % of full scale value, not better than 0.1 vol%
Sample gas flow	25 - 60 Nl/h
Sample gas pressure	0.8 to 1.2 bar absolute
Sample gas temperature	3 to 40 °C [37.4 to 104 °F] dry, particle-free gas
Ambient temperature	5 to + 45 °C [41 to 113 °F]
Wetted material	ABS, PVC, PPS, PVDF, PTFE, SS

[1] *Calibration and determination of measurement accuracy under constant ambient conditions in the compensated temperature and pressure range (±0.015 %/mbar)*

6.3 Zirconium dioxide oxygen sensor

This sensor type uses the diffusion properties of oxygen ions on a highly heated doped yttrium-stabilized ZrO_2 solid electrolyte. The voltage generated between a platinum working and reference electrode is known as the Nernst voltage. The logarithmic characteristic curve enables a robust in-situ oxygen measurement from 0 to 21 vol% with downstream linearization. Mounted in a M&C gas sample probe, it can be used for control tasks in combustion processes.

Note

The zirconium dioxide oxygen sensor will be mounted inside a M&C sample gas probe, e.g. SP2000H with O_2 connection port.

Observe the wire identification and the correct connection of the zirconium dioxide oxygen sensor.

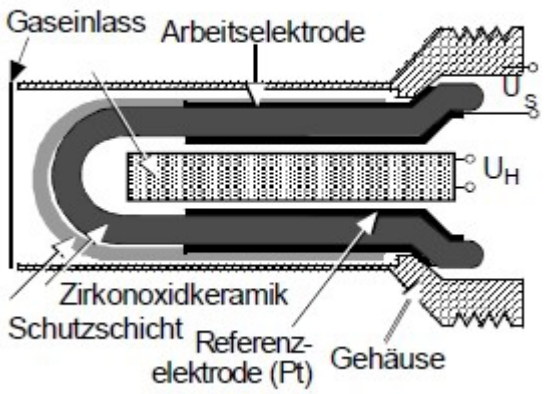

Fig. 6: ZrO_2 oxygen sensor - general design

6.3.1 Technical data ZrO_2 sensor

ZrO_2 sensor	
Gas measured	O_2
Measuring range	0 to 21 vol%
Limit of detection (LOD)	0.1 vol%
Response timefor 90 % value	< 5 s for measuring cell at 60 Nl/h
Noise	0.2 % of full scale value
Linearity	< ±0.5 vol% of full scale value
Zero drift	< 1 % of full scale value per month

ZrO_2 sensor	
Accuracy after calibration[1]	10 % of full scale value , not better than ±0.5 vol%
Sample gas flow	25 to 300 Nl/h
Sample gas pressure	0.8 to 1.2 bar absolute
Sample gas temperature	up to + 320 °C [608 °F] process gas
Ambient temperature	5 to 50 °C [41 to 122 °F]
Wetted parts	SS, platinium, ZrO_2

6.4 Thermal conductivity detector (TCD)

This type of sensor uses the thermal properties of gases. In the structure implemented here, the thermal conductivity of hydrogen in a binary gas mixture is used to determine the H_2 concentration.

Fig. 7: Thermal conductivity detector

6.4.1 Flow chart TCD

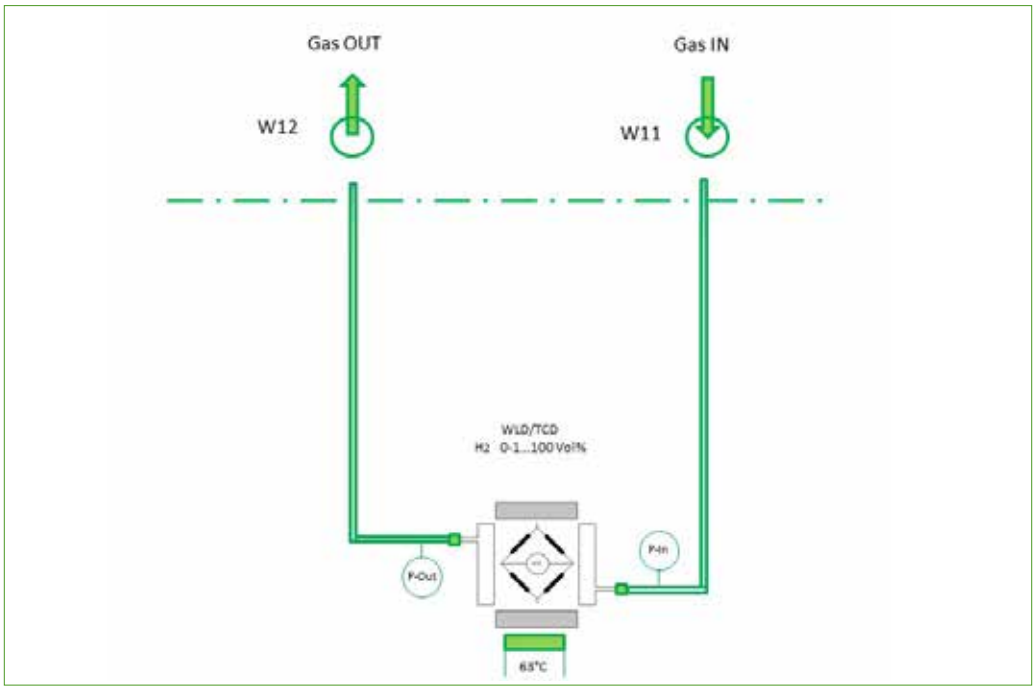

Fig. 8: Flow chart TCD with pressure sensors

6.4.2 Technical data TCD

TCD	
Gas measured	H_2
Measuring range	0.5 - 100 vol%
Limit of detection (LOD)[1]	0.1 vol%
Response time for 90 % value	< 1 s for measuring cell at 60 Nl/h
Noise	< 1 % of full scale value
Linearity	< 1 % of full scale value
Zero drift	< 2 % of full scale value per week
Reproducibility deviation	< 1 % of full scale value
Sample gas flow	25 - 125 Nl/h
Sample gas pressure	0.8 to 1.2 bar absolute
Sample gas temperature	3 to 50 °C [37.4 to 122 °F] dry, particle-free gas
Ambient temperature	5 to 50 °C [41 to 122 °F]
Sensor temperature	63 °C [145.4 °F]
Warm-up period	30 to 60 min
Wetted materials	SS 316Ti, silicon oxinitrite (ceramic), gold, covar (iron-nickel alloy), epoxy

[1] Calibration and determination of measurement accuracy under constant ambient conditions in the compensated temperature and pressure range (±0.015 %/mbar)

6.5 NDIR/NDUV/UVRAS measuring benches (ULTRA.sens®, INFRA.sens®)*

The measuring principle of the NDIR/NDUV/UVRAS measuring benches (ULTRA.sens®, INFRA.sens®)* is based on the absorption of ultraviolet or infrared radiation in wavelength ranges specific for different gases. A broadband UV or infrared light source generates a radiant power I0.

The light passes through a cuvette of known length through which sample gas flows. If the sample gas contains UV/IR-absorbing gas molecules, the beam power I0 is reduced to the reduced value I1 at a detector located behind the cuvette.

Using Lambert-Beer's law, a gas concentration is calculated from the ratio of I0 to I1 taking into account the optical path length and other parameters of the gas concentration.

In order to be able to make a statement for a specific molecule contained in the sample gas, a narrow-band filter element is arranged in the optical path, which only passes the spectral light component that corresponds to the absorption band of the type of gas of interest.

With this technique the concentration of multi-atomic gases, i.e. molecules with permanent or induced electrical dipole moment, can be determined. It is not suitable for elementary gases such as O_2, H_2, N_2, Ar, Ne etc.

The measuring modules are available in different lengths for different measuring ranges, they are characterized by a large dynamic range and a fast response time. Pressure measurement for process pressure compensation and a sensor for water vapor correction for NDIR measurements are available as options. In the field of application of NDUV measurements, there are advantageously no cross-sensitivities to water vapor.

** ULTRA.sens® and INFRA.sens® are trademarks of Wi.Tec - Sensorik GmbH*

Fig. 9: NDUV module

Fig. 10: NDIR module

6.5.1 Flow chart NDIR photometer

The following picture shows a 3 channel NDIR photometer.

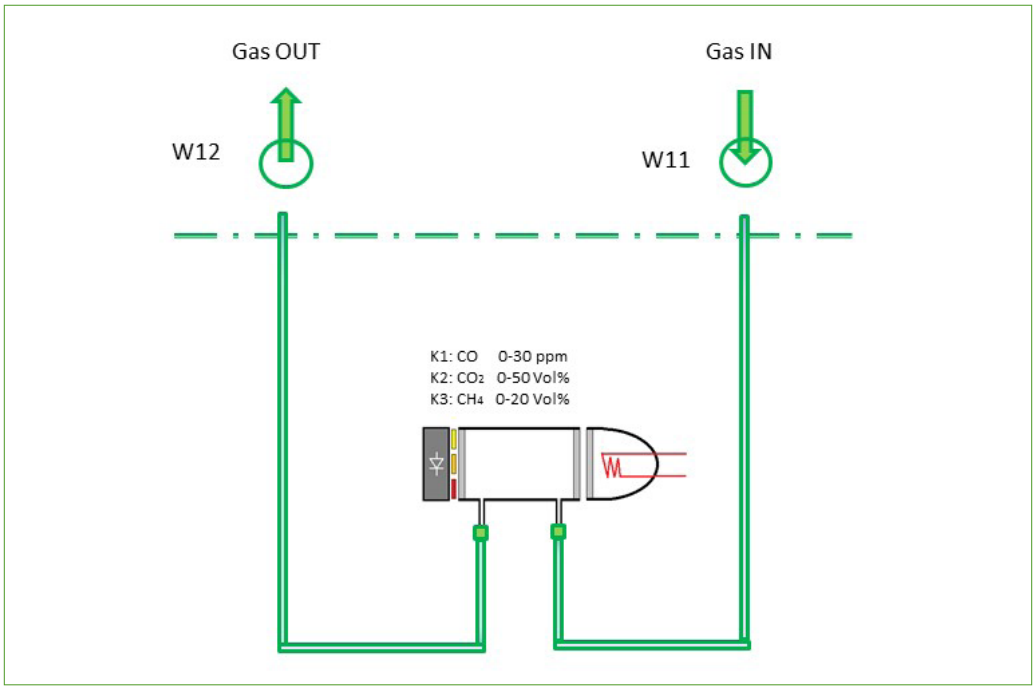

Fig. 11: Flow chart of 3 channel NDIR photo meter

6.5.2 Technical data NDIR/NDUV/UVRAS measuring benches

NDIR/NDUV/UVRAS measuring benches (ULTRA.sens®, INFRA.sens®)			
Gases and measuring ranges		**Min. measuring range**	**Max. measuring range**
NDIR	CO_2	0 - 50 ppm	0 - 100 Vol.-%
	CO	0 - 500 ppm	0 - 100 Vol.-%
	C_nH_m	0 - 1000 ppm	0 - 100 Vol.-%
	NO	0 - 1000 ppm	0 - 5000 ppm
	CH_4	0 - 5000 ppm	0 - 100 Vol.-%
	N_2O	0 - 100 ppm	0 - 100 vol%
	SF_6	0 - 30 Vol.-%	0 - 100 Vol.-%
NDUV	SO_2	0 - 100 ppm	0 - 100 Vol.%
	NO_2	0 - 100 ppm	0 - 10 Vol.-%
	C_6H_6	0 - 1000 ppm	0 - 10 Vol.-%
	Cl_2	0 - 1000 ppm	0 - 1 Vol.-%
	O_3	0 - 50 ppm	0 - 1 Vol.-%
UVRAS	NO	0 - 300 ppm	0 – 5000 ppm
	H_2S	0 - 100 ppm	0 - 5000 ppm

Other gases on request

** NDIR: non-dispersive infrared photometer, NDUV: non-dispersive ultraviolet photometer, UVRAS: ultraviolet resonance absorption spectrometer.*

ULTRA.sens® and INFRA.sens® are trademarks of Wi.Tec - Sensorik GmbH

Technical specifications	NDIR	NDUV	UVRAS
Response time for 90% value	1.5 to 15 s		
Limit of detection (LOD)	< 1 % of full scale value (F.S.) (3 σ)	1 ppm (3 σ)	< 1 ppm (3 σ)
Linearity error	< ±1 % of F.S.		
Repeatability	±0.5 % of F.S.		
Longterm stability (zero drift)*	< ±2 % of F.S. per week	< ±1 % of F.S. per 24 hours	< ±2 % of F.S. per 24 hours
Longterm stability (span drift)	< ±2 % of F.S. per month	< ±1 % of F.S. per month	
Temperature influence zero**	< 1 % of F.S. per 10 Kelvin		
Temperature influence span**	< 2 % of F.S. per 10 Kelvin		
Pressure influence (with pressure compensation)	0.15 % per 10 hPa of reading		

Technical specifications	NDIR	NDUV	UVRAS
Operating temperature	15 to + 45 °C [59 to 113 °F]	15 to + 45 °C [59 to 113 °F]***	15 to + 45 °C [59 to 113 °F]
Wetted materials	Depends on the selected version: FKM (Viton®), SS316Ti, aluminium with or without protective coating, PVDF, PPS		

** The long-term zero drift can be reduced by using an AutoZero module.*

*** The temperature dependence can be reduced by using a heated box (THB 50 °C [122 °F])*

**** With THB max. 40 °C [104 °F]*

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Options
Pressure sensor for process pressure compensation
H_2O measurement with a measuring range from 0 to 1 vol%, water vapor correction

7 Technical data basic instrument

Multigas Analyzers	Multigas V2.2
Basic instrument w/o sensors: short enclosure Part-No:	**08A2210**
Basic instrument w/o sensors: long enclosure Part-No:	**08A2200**
Warm-up period	Approx. 30 min. depending on sensor configuration
Response time for 90 % value	< 5 s depends on sensor and configuration
Flow rate of sample gas	25 to 120 Nl/h
Sample gas inlet pressure	800 to 1200 mbar abs. pressure-compensated
Sample gas outlet pressure	Recommendation: discharge freely into atmosphere (requires higher pressure at the analyzer inlet compared to the outlet)
Sample gas temperature and characteristics	0 to 50 °C [32 to 122 °F]; dry, oil- and dust-free gas, avoid temperature dropping below dew point
Ambient temperature	0 to 50 °C [32 to 122 °F] depending on sensor configuration, avoid temperature dropping below dew point
Display	7" resistive color touchscreen
Measuring ranges in general	4 measuring ranges, two of them adjustable, suppressed zero possible
Output signals	Adjustable: 0-20 mA /4-20 mA, max. 500 Ohms burden, Modbus, AK-protocol TCP/IP
Relay outputs	2 x relay output (1 x status, 1 x Cal-mode) contacts: 24 V DC/ 3 A, change-over contact, potential-free
Digital outputs (DO)	4 x per measuring signal DO 24 V DC, max. 3 A (2 x limit values, 2 x measuring range feedback)
Interfaces	Ethernet / USB
Communication protocol	Modbus TCP/IP and AK protocol TCP/IP
Storage temperature	-20 to +60 °C [-4 to +140 °F], avoid temperature dropping below dew point
Power supply	115 to 230 V AC, 50 to 60 Hz power supply or 24 V DC connector plug
Power consumption	Max. 150 VA
Wetted materials	Platinum, Epoxy resin, glass, FKM (Viton®)*, stainless steel 316Ti, PVDF, PPS, depending on the type of sensor used
Sample gas connection	Screw-on bulkhead fitting with 1/4" internal thread, PVDF (standard)
Case protection	IP40, EN 60529
Electrical standard	EN 61010
Housing / front color	19 inch rack mounting (4RU) / white RAL 9003
Maximum installation altitude	1500 m [≈ 4921.3 ft]
Dimensions long enclosure (W x H x D)	Long enclosure with 230 V power supply (dimensions include front handles and power supply): 482 x 185 x 436 mm [19" x 7.3" x 17.1"] + approx. 60 mm [approx. 2.36"] connection depth

Multigas Analyzers	Multigas V2.2
Basic instrument w/o sensors: short enclosure Part-No:	**08A2210**
Basic instrument w/o sensors: long enclosure Part-No:	**08A2200**
Dimensions short enclosure (W x H x D)	Short enclosure with power supply (dimensions include front handles and power supply): 482 x 185 x 297 mm [19" x 7.3" x 11.7"] + approx. 60 mm [approx. 2.36"] connection depth
Weight long enclosure	Approx. 13 kg [approx. 29 lb] (depending on sensor configuration)
Weight short enclosure	Approx. 11 kg [approx. 24 lb] (depending on sensor configuration)

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7.1 Dimensions

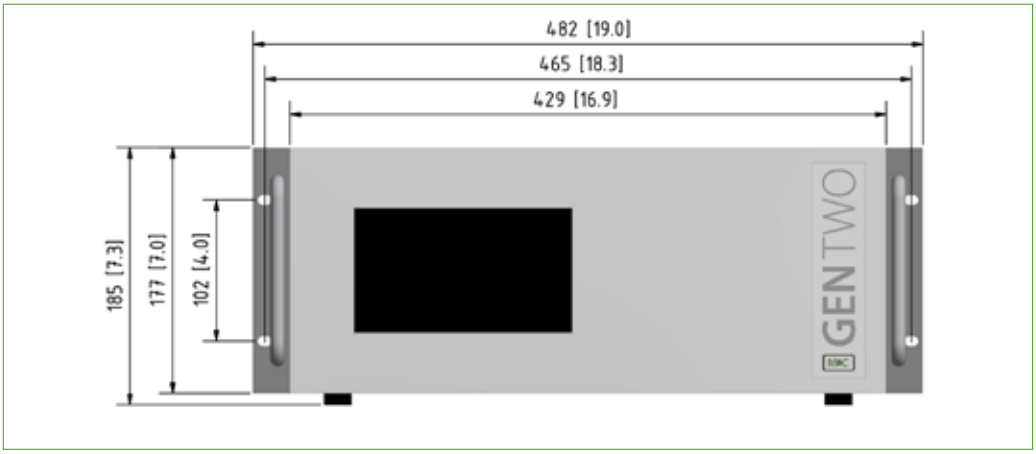


Fig. 12: Enclosure front view

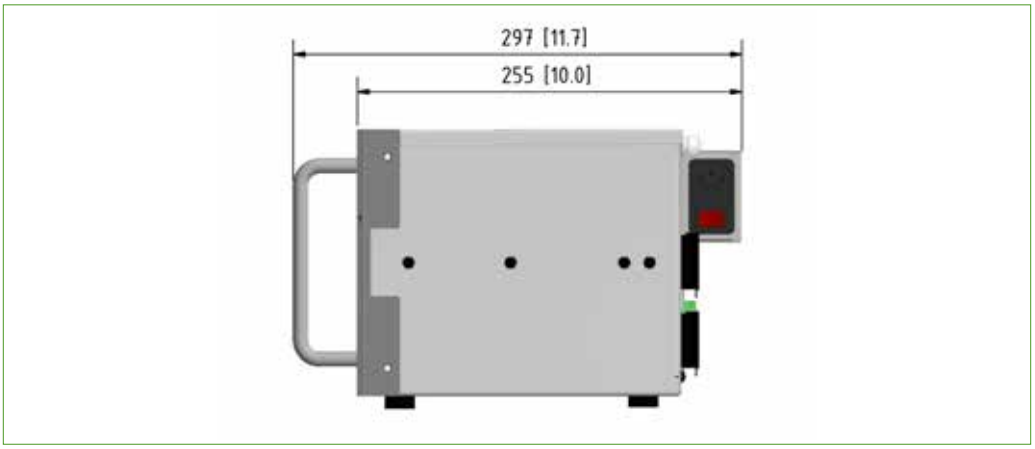


Fig. 13: Short enclosure side view with power supply unit

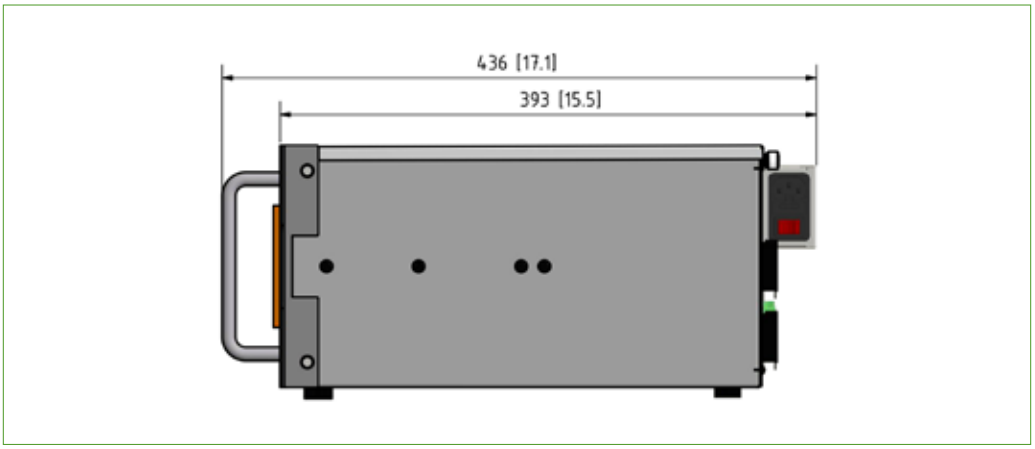


Fig. 14: Long enclosure side view with power supply unit

7.2 Connections

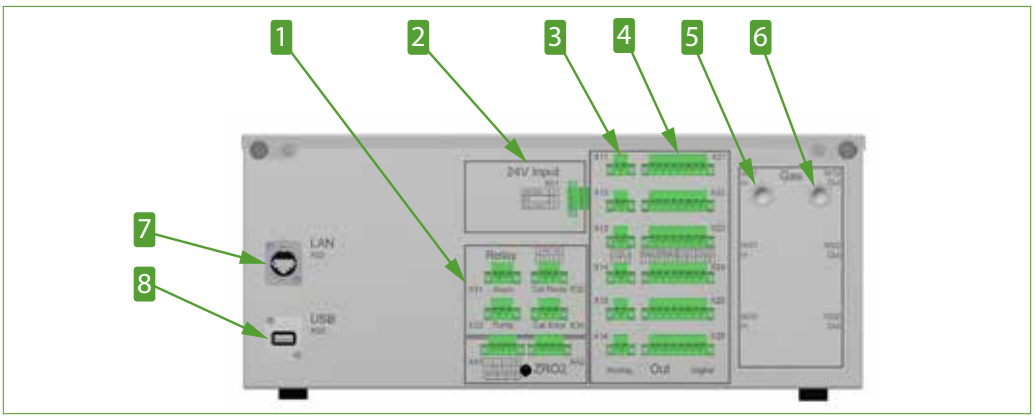


Fig. 15: Rear view 24 V DC device (fully equipped)

1 *Relay outputs with 3-pin connectors (X33 and X34 option AutoCal only)*

2 *Connector for 24 V DC power supply*

3 *mA-output (measurement value) with 2-pin connectors per channel*

4 *Digital outputs with 8-pin connectors per channel (4 x valve control option AutoCal only)*

5 *Sample gas input "1"*

6 *Sample gas output "1"*

7 *Ethernet connector*

8 *USB connector*

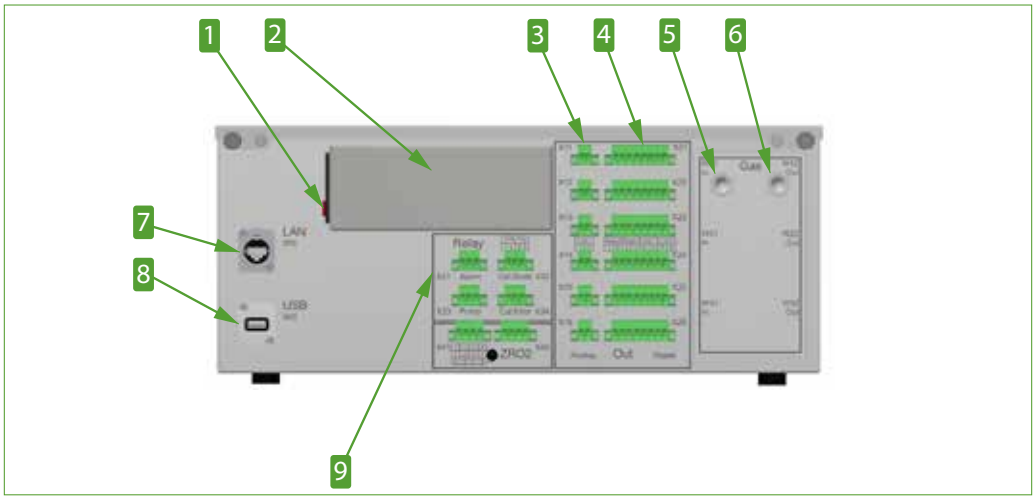


Fig. 16: Rear view with power supply unit (fully equipped)

1 *Power switch*
2 *Power supply unit 115 to 230 V AC*
3 *mA-output (measurement value) with 2-pin connectors per channel*
4 *Digital outputs (DO) with 8-pin connectors per channel (4 x valve control option AutoCal only)*
5 *Sample gas input "1"*
6 *Sample gas output "1"*
7 *Ethernet connector*
8 *USB connector*
9 *Relay outputs with 3-pin connectors (X33 and X34 option AutoCal only)*

7.3 Gas connections and pin assignment diagram

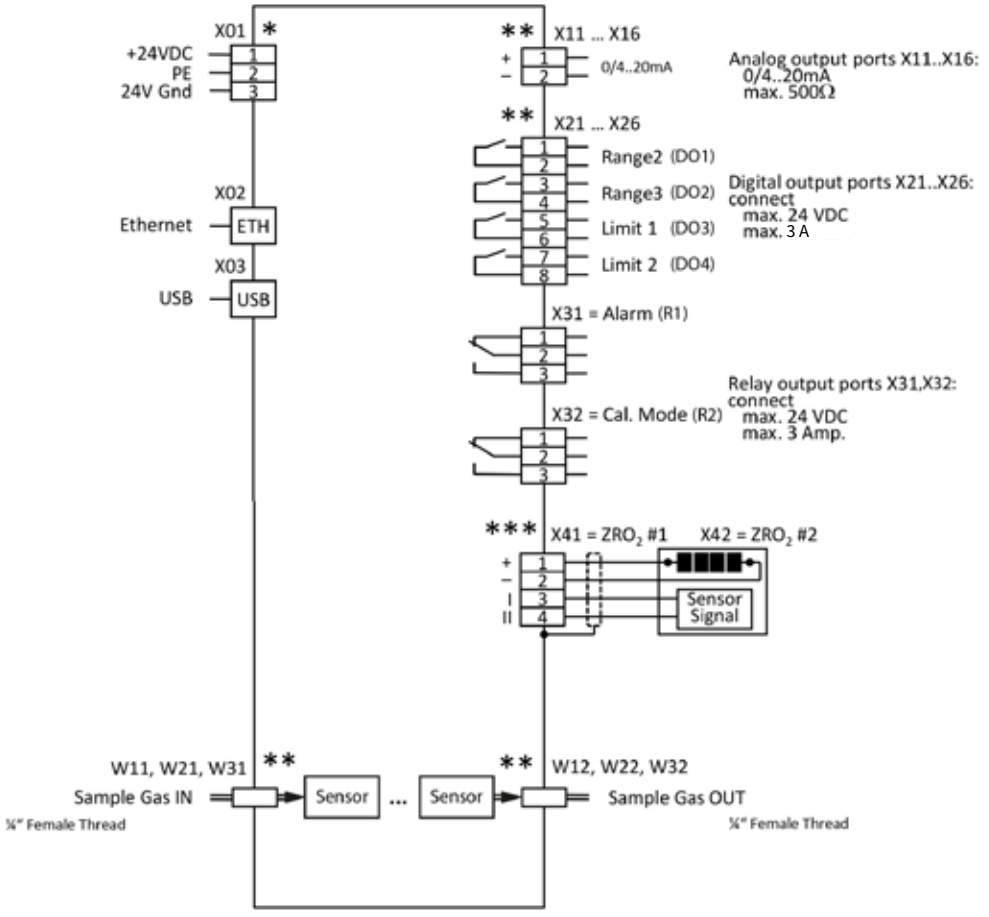


Fig. 17: Gas connections and pin assignment diagram

7.4 Gas connections and pin assignment diagram with AutoCAL

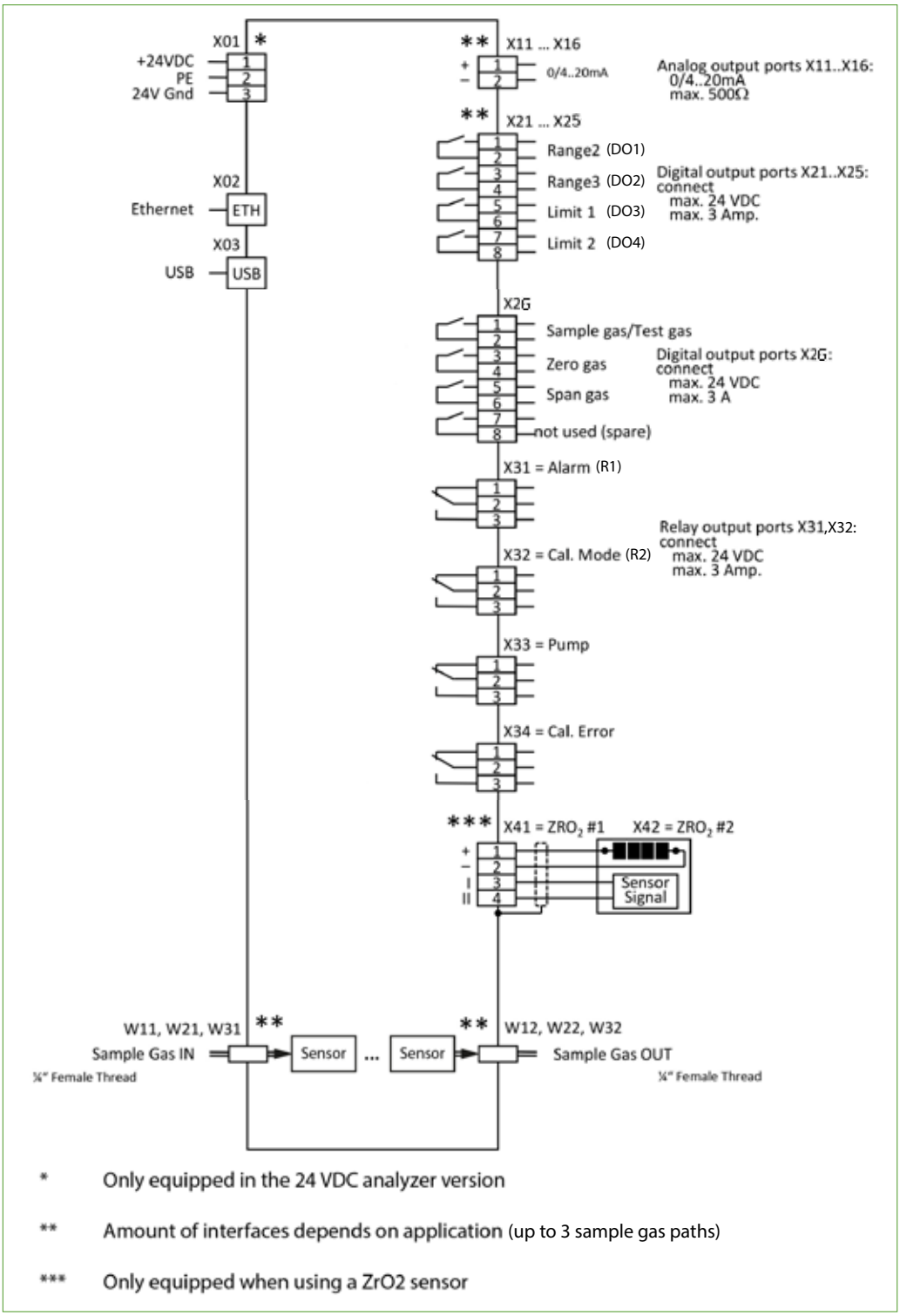
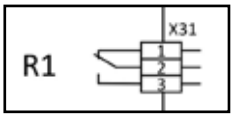
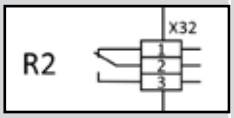
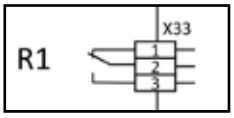
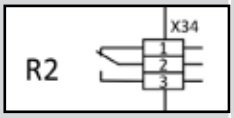


Fig. 18: Gas connections and pin assignment diagram with AutoCal

7.5 System functions

7.5.1 Relais states and functions

The following table shows the states and functions of relays R1 and R2.

Relay	Displayed state	Description
	De-energized	X31 = Alarm The alarm output represents a so-called collective alarm to which various individual alarms are connected in series. In measuring mode, when all single alarms are in the good state, the relay is energized. Multigas analyzer V2.2 single alarms: • Sensor temperature out of specification 55 °C ±3K or in warm up • P-IN (inlet pressure) outside 800-1200 mbar or pressure difference ΔP too small. • Flow rate outside 25-120 l/h, this single alarm can be deactivated (with parameter). • Power failure (Power OFF/Fail)
	De-energized	X32 = Cal. Mode This status shows whether the device is being calibrated or not. During calibration, the relay is energized.
	De-energized	X33 = Pump, relay for option AutoCal only This contact controls an externally connected load up to 24 V DC, 3 A. In measuring mode with the load switched on, the relay is de-energized.
	De-energized	X34 = Cal. Error, relay for option AutoCal only This status indicates whether an error occurred during the last AutoCal calibration The relay is energized if an error occurred.

7.5.2 Accuracy of mA readings

The analyzer displays the mA value with three decimal places (see section M2/S2). Internally, the mA value is calculated exactly to 4 decimal places from the concentration value and sent to the IO card.

Note

Notice the maximum permissible burden of 500 Ohm.

If the burden is too high, the output will result in too low mA values, especially with high current signals.

8 Using the analyzer

8.1 Graphical user interface (GUI)

The Multigas Analyzer V2.2 is equipped with a 7" touch screen and an intuitive graphical user interface (GUI). The GUI is designed to easily navigate through the menus and sections. The concept behind the interface is as intuitive as operating a smart phone.

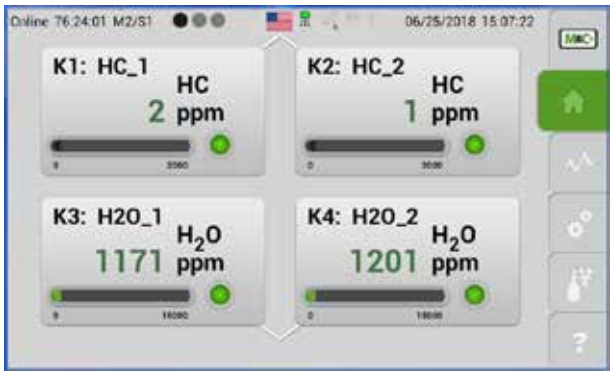


Fig. 19: Startup screen of the 6-Channel configuration

Fig. 20: Second part of the startup screen with channel 3 to 6

The analyzer has a touch-sensitive display. Unlike the capacitive touch screen panel of a smart phone, this is a resistive touch screen. It responds to pressure on its surface. The display is made out of several transparent layers. The most important layers are two electrically-resistive layers, which are separated by a thin space. Both layers have conductive connections facing each other. By pressing down on the touch screen, the two layers touch each other to become connected at this point. The resistance of the layers changes and the precise location of the touch is registered by the touch-sensitive display. The display can also be used with any kind of stylus-like objects or gloved fingers.

The GUI collects all the information from the sensor modules, processes the individual input signals and initiates the necessary actions. The I/O module gets a signal from the GUI to switch an output "on" or "off" or change the mA output. The GUI is the heart of the Multigas Analyzer V2.2. All settings and configurations can be controlled by the GUI and displayed and edited right on the touch screen. You will find a detailed description of the menu structure on page 35 chapter 'Menu structure' .

8.2 How to use the touch screen

The operating concept was designed to be intuitive as far as possible and is based on the gestures “wipe” and “ tap”. To meet the conceptual demand for transparency, In order to achieve a high degree of logic and recognition, almost all settings and displays can be accessed on a single two-dimensional level. A deeply nested menu hierarchy was deliberately omitted.

The first dimension represents the “menu” (in the following also abbreviated as “M”). Six menu items M1...M6 can be called directly at any time and from any display. The second dimension is represented by the so-called “sections” (in the following also abbreviated as “S”). For each menu there are up to 4 sections, which can be displayed according to the selected menu item to provide different information and functions.

Please tap on a button from the menu bar on the right side of the screen to select the menu item and wipe horizontally on the display to navigate through the corresponding sectionss (S1...S4).

Note	The horizontal wipe function can only be executed on areas without a vertical scroll function, e.g. lists, selection wheels. As an alternative to the “wipe to the left” function, you can tap on the active menu button (green). Simultaneous operation with several fingers, e.g. for zooming, is not supported.

Gesture	What it means
	Swipe your finger to the left. You will reach the next section of the menu item.
	Swipe your finger to the right. You will go back to the previous section of the menu item.
	Swipe your finger down to scroll down a list.
	Swipe your finger up to scroll up a list.
	Tap your finger on an active area to select a menu item or open another section.

Note	Instead of swiping to the right to reach the previous section, you can also get back by tapping on the highlighted (green) menu button.

8.3 Menu structure

In the following, the menu structure is explained. The images may vary slightly depending on the operating status. This description does not replace familiarizing yourself with navigating through the menus directly on the device.

Up to four sections are available for a menu item. In the system information, the available sections are represented by grey and black dots. A black dot indicates the section currently displayed on the screen.

Note	Please note, that depending on the operation mode, the actual display on your device can differ from the screen shots in this instruction manual. We recommend you get familiar with navigating through the menus and sections directly at the Multigas Analyzer V2.2.

In this chapter we introduce you to the menus and sections of the GUI. For better navigation, we labeled the section numbers as following:

"Menu 1 – Section 1" = M1/S1

Any settings and functions will be described separately.

Fig. 21: Menu structure overview M2/S2

1 *System status line*
2 *Sensor temperature*
3 *Pressure during operation*
4 *Gas flow*
5 *Display of deviation from factory calibration*
6 *Measuring range*
7 *Operating limit 1*
8 *Operating limit 2*
9 *Menu bar M1 to M6 (home button activated)*
10 *Channel scroll bar*

8.3.1 System status line

The system status line is the first line displayed at the top of the touch screen. Starting on the left side, it shows the online time of the unit. The online time displays how long the Multigas Analyzer V2.2 is online since the last time the device was switched on. Next to the online time is the little bar with dots to show the number of sections available for this menu item. A black dot indicates the current section and the gray dots the available sections.

The language/country recognition is represented by the flag symbol. By touching the flag symbol, another available language can be selected. The following four symbols indicate from left to right:

- Internal data bus indicator (green blinking light:1 Hz- pulse; red light: error)
- LAN interface
- Wi-Fi (not supported by the current GUI version)
- USB interface

On the right side of the system status line, the date and the actual time in your time zone is displayed.

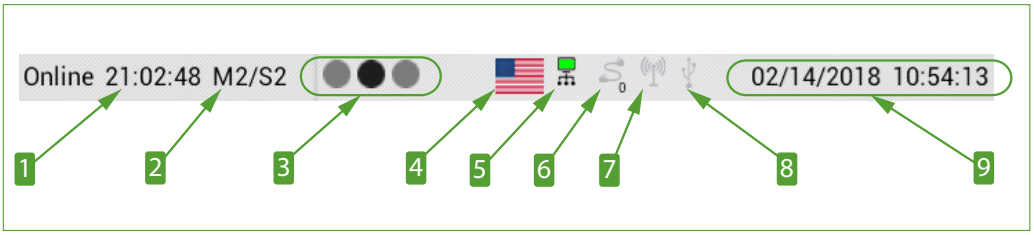


Fig. 22: System status line

1 *Online time*
2 *Menu item number/section number*
3 *Section indicator: current section shown in black*
4 *Language selection*
5 *Internal data bus indicator (screen symbol)*
6 *LAN interface*
7 *Wi-Fi (not supported by current GUI version)*
8 *USB*
9 *Current date and time*

8.3.2 Main menu bar

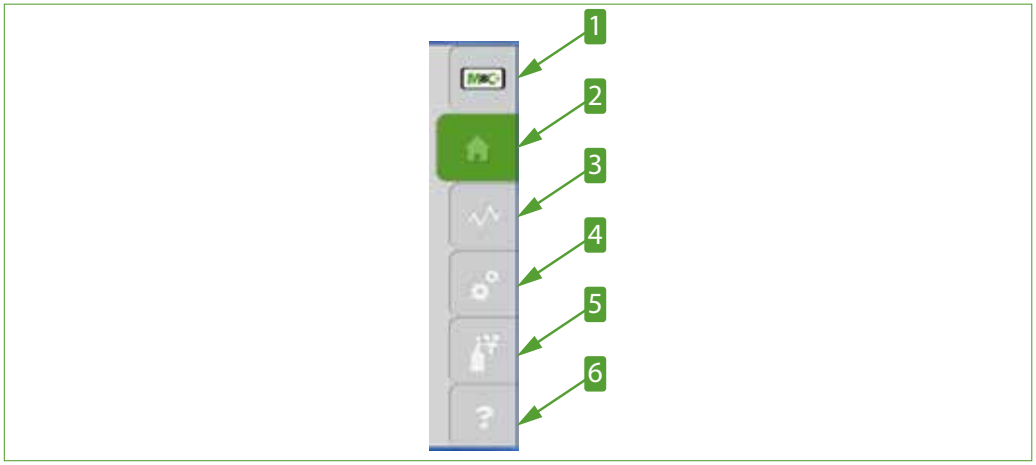


Fig. 23: Menu bar with the menu items M1 to M6

1 *M&C info button M1*
2 *Home button M2, active*
3 *Data logger button M3*
4 *Settings button M4*
5 *Calibration button M5*
6 *Help button M6*

8.3.3 Main display area

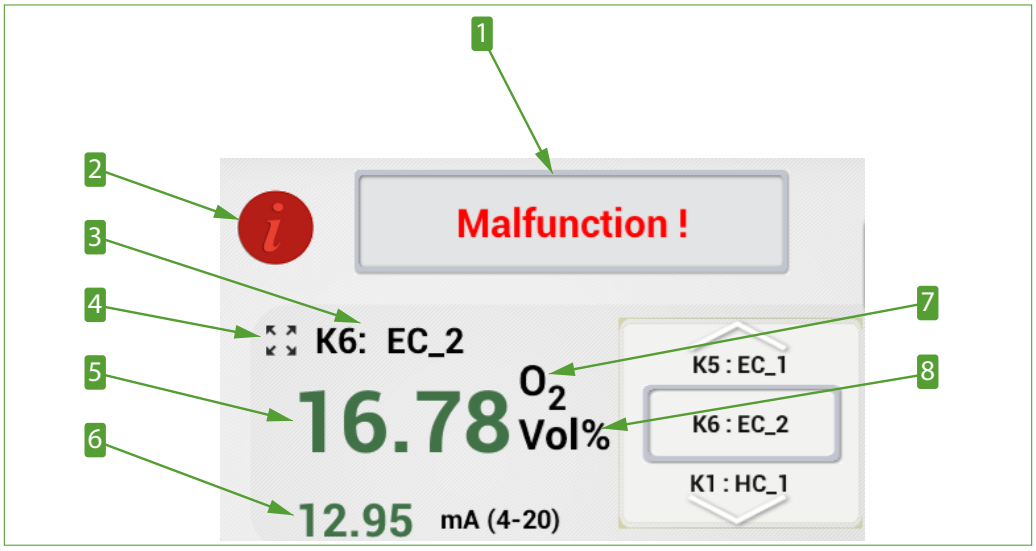


Fig. 24: Main display area M2/S2

1 *Message box*
2 *Info button (changes color depending on status)*
3 *Channel name: channel ID*
4 *Zoom button*
5 *Measured value*
6 *mA display (measuring range)*
7 *Molecule (sensor type)*
8 *Unit of the measured value*

8.3.4 Language selection

The language can be selected from any section displayed on the screen. With a tap on the flag symbol the language window opens. Another tap on the selected flag symbol closes the window and changes the language of the GUI.

Some of the languages are not supported by the current software version.

Note	Please note, if the selected language is not available, the flag in the system status line does not change and the language window stays on the screen.

Fig. 25: Available languages/flags

8.3.5 M1/S1 and M1/S2 - M&C contact and GUI version number

You will reach menu 1 (M1) by tapping on the button with the M&C logo on the right hand side. If you tap on the M&C logo, the first section opens.

Fig. 26: M1/S1 - M&C contact information

To navigate through the sections, please swipe horizontally. Swipe to the left side to reach the next sections. By swiping to the right side you will go back to the previous sections.

Fig. 27: Swipe to navigate through the sections

The second section of M1 shows information about the current software version, type and components of the analyzer. To get more information about the analyzer configuration, please tap on the green information button.

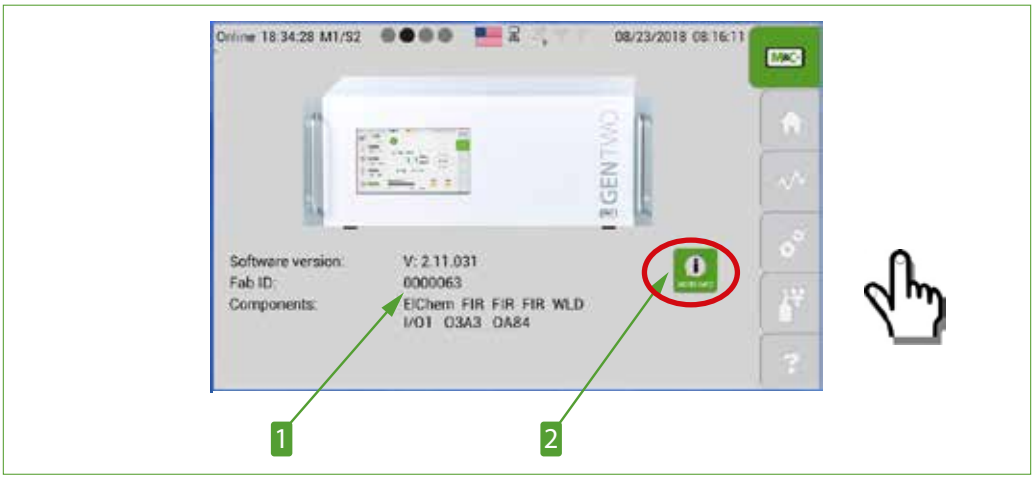


Fig. 28: M1/S2 - Analyzer configuration

1 *Software version, fabrication ID and components*

2 *Button for more detailed information*

After tapping on the green button, a scection with more detailed information about the current software version of the GUI opens.

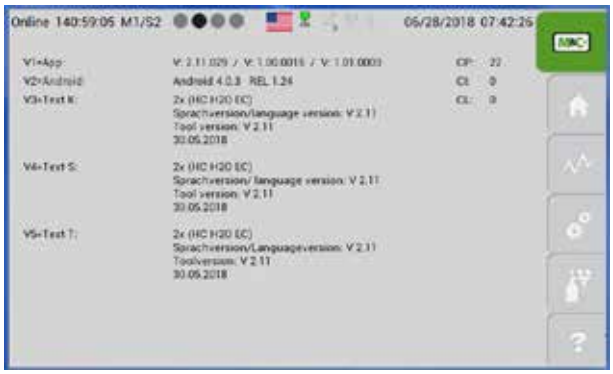


Fig. 29: Detailed information about the GUI software version

To get back to the M1/S1 section, please swipe horizontally to the right side or tap on the M&C button M1.

Fig. 30: Navigate back to the M1/S1 section

8.3.6 M1/S3 - Pneumatic connections

This section shows the schematic of the gas connections and the gas lines inside the Multigas Analyzer V2.2.

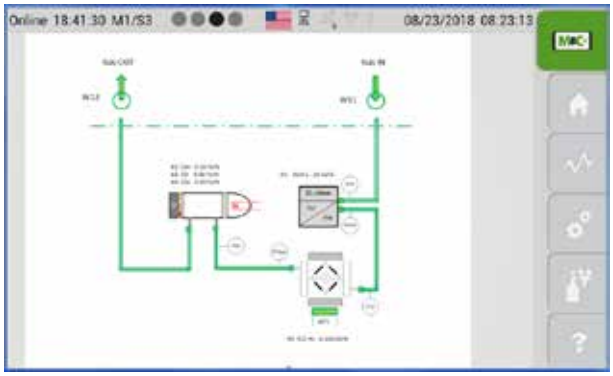


Fig. 31: M1/S3 - Pneumatic connections of a 5 channel analyzer

8.3.7 M1/S4 - Operating hours counter

The operating hours counter shows the days and hours that the entire device and the individual channels are in operation. Under" Service" the operating times are listed, according to which the components of the used channels should be serviced.

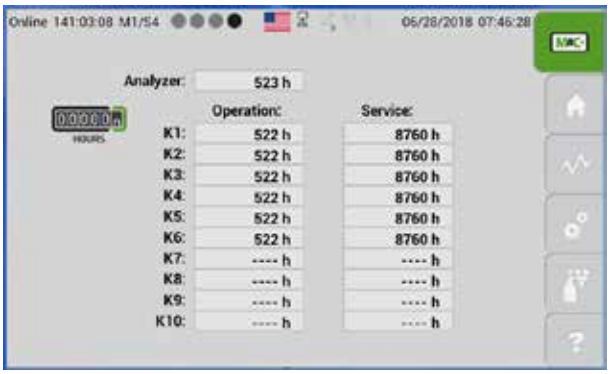


Fig. 32: M1/S4 - Operating hours counter (OHC)

Note The operating hours counter of the analyzer cannot be reset by the user.

8.3.8 M2/S1, M2/S2 - Measured values, operating parameters and limits

You can reach the start screen by tapping on the Home button M2 in the menu bar. This section contains the following information:

- currently used channel with channel name
- measured value
- unit of measured value
- type of gas being measured
- bar graph with measuring range and indicator light

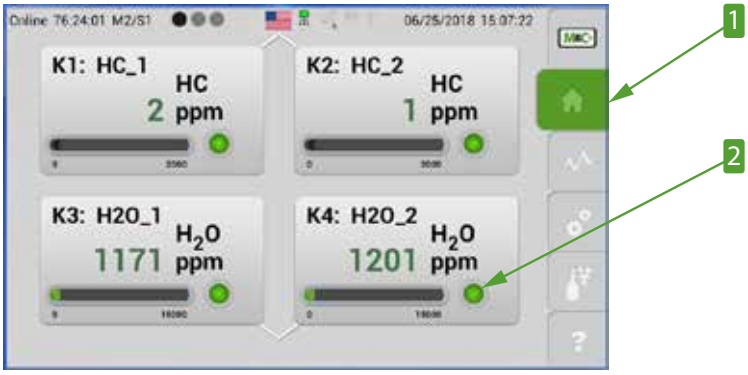


Fig. 33: M2/S1 - Start screen of the home button

1 *Home button M2*

2 *Indicator light (status: green, yellow or red)*

The second section M2/S2 shows a more detailed view of the measuring parameters. The info button on this screen is green, that indicates that the instrument is in standard operation mode.

Fig. 34: M2/S2 - Detailed view of the measuring parameters

To get back to the start screen M2/S1, please swipe to the right or tap on the home button.

Fig. 35: Navigate back to the start screen

The warm-up period of the Multigas Analyzer V2.2 can take approx. six minutes, starting from 25 °C [77 °F]. For PMA, WLD and ZRO_2 sensors, a 60 s timer is started in the warm-up phase. If the fixed target temperature is not reached in 60 seconds, the timer is reloaded up to 14 times. If the target temperature still deviates by more than 3 Kelvin, a temperature error will be displayed.

During the warm-up period the info button on the M2/S2 screen turns yellow, to show that the device is not ready for operation yet.

The mA output is not active during the warm-up phase. The default value of the mA output is set to zero and the mA-display no longer appears on the screen. The word "warmup" appears in its place.

During "warmup", RS1 "Status" is set to "Malfunction" and RS2 "Calibration Mode" is set to "Calibrate". In the diagnosis screen M3/S3 "B=Diagnosis" there are no mA values available during the warm-up phase.

Fig. 36: M2/S2 - Detailed view during warm-up period

The zoom button on the M2/S2 section lets you zoom-in into the main display area. Please tap on the zoom button next to the channel information.

In the zoomed view the measurement value display is highlighted and the data is displayed larger with less information.

Fig. 37: M2/S2 - Using the zoom button

To get back from the zoomed view to the standard view, please tap anywhere on the highlighted area.

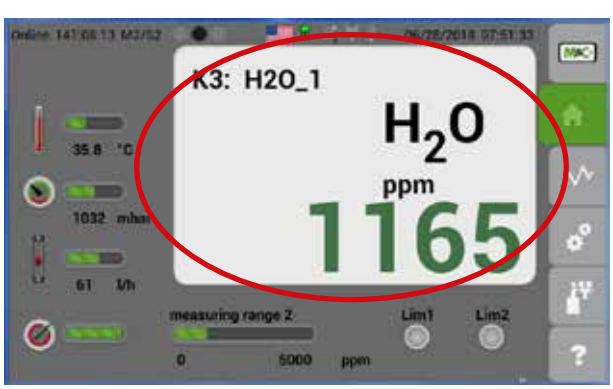


Fig. 38: Zoomed and highlighted area

8.3.9 M2/S3 - Event list

This screen shows an overview of all events in chronological order. A complete event list can be selected for each channel present in your device.

The notifications on the event list are color-coded:

- Green: OK
- Yellow: Warning/ the value reached or exceeded the operating parameter limit
- Red: Error or malfunction
- White: Zero (offset) and Span (Gradient)

Fig. 39: M2/S3 - Event list

You can reach this screen by swiping through the sections of menu item M2 or by tapping on the info button.

8.3.10 M3/S1 - Data logger/history archive

The data logger screen opens, when you tap on M3 the third menu item of the menu bar. This screen shows the recorded data in a diagram.

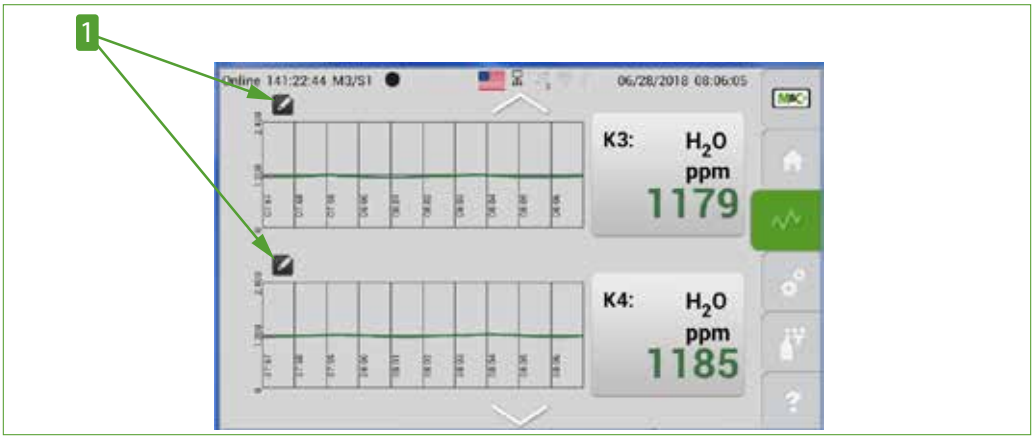


Fig. 40: M3/S1 data logger screen

1 *Edit button*

Please tap on the edit button. The calender display opens. It displays month, day and hour in separate scroll bars. To select a prior measurement, please scroll to the date and time of the measurement you are looking for. Confirm your entry with the "Data updated" button. The selected data will then be loaded and displayed in the diagram on section M3/S1.

Note	If the month, day or hour of your selected measurement is already displayed, please tap on the corresponding scroll bar to reconfirm this selection.

The history archive can store data up to 365 days. The data structure of the data logger is a circular buffer.

Fig. 41: M3/S1 - Recorded data selection screen

1 *Area for displaying the calibration symbols*
2 *"Data updated" button*
3 *"*.csv export" button*

With the 'Export *.csv' button recorded data can be stored in the analyzer for a period of one hour with the selected start time. This data can also be stored on a USB stick in CSV format. The CSV format can be opened in spreadsheet programs such as MS Excel.

To export data, please select the month, day and hour of the desired data recording. Each file can only store one hour of the recorded data, therefore the desired hour must be selected for the data export.

Tap on the *.csv export button to export the selected data and save the data to a CSV file.

Note

If you don't select the hour of the recorded data, the measurements of the whole month or day will be displayed in the diagram.

This amount of data is too large to save in one file. To prevent a larger file size the "*.csv export" button will not be displayed if the data is recorded for more than an hour.

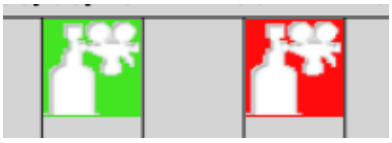


Fig. 42: Calibration symbols to highlight calibration procedures

These symbols indicate successful and failed calibration procedures.

The calibration symbols are displayed in the upper half of the diagram in section M3/S1. The red symbol shows a failed calibration process and the green symbol indicates a successful calibration.

8.3.11 M4/S1 - Measuring range selection, sensor evaluation, Lim settings

Tap on the M4 setting button to select predefined measuring ranges, display the list of sensor evaluation and set limit values. The start screen opens. There is an edit button next to the values for each possible setting and display.

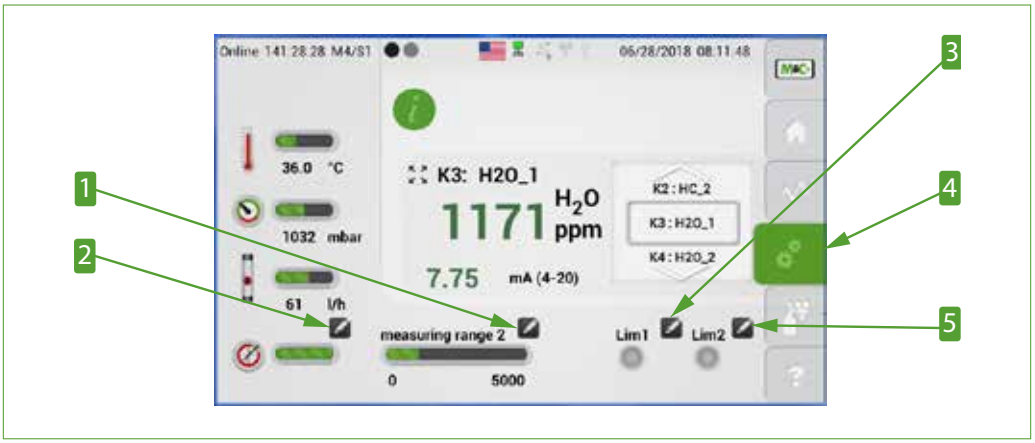


Fig. 43: M4/S1 Edit buttons for measuring range and operating parameter settings

1 *Edit button for measuring range selection*
2 *Edit button for sensor evaluation list*
3 *Edit button for alarm limit Lim1*
4 *Settings button M4*
5 *Edit button for alarm limit Lim2*

Measuring range selection

When you tap on the edit button close to the measuring range the highlighted scroll bar opens. The active edit button changes to a green check mark. Please scroll through the predefined measuring ranges by swiping vertically.

The selected measuring range needs to be displayed in the gray frame in the middle of the scroll bar. Please tap on the green check mark to confirm your selection.

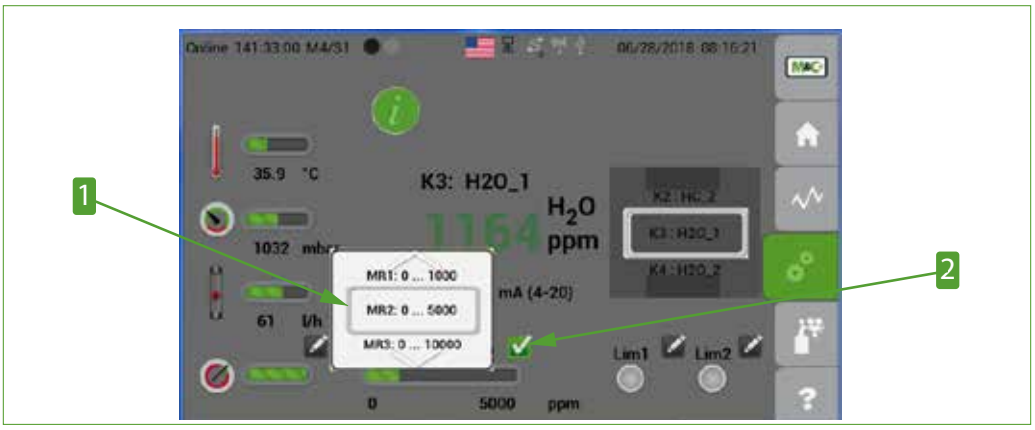


Fig. 44: Highlighted scroll bar to select measuring range

1 *Scroll bar to select measuring range*
2 *Active edit button changes into a check mark*

In gereral four measuring ranges (MR) can be selected. MR1 is the smallest possible physical measuring range and MR4 the largest possible physical measuring range. MR1 and MR4 cannot be modified by the operator. The values displayed and the units of the measuring ranges depend on the configuration of the instrument.

Measuring ranges for PMA sensor [vol%]			
MR1	**MR2**	**MR3**	**MR4**
0.0 to 1.00 (can not be modified)	0.0 to 10.0	0.0 to 30.0	0.0 to 100.00 (can not be modified)

NDIR/NDUV/UVRAS measuring benches are calibrated for a certain measuring range. This measuring range must correspond to the specifications on page 22 chapter ‚NDIR/NDUV/UVRAS measuring benches (ULTRA.sens®, INFRA.sens®)*' on page 24 chapter ‚Beispiel-verweis:' .

You will find a more detailed description about the measuring range selection on page 50 chapter "M4/S2 - Settings menu/ parameters" .

Sensor evaluation

The sensor evaluation list shows the real measured gradient and the real offset of the oxygen concentration and, for comparison, the factory setting of the gradient and the offset. The real gradient and offset can deviate from the factory settings as long as the values are staying in the stated range. Is the current gradient or offset higher or lower than the permitted range, the indicator below the edit button turns from green to red, but only if the parameter "Rating active" is turned on.

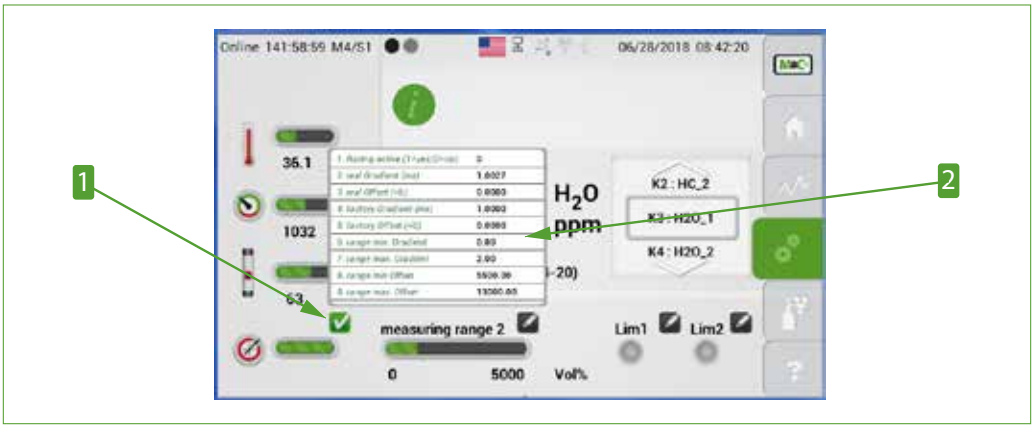


Fig. 45: Sensor evaluation list

1 Edit button to open sensor evaluation list *2 Parameter list of the sensor ratings*

The real values for slope (mx, sensitivity, gradient) and offset (b, zero point) change over time as a result of ageing, contamination or other influencing factors. These deviations from the stored factory values are registered during calibration, stored as real values and compensated for by the software.

The relative position of a real gradient or offset value on the distance between the factory value and the range end value (min. or max.) is displayed as a percentage below the green bar "% number for mx deviation / % number for b deviation". "0 / 0" is displayed on delivery. If the sensor evaluation is not activated, no numbers are displayed.

If, for example, one of the real values is exactly half the distance from the factory value to its associated range end value, a 50 is shown which means that 50 % of the permissible deviation from the stored factory value (factory setting) has been used up. Starting from this value, the color of the bar changes from green to red. It is then recommended to check the sensor, if necessary contact M&C for this purpose.

By observing and evaluating several successive calibration events (see on page 44 chapter 'M2/S3 - Event list' "; "white" entries in the event list), you can determine whether the sensor behavior is due to irregular fluctuations or a continuous drift of the sensor signal. Depending on the sensor type, it is possible to conclude whether the sensor is contaminated, aged/worn, or whether the application/process conditions have changed.

Lim settings

To change the value of Lim1, please tap on the edit button to the right of operating parameter "Lim1". A scroll bar will open, where you can select numbers before and after the decimal point. The selected value needs to be displayed in the gray frame in the middle of the operating parameter scroll bar. Please tap on the green check mark to confirm your selection.

Fig. 46: Highlighted scroll bars to set operating parameter Lim1

1 *Selected value for Lim1*
2 *Active edit button changes into a check mark*
3 *Indicators for operating parameter Lim1 and Lim2*
4 *Current operating parameter values Lim1 and Lim2 (setting not activated by default)*

The operating parameter Lim2 can be changed in the same way as Lim1, by clicking on the corresponding Edit button. A scroll bar will open, where you can select numbers before and after the decimal point. The selected value needs to be displayed in the gray frame in the middle of the operating parameter scroll bar. Please tap on the green check mark to confirm your selection.

Fig. 47: Highlighted scroll bar to set operating parameter Lim2

1 *Selected value for Lim2*
2 *Active edit button changes into a check mark*
3 *Indicators for exceeding the value of operating parameters Lim1 and Lim2*

To define operating parameter values and change the calculation method behind the values, please refer to chapter "M4/S2 - Settings menu/ parameters".

8.3.12 M4/S2 - Settings menu/ parameters

Qualified personnel	Changing settings can only be done by qualified personnel.

In section M4/S2 you can define the parameters for the scroll bars you are using in section M4/S1. The screen of section M4/S2 shows a scroll bar and a green "Restart" button.

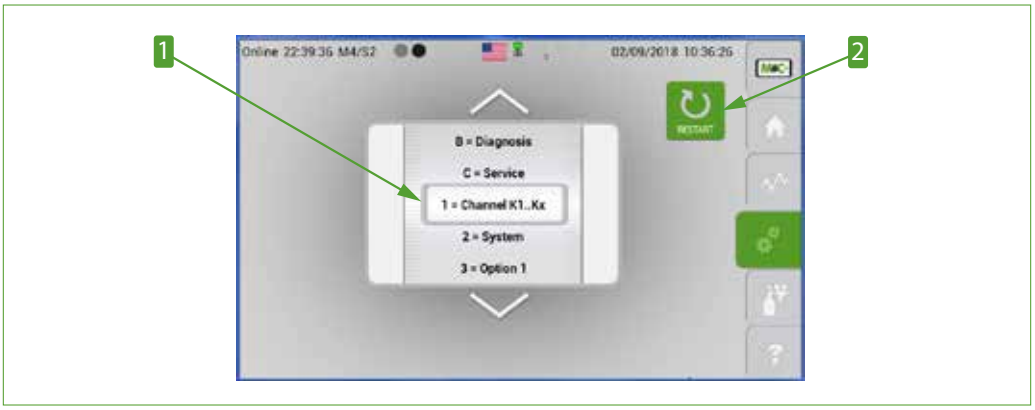


Fig. 48: M4/S2 screen with "Restart" button

1 *Scroll bar* **2** *"Restart" button*

After tapping on the "Restart" button, a screen opens where you need to confirm the restart of the analyzer. The restart of the analyzer interrupts the measurement and deletes all data collected during this day.

The RAM stores data collected from 12:00 a.m. until the next day at 12:00 a.m. After 24 hours of collecting data in the RAM, this data will be stored permanently in the flash memory of the analyzer. Any measuring values collected from 12:00 a.m. to the restart of the analyzer will be deleted from the RAM.

NOTICE	Loss of data! By tapping on the "Restart" button, the measuring process is interrupted. The current measuring values in the RAM which are not permanently saved, are lost.

With the scroll bar in section M4/S2 you can select different parameters. In the first range there are 9 parameters and in the second range two, A and B.

To make sure that the settings will not be changed by accident, you will need to select the parameter first by displaying it in the gray frame, and then tap on the "hidden password".

Note	To select a parameter in the settings menu, please display the selected parameter in the gray frame of the scroll bar, and then tap on the word "Online" on the left-hand side of the system status line.

With tapping on the hidden password, you are opening a settings screen, where you can change the current settings.

NOTICE	Analyzer is not ready to set alarm after tapping “Online” or during parameter setting! Alarm and warning messages will not be updated! Dangerous situation! Close the parameter screen immediately after changing settings.

Note	When a settings screen is open, the display stays on this settings screen. All other screens jump back to the start menu M2/S1, if the touchscreen has not been used for 30 Minutes.

- 1 = Channel K1-Kn settings

The first screen of the menu item M4/S2 shows the selection wheel with the channel settings “1 = channel K1-Kn” in the grey frame.

Fig. 49: Channel settings

Tap on the word “Online”. The list of basic settings opens.

Note	The display shows only part of the list. Scroll down the list by swiping vertically or by pressing the arrow buttons to have a look at all parameters.

The following figure shows the upper part of the basic settings list. The existing channel names are on top of the list. To change a channel name, tap on the “Alias name” field. The field is highlighted in orange and the current name of the channel “Alias” appears in the edit field. Tap on the edit field to open the keypad.

Fig. 50: Basic settings for channel 1

1 *"Selection" button*
2 *Channel selection scroll bar*
3 *Edit field*
4 *Highlighted field*

Here you can enter the new channel name.

Fig. 51: Keypad

Please tap on the "<Enter> = To save into database" button to confirm your new channel name. After your confirmation, you will get back to the parameter list.

There are several more detailed parameters regarding the channel settings. To open a list with these detailed parameters, please tap on the "Selection" button. In this list you will find the following channel-specific settings:

1 = Basic settings
2 = Hardware configuration
3 = Calibration / Adjustment
4 = Measuring range setting
5 = Operational limits (Lim)
6 = Sensor rating
7 = Linearizaton

By tapping on the items of the list, you will reach the corresponding screen to enter the settings.

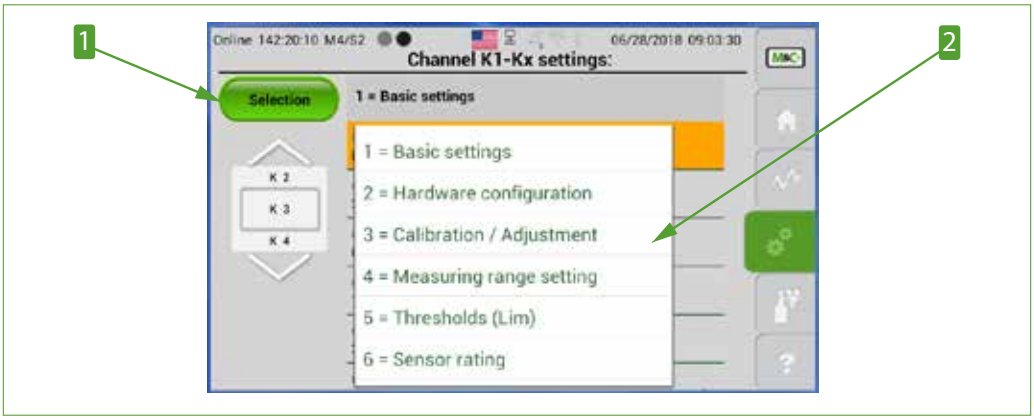


Fig. 52: Channel-specific settings list

1 *"Selection" button* 2 *Channel-specific settings list*

The following list contains a selection of the most common parameters which belong to the "1 = Channel K1-Kn settings".

Parameter description	Default value*
Selection: 1= Basic settings	
channel ID	PMA*
concentration average value: no=0, yes=1..100	0
unit temperature (1 = °C, 2 = °F)	1
unit pressure (1 = bar, 2 = hPa, 3 = mbar, 4 = psi)	3
unit sample flow (1 = l/h, 2 = l/min)	1
number of decimal digits	2
Selection: 2= Hardware configuration	
correction factor sample flow	1.000
mA range 1=0-20 mA, 2=4-20 mA	2
gas flow from Kx (1...n)	1
pressure reading on screen Kx (1...n) enable=0, disable=1	0
flow reading on screen Kx (1...n) enable=0, disable=1	0
Negative reading enable: 0=yes, 1=no active	0
pressure compensation: 0=no, 1=P-In, 2=P-Out	2
Assignment sensor module values (No. 1-3)	1
Selection: 3= Calibration / Adjustment	
pressure calibration offset P-IN	0.000
pressure calibration offset P-OUT	0.000
zero gas [unit*]	0.000*
span gas [unit*]	20.960*

Parameter description	Default value*
Calibration: gradient (mx)	1.000
Calibration: Offset (+b)	0.000
Holding time [s] of digital out 2, Cal. mode after calibration	1
Calibration: MIN range zero gas [vol%*]	-2.000*
Calibration: MAX range zero gas [vol%*]	2.000*
Calibration: MIN range span gas [vol%*]	19.000*
Calibration: MAX range span gas [vol%*]	24.000*
Calibration: MeasRange for zero gas	1
Calibration: MeasRange for span gas	4
Selection: 4= Measuring range setting	
measuring range at start	3
measuring range 2 from [vol%*]	0.000*
measuring range 2 to [vol%*]	10.000*
measuring range 3 from [vol%*]	0.000*
measuring range 3 to [vol%*]	30.000*
Selection: 5= Thresholds (Lim)	
op. Lim1 [vol%*]	(20.000[1])*
op. Lim2 [vol%*]	(18.000[1])*
mode op. Lim1 0: inactive, 1: <, 2: ≤, 3: >, 4: ≥	0 (1[1])
mode op. Lim2 0: inactive, 1: <, 2: ≤, 3: >, 4: ≥	0 (1[1])
threshold pressure [mbar] min	800
threshold pressure [mbar] max	1200
Selection: 6= Sensor rating	
Sensor rating: Rel. deviation\nCalculation active: 0=no, 1=yes	0
Sensor rating: Rel. deviation\nRange min Gradient (mx)	0.800
Sensor rating: Rel. deviation\nRange max Gradient (mx)	1.200
Sensor rating: Rel. deviation\nRange min Offset (+b)	-5.000
Sensor rating: Rel. deviation\nRange max Offset (+b)	5.000
Sensor rating: Factory value\nGradient (mx)	1.000
Calibration: Factory value\nOffset (+b)	0.000
Selection: 7= Linearization	
Linearisation polynomial m. range 1 active=1, inactive=0	0
Linearisation polynomial m. range 2 active=1, inactive=0	0
Linearisation polynomial m. range 3 active=1, inactive=0	0
Linearisation polynomial m.range 4 active=1, inactive=0	0

* Default values and units with "*" depend on gas type and measuring range.

[1] If the Lim1 mode and the Lim2 mode are set to "1", the set limit values are displayed on section M4/S1.

2 = System settings

The system parameters are the second group of parameters which can be set by the user.

To go from the channel settings screen to the system settings, please tap on the settings button M4. The section M4/S1 opens. Please swipe horizontally to reach section M4/S2 with the scroll bar.

Swipe the scroll bar vertically or tap on the arrows to display "2= System" in the gray frame, then tap on the hidden password "Online".

Fig. 53: System settings

Note Generally, the analyzer must be restarted after system settings have been changed in order for the changes to take effect.

The following list contains a selection of the most common system settings:

Parameter description	Default value
Language/flag: 1 = D; 22 = GB; 33 = F; 44 = I, ..., 132=USA	132
1 = zero gas, 2 = span gas, 3 = zero + span gas	1
System time [s] until back to the main menu display	1800
Screensaver Brightness: 20 ... 100%	35
Flow error ignore: 0=no, 1=active	0
Option: Information box 0=no, 1=with confirmation of status, 2=display only for multiple messages	2
Interval time [h]: main unit	8760
1. Operating hours counter	0
1. Interval time [h]	8760
...	...
10. Operating hours counter	0
10. Interval time [h]	8760

3 = not available

This feature is not available.

- 4 = Updates

To update the firm ware, please open the “Updates”-screen.

Fig. 54: Scroll bar with “4=Updates” displayed in the gray frame

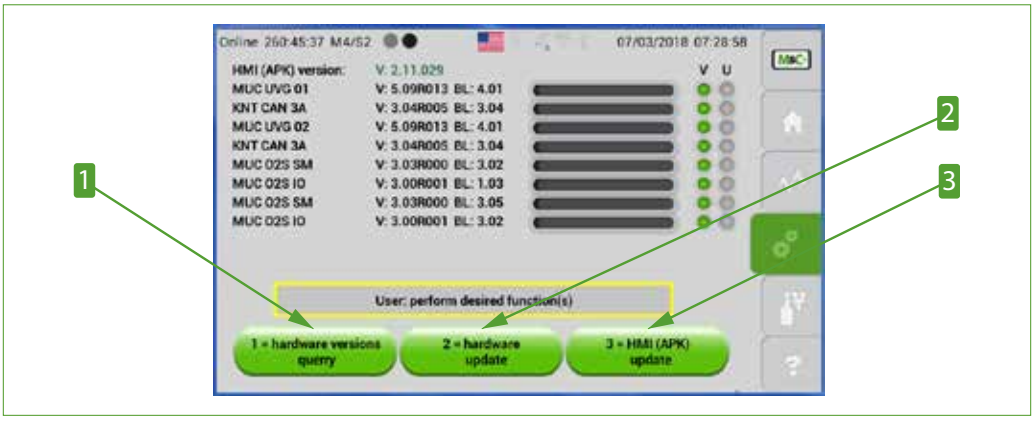


Fig. 55: Buttons to get information and install hardware and software updates

1 *“Hardware versions querry” button*
2 *“Hardware update” button (not active)*
3 *“HMI (APK) update” button*

To get information about the current hard- and software version of all the components in your device, please tap on the “1 = Hardware versions querry” button.

With the “3 = HMI (APK) update” button on the right-hand side the application software can be updated. This update is often called the “software update” of the device.

Fig. 56: Screen to confirm the update of the application software

Please insert a USB stick with the correct software version into the USB port on the back and confirm the start of the update.

Note

The currently running measuring operation is terminated by this.

After a software update, it may also be necessary to update the database.

It may also be necessary to reset parameter settings that have been changed by the user if they have not been saved and read back using the DB Update/DB Backup function.

- 5 = Factory reset

Fig. 57: M4/S2 screen with "Factory reset" selected

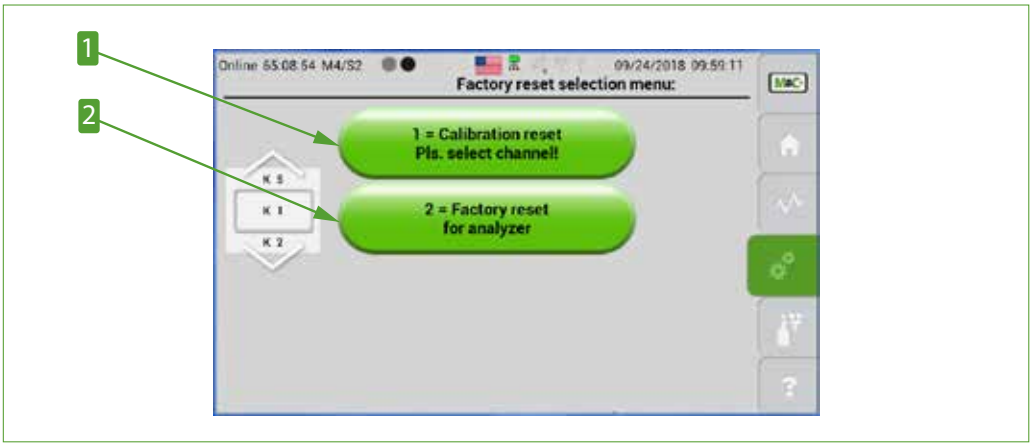


Fig. 58: Select factory settings

1 *Calibration reset* 2 *Factory reset*

- 6 = Database

Fig. 59: Database settings

With the "1 = DB Update" button database files can be imported. With the button "2 = DB Backup" data can be exported. The exported files have the extension exp (instead of csv). If you tap on the "3 = DB Restore" button, then you can read in an exp file again.

Note	For data processing the *.exp must be renamed to *.csv, they can then be processed in LibreOffice. Attention when using Excel regarding data separators and " ." or " ," as decimal characters.

The following files are created: calibration history, event list and the three configuration files: channels, texts, system.

The event buffers of the files are limited to 2000 events. Each individual event has an ID number. All buffers are configured as ring buffers, i.e. event no. 2001 overwrites event no. 1.

In supervisor mode, the event buffers can be deleted. The ID number continues counting even in this case, although events in between may have been deleted.

Note	Save your data to a flash memory before turning off the analyzer. This ensures that all events of the current day are stored even if the analyzer is turned off.

The ring buffer assigned to the measured values consists of a series of individual day files. Each day a file with channel number and date is created for each channel. The writing frequency is 1 Hz independent of the number of analysis channels. Each day file consists of 86400 entries (86400s = 24 h).

A current file is stored from RAM to the analyzer's permanent flash memory at 12:00 a.m.. If an analyzer is turned off before 12:00 a.m., all current measurement data stored from 12:00 a.m. or from the last power on in the non-permanent RAM will be erased. After the analyzer is switched on again, the data storage process starts again. Zero values are then stored in the day file for the deleted data.

If the internal analyzer time (clock) is changed, the affected hours of the time offset are overwritten or left empty. If the time (date) of the internal analyzer is changed, the affected days of the time shift are overwritten or left empty.

There is a maximum of 365 day files in flash memory (1 year), 366 in a leap year.

The file next to the very last possible over-writes the first one (ring buffer). There is no direct access to the day files stored in the Flash. Only hour steps can be selected and exported to a memory stick. The data format is Kx_DD.MM.YYYYYYY_yzH.csv.

Note	The Modbus and AK protocol description can be found in the appendix of this instruction manual.

- 7 = IP config

Fig. 60: IP address input screen

To enter a new IP address, please tap on the first block of numbers. A keypad to enter numbers opens. Please enter the first block of numbers and press the "Next" button. Then you can enter the second block of numbers. For the last block of numbers, the "Done" button appears on the screen. After tapping the "Done" button, you will get back to the IP address input screen. Please check your new IP address and confirm your entries with the "Safe & Exit" button.

A window with the information "IP address: Pls. restart if IP address has been changed" and the "Pls. confirm!' button opens. Please confirm the new IP address again with the "Please confirm" button.

Note	If you don't want to change the IP address, please tap on the "Cancel" button. The "IP address: Pls. restart if IP address has been changed" window opens, and with tapping on the "Pls. confirm!" button you will get back to the M4/S1 screen.

Note	To successfully change the IP address, it is necessary to restart the analyzer. If you don't reboot your device, the new IP address will not be activated.

- 8 = Date & Time

Fig. 61: Date and time settings

Independent from the date and time settings, the format of the date changes from "DD.MM.YYYY" to "MM.DD.YYY", when you choose the American flag symbol in the system status line.

- 9 = Supervisior

The administrator settings are only for M&C Service personnel. For questions or more information please contact your M&C contact or authorized M&C distributor.

Fig. 62: Supervisor settings for administrators

Note If you tap on the hidden password here, the section M2/S1 will open.

- A = PDF1 update

This function can be used to permanently upload documentation provided by M&C on a specially formatted USB stick to the analyzer. This information is displayed by tapping the help button M6.

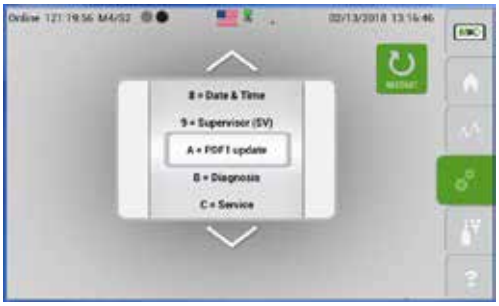


Fig. 63: PDF1 update

Please contact M&C for instructions. The USB input of the analyzer is located on the back of the device. Tap the “Pls. confirm!” button to start the download of the PDF-file.

- B = Diagnosis

Fig. 64: Scroll bar with "B=Diagnosis" displayed in the gray frame

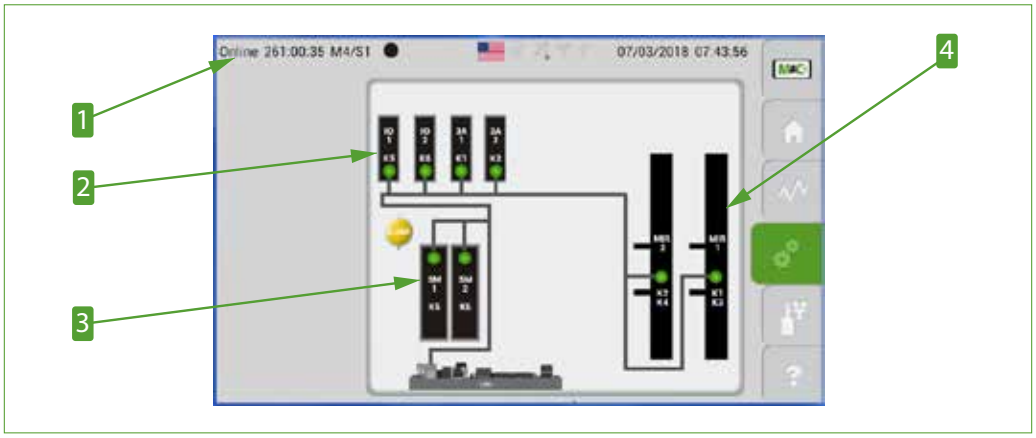


Fig. 65: Schematic for diagnosis

1 *Hidden password*
2 *IO1, IO2, 3A1, 3A2 hardware components*
3 *SM1 and SM2 hardware components*
4 *MIR1 and MIR2 hardware components*

Qualified personnel

Changing settings can only be done by qualified personnel. After tapping on the hidden password the analyzer usually stops the measuring process. This process is idle as long as the settings screens are open.

To diagnose a part of the analyzer, please tap on the components displayed in the schematic. In the example shown on page 64 in Fig. 66 the IO1 component is selected.

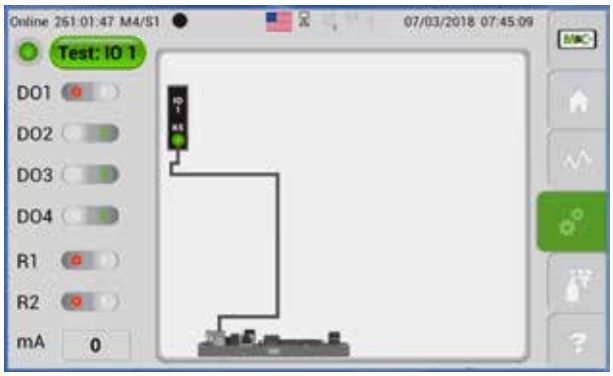


Fig. 66: IO1 component: DO1 to 4, relay outputs R1, R2 and mA output

Here all of the DO- and relay-outputs with the mA-output of IO1 are displayed on the left side of the screen. The switches are active, and you can test them by switching them off ("0") or on ("1"). The mA-output can be changed by tapping on the displayed value. The keypad opens, and there you can enter the new output value. Please tap on the "<Enter> = to save into database" button to confirm your entry.

To check another part of the hardware, please tap on the module to get back to the M4/S1 diagnosis screen. You can also swipe horizontally to go back to the M4/S2 screen with the scroll bar. Display "B=Diagnosis" in the gray frame of the scroll bar. Then tap on the hidden password again. The screen on page 63 in Fig. 65 opens. Please tap on the hardware components to select and highlight them.

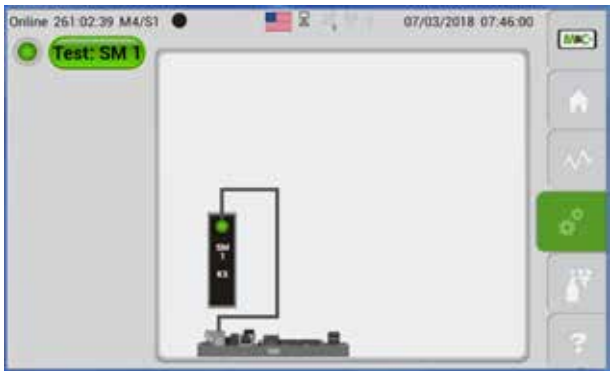


Fig. 67: Display of the highlighted SM1 components

To test the internal data bus, please tap on the SM1 components. The screen displayed on page 64 in Fig. 67 opens. Please tap on the "Test SM1" button to initiate the test. The line "Connection check in progress" appears on the screen. This means, that the connections of the internal data bus are tested at this moment.

To return from the M4/S1 diagnosis menu to the start screen, please swipe through the sections or tap on the M&C button M1.

Note	You need to tap on the Home button M2 to re-initialise the internal data bus and to set all DO and relay-output settings back to the initial values. A 60 seconds reset phase starts. This reset is necessary to delete the test data.

- C = Service

Fig. 68: Service settings

After pressing the "1=Operational hours counter" button, a screen opens with the channel selection wheel, the hour counter and a reset button.

Note	The operating hours counter of the analyzer cannot be reset by the user.

8.3.13 M5/S1 and M5/S2 calibration menu

- Calibration screen

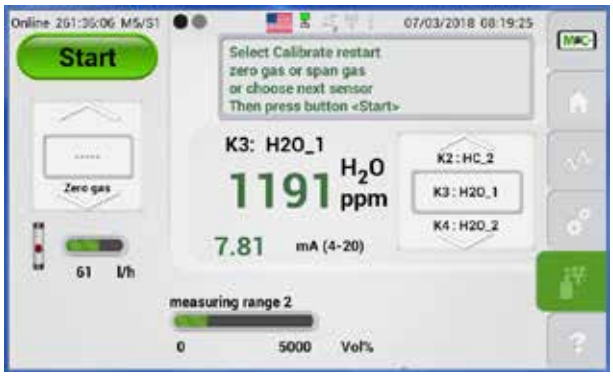


Fig. 69: Gas calibration screen

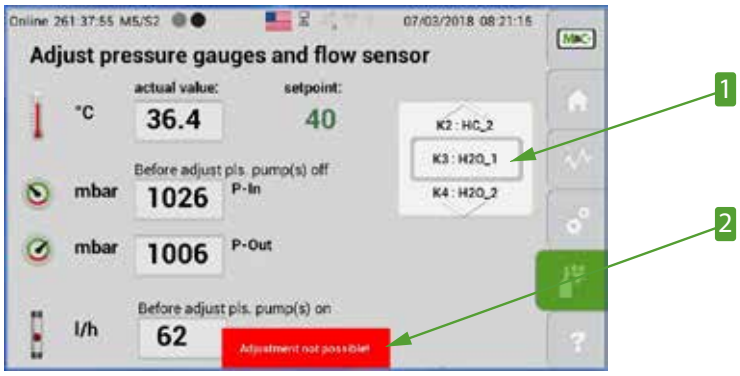


Fig. 70: Adjustment not possible for selected channel

1 Channel selection scroll bar 2 Note shown, when adjustment is not possible for this channel

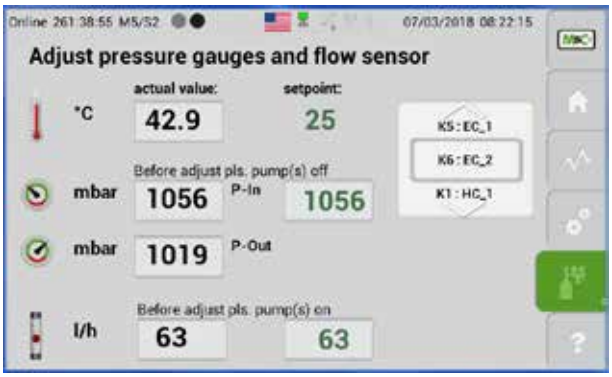


Fig. 71: Adjust pressure gauges and flow sensor

This section shows the actual value and the set point of the pressure gauges and flow sensor. By tapping on the set point values, the temperature, pressure or flow rate can be adjusted. The actual values change to the new set points.

Note	To set P-IN and P-OUT values for the barometric pressure correction, the gas connections must be disconnected, and the analyzer must be free of any gas flow.

Note	Please be careful when changing these values. Make sure that you enter the correct values. These values have a direct impact on the measuring values and ranges.

For more information about the calibration of the analyzer, please go to page 72 chapter 'Calibration' .

8.3.14 M6/S1 Help button

If you tap on the help button M6, a technical documentation opens.

With the zoom buttons at the bottom of the screen, you can display a whole page on the screen and zoom in and out of the document.

To scroll through the technical document, please swipe vertically up and down.

9 Mounting and installation

9.1 General

The Multigas Analyzer V2.2 is enclosed in a 19" housing. This gas analyzer is intended for use as a stationary device. The correct installation of the device and proper sample gas conditioning guarantees a long life-time and a minimum of maintenance work. You can optimise the sample gas conditioning by mounting a cooler and fine filter in line before the sample gas enters the analyzer.

If you are planning to use the analyzer outdoors, please make sure to protect the device against any weather influences. The climate conditions should be kept as constant as possible.

Please mount the Multigas Analyzer V2.2 in a vibration-free environment. If the environment is not vibration-free, you will need to mount vibration control air springs to de-couple the enclosure from the vibration source.

The analyzer should not be mounted close to a heat source. The normal operating position for the instrument is the horizontal position. The sample gas needs to freely pass through the air outlet of the analyzer without any special precautions.

WARNING

Explosion hazard!

For general purpose areas ONLY. Don't use the Multigas Analyzer V2.2 in hazardous areas or for the measurement of explosive gases.

9.2 Special mounting and installation instructions for ZrO_2 sensor

NOTICE

Warning! ZrO_2 installation:

Faulty sensor connection can destroy the sensor. Check sensor connection terminals 33 to 36 before commissioning:

33 (-) Sensor signal

34(+) Sensor signal

35 Sensor heating

36 Sensor heating

10 Starting-up and operating the analyzer

10.1 Preparations for start-up

Observe the generally accepted engineering standards, and all of your national and local regulations before starting up the analyzer.

Ensure that the specified voltage displayed on the product label matches the available supply voltage before connecting the device to the supply voltage.

NOTICE	Incorrect voltage may damage the device. The supply voltage must match the technical data displayed on the product label.

10.2 Start-up and operation

After turning the analyzer on, the device starts to warm-up. The yellow light indicates that the device is not ready to operate yet. An accurate measurement during the warm-up phase is not possible.

After the device has reached the operation temperature of the sensors inside, the start screen with the measured values will be automatically displayed on the screen.

Fig. 72: Warm-up phase in M2/S1 and warm-up info on M2/S2

The green indicator light on screen M1/S1 shows that the analyzer is ready to operate.

Fig. 73: Analyzer is ready to operate

NOTICE

The measuring mode is interrupted while the parameter menu is open.

Within M4/S2, the measuring operation of the analyzer is interrupted when the following selection wheel functions are selected:

4 = Updates

7 = IP config

8 = Date/Time

B = Diagnosis

No measurement results are stored or displayed during this period.

Only in the setting screen "B = Diagnosis" the display returns to the start screen M2/S1 after 30 minutes without input.

The analyzer is in operation mode when the screen symbol in the status line flashes green. When the screen symbol is red or empty, the analyzer's measuring operation is interrupted.

10.3 Confirm system messages

In many applications, the analyzers run in 24/7 continuous operation and are not regularly inspected on site. If an error message occurs during operation, e.g. due to a flow error, this message is displayed on the M2/S2 screen (see on page 37 chapter 'Main display area'). In this case, the Info button lights up red and the message "Malfunction" flashes inside the message field.

Tapping the Info button confirms that the message has been seen. After confirming the "Malfunction", the message turns into continuous light and disappears as soon as the cause of the malfunction has been eliminated. If there is no confirmation and new fault messages occur, they are only stored in the background and not displayed.

To inform the user, an information box can be activated which is displayed on the analyzer after a defined number of unconfirmed messages has been reached. This number is calculated as follows: 9 consecutive unconfirmed messages x number of available channels. I.e. with a 4-channel multi-gas analyzer this information box only appears after 36 unconfirmed messages.

Tap on the "Please confirm" button in the information box to confirm the messages and set the number of unconfirmed messages to zero (reset unconfirmed messages).

The display of the information box is activated in the system settings (see in chapter '8.3.12 M4/S2 - Settings menu/ parameters' on page 56) of the analyzer. The following settings are possible:

- 0 = No information appears. The number of unconfirmed messages can be displayed in the screen M1/S2 under "More Info". The CE value indicates the number of unconfirmed messages. The status output of the analyzer continues working with and without confirmation.
- 1 = The information box appears and must be confirmed. The last malfunction message received to activate the information box sets the status output of the analyzer to " Malfunction ". It remains at " Malfunction " until the information box is confirmed. Regardless of whether the messages have already been cleared or not.
- 2 = The information box appears and can be confirmed. The status output of the analyzer continues to work with and without confirmation.

11 Calibration

11.1 General

The Multigas Analysator V2.2 includes manual calibration. To calibrate the analyzer, you need a test gas with a known gas concentration. During the calibration phase the corresponding mA value to the known gas concentration is applied to the mA-output.

Hazardous Gas! Caution, hazardous gas! Do not inhale!

11.2 M5/S1 Manual Calibration

Note

Even with manual CAL, the solenoid valve actuators or solenoid valves that may be present switch.

This may make it necessary to use nitrogen as the zero gas at gas input W21 instead of ambient air, e.g. to be able to calibrate an oxygen sensor manually at the zero point.

- Select your test gas and set calibration parameters

Start the manual calibration by selecting the test gas. Please choose between zero gas and end gas.

Note Please don't forget to use the scroll bar and select "Zero gas" or "Span gas". An error message will open, when the test gas is not selected.

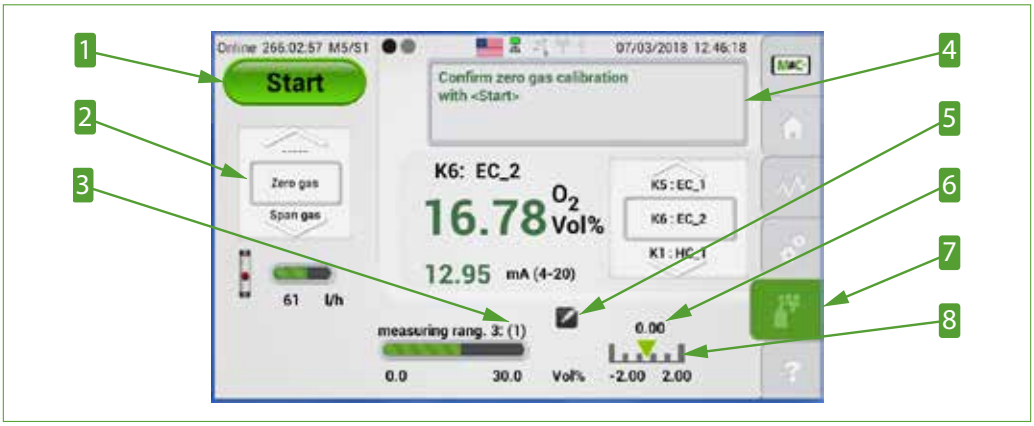


Fig. 74: Manual calibration

1 *Start button*
2 *Scroll bar to select test gas*
3 *Measuring range of calibration in brackets*
4 *Message box*
5 *Edit button*
6 *Test gas concentration*
7 *Calibration button M5*
8 *Calibration range*

The measuring range in which the calibration is to be performed is shown in brackets next to the current measuring range. The current measuring range is "3" and the measuring range of the calibration is "1".

The test gas concentration, here "0.0", is shown above the green arrow on the right hand-side at the bottom of the screen. The green arrow is pointing at a calibration range of "-2.0 to +2.0 vol%". The value of the actual gas and the test gas concentration needs to be in this predefined measuring range.

To adjust the calibration range or test gas concentration, please tap on the edit button. The M4/S2 screen opens with the channel-specific parameter "3 = Calibration/Adjustment". Here you can enter the parameters of your test gas and change the calibration range.

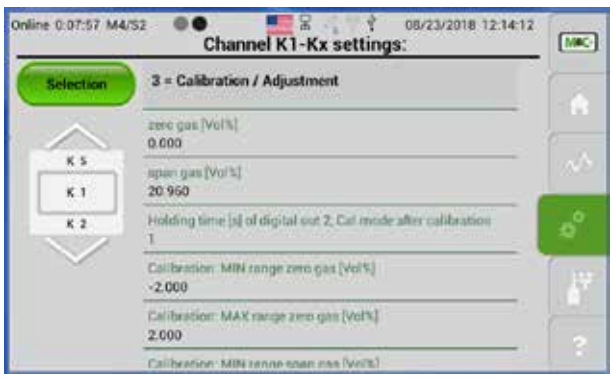


Fig. 75: Setting the channel-specific calibration parameters

Please set the values to meet your calibration requirements. After adjusting the parameters, please tap on the Calibration button M5 to confirm your entries.

- Example of a manual calibration procedure with span gas

Fig. 76: Manual calibration with span gas

Example: in "'Fig. 76 Manual calibration with span gas'" the test gas has a 20.96 vol% oxygen concentration.

Note

The concentration of the sample gas and the test gas must be within the maximum calibration range.

If you change the test gas concentration, you must adjust the maximum calibration range to the new test gas concentration. An error message appears if the test gas used does not fit within the maximum calibration range.

Please tap on the start button to initiate the manual calibration procedure. This tap on the start button triggers the status relay R2, which is part of the IO2 hardware components (digital output port X32).

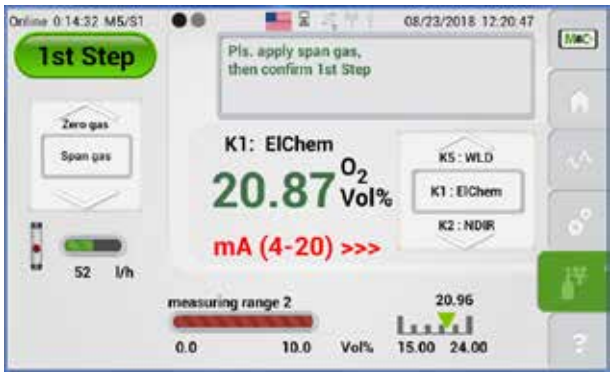


Fig. 77: First step of the manual calibration procedure

The label on the start button changes to "1. Step" button. Observe the message in the message box and connect the test gas lines manually.

Note

The test gas lines need to be manually connected and disconnected to the analyzer for calibration.

Please tap on "1. Step" button to confirm that the test gas is correctly connected.

Fig. 78: Second step of the manual calibration procedure

The label on the start button changes to "2. Step" button. Now you have to wait until the measured value is stabilized. When the measured value on the screen displays a stable reading, please tap on the "2. Step" button. The label on the start button changes to "3. Step" button.

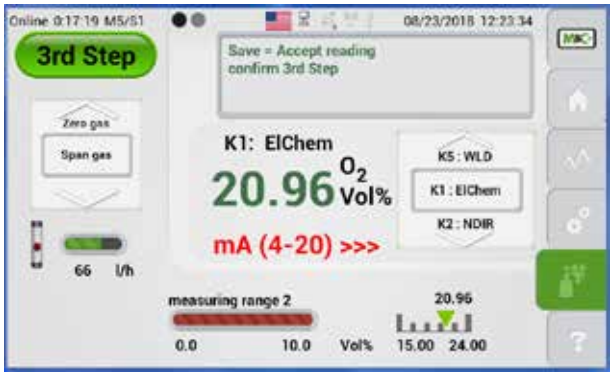


Fig. 79: Third step of the manual calibration procedure

Save the reading by tapping on the "3. Step" button.

Note

When calibrating channels with NDIR/NDUV/UVRAS measuring benches, a yellow LED appears next to the test gas selection wheel and the button label changes to "wait...".

When this step is finished, the LED lights green and the button shows "Complete".

The label on the start button changes to "Complete".

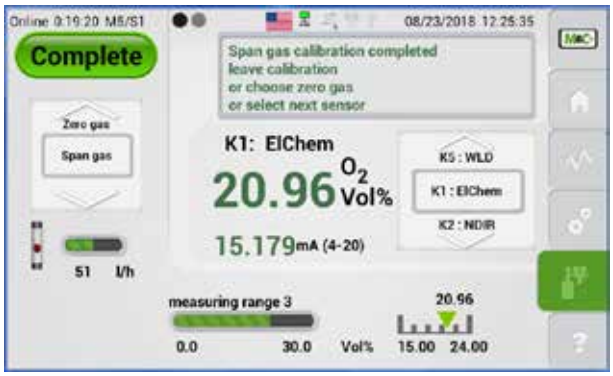


Fig. 80: End of the manual calibration procedure

Note

To continue the manual calibration procedure with another test gas, please scroll to "Zero gas" or "Span gas".

Manual calibration with "Zero gas" or "Span gas" can be repeated at any time.

With confirmation of "Complete" the status relay R2 is reset to IO2 (relay output connection X32), i.e. the signal calibration mode is cancelled.

After you tap on the "Complete" button the display immediately goes back to the start screen. Alternatively, the calibration can be continued with another test gas. Please use the selection wheel to do this. Repeating with zero or end gas can take place at any time.

Fig. 81: Data logger screen with green calibration symbol

Calibration procedures are shown in the data logger M3/S1 screen. The green symbols indicate successfully completed calibrations, and red symbols failed calibration procedures.

- Termination of a manual calibration procedure

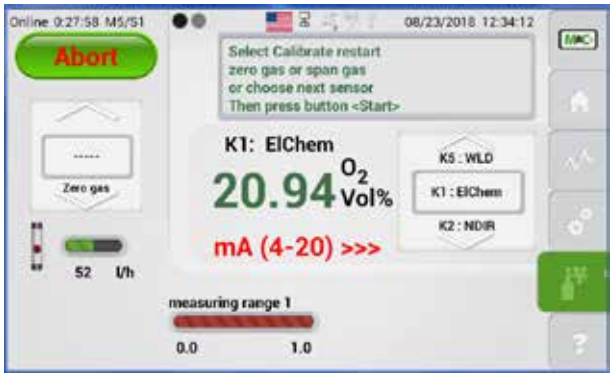


Fig. 82: A terminated manual calibration procedure

A manual calibration procedure can be terminated before the measured values are confirmed and saved. To terminate the procedure, please scroll to the "-------" line. The label on the green button changes to "Abort". Tap on the "Abort" button and the screen changes to the M2/S1 section.

You can also exit the calibration menu by tapping on another menu item. All terminated calibration processes are recorded in the event list M2/S3. An event list is shown in this manual on page 44 in Fig. 39.

- Errors during manual calibration procedure

Fig. 83: Manual calibration error

An error occurs during the manual calibration procedure, when the test gas has the wrong gas concentration or the actual value does not fit into the predefined measuring range of the gas concentration (calibration range limits).

The label on the green button changes to "Error" and the manual calibration procedure can not be completed.

In the example above, ambient air was used for the calibration procedure. The calibration range was predefined from -2.0 to +2.0 vol%. The oxygen concentration in ambient air does not fit into this predefined calibration range. The calibration procedure could not be completed.

Fig. 84: Datalogger screen with red calibration symbol

The data logger shows the failed calibration attempt with a red symbol. Tapping the red calibration symbol makes the screen in Fig. 85 appear.

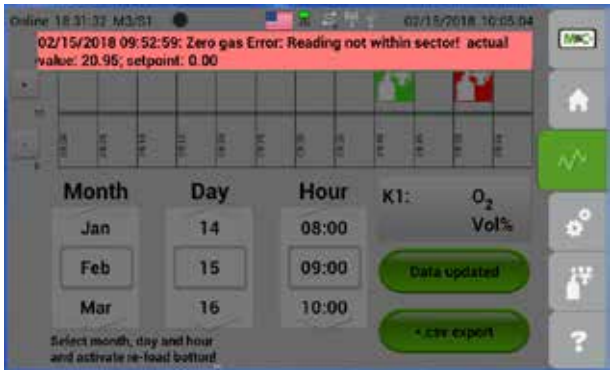


Fig. 85: Screen showing details about a single calibration procedure

A screen with detailed information about the failed calibration procedure opens. In this example it says that the measured value is too high. The measuring range needs to be adjusted to include the measured value.

Note	Manual calibration with “Zero gas” or “Span gas” can be repeated at any time.

11.3 Automatic Calibration starting from Software version 2.24

Note	Even with manual CAL, the solenoid valve actuators or solenoid valves that may be present switch. This may make it necessary to use nitrogen as the zero gas at gas input W21 instead of ambient air, e.g. to be able to calibrate an oxygen sensor manually at the zero point.

In addition to the manuall calibration (ManuCal) an automatic calibration (AutoCal) feature is available for single and multi channel multigas analyzers starting from software version 2.24.

Note

AutoCal can only be set for one channel present in the device. Automatic calibration for several channels is not possible.

Follow these steps for automatic calibration. The numbers refer to ‚Fig. 85 Screen showing details about a single calibration procedure‘:

- 1: Activate AutoCal on the M4/S2 System Settings page. Enter the number of the selected channel for activation.

Fig. 86: Activating AutoCal and entering parameters

1 *Activating AutoCal procedure*
2 *Choose zero or span gas or both*
3 *Enter starting time for AutoCal procedure*
4 *Select interval of the AutoCal procedure*
5 *Enter holding time of the solenoid valves*

Note

Choose an IR or UV-bank measuring channel:

If a measuring channel (MK) of an IR or UV bank is selected as a channel, all measuring channels provided by this bank (max. 3 MK in total) are calibrated at zero point during AutoCal start. The zero adjustment for all MKs of an IR or UV bank is independent of whether the measuring channel is assigned to a device channel or is used for internal, non-displayed compensation purposes.

The end gas values are not affected.

- 2: Select the calibration gas. Zero gas (AutoZero calibration), span gas or span gas and zero gas.
- 3: Select the starting hour of the first AutoCal interval, e.g. 11:00 a.m. of the currently running or upcoming day.
- 4: Select the time between two AutoCal intervals, e.g. an automatic calibration should be performed every 24 hours. The automatic calibration always starts at the starting hour defined in 3.

- **5: Set the holding time of the solenoid valves. By delaying the switching of the solenoid valves, gas paths of different lengths are compensated.**

Note

Due to the holding time of the solenoid valves, gas running times through supply lines of different lengths can be compensated. This ensures that the gases required for correct flow actually reach the sensor that is being calibrated.

CAUTION

Note for AutoCal intervals with n > 24 hours

Select any hour with the start hour (in the example: start at hour n = 11). You can choose between n = 1 to 23. The AutoCal interval is set to 168 hours in the example.

Current day of the week: Friday

Current time: 10:00 a.m.

Starting at n = 11 hours

Selected Start time: 11 a.m. on Friday
Waiting time until AutoCal starts: 1 hour

If you switch the analyzer off and then back on again on another day of the week (Tuesday in the example), the start and interval times are adjusted to the current time and current day of the week.

Restarting the analyzer,
current day of the week: Tuesday

Current switch-on time: 11:35 p.m.

After restart:
starting at n = 11 hours

Start time: 11 a.m. on Wednesday,
waiting time until AutoCal starts: 11 hours 25 minutes

The AutoCal interval restarts, previous values are discarded. The automatic calibrations that belong to the AutoCal interval n=168 hours are performed at 11:00.

This applies as long as the analyzer is not restarted.

The digital output card "IOAC 0" is necessary for switching the AutoCal solenoid valves. In the diagnostics diagram M4/S1 (see also on page 63 chapter 'B = Diagnosis'), a black symbol box represents the digital output card "IOAC 0". In Fig. 86, IOAC 0 belongs to device channel K2.

Tapping the symbol box opens a switch field on the left side. This switch field can be used to test the switching outputs DO 1, 2, 3 (DO 4 is not used) and the relays R1, R2.

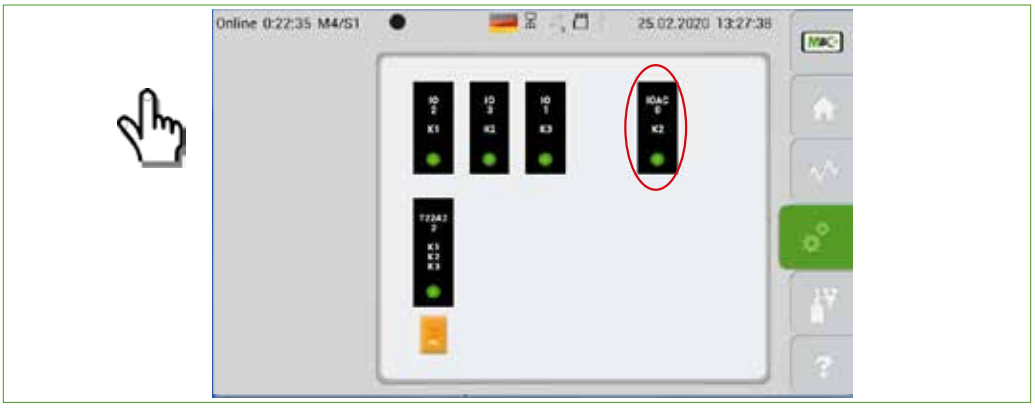


Fig. 87: Diagnostic diagram: Opening the output card "IOAC 0" of channel K2

Fig. 88: Diagnostic diagram: Opened output card for channel K2

11.3.1 AutoCal for external mounting of the solenoid valves

Usually, solenoid valves that are not part of the analyzer are used for switching between sample and test gas and for connecting zero and span gas. These solenoid valves are controlled by the switching outputs of the analyzer.

When connecting the solenoid valves, observe the marking of the corresponding sockets.

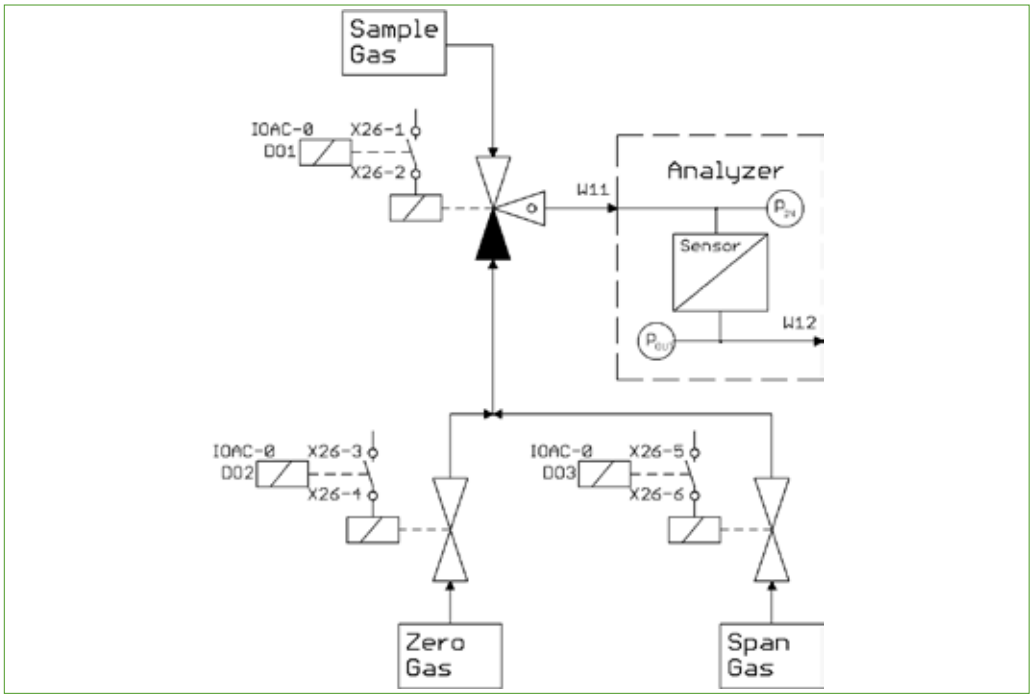


Fig. 89: Circuit diagram for external mounting of the solenoid valves

Solenoid valves, suction filter and pump (if applicable) are mounted outside the analyzer. Y2 and Y3 are used to supply test gases.

11.3.2 AutoCal for internal mounting of the solenoid valves

In special versions, the solenoid valves are installed inside the analyzer and controlled internally. Unless otherwise marked on the instrument, the process gas is supplied via gas connection W11, zero gas via W21 and span gas via W31. The gas outlet is via W12.

11.3.3 Example 1: AutoCal with pump for zero gas

In this example, ambient air is used as the zero gas. The ambient air is sucked in through a fine filter (F1) and a pump (M1).

Note	The ambient air must not contain a concentration of the gases to be measured. Make sure that measuring components, e.g. CO, CO_2, CH_4, H_2O, are not present in the ambient air. The ambient air must be pretreated if concentrations of the measuring components are present.

Solenoid valve Y1 connects the process gas input and output during calibration, Y2 and Y3 are used to supply test gases.

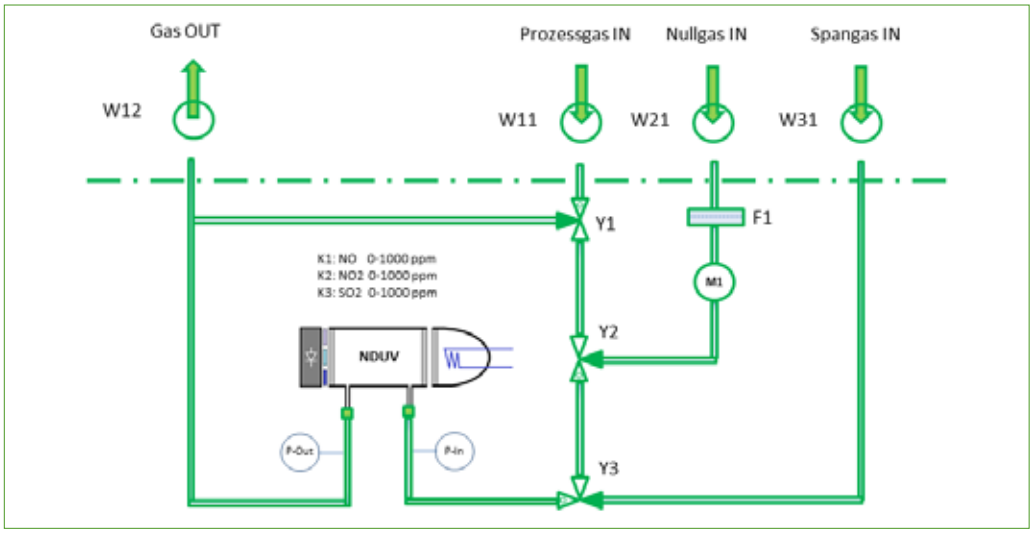


Fig. 90: AutoCal with zero and span gas

11.3.4 Example 2: AutoZero with zero gas (suction pump)

In this example, ambient air is used as the zero gas. The ambient air is sucked in through a fine filter (F1) and a pump (M1).

Note

The ambient air must not contain a concentration of the gases to be measured. Make sure that measuring components, e.g. CO, CO_2, CH_4, H_2O, are not present in the ambient air. The ambient air must be pretreated if concentrations of the measuring components are present.

Solenoid valve Y1 connects the process gas input and output during calibration, Y2 is used to supply zero gas.

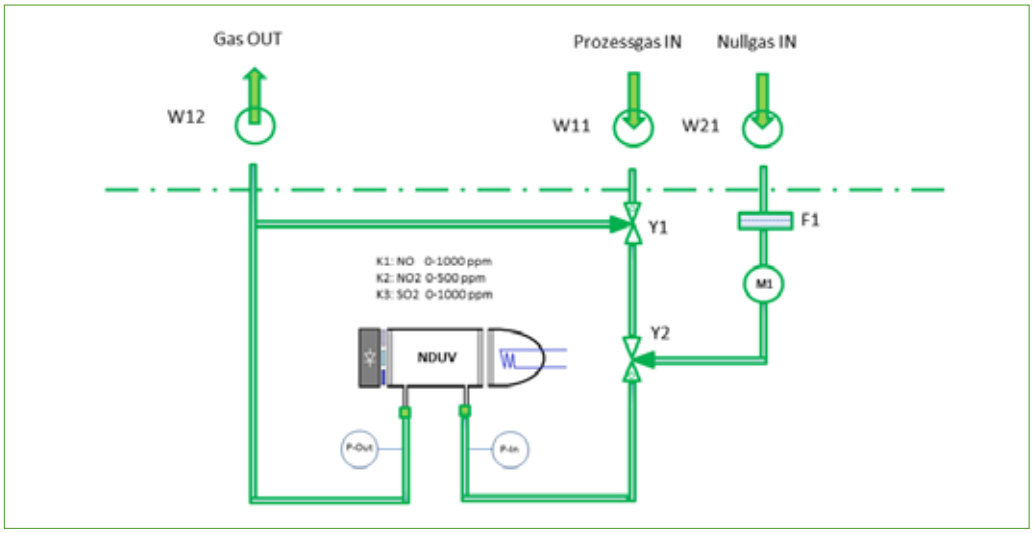


Fig. 91: AutoZero with zero gas (suction pump)

In this example, ambient air is used as the zero gas. The ambient air is sucked in through a fine filter (F1) and a pump (M1). Solenoid valve Y1 connects the process gas input and output during calibration, Y2 is used to supply zero gas.

11.3.5 Example 3: AutoZero with zero gas (compressed air/N_2)

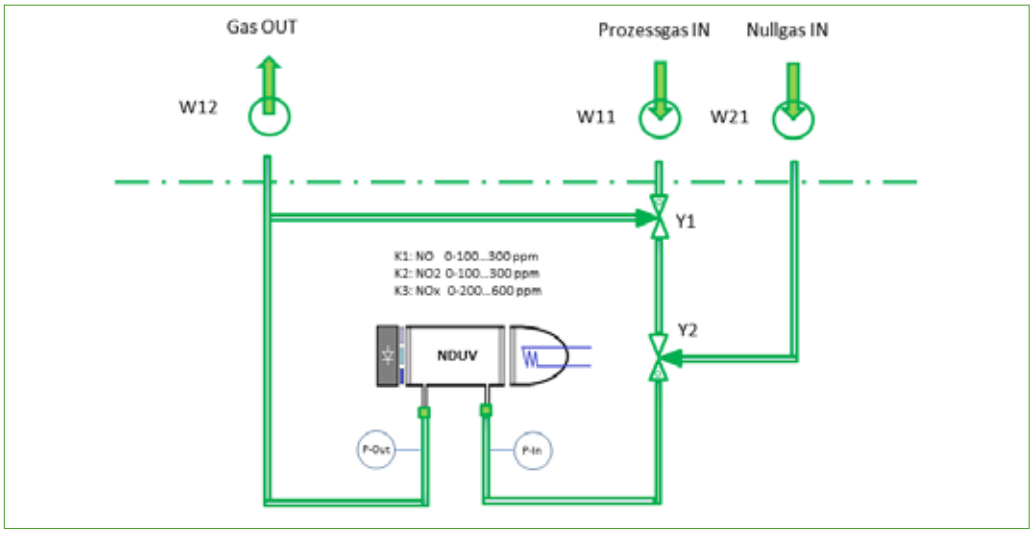


Fig. 92: AutoZero with zero gas (compressed air/N_2)

A compressed gas, e.g. N_2 cylinder gas, is used as zero gas. Solenoid valve Y1 connects the process gas input and output during calibration, Y2 is used to supply zero gas.

Note

In all cases of test gas application, care must be taken to ensure that no under- or overpressure builds up in the process gas flow during calibration, which could possibly lead to a pressure surge after switching back Y1 and damage sensitive components of the analyzer.

Test gases must always be fed in at a suitable minimum inlet pressure and the permissible flow range of approx. 30 to max. 120 Nl/h must be set and monitored using a needle valve and flow meter.

In menu M5/S1, the AutoCal procedure for the device channel nominated for auto-calibration can be triggered manually on the analyzer, provided an AutoCal interval has not already been activated at that moment for the set times.

Fig. 93: AutoCal-Start without setting an AutoCal interval

1 *Start button*
2 *Select calibration type*
3 *Channel selection*

To do this, set selection wheel 3 to the nominated device channel, set selection wheel 2 to AutoCal and then tap on the Start button 1. All valves for switching between sample and test gas(es) switch identically to the predefined time-controlled sequence..

Note	When the zero point or span value is checked manually, the associated solenoid valves switch.

Note	If no valves are connected, the user must ensure that the correct test gas is supplied manually and fed via the correct gas inlet, usually via gas inlet W11.

The AutoCal function is not available for non-nominated device channels, marked with "-----".

Fig. 94: AutoCal start without setting the interval: Channel selection

11.3.6 Setting the mA behaviour during calibration

For better integration of the GENTWO Multigas analyzers into external control processes, the behaviour of the mA outputs during a calibration process can be set for all instrument channels (starting from HMI software version 2.24).

Three settings of the mA behaviour during calibration can be selected. The mA output follows the concentration of the applied test gases (setting 0), a previously defined substitute mA value is connected to the output socket (setting 1) or the last mA value before calibration is frozen and permanently displayed (settings 2, 3 and 4).

Select the following settings in the „Configuration mA during calibration" parameter:

- 0 = no change, mA value is displayed according to the applied gas concentrations and selected measuring ranges, as shown in the measuring mode
- 1 = the value stored in the parameter „Substitute value mA during calibration" is displayed. A separate value can be defined for each device channel.
- 2 = Freezing and displaying the last mA value - only applies to manual calibration
- 3 = Freezing and displaying the last mA value - only applies to automatic calibration
- 4 = Freezing and displaying the last mA value - applies to manual or automatic calibration

Fig. 95: mA setting: Page M4/S2, 3=Calibration/Adjustment

11.3.7 Parameter settings for automatic calibration

Analog to the parameters that apply for manual calibration (ManuCal), the concentration values and permissible ranges for zero and span gas are entered in the parameters intended for automatic calibration (AutoCal).

Fig. 96: Parameter settings for AutoCal

Fig. 97: Parameter settings for AutoCal: section

11.4 Adjust pressure gauges and flow sensor

Pressure gauges and the flow sensor can be adjusted in the M5/S2 section. You can reach this section by tapping on the Calibration button and swiping left.

Note	For some channels it is not possible to adjust the pressure and flow sensors. The message "Adjustment not possible" will then appear on section M5/S2.

While this screen is open, the analyzer is still in operating mode.

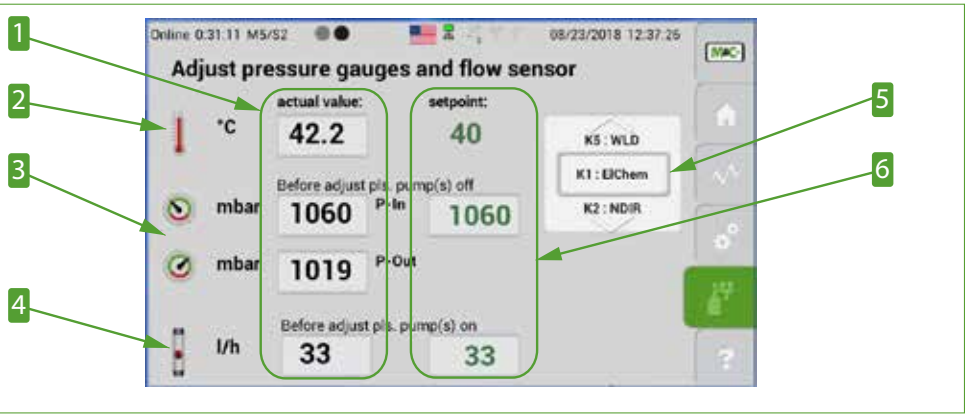


Fig. 98: Adjust pressure gauges and flow sensor

1 *Actual values*
2 *Temperature in °C*
3 *Pressure P-IN and P-OUT in mbar*
4 *Flow rate in l/h*
5 *Channel scroll bar*
6 *Set point values*

By tapping on the set point values, the temperature, pressure or flow rate can be adjusted. The actual values change to the new set points.

Note Please note, that in some configurations the temperature is fixed and cannot be changed.

If there is no gas present in the analyzer, the pressure sensors P-IN and P-OUT can be calibrated using the barometric pressure. The pressure entered in the field for the set point value, in mbar, is used for both pressure sensors.

The pressure sensors should be calibrated occasionally. To calibrate the pressure sensors, please remove all gas lines from the analyzer. The removing of the gas lines makes sure that there is no gas flow during the sensor calibration. The pressure sensors will adapt to the atmospheric pressure. Please use a pressure measuring device to determine the current barometric pressure. Enter this value in the “Set point” field of M5/S2.

The pressure sensors are now calibrated and the gas lines need to be connected to the analyzer again.

Note If you change the P-IN set point and don’t disconnect the gas connections, both P-IN and P-OUT will accept the same value. In this case the gas flow rate is set to zero and the flow measurement after this change will not reflect the true flow value.

The sample gas flow can be adjusted, when a preset gas flow is present. The correction factor for the flow rate can also be changed in the channel specific settings list (see page 54 ‘Fig. 52 Channel-specific settings list’)

After leaving the section M5/S2, the set points will adopt the actual values shown on the screen. If you open this section again, the actual values and the set points will have the same values.

11.5 Cross-sensitivity of coexisting gases

11.5.1 Cross-sensitivity of oxygen sensor (PMA)

Oxygen is a paramagnetic gas, which means that oxygen molecules are attracted into a strong magnetic field. This paramagnetic susceptibility distinguishes oxygen from most other gases.

The PMC (paramagnetic measuring cell) uses this paramagnetic characteristic to measure the concentration of oxygen in a gas mixture.

Here are two examples of coexisting gases which have an effect on the accuracy of the oxygen concentration measurement.

- Example 1

To determine the residual oxygen content of a 100% carbon dioxide (CO_2) inert gas atmosphere at +20 °C [+68 °F], please take a look at the table in this chapter.

If the analyzer is calibrated at zero point with nitrogen the reading will show -0.27 %. Then due to the Cross-sensitivity of CO_2 at +20 °C [+68 °F] the analyzer shows a value of -0.27 %. This means, if you calibrate the analyzer with 100 % N_2, the zero point needs to be set to +0.27 %. This zero point adjustment compensates the effect of CO_2 in the measurement and 100 % CO_2 show a reading of 0 %.

This is an example for a gas composition with CO_2 and O_2 only. To eliminate the cross-sensitivity effects, we can simply use CO_2 instead of N_2 for the zero point adjustment.

- Example 2:

To determine the oxygen content of a gas mixture at +20 °C [+68 °F], please take a look at the following values from the table.

C2H6 (Ethane)	1 vol%
O2	5 vol%
CO2	40 vol%
N2	54 vol%

N_2 will be used for the zero point adjustment. The cross-sensitivity values from the table are referring to 100 vol% of the corresponding gases.

To estimate the actual cross-sensitivity of the existing gases, the values need to be adjusted to the real concentrations in the gas mixture. In general the following formula is applicable:

$$\text{actual. cross-sensitivity} = \frac{\text{value given in the table} \times \text{volume concentration}}{100} \quad \text{(Vol.-\%)}$$

Fig. 99: Formula to calculate the effects of coexisting gases

The adjusted concentration values of the gas mixture components have the following values:

C2H6 (Ethane)	- 0.0045 vol%
CO2	- 0.1134 vol%
N2	0.0000 vol%

The value of the sum of the cross-sensitivities is -0.1179 vol%. This value is needed to adjust the zero point. The zero point needs to be set to +0.1179 vol%.

As you see here, the cross-sensitivity is not negligible. If you don't consider the effects of coexisting gases, it could mean an approximately 2 % relative error for the whole measurement.

Note The cross-sensitivity values from the table are referring to 100 vol% of the corresponding gas at +20 °C [+68 °F] and +50 °C [+122 °F].

The following table shows the cross-sensitivity of the most important gases at +20 °C [+68 °F] and +50 °C [+122 °F]. All values are corresponding to a zero point calibration of 100 vol% N_2, and a limit point calibration of 100 vol% O_2. The deviations apply in each case to 100 % by volume of the corresponding gas.

Gas	Chemical formula	+ 20 °C [+68 °F]	+50 °C [+122 °F]
		Cross-sensitivity values	
Argon	Ar	- 0.23	- 0.25
Acetylene	C_2H_2	- 0.26	- 0.28
Acetone	C_3H_6O	- 0.63	- 0.69
Acetaldehyde	C_2H_4O	- 0.31	- 0.34
Ammonia	NH_3	- 0.17	- 0.19
Benzene	C_6H_6	- 1.24	- 1.34
Bromine	Br_2	- 1.78	- 1.97
Butadiene	C_4H_6	- 0.85	- 0.93
Methyl propene	C_4H_8	- 0.94	- 1.06
n-Butane	C_4H_{10}	- 1.10	- 1.22
Chlorine	Cl_2	- 0.83	- 0.91
Hydrogen chloride	HCL	- 0.31	- 0.34
Nitrous oxide	N_2O	- 0.20	- 0.22
Diacetylene	$(CHCl)_2$	- 1.09	- 1.20
Ethane	C_2H_6	- 0.43	- 0.47
Ethylene oxide	$C_2H_4O_2$	- 0.54	- 0.60
Ethylene	C_2H_4	- 0.20	- 0.22
Ethylene glycol	$(CH_2OH)_2$	- 0.78	- 0.88
Ethylbenzene	C_8H_{10}	- 1.89	- 2.08
Hydrogen fluoride	HF	+ 0.12	+ 0.14
Furan	C_4H_4O	- 0.90	- 0.99
Helium	He	+ 0.29	+ 0.32
n-Hexane	C_6H_{14}	- 1.78	- 1.97
Krypton	Kr	- 0.49	- 0.54
Carbon monoxide	CO	- 0.06	- 0.07
Carbon dioxide	CO_2	- 0.27	- 0.29
Methane	CH_4	- 0.16	- 0.17
Methylene chloride	CH_2Cl_2	- 1.00	- 1.10
Neon	Ne	+ 0.16	+ 0.17
n-Octane	C_8H_{18}	- 2.45	- 2.70

Gas	Chemical formula	+ 20 °C [+68 °F]	+50 °C [+122 °F]
		Cross-sensitivity values	
Phenol	C_6H_6O	- 1.40	- 1.54
Propane	C_3H_8	- 0.77	- 0.85
Propylene	C_3H_6	- 0.57	- 0.62
Propylene oxide	C_3H_6O	- 0.90	- 1.00
Propylene chloride	C_3H_7Cl	- 1.42	- 1.44
Monosilane	SiH_4	- 0.24	- 0.27
Styrene	C_8H_8	- 1.63	- 1.80
Nitrogen	N_2	0.00	0.00
Nitrogen oxide	NO	+ 42.70	+ 43.00
Nitrogen dioxide	NO_2	+ 5.00	+ 16.00
Oxygen	O_2	+100.00	+100.00
Sulphur dioxide	SO_2	- 0.18	- 0.20
Sulphur fluoride	SF_6 -	0.98	- 1.05
Hydrogen sulphide	H_2S	- 0.41	- 0.43
Toluene	C_7H_8	- 1.57	- 1.73
Vinyl chloride	C_2H_3Cl	- 0.68	- 0.74
Vinyl fluoride	C_2H_3F	- 0.49	- 0.54
Water (steam)	H_2O	- 0.03	- 0.03
Hydrogen	H_2	+ 0.23	+ 0.26
Xenon	Xe	- 0.95	- 1.02

11.5.2 Cross-sensitivity of electrochemical oxygen sensor

This sensor shows a negligible cross-sensitivity <20 ppm for most gases occurring in combustion processes.

Electrochemical oxygen sensor		
Cross-sensitivity		
< 20 ppm O_2 @	CO	100 vol%
	CO_2	100 vol%
	C_3H_8	100 vol%
	Benzol	1000 ppm
	NO	3000 ppm
	H_2	1000 ppm
	H_2S	2000 ppm
	SO_2	500 ppm

11.5.3 Cross-sensitivity of ZrO_2 sensor

The ZrO_2 sensor is cross-sensitive to all unburned hydrocarbons (e.g. COH_2). If unburned hydrocarbons are present, the ZrO_2 sensor will show a lower result.

11.5.4 Cross-sensitivity of thermal conductivity detector (TCD)

Please contact M&C for further information.

11.5.5 Cross-sensitivity of NDIR/NDUV/UVRAS measuring benches

In the field of application of NDUV measurements, there are advantageously no cross-sensitivities to water vapor. There are no disturbing cross-sensitivities to CO_2 and H_2O.

12 Service and maintenance

Before starting any service or maintenance work, please make sure that any work done on the analyzer is in compliance with all relevant regulations and standards.

Qualified personnel	The service and maintenance work should be carried out exclusively by qualified personnel, preferably by M&C or your authorized M&C distributor.

High Voltage!	Disconnect power supply before opening the device for access. Make sure that all external power supplies are disconnected.

Make sure to follow the proper precautions by working on unplugged or low-voltage devices. Unplugged devices need to be properly grounded to prevent damage to internal electronics from electrostatic discharges (ESD).

- In case of an error, please check if the conditioning of the sample gas, before the gas enters the analyzer, is in good working condition.
- Make sure that there are no leaks in the sample gas lines. Check all gas fittings if they are connected correctly.
- To ensure a long analyzer lifetime and accurate operation use only original spare parts and consumables from M&C.

12.1 Recommended maintenance work

The routine maintenance work is only limited to monitoring the zero point or limit point, and if necessary, calibrating these values.

The intervals between servicing are dependent on the process and system conditions in your facility.

The facility QA/QC plan should address the frequency for maintenance and should be updated based on your operations and analyzer functionality.

13 Options and spare parts list

Option: Filters for front mounting		
Part-No.	**Description**	**Comments**
04F2100	Filter for front mounting FPF+	Material of wetted parts: PTFE, glass, FPM
The following parts can only be used in combination with the above-mentioned front installation filter FPF+		
90F0002	Filter element type F-2T, length: 75 mm, material: PTFE, pore size: 2 µm	
90F0004	Filter element type F-20T, length: 75 mm, material: PTFE, pore size: 20 µm	
90F0003	Filter element type F-50T, length: 75 mm, material: PTFE, pore size: 50 µm	
90F0005	Filter element type F-3G, length: 75 mm, material: glass, pore size: 3 µm	
90F0011	Filter element type F-2GF, length: 75 mm, material: glass fiber, pore size: 2 µm, packs of 25 pieces (2 x adapter rings Part-No. 93S0050 are needed to mount the filter element)	
90F0016	Filter element type F-0,1GF, length: 64 mm, material: glass fiber, pore size: 0.1 µm, (2 x adapter rings Part-No. 93S0050 are needed to mount the filter element)	
90F0550	Filter element type F-0,05SIC, length: 75 mm, material: ceramic, pore size: 0.05 µm.	
90F0006	Filter element type F-2K, length: 75 mm, material: ceramic, pore size: 2 µm	
90F0007	Filter element type F-20K, length: 75 mm, material: ceramic, pore size: 20 µm	
90F0008	Filter element type F-3SS. length: 75 mm, material: SS 316L, pore size: 3 µm	
90F0010	Filter element type F-20SS. length: 75 mm, material: SS 316L, pore size: 20 µm	
90F0115	Filter wool holder element FW-1 for universal filters, without filling, material: SS 316Ti	
90F0117	Filter wool holder element FW-2 for universal filters, without filling, material: PVDF	
93S2083	Special glass wool, resistant to high temperature for filter wool holder element FW. Content: 1000 g	
93S0050	Adapter ring for filter element F-0,1GF and F-2GF. material: PTFE (1 piece)	

Option: Flow meter		
Part-No.	**Description**	**Comments**
09F4000	Flow meter for front mounting	7-70 Nl/h air, Measuring range calibrated at 1 bar abs, 20 °C [68 °F], material of the wetted parts: PVDF, glass, Hastelloy C4, FPM, the flow meter is equipped with a fine adjustment valve in the inlet for precise flow rate adjustment.

Option: Telescopic slides for 19“-Rack		
Part-No.	**Description**	**Comments**
98A2500	US-version: Set of telescopic slides for 19"-Rack	Allows the analyzer enclosure to be completely extended from the 19“ rack. Kit for retrofitting to enclosure and rack. Telescopic slide type: GeneralDevices C-300-S-124 Incl. mounting adapter and mounting material
98A2550	European-version: Set of telescopic slides for 19“-Rack	Allows the analyzer enclosure to be completely extended from the 19“ rack. Kit for retrofitting to enclosure and rack. Telescopic slide type: Rittal RP 3659.180 Incl. mounting adapter and mounting material

The replacement interval for spare parts and consumables depends on the specific operating condition of the analyzer.

The product label with the serial number is located on the back of the Multigas Analyzer V2.2. Please refer to this serial number if you need to order spare parts or consumables.

Spare parts: Fuses		
Part-No.	**Description**	**Comments**
S10012	Spare fuse TR5 50 mAT	Type TR5, current 50 mA, Protection type: Time delay
S10009	Spare fuse TR5 200 mAT	Type TR5, current 200 mA, Protection type: Time delay
S10015	Spare fuse TR5 500 mAT	Type TR5, current 500 mA, Protection type: Time delay
S10011	Spare fuse TR5 1 AT	Type TR5, current 1 A, Protection type: Time delay
S10021	Spare fuse TR5 2 AT	Type TR5, current 2 A, Protection type: Time delay

Spare parts: Enclosure spare parts		
Part-No.	**Description**	**Comments**
MM0090	Set with 4 pieces of device feet (rubber)	
GH4G2.2/08	19"-mounting bracket	order 2 pieces per device, steel, powder-coated dust-grey RAL7037
GH4SCC-S/10	Handle for 19"-mounting bracket	Steel, matt-finished chrome, order 2 pieces per device

14 Appendix

14.1 Trouble shooting

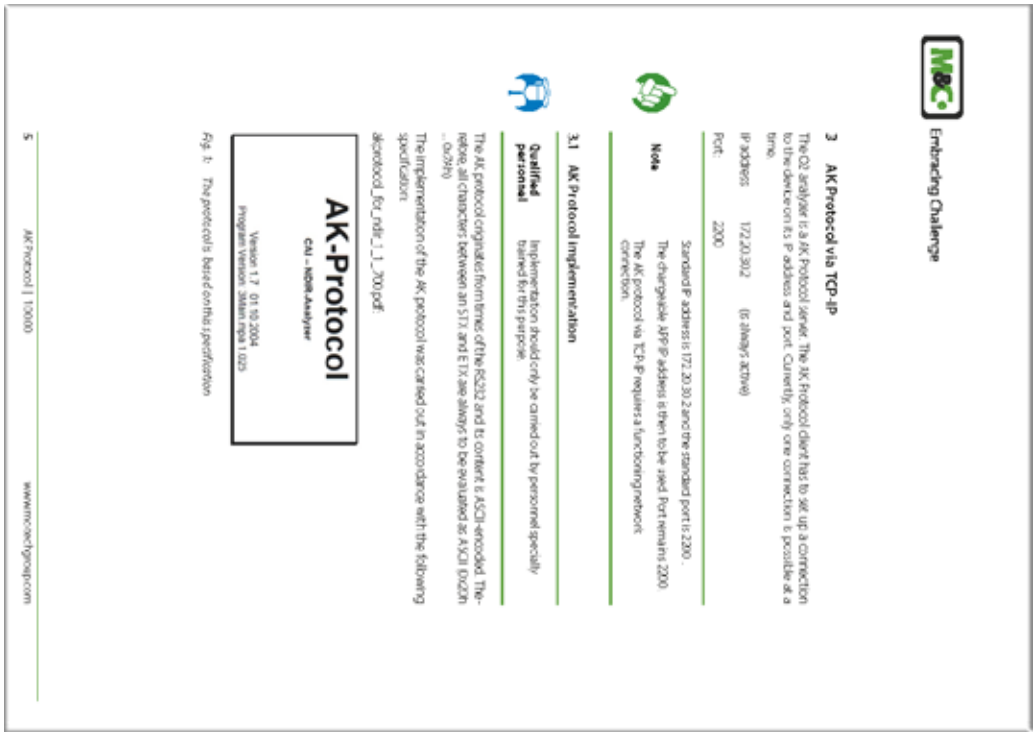
For easy access to information, please look at the technical documentation in section M6/ S1. You will reach this screen by tapping on the Help button.

Do you need help?	Please contact M&C, if you need help with trouble shooting!

14.2 AK protocol

This communication protocol is an excerpt from the document „GenTwo® AK Protocol Description", Version 1.00.00, software version 1.00.010.

Note	The AK protocol description is available as a separate document.



3.2 Protocol Legend

Abbreviation	Description
Kx	"K" + channel number of the HMI display (Kl ...K9)
fl	float measuring value (e.g. concentration)
E	Error code '0' = No error 'S' = Syntax error, e.g. received message not complete 'N' = Not included, e.g. received request is not (yet) included in the HMI software
s	Status individual bits '0' or '1'
S32	Status 32 bit '0' or '1'
STX	Start identifier of a data record (0x02h) "Start of text"
ETX	End identifier of a data record (0x03h) "End of text"
SPACE	Separating identifier of a data record (0x20h) "space = Separator" between data blocks and control characters
HMI	is AK protocol server and replies to requests from the PC
PC/Remote software	is AK protocol client and initiator of the protocol

3.3 General setup: Data Record/Request from PC (Initiator)

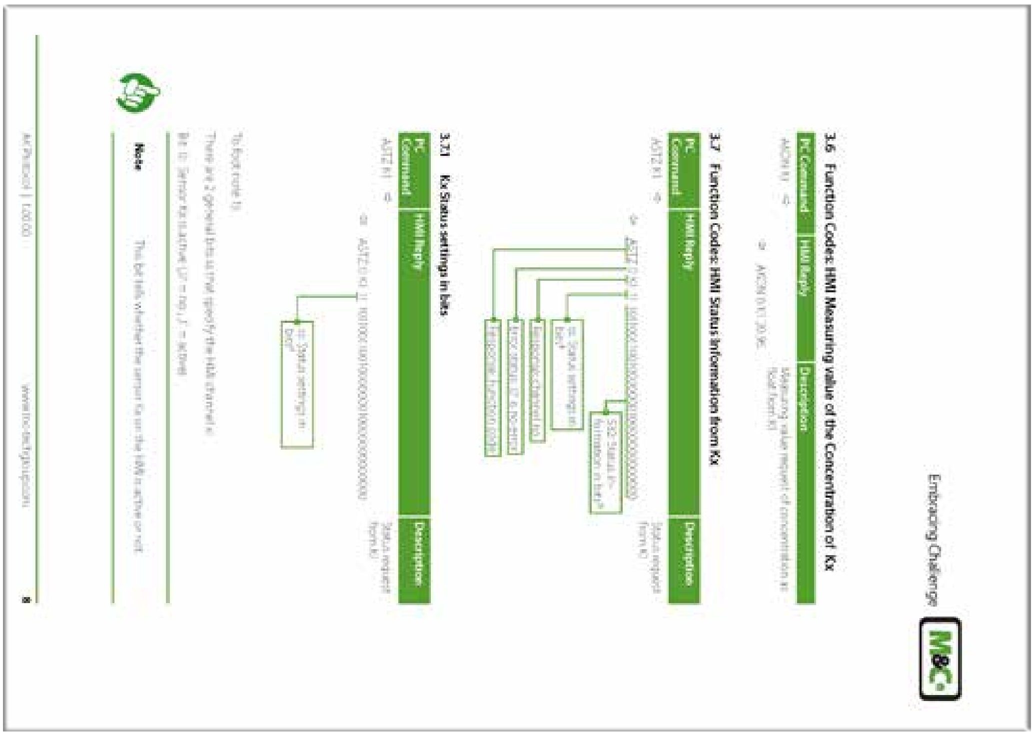
Byte	Description	Value (HexCode)	Note
1	STX	0x02	Start identifier
2	SPACE	0x20	Separator
3	Function Code 1	0xXX	AK function code, eg.: ASTZ always consists of 4 ASCII codes Between 'A' and 'Z'
4	Function Code 2	0xXX	
5	Function Code 3	0xXX	
6	Function Code 4	0xXX	
7	SPACE	0x20	Separator
8	K	0x4B	'K' for channel
9	x	0x31 - 0x39	Indicates the HMI channel no. "Kx" which data are to be read by the HMI
10	SPACE	0x20	Separator
...	D		AK functional parameter
...	s		Length is variable
...	t		For most requests, further parameters do not apply, therefore these data remain "empty"
...	e		
...	n		
n-1	SPACE	0x20	Separator in front of the end of text
n	ETX	0x03	End identifier

3.4 General setup: Response Data Record of the HMI

Byte	Description	Value (HexCode)	Note
1	STX	0x02	Start identifier
2	SPACE	0x20	Separator
3	Function Code 1	0xXX	HMI response on the AK function code. Always consists of 4 ASCII codes between 'A' and 'Z'
4	Function Code 2	0xXX	
5	Function Code 3	0xXX	
6	Function Code 4	0xXX	
7	SPACE	0x20	Separator
	Error status		Error status
		0x30	'0' is no error
		0x53	'S' = Syntax error
		0x4E	'N' = Not included
8	SPACE	0x20	Separator
9	K	0x4B	'K' for channel
10	x	0x31 - 0x39	HMI response of the requested channel no. "Kx"
11	SPACE	0x20	Separator
...	D		HMI response data
...	s		Length is variable
...	t		Can be a status or a measuring value or ...
...	e		
...	n		
n-1	SPACE	0x20	Separator before end of text
n	ETX	0x03	Indicator for end

3.5 Protocol Error Descriptions

Byte	Description	Value (HexCode)	Note
	Error status		Error status
		0x30	'0' is no error
		0x53	'S' = Syntax error
		0x4E	'N' = Not included



Embracing Challenge

3.6 Function Codes: HMI Measuring value of the Concentration of Kx

PC Command	HMI Reply	Description
AKON Ki ⇨	⇨ AKON 0 Ki 20.95	Measuring value request of concentration as float from Ki

3.7 Function Codes: HMI Status Information from Kx

PC Command	HMI Reply	Description
ASTZ Ki ⇨	⇨ ASTZ 0 Ki 11 10010001001000000001000000000000000	Status request from Ki

3.7.1 Kx Status settings in bits

PC Command	HMI Reply	Description
ASTZ Ki ⇨	⇨ ASTZ 0 Ki 11 10010001001000000001000000000000000	Status request from Ki

To foot note 1):

There are 2 general bits ss that specify the HMI channel xi:

Bit 0: Sensor Kx is active ('0' = no, '1' = active)

Note This bit tells whether the sensor Kx on the HMI is active or not.

AK Protocol | 1.00.00 www.mc-techgroup.com 8

Embracing Challenge

Bit 1: Kx concentration unit in Vol-%/ppm ('1' = vol%, '2' = ppm)

Note If no previous ASTZ request takes place, then the unit of concentration is undefined.

3.7.2 Kx Status information in 32 bits

PC Command	HMI Reply	Description
ASTZ Ki ⇨	⇨ ASTZ 0 Ki 11 10010001001000000001000000000000000	Status request from Ki

To foot note 2):

Bit	Channel	
0	Kx ready for measuring	(0 = not ready [false], 1 = ready [true])
1	Kx Collective Status	(0 = ok, no error, 1 = any error)
2	I/O Relais R1	(0 = off, 1 = on) for safety first
3	I/O Relais R2	(0 = off, 1 = on) for calibration
4	I/O HighSideSwitch 1	(0 = off, 1 = on) for measuring range 2
5	I/O-HighSideSwitch 2	(0 = off, 1 = on) for measuring range 3
6	I/O-HighSideSwitch 3	(0 = off, 1 = on) for operational limit Um1
7	I/O-HighSideSwitch 4	(0 = off, 1 = on) for operational limit Um2
8	Error: Temperature	(0 = no, 1 = yes)
9	Error: Pressure	(0 = no, 1 = yes)
10	Error: Flow	(0 = no, 1 = yes)
11	Not in use	Reserve (bits 11 to 15)
12		
13		
14		
15		
16	measuring range 1	(0 = no, 1 = yes) selected measuring range 1
17	measuring range 2	(0 = no, 1 = yes) selected measuring range 2
18	measuring range 3	(0 = no, 1 = yes) selected measuring range 3
19	measuring range 4	(0 = no, 1 = yes) selected measuring range 4
20 bis 31	Not in use	Reserve (bits 20 to 31)

9 AK Protocol | 1.00.00 www.mc-techgroup.com

14.3 Modbus protocol

This communication protocol is an excerpt from the document „GenTwo® Modbus Protocol Description with Applications“, Version 1.00.00, software version 2.00.100.

Note	The Modbus protocol description with applications is available as a separate document.

3 Modbus-TCP

The O2 analyzer is a TCP server. The TCP client has to set up a connection to the device on its IP address and port. Currently, only one connection is possible at a time.

IP adresse: 172.20.30.2 (is always active)

Port: 5000 or 502

3.1 Modbus protocol implementation

Qualified personnel Implementation should only be carried out by personnel specially trained for this purpose.

The MODBUS protocol was implemented in line with the following specifications:

MODBUS Protocol Specification, December 28, 2006

(Modbus_application_Protocol_V1_1b.pdf)

MODBUS Messaging in TCP/IP Implementation Guide, October 24, 2006

(Modbus_Messaging_Implementation_Guide_V1_0b.pdf)

The specifications are available at:

http://www.modbus.org

http://www.modbus.org/specs.php

3.2 User data format

The data transmission is carried out in the Big Endian format (High Byte/Low Byte, High Word/Low Word).

Floating point data are transmitted in the IEEE 754 format.

Term	Number Bits	Description
S	1	Sign
E	8	Exponent
M	23	Mantissa
SEEEEEEE	EMMMMMMM	MMMMMMMM MMMMMMMM

3.3 Modbus frame

Example Request: Read Input Register

Byte	Description	Value	Description
	MBAP Header		
0	Transaction identifier (high)	0x00	0x0005: Consecutive number of request
1	Transaction identifier (low)	0x05	
2	Protocol identifier (high)	0x00	0x0000 = Modbus protocol
3	Protocol identifier (low)	0x00	
4	Length (high)	0x00	0x0006 bytes follow this byte
5	Length (low)	0x06	The value includes the last byte of the MBAP header
6	Unit identifier	0xFF	Can be any value
	General Modbus Frame		
7	Function code	0x04	0x04 = read input register
8	Start adress (high)	0x75	0x7531: start address 30001
9	Start adress (low)	0x31	
10	Number of 16 bit register (high)	0x00	Number of 16 bit register = 0x0004
11	Number of 16 bit register (low)	0x04	

Example Response: Read Input Register

Byte	Description	Value	Description
	MBAP Header		
0	Transaction identifier (high)	0x00	0x0005: Same identifier as in the request for clear assignment
1	Transaction identifier (low)	0x05	
2	Protocol identifier (high)	0x00	0x0000 = Modbus protocol
3	Protocol identifier (low)	0x00	
4	Length (high)	0x00	11 bytes follow this byte
5	Length (low)	0x0B	The value includes the last byte of the MBAP header
6	Unit identifier	0xFF	Same identifier as in the request

Byte	Description	Value	Description
	General Modbus Frame		
7	Function code	0x04	0x04 = read input register
8	Byte count	0x08	0x08 bytes follow
9	Byte 1	0x41	0x411E3282 IEEE = 9.882733
10	Byte 2	0x1E	
11	Byte 3	0x32	
12	Byte 4	0x82	
13	Byte 5	0x80	Status bits
14	Byte 6	0x00	
15	Byte 7	0x00	
16	Byte 8	0x0F	

3.4 Modbus functions implemented

Function Code	Function
0x01	Read Coils
0x02	Read Discrete Inputs
0x03	Read Holding Registers
0x04	Read Input Registers
0x05	Write Single Coil
0x06	Write Single Register
0x0F	Write Multiple Coils
0x10	Write Multiple Registers
0x14	Read File Record
0x15	Write File Record

Note MODBUS Protocol V 1.00 ... V 1.20 only includes **0x04**

3.5 Input register: general structure

The GenTwo® Multigas-Analyzer can process up to 10 channels, K1 ... K10. Per channel all input registers are identical.

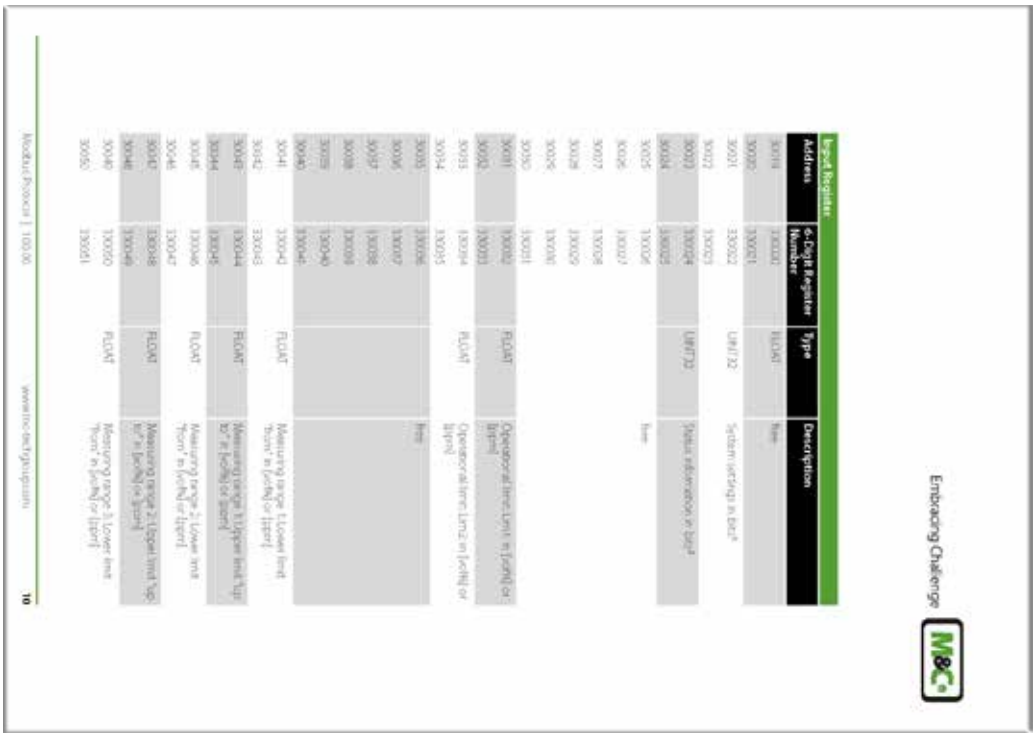
An offset of 100 is specified per channel, resulting in the following address ranges:

Channel	Address	Offset
K1	30001 ... 30099	0
K2	30101 ... 30199	100
K3	30201 ... 30299	200
K4	30301 ... 30399	300
K5 ...	30401 ... 30499	400

Note The polling frequency should not exceed 1 Hz.

3.6 Input register (description only applicable for K1, K2-K10)

Input Register			
Address	**6-Digit Register Number**	**Type**	**Description**
30001	330002	FLOAT	Measuring value 1: Concentration gas [vol%] or [ppm]
30002	330003		
30003	330004	FLOAT	Measuring value 2: Temperature in [°C]
30004	330005		
30005	330006	FLOAT	Measuring value 3: Pressure PIN in [mbar]
30006	330007		
30007	330008	FLOAT	Measuring value 4: Flow / Flow in [l/h]
30008	330009		
30009	330010	FLOAT	Measuring value 5: Pressure POUT in [mbar]
30010	330011		
30011	330012	FLOAT	Analog output I/O module; Current in [mA]
30012	330013		
30013	330014	FLOAT	Measuring value 6: pressure delta P (PIN – POUT) in [mbar]
30014	330015		
30015	330016	FLOAT	Calculation relative deviation of calibration-gradient mx in [%]
30016	330017		
30017	330018	FLOAT	Calculation relative deviation from calibration-offset +b in [%]
30018	330019		



Input Register

Address	6-Digit Register Number	Type	Description
30030	330031	UINT32	Status information in bin*
30031	330032		
30032	330033		
30033	330034		
30034	330035		
30035	330036		
30036	330037		
30037	330038		
30038	330039		
30039	330040		
30040	330041		
30041	330042	FLOAT	Measuring range 1 Lower limit "from" in [unit] or [ppm]
30042	330043		
30043	330044	FLOAT	Measuring range 1 Upper limit "to" in [unit] or [ppm]
30044	330045		
30045	330046	FLOAT	Measuring range 2 Lower limit "from" in [unit] or [ppm]
30046	330047		
30047	330048	FLOAT	Measuring range 2 Upper limit "to" in [unit] or [ppm]
30048	330049		
30049	330050	FLOAT	Measuring range 3 Lower limit "from" in [unit] or [ppm]
30050	330051		

Input Register

Address	6-Digit Register Number	Type	Description
30031	330032		
30032	330033		
30033	330034	FLOAT	Measuring range 4 Lower limit "from" in [unit] or [ppm]
30034	330035		
30035	330036	FLOAT	Measuring range 4 Upper limit "to" in [unit] or [ppm]
30036	330037		

3.6.1 System settings in bits

Input Register

Address	6-Digit Register Number	Type	Description
30031	330032	UINT32	System settings in bin*
30032	330033		

Focus note 1)

Bit	Channel	
0	Fix Sensor active	0 = no, 1 = active
1	Fix concentration used as volley point	0 = no, 1 = ppm

3.6.2 Status Information in bits

Input Register			
Address	**6-Digit Register Number**	**Type**	**Description**
30023	130024	UINT32	Status information in bits[2]
30024	130025		

Foot note 2):

Bit	Channel	
0	Kx Ready for measuring	(0 = not ready [false], 1 = ready [true])
1	Kx Collective status	(0 = ok, no error, 1 = any error)
2	I/O-Relais R1	(0 = off, 1 = on) for safety first
3	I/O-Relais R2	(0 = off, 1 = on) for calibration
4	I/O-HighSideSwitch 1	(0 = off, 1 = on) for measuring range 2
5	I/O-HighSideSwitch 2	(0 = off, 1 = on) for measuring range 3
6	I/O-HighSideSwitch 3	(0 = off, 1 = on) for operational limit Lim1
7	I/O-HighSideSwitch 4	(0 = off, 1 = on) for operational limit Lim2
8	Error: Temperature	(0 = no, 1 = yes)
9	Error: Pressure	(0 = no, 1 = yes)
10	Error: Flow	(0 = no, 1 = yes)
11	Error: IRbench error 1	(0 = no, 1 = yes) emitter faulty
12	Error: IRbench error 2	(0 = no, 1 = yes) signal measuring channel 1 not working properly
13	Error: IRbench error 3	(0 = no, 1 = yes) signal measuring channel 2 not working properly
14	Error: IRbench error 4	(0 = no, 1 = yes) signal measuring channel 3 not working properly
15	Not used	
16	Measuring range 1	(0 = no, 1 = yes) selected measuring range 1
17	Measuring range 2	(0 = no, 1 = yes) selected measuring range 2
18	Measuring range 3	(0 = no, 1 = yes) selected measuring range 3
19	Measuring range 4	(0 = no, 1 = yes) selected measuring range 4
20	Not used	
21	Error: RA gradient mir	(0 = no, 1 = yes)
22	Error: RA offset +b	(0 = no, 1 = yes)

Note The IR bench (if a circuit board is available) can have up to 4 errors. Further information can also be obtained in the event list at the HMI.

3.7 Holding Register

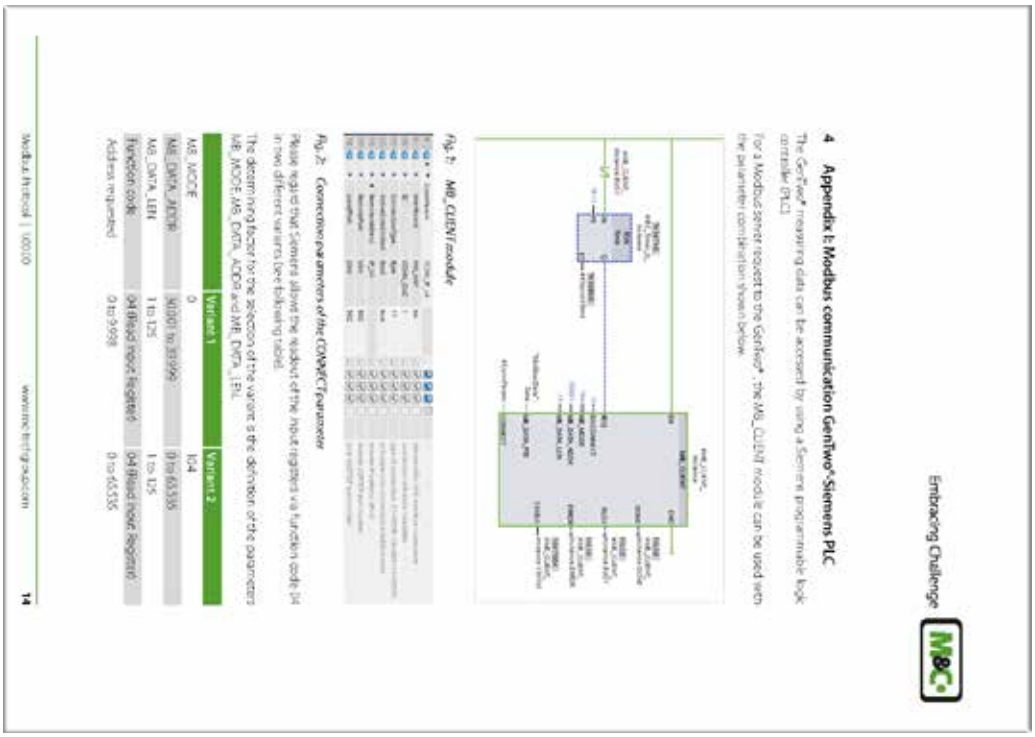
The holding register is currently not in use.

3.8 Coils

The coils are currently not in use.

3.9 File Records

The file records are currently not in use.



4 Appendix I: Modbus communication GenTwo®-Siemens PLC

The GenTwo® measuring data can be accessed by using a Siemens programmable logic controller (PLC).

For a Modbus client request to the GenTwo®, the MB_CLIENT module can be used with the parameter combination shown below.

Fig. 1: MB_CLIENT module

Fig. 2: Connection parameters of the CONNECT parameter

Please regard that Siemens allows the output of the input registers via function code 04 in two different variants (see following table).

The determining factor for the selection of the variant is the definition of the parameters MB_MODE, MB_DATA_ADDR and MB_DATA_LEN.

	Variant 1	Variant 2
MB_MODE	0	104
MB_DATA_ADDR	30001 to 39999	0 to 65535
MB_DATA_LEN	1 to 125	1 to 125
Function code	04 (Read input Register)	04 (Read input Register)
Address required	0 to 9998	0 to 65535

In variant 1 the function code to be used is determined in accordance with the parameter MB_MODE. In variant 2, the function code to be used is determined directly via the MB_MODE parameter.

Only variant 2 is suitable for reading out the measurement data of the GenTwo® from address 30001 due to the limited addressing of the first variant.

Note Read out GenTwo® measurement data starting from address 30001 with MB_MODE = 104

The response from the GenTwo® server is stored in the memory area of the PLC referred to by the MB_DATA_PTR parameter on the MB_CLIENT block. The screenshot shows the values of the „Modbus Data" block, which is the example server in the location of the received data.

Fig. 3: Data block structure by MB_DATA_PTR with GenTwo®-server response

Fig. 4: Screenshot of the GenTwo®-display (in comparison with Fig. 3)

The measured values of the GenTwo® are transmitted as IEEE754 32-bit floating point number in two 16-bit registers, therefore two registers must be queried per measured value (MB_DATA_LEN = 2 * number of measured values).

Note Two registers must be queried per measured value for readout (MB_DATA_LEN = 2 * number of measured values).

Components used:

- Hardware:
  SIMATIC ET 200SP - CPU1510SP-1 PN Siemens PLC (Siemens part No. 6ES7510-1DJ01-0AB0)
- Software:
  TIA Portal V15.1
  MB_CLIENT V5.1

5 Appendix II: application examples for troubleshooting

Note The Windows PC programs listed here are only application examples. It is completely up to you which program you want to use in your specific case. If you have any questions, please feel free to contact M&C TechGroup.

Various free or shareware Windows PC programs can be used for troubleshooting when commissioning the Modbus TCP function of the GenTwo® analyzer. These Windows PC programs can be used for many different Modbus protocols and hardware interfaces.

Due to the universal use of these Windows PC programs, it is possible that the address settings of the individual programs differ. This can lead to transmission problems and interfere with successful communication with the GenTwo®.

In these application examples, we describe the address settings of three different Windows PC programs as examples.

Note For checking TCP communication, it is recommended to use a network sniffer.

Note The reaction of these programs is according to the protocol description MODBUS Protocol V 1.00 .. V 1.20 only includes: **0x04**

Application examples in the form of screenshots are available for the following programs:

- CAS Modbus Scanner by Chipkin
- ModScan64
- Modbus Poll

5.1 Sample data

Queried for measuring channel 1:

- Gas concentration (30001+30002)
- Temperature of the sensor (30003+30004)

Values at the time of recording:

- Gas concentration: 0.07 or 0.09 vol%
- Temperature of the sensor: 41.6 or 42.4 °C

5.2 CAS Modbus Scanner by Chipkin

Fig. 5: Overview: screenshots for CAS Modbus Scanner by Chipkin

1. *GenTwo® display with measuring values*
2. *CAS Modbus Scanner input window*
3. *Reaction from the CAS Modbus Scanner with retrieved measuring data*
4. *Log: query and response telegram of the CAS Modbus Scanner*

Fig. 6: Sample values: CAS Modbus Scanner by Chipkin

1. *Retrieved measured value concentration: 0.09 Vol.-% shown here in CAS Modbus Scanner, displayed as Float32*
2. *Retrieved measured value temperature: 42.4 °C shown here in CAS Modbus Scanner, displayed as Float32*
3. *Settings for query starting from address 30001, length = 4*

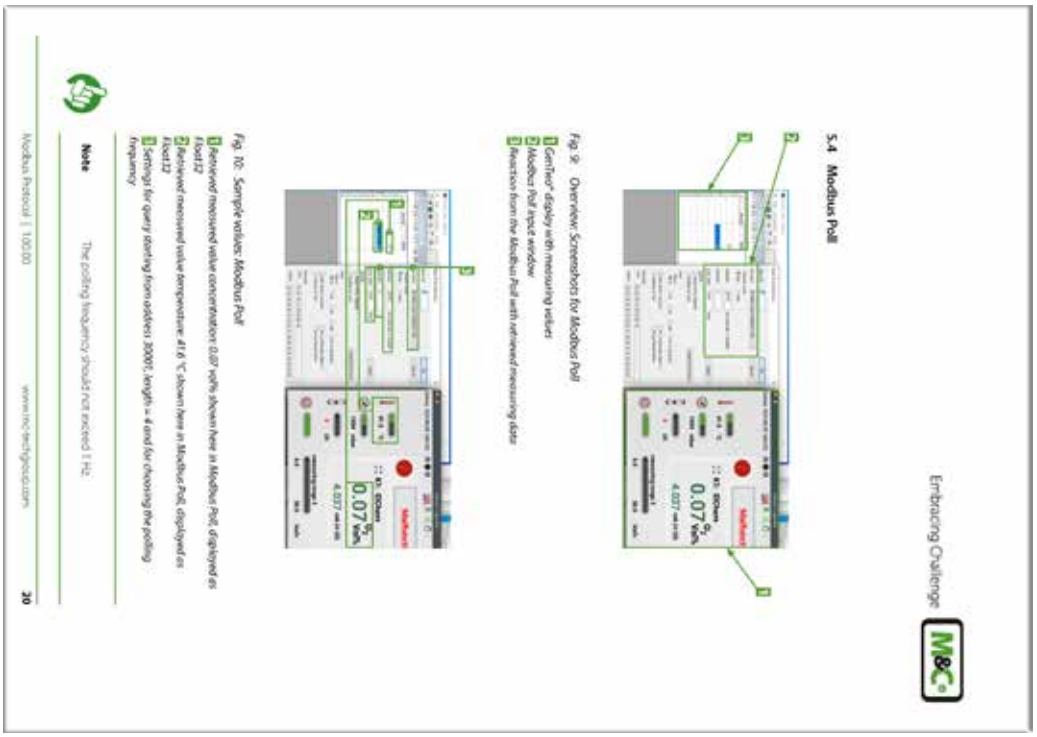
5.3 ModScan64

Fig. 7: Overview: Screenshots for ModScan64

1. *GenTwo® display with measuring values*
2. *ModScan64 input window*
3. *Reaction from the ModScan64 with retrieved measuring data*

Fig. 8: Sample values: ModScan64

1. *Retrieved measured value concentration: 0.07 vol% shown here in ModScan64, displayed as Float32*
2. *Retrieved measured value temperature: 41.6 °C shown here in ModScan64, displayed as Float32*
3. *Settings for query starting from address 30001, length = 4*



14.4 Additional Information

More information about the analyzer can be found on our website:

www.mc-techgroup.com

14.5 Declaration of conformity

CE - Certification

The Multigas Analyzer V2.2 complies with the following EU directives:

EMC directives

The Multigas Analyzer V2.2 complies with the EC directive 2014/30/EU "Electromagnetic compatibility".

Low Voltage Directive

The Multigas Analyzer V2.2 meets the requirements of the Low Voltage Directive 2014/35/EU.

To ensure the compliance with this EC directive, the Multigas Analyzer V2.2 conforms to the DIN EN 61010 standard.

Declaration of conformity

The EU Declaration of conformity can be downloaded from the M&C website or directly requested from M&C.

14.6 Certificates

Certificates are available on our website:

www.mc-techgroup.com

14.7 Warranty

In case of a device failure, please contact M&C immediately or your authorized M&C distributor.

We have a warranty period of 12 months from the delivery date. The warranty covers only appropriately used products and does not cover the consumable parts. Please find the complete warranty conditions in our terms and conditions.

The warranty includes a free-of-charge repair at a M&C facility or the free replacement of the device. If you return a device to M&C, please be sure that it is properly packaged and shipped with protective packaging. The repaired or replaced device will be shipped free of delivery charges to the point of use.

For more information about shipping and handling of returned devices, please see page 110 '14.10 Shipping and handling'.

14.8 Liability and disclaimer

This instruction manual is an original M&C document. It does not claim to be complete and it may be subject to technical modifications. We are not responsible for any printing errors or errors in the content of the manual. Please be assured that precautions have been taken to prevent errors in our product documentation to provide you with the best possible and accurate information.

Liabilities for indirect and direct damages that are related to the delivery or the usage of this instruction manual are excluded.

We are not liable for the content of translations from sources which are not authorized by M&C.

With the release of this version all older instruction manual versions will no longer be valid.

14.9 Storage

If you plan to store your M&C product before installing and operating, please follow these storage recommendations. Make sure that the device is stored in a protected, dry and well ventilated area. Please cover the device with an appropriate cover to protect it from dirt and liquids.

If you have any questions about proper storage of your M&C products, please feel free to contact us.

14.10 Shipping and handling

If you need to ship your M&C product to another department inside your company or back to M&C, please follow these shipping and handling recommendations.

Please ship the device in its original packaging. This is the best way to protect the device. If the original packaging is not available any more, please use a sturdy cardboard box with enough packaging material to protect the device from damages during shipping.

If you send your M&C product in for maintenance work at our M&C facility, please send the properly packaged device to the M&C TechGroup address in the USA or Germany as needed.

14.11 Proper disposal of the device

At the end of the life cycle of our products, it is important to take care of the appropriate disposal of obsolete electrical and non-electrical devices. To help protect our environment, please follow the rules and regulations of your country regarding recycling and waste management.

15 About us

15.1 M&C's group of companies

The M&C group of companies with its German headquarter and world wide market activities, has earned the reputation as one of the well-known and strongest partners in the market.

Our company, our products, special systems and overall services are well established in the market. We continuously belong to the best of the best of our industry. This makes us very proud. Our core competences are to find qualified solutions for even the most complex and demanding measuring tasks. We are developing answers to solve the technical demands of the future. With our focus on premium services, we are reliable, innovative and an overall cost effective market partner worldwide.

To learn more about M&C, please visit our website:

www.mc-techgroup.com

For even quicker access, please use our QR-code:

15.2 The quality-oriented M&C catalog

M&C offers national and international services, project planning and construction of special systems with a wide range of products. Our catalog covers a large variety of high quality products with in-depth knowledge of various customer applications. Our product excellence and innovative solutions continues to make M&C a world class company.

You can find the following product groups in our catalog. The combination of products from these groups offers a complete solution for most industrial needs. We develop, manufacture and test our products in accordance with a wide range of national and international standards.

Probes

Comprehensive range of probes with a large spectrum of available options for an almost unlimited range of applications.
Different materials available (Hastelloy, Titan, PTFE etc.)

Cooler

Optimised gas and condensate separation, low maintenance and self monitoring.
Compact design for wall mounting or 19" rack.

Filter

Suitable for all processes, due to the modular and user-specific configuration possibilities of the filter components.
Filter enclosures available in glass, stainless steel, PVDF, PTFE or in different metal combinations.

Portable components

Developed for high quality gas analysis at different locations.

Compact systems

Compact standard systems designed for a 19" enclosure or a plate structure.

Oxygen analyzer

A broad variety of products with high measuring accuracy.
Direct measuring is based on paramagnetic measuring principle (dumbbell-type).

15.3 Technical consulting services

M&C has earned a reputation as one of the most capable and experienced companies in the world, especially when it comes to difficult or complex measurement projects. We are proud that our customers have confidence in our products and continue to experience repeat business.

We also offer technical consulting for our components, devices and complete systems. We support our customers in finding individual solutions for their specific measuring tasks.

These individual solutions lead to new concepts of designing and building custom-made devices or complete systems. The dedication and commitment to finding solutions to the most complex and challenging tasks for our customers sets us apart from our competitors.

We have custom-made application experiences in many different fields worldwide. With this experience we are able to support our customers by seeking and finding errors, trouble shooting during day-to-day operation or identifying hard to find interferences.

15.3.1 Ideas, suggestions and feedback

All our activities are designed to meet and exceed the demands of the market and the specific interests of our customers. That's why M&C is very interested in developing products, processes and services which are in demand and up to date.

This means that your feedback, ideas and suggestions are very important to us.

Please let us know what kind of new improvements and innovations you would like to see at M&C. Tell us, what you like about M&C and what needs improvement.

Please send us an email or feel free to just call us ...

We appreciate your comments.

Table of Illustrations

Your contact to M&C in Germany and the USA

M&C TechGroup Germany GmbH

Rehhecke 79, 40885 Ratingen

- Service & repair phone: **+49 2102 935 - 888**
- Service & repair e-mail: **service@mc-techgroup.com**

M&C TechGroup NorthAmerica

6019 Olivas Park Drive, Suite G

Ventura CA 93003

- Phone: **+1 805 654 6970**
- E-mail: **info-usa@mc-techgroup.com**

Your M&C contacts world-wide

A detailed overview of our worldwide contacts can be found here:

http://www.mc-techgroup.com/en/contact