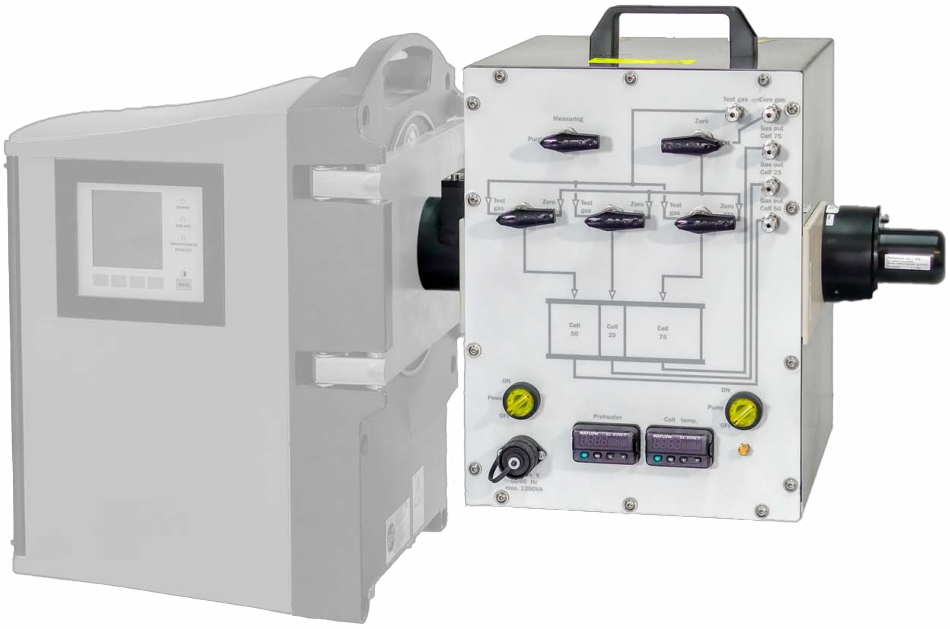
Operating Instruction
GMK03

Gas Test Unit



Endress+Hauser
People for Process Automation

Document identification
Product name: GMK03 Gas Test Unit

Manufacturer
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Legal information

Original document
This document is an original document of Endress+Hauser SICK GmbH+Co. KG.

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Content

1 About this Manual

1.1 Scope of application

These operating instructions apply exclusively to the measuring device described in the product identification.

It does not apply to other Endress+Hauser measuring devices.

The standards mentioned in the operating instructions must be observed in their current version.

1.2 Target groups

This manual is intended for persons who install, operate and maintain the device.

Operation

The device may only be operated by authorized persons who, due to their training and knowledge of the appliance and knowledge of the relevant regulations can assess the work assigned to them and recognize hazards.

Installation and maintenance

Installation and maintenance may only be carried out by trained specialists who are familiar with the installation conditions.

Observe the instructions at the beginning of each chapter.

1.3 Knowledge requirements

Additional technical qualifications for this product

- Safe handling of gases with health risk
- Safe handling of combustible gases
- Protection against the dangers of invisible laser radiation
- Service training for the respective gas analyzer
- *For applications with "Ex" versions of the gas analyzers:* Basic knowledge of explosion protection

Further knowledge requirements see "Other applicable documents", page 8.

Consequences of unauthorized interventions

CAUTION: Hazards through incorrect measures

Possible consequences of improper interventions and changes:

- Electrical safety is incomplete. This can endanger life.
- Sample gas paths are no longer tight. Sample gas released can be hazardous to health or form a dangerous gas mixture with air (depending on the application).
- Overpressure can cause the windows to burst (splinters and gas released).
- Dangerous artificial optical radiation may be emitted from the connected measuring devices.
- Measurement accuracy is impaired.
- Device functions are impaired or defective.
- The ex protection becomes void.

▶ Interventions and modifications must only be carried out according to the technical information provided by the manufacturer.

▶ Check and observe local regulations.

WARNING: Special hazards with this product
see “Special safety information for this product”, page 13

1.4 Manual contents (overview)

- Application variants
- Necessary auxiliary means
- Assembly and electrical installation of a test setup
- Safety information
- Preparation and execution of the metrological test
- Dismantling and transport

This Manual does not contain any information concerning maintenance and repair of the GMK03 gas test unit.

1.5 Other applicable documents

- Operating Instructions of the gas analyzer concerned
- Safety information (No. 8030257)

NOTE: Observe specific information of the gas analyzer
▶ *In addition to the information in this document:*
▶ Observe such information with priority in addition to this document.

1.6 Support

▶ *Primary contact:* Local Helpdesk

▶ Keep the following information available as far as possible:
- Device type, serial number, firmware version
- Measuring components, measuring ranges
- Ambient conditions (temperature, air humidity, possible acidic gases)
- Error messages (display)
- Own error description
- Damage history
- Repairs already made and replaced parts
- Contact address for calling back

1.7 Symbols in this Manual

1.7.1 Warning symbols

Symbol	Significance
	Hazard (general)
	Hazard by voltage
	Hazard in potentially explosive atmospheres
	Hazard through explosive substances/substance mixtures
	Hazard through toxic substances
	Hazard through corrosive substances
	Hazard through noxious substances
	Hazard through laser radiation
	Hazard through high temperature and hot surfaces
	Hazard for environment/nature/organisms

1.7.2 Warning levels and signal words

WARNING: Risk or hazardous situation which *could* result in severe personal injury or death.
CAUTION: Hazard or unsafe practice which *could* result in less severe or minor injuries.
NOTE: Hazard which *could* result in property damage.

1.7.3 Information symbols

Symbol	Significance
	Important technical information for this product
	Important information on electrical or electronic functions

2 General safety information

2.1 Responsibility of the plant operator

The plant operator must ensure that:

- Devices are mounted on both sides before operation
- Dummy plugs are removed before heating up or gas feed and only refitted after cooling down
- The maximum pressure of 1.1 bar(g) is not exceeded
- The GMK leak test is valid and the systems connected to it are leakproof
- Measures for operation with the gas choice at the concentration chosen are complied with, in particular for toxic/noxious/irritant gases. At best, concentrations should be selected that would also be safe in the event of a malfunction.
- The GMK03 gas test unit is purged with air or zero gas (30 minutes) after use, in particular when corrosive or toxic gases are used

2.2 General hazards through sample gas/test gases

WARNING: Hazards through explosive or combustible test gases

- ▶ Do not use the GMK03 gas test unit
  - – with explosive or flammable gases/gas mixtures
  - – with gases that can form an explosive gas mixture with air.

WARNING: Hazards through hazardous test gas

- *When the test gas can be hazardous to health:* Escaping test gas can be a hazard for humans.
- *When the test gas is flammable:* If test gas escapes in the event of a defect, a flammable gas mixture can form with the ambient air. This can result in a danger of explosion.
- Test gas could be released when the gas pressure at the gas connections of the GMK03 gas test unit is higher than the maximum allowable gas pressure[1].

- ▶ Observe the Safety Datasheets of the substances used. Observe the safety regulations described.
- ▶ Ensure gas paths are gas-tight (seals, screw connections).
- ▶ Ensure the maximum allowable gas pressure is not exceeded.
- ▶ Ensure the workplace is adequately ventilated.

[1] see “Gas technical data”, page 53.

WARNING: Hazards through condensate

- ▶ see “Dismantling the test setup”, page 50

2.3 General electrical safety

CAUTION: Hazards during electrical installation work

- ▶ **Install a circuit breaker:** Make sure the power voltage can be switched off at a circuit breaker that can be reached immediately (EN 61010-1/A1:2019).
- ▶ **Work without current applied:** Make sure the power voltage is disconnected before working on or in electrical components.
- ▶ **Ensure protective grounding:** Install the protective grounding (PE connections) of the devices before all other electrical installations.
- ▶ **Use suitable power lines:** Dimension power lines correctly (observe device specifications).
- ▶ **Ensure proper installation:** Only activate the power voltage when electrical safety is guaranteed.

- ▶ **Always follow the 5 safety rules:**

1 Switch off.
2 Secure against switching on.
3 Determine no voltage is applied.
4 Ground and short-circuit.
5 Cover or barrier off adjacent live parts.

3 About this product

The type plate is on the left side of the housing.
▶ Observe the sign indicating the next maintenance date (see “Maintenance (information)”, page 51).

3.1 Intended use

Purpose of the device

The GMK03 gas test unit is used to test the linearity of the measurement results of gas analyzers as required for a metrological quality test (e.g. for QAL2, QAL3). For this purpose, the GMK03 gas test unit can simulate several graded test gas concentrations with a single (suitable) test gas.

The associated PC software visualizes and stores the current test values. The final result of the test measurements is summarized in an XLS file (Microsoft Excel).

Application fields

The GMK03 gas test unit can be used with in-situ gas analyzers of the GM32, GM35 and GM700 series.

The GMK03 gas test unit is designed for indoor installation.

NOTE: Important application restriction
The GMK03 gas test unit is not suitable for use with test gases containing corrosive components (HCl, HF).
▶ Use the GMK10 gas test unit for this kind of application.

3.2 Application principle

The sender/receiver unit of the gas analyzer must be removed from the installation location for the test. The sender/receiver unit and the GMK03 gas test unit are then integrated together at a separate workplace.

A complete test setup comprises (overview):

- GMK03 gas test unit
- Sender/receiver unit of the gas analyzer
- Pressure cylinder with suitable test gas
- Adjustable pressure reducer for the pressure cylinder
- Gas lines for gas inlet and outlet

- Test setup example, see “Demonstrative test setup (example with GM32)”, page 27.
- Necessary accessories, see “Packing lists”, page 24.

3.3 Special safety information for this product

3.3.1 Application limitations

WARNING: Explosion hazard in potentially explosive atmospheres
The GMK03 gas test unit is not suitable for use in potentially explosive atmospheres.
- ▶ Do not use the GMK03 gas test unit in potentially explosive atmospheres.

WARNING: Explosion hazard through explosive sample gas
- ▶ Do not feed explosive gas mixtures.

WARNING: Poisoning hazard through escaping sample gases
If a pressure greater than 1,1 bar(g) is applied, toxic gases may escape through cell windows bursting and lead to severe poisoning.
- ▶ Do not apply a pressure greater than 1,1 bar(g).
- ▶ Do not heat the cell with dummy plugs.

3.3.2 Health hazards through measuring gases

WARNING: Toxic and corrosive substances in parts with sample gas contact
The gas analyzer must be disassembled to use the GMK03 test gas unit. If the gas analyzer was already in operation, the gas analyzer components with sample gas contact may contain toxic or corrosive substances - depending on the sample gas composition at the installation location.
Before working on the sample gas path:
- ▶ Clarify which substances the sample gas at the installation location may contain.
- ▶ Clarify whether and how the analyzer sample gas path has been cleaned.
- ▶ If necessary, clean the sample gas path.
- ▶ *In case of doubt:* Take suitable protective measures (ventilation/extractor, protective goggles/safety mask, protective gloves, acid-resistant protective clothing).

3.3.3 Regular maintenance tasks

NOTE:
- ▶ *After each period of use of 2 years:* Have all components of the GMK03 gas test unit checked and serviced (see “Maintenance (information)”, page 51).

Otherwise the measuring accuracy is no longer guaranteed.

3.4 Transport cases contents

Fig. 1: Transport case for GMK03

Legend		Explanation/Application
1	3-in-1 adapter for gas connections	see “Connect gas outlets”, page 29
2	GMK03 gas test unit	see “Device components”, page 16
3	Power cable	see “Create electrical connections”, page 30
4	Reflectors	see “Fit the reflector”, page 26
5	Documentation	*Ex manufacturer's works:* Test protocol

- Ordering data for individual parts, see “Order data”, page 54
- Necessary regular maintenance, see “Maintenance (information)”, page 51

Fig. 2: Transport case for GMK03 accessories

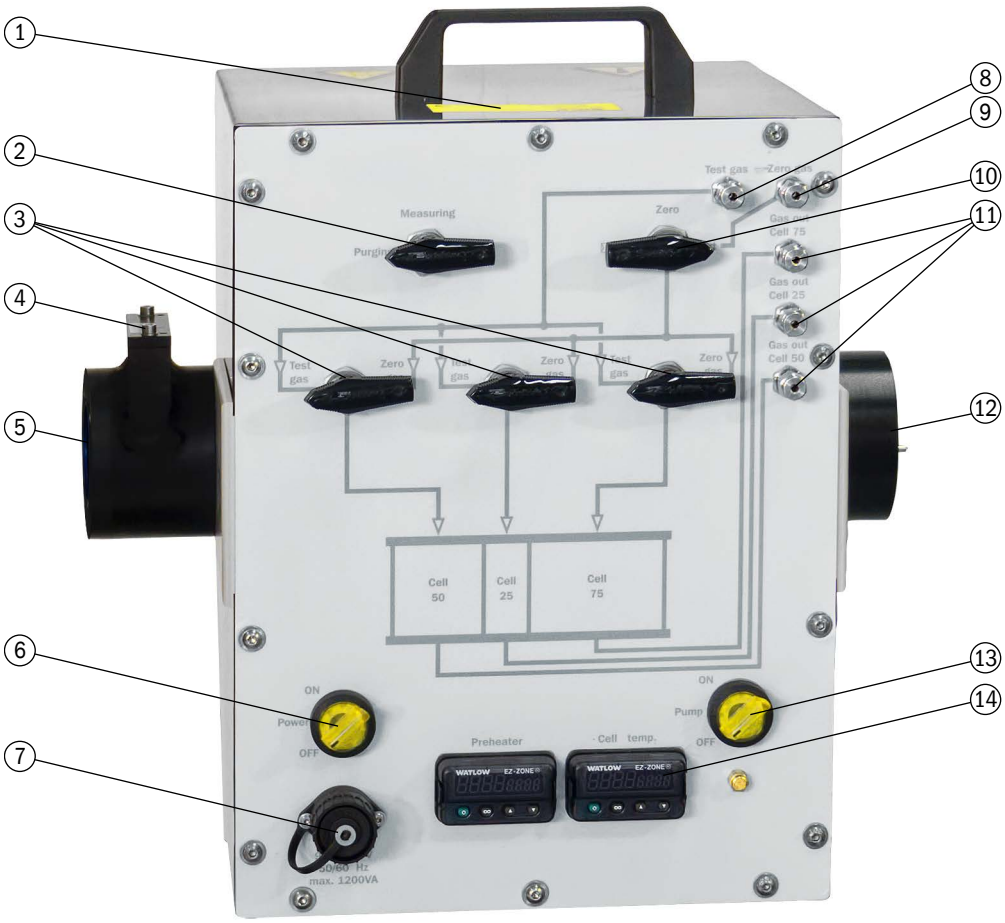
Legend		Explanation/Application
1	2 gas lines, ready to use for Swagelok connections	see “Connect zero gas and test gas”, page 30
2	Hose for gas outlet	see “Connect gas outlets”, page 29
3	Pressure measurement device	–
4	Wrenches	Open-end wrench SW 19/21/24 mm
5	Grid filter set	see “Performance with GM35”, page 40
6	Adapter for GM35	see “Fit the sender/receiver unit”, page 28
7	Adapter for GM32	
8	Adapter for GM700	
9	2 tension straps for pressure cylinders	see “Connect zero gas and test gas”, page 30
10	2 pressure reducers (for zero gas/test gas)	

- Ordering data for individual parts, see “Order data”, page 54
- Necessary regular maintenance, see “Maintenance (information)”, page 51

3.5 Device components

3.5.1 External elements (overview)

Fig. 3: Exterior view

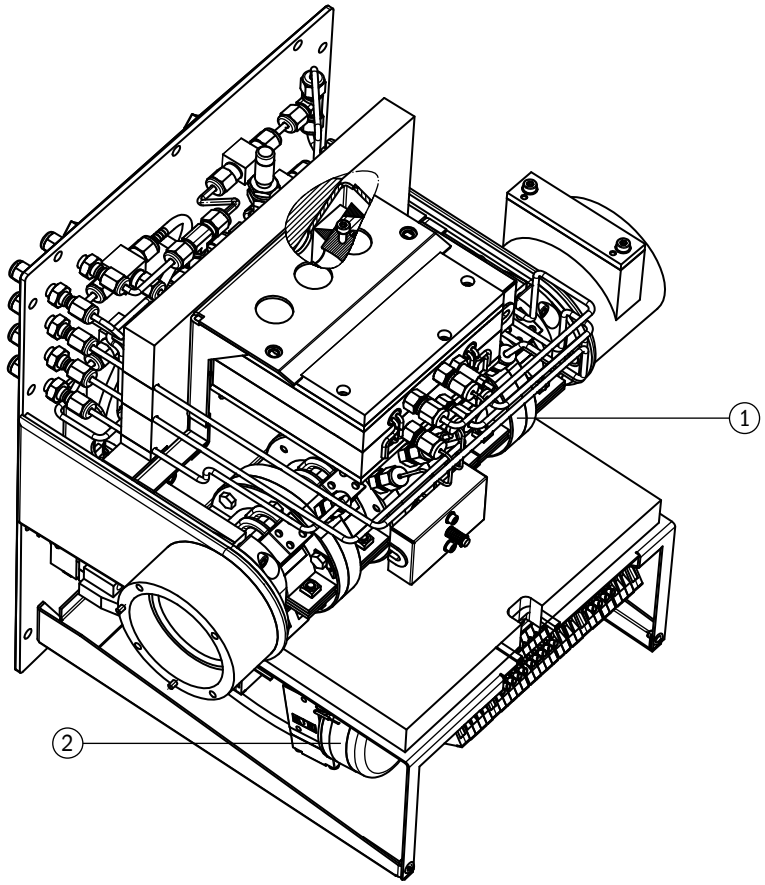


Legend		Explanation/Application
1	“Next test” label	see “Maintenance (information)”, page 51
2	Throttle valve	see “Performing test measurements”, page 37
3	Cell chamber valves	see “Application principle”, page 18
4	Grid filter slot	see “Performance with GM35”, page 40
5	Sender/receiver unit connection	see “Fit the sender/receiver unit”, page 28
6	Power switch	see “Prepare the test setup ready for operation”, page 31
7	Power cable connection	see “Create electrical connections”, page 30
8	Test gas inlet	see “Connect zero gas and test gas”, page 30
9	Zero gas inlet	
10	Switching valve for zero gas feed	see “Purge the cell with zero gas”, page 32
11	Cell chambers gas outlets	see “Connect gas outlets”, page 29
12	Reflector connection	see “Fit the reflector”, page 26
13	Internal gas pump switch	see “Purge the cell with zero gas”, page 32
14	Temperature controller of internal heaters	see “Prepare the test setup ready for operation”, page 31

3.5.2 Internal components

- Cell
- Switchover valves
- Power device (power voltage → 24 V DC)
- Auxiliary relay for temperature control (24 V DC → power voltage)
- 2 heaters (operated with power voltage)
- 2 over-temperature switches
- Gas pump (24 V DC)

Fig. 4: Internal view



Ref.: 9127640

1	Cell
2	Gas pump

3.6 Application principle

1 The sender/receiver unit of the gas analyzer and the GMK03 gas test unit are integrated together.
2 A PC with SOPAS software is connected and started.
3 A suitable test gas is fed into one of the cell chambers. The measured test value progression is displayed graphically on the PC.
4 This test measurement is repeated with the other two cell chambers.
5 The linearity of the measured values is visually evaluated on the PC screen.

- This allows simulating three different test gas concentrations with the same test gas (Calculation table see “Clarifying the technical conditions at the installation location”, page 20).
- The operator controls gas feed and purging times.
- The gas paths in the GMK03 gas test unit are selected manually.

Further test gas concentrations can be simulated by combining several cell chambers.

Fig. 5: Switching example: Filling one cell chamber with test gas

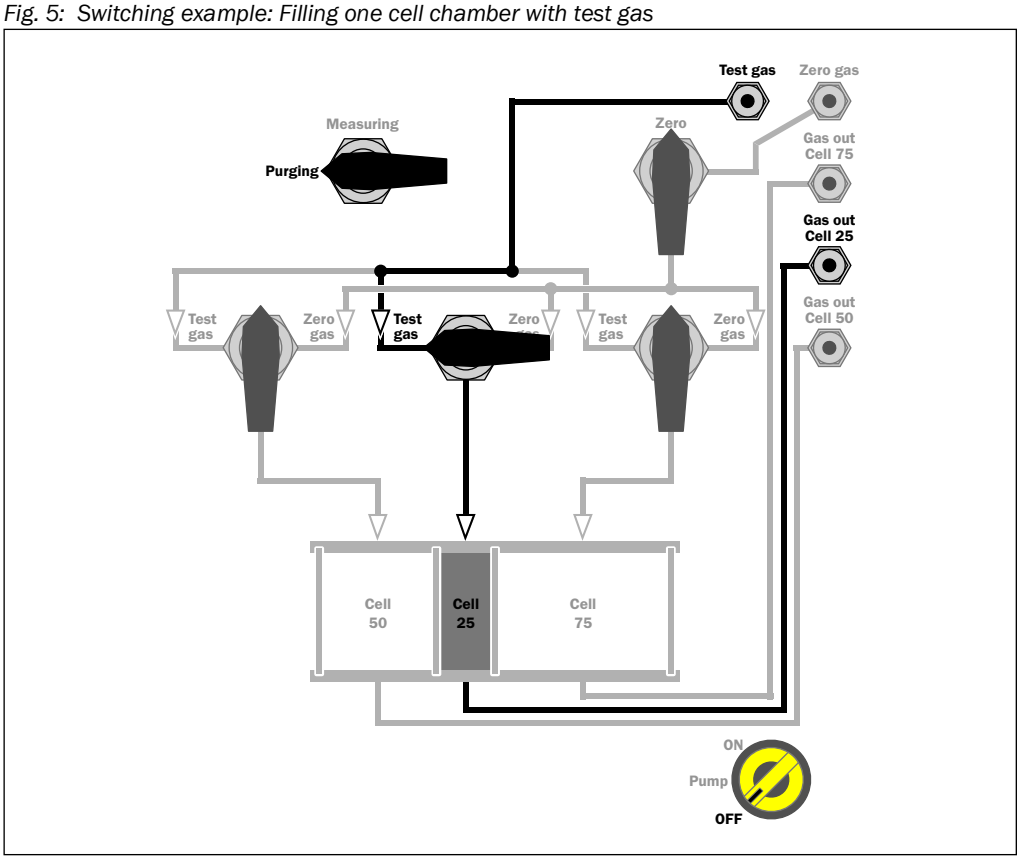


Fig. 6: Switching example: Purging all cell chambers with zero gas

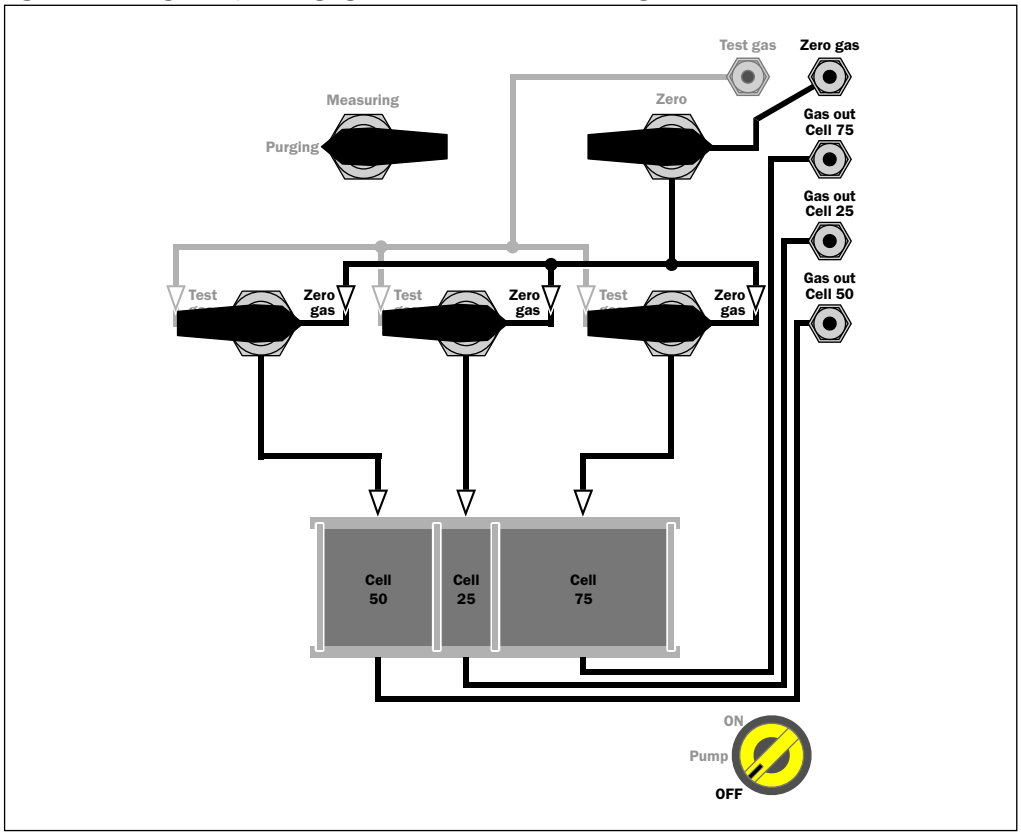
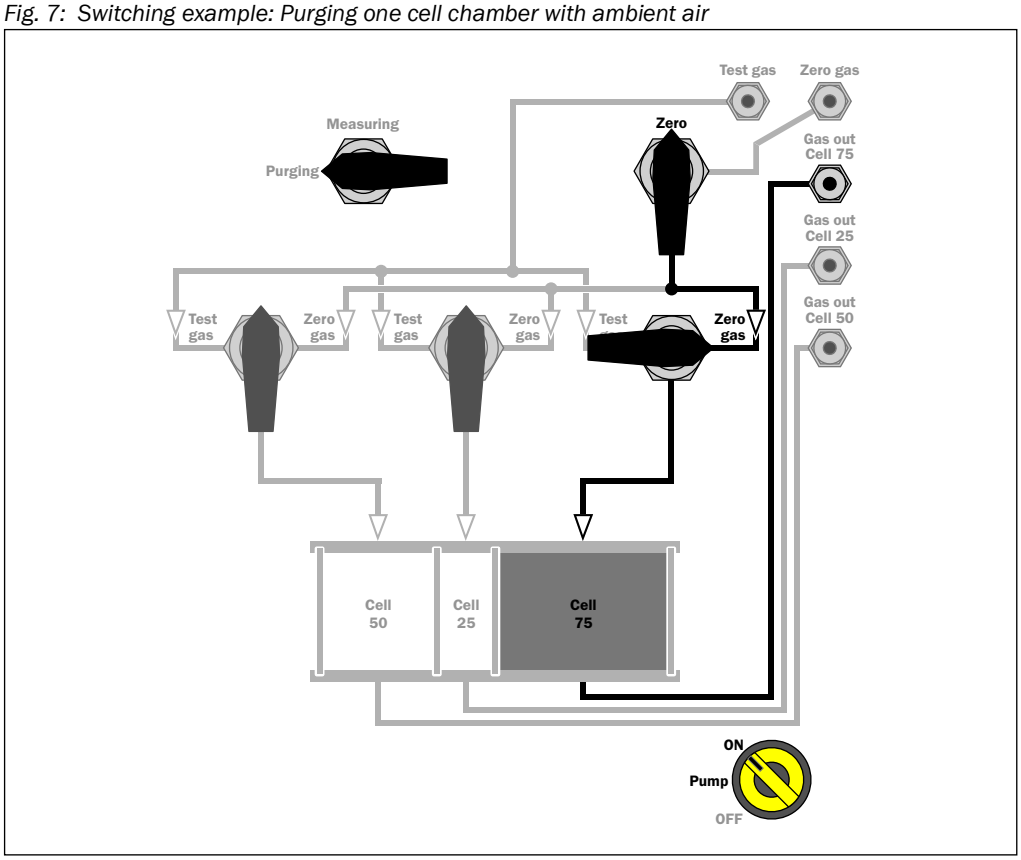


Fig. 7: Switching example: Purging one cell chamber with ambient air



4 Resource planning

4.1 Considering the amount of work involved

- The gas analyzer must be removed from the installation location.
- A suitable workplace is needed on site for the service work (see “Organizing the workplace at the test location”, page 20).
- After the work, the gas analyzer must be reassembled and put into operation as complete unit.

The GMK03 gas test unit takes about 2 hours after switching on until it reaches operating temperature and is ready for use.

4.2 Clarifying the technical conditions at the installation location

▶ Clarify type of gas analyzer (Cross-Duct/Probe, EX)

▶ Clarify measuring components and measuring range of the gas analyzer.
  »» Calculate suitable test gas (see “Calculating the suitable test gas”, page 21) and provide one pressure cylinder with this test gas.

4.3 Organizing the workplace at the test location

A suitable temporary workplace is required at the test location for the test work.
Requirements:

- Weatherproof, dust-free, ESD secured.
- Sufficient space for the test setup (see “Demonstrative test setup (example with GM32)”, page 27).
- *Recommendation:* Safe, stable work surface with space for the GMK03 gas test unit + gas analyzer sender/receiver unit.
- Power voltage supply.
- Connection to an exhaust gas line into which the test gas outlet can be routed.

4.4 Coordinating the work with the plant operator

▶ Coordinate the schedule date with the plant operator:
  – Clarify access to the installation location.
  – Announce disassembly of gas analyzer.
  – Announce downtime of gas analyzer.

▶ *If the installation location is in an EX area:*
  – Ensure the installation location does not have a potentially explosive atmosphere during this work.
  – Organize access authorization.

▶ Organize a suitable workplace for the test work.

4.5 Determining the suitable zero gas

Criteria

- *For measuring component NH_3:* Nitrogen must be used as zero gas (N_2 5.0).
- *For other measuring components:* If an inert gas supply is available on site at the workplace, this inert gas can be used as zero gas (instead of N_2). Prerequisite: The inert gas is dust-free and oil-free.
  - Instrument air can be used when purity is guaranteed (check visually).
  - Compressed air from a compressor or similar is generally not suitable.
- *For other measuring components with high measuring range end values:* Ambient air can be used as the zero gas when the ambient air at the workplace is free of gases measured by the gas analyzer used. The built-in gas pump can be used for suction.

NOTE:

▶ Only use the ambient air in exceptional cases when no other zero gas is available.

Consequences

▶ *When N2 must be used:* Provide a suitable N_2 pressure cylinder (*Recommendation:* 50 liter pressure cylinder).
▶ *When inert gas/instrument air could be used:* Clarify whether there is an appropriate gas supply on site at the planned workplace. *When this is the case:* Clarify quality and availability.
▶ *When ambient air could be used:* Clarify how the quality of ambient air at the workplace is (or will be) on-site. Using ambient air should be considered carefully. *In case of doubt:* Use N_2.

4.6 Calculating the suitable test gas

▶ Use the 'Test gas Calculator for GMK03 GMK10' software for all test gas calculations or contact the manufacturer.

4.6.1 Determine the necessary test gas concentration using the Conversion Table

1 Select the respective gas component in the Conversion Table.
2 Transfer the measurement range from the Test protocol to the Conversion Table. If the test protocol is not available, take the values from SOPAS (SOPAS project tree Diagnosis -> Device information).
3 The cuvette temperature is set to 80 °C as standard (Enter the cell temperature).
4 Provide test gas in the concentration calculated with the Conversion Table.

Test gas calculation (KiCo Tool)	
1. Select gas component	
Gas component	CO
2. Select ISO/DIN condition	
Country-specific	DIN1343: 1013,25 mbar, 0 °C
3. Select tool	
Tool	GMK03
4. Select measuring range of analyzer	
Measuring range concentration unit	mg/m3*m
Measuring range in mg/m3*m	50
Cuvette temperature in °C	80
Process temperature at time of measurement in °C	50
Active measuring path in mm	500
5. Concentration of test gas to order:	
Test gas concentration unit	ppm
Test gas concentration in Vppm	344,80

Value equals 100% of the possible measuring range. A lower concentration is possible. A higher concentration cannot be measured with the analyzer

4.6.2 Determine the necessary test gas concentration using formulas

Calculate the necessary test gas concentration using the following formulas:

$c_{analyzer}$	Analyzer concentration in according unit
c_{TG}	Test gas concentration in according unit
F_G	Gas conversion factor in g/dm^3 (for conversion ppm in mg/Nm3) (= Molecular weight/molar volume) See table for gas factor for each gas under reference values.
T_{gas}	Set temperature of filter box in °C
T_{ref}	Reference temperature
p_{gas}	Ambient pressure
p_{ref}	Reference pressure
L	Chamber length in mm

Formula for conversion ppm (test gas) to mg/Nm^3 (Analyzer concentration unit)

$$c_{analyzer} = c_{TG} * F_G * L * 0.001$$

Formula for conversion (test gas) to mg/m3 act. (Analyzer concentration unit)

$$c_{analyzer} = c_{TG} * F_G * \frac{273.15 + T_{ref}}{273.15 + T_{gas}} * \frac{p_{air}}{p_{ref}} * L * 0.001$$

Formula for conversion mg/Nm3 (test gas) to mg/m3 act. (Analyzer concentration unit)

$$c_{analyzer} = c_{TG} * \frac{273.15 + T_{ref}}{273.15 + T_{gas}} * \frac{p_{air}}{p_{ref}} * L$$

4.7 Evaluating the test measurements

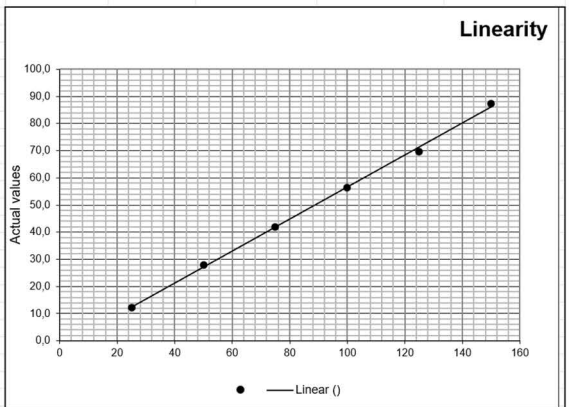
- ▶ Use the “Linearity test GMK03 GMK10” software for all test gas evaluations. If not available, the current version can be requested from the manufacturer.
- ▶ Use the linearity test computer as planned:

1 Enter the results of the test measurements.
2 Create the protocol file.
3 Archive the protocol file internally.
4 Hand over the protocol to the client.

Fig. 8: View of the Test protocol for GMK03

Certificate

	Value	Unit	
Date			
Tester			
Measurement point			
Company			
Mounting location			
Measuring device			
Manufacturer	Endress+Hauser SICK GmbH+Co. KG		
Type	GM32		
Serial no.			
Component			
Measuring range		mg/Nm3 (actual)	
Live Zero		mA	
MDI		mm	
Output of measuring values	Operation		
	Standard cond.		
GMK calibration			
Temperature test cell		°C	
Air pressure	1024	hPa	
Humiditiy		%	
Cell length	150	mm	
Ambient reference values			
Reference temperature		K	
Reference pressure		hPa	
Test equipment			
Test cell			
Serial no. Hovacal			
Test solution (test gas cylinder)			
Concentration		mg/Nm3 (actual)	
Manufacturer date			
Stability		M	
Tolerance		%	
Manufacturer no.			
Messtoleranz laut Prüfprotokoll			
Date		Date	
Test person		Customer	
Signature		Signature	



Chamber in mm	GM32 display		GM32 analog output	
	GMK	GM	GMK	GM
	Desired value	Average	Desired value	Average
25	0,00			
50	0,00			
75	0,00			
100	0,00			
125	0,00			
150	0,00			
Deviation				
Result				

4.8 Packing lists

4.8.1 GMK03 components

×	Designation
1	GMK03 gas test unit, in transport case [1][2]
2	Standard accessories for GMK03 gas test unit, in transport case [1][3]
3	Power cable, 10 m (2017519)
4	Power cable for a sender/receiver unit

[1] Order data, see page 54.
[2] Fig., see “Transport case for GMK03”, page 14.
[3] Fig., see “Transport case for GMK03 accessories”, page 15.

4.8.2 Test gases/pressure cylinders

×	Designation
1	Test gas pressure cylinder (with pressure reducer) [1]
2	Zero gas pressure cylinder (with pressure reducer) [2]
3	Suitable pressure reducers for the pressure cylinders [3]
4	Gas hoses [4]

[1] Test gas concentration, see “Calculating the suitable test gas”, page 21.
[2] Possibly not required (see “Determining the suitable zero gas”, page 21).
[3] Included in the accessories case (see “Transport case for GMK03 accessories”, page 15).
[4] Compare the contents of the accessories case (see “Transport case for GMK03 accessories”, page 15).

4.8.3 Special aids

×	Designation	Application
1	Interface cable, special (2048052)	Connection from gas analyzer to computer
2	IR identification card (5314327)[1]	Laser beam control (gas analyzer)
3	Laser adjustment fixture, set (2070444) [1]	Laser wave adjustment (gas analyzer)

[1] For GM700

4.8.4 Computer

×	PC hardware	Application
1	Mobile PC – with “Microsoft Windows” operating system – with RS-232 interface – with Ethernet interface [1]	Communication with the gas analyzer
2	USB-RS232 adapter [2]	
3	RS-232 extension cable	
4	Network cable [1]	

[1] For GM32
[2] Only when necessary (for PC without built-in RS-232 interface)

×	PC software (installed)	Application
1	SOPAS	Test procedures
2	Test gas calculator for GMK03/GMK10	Test gas calculations, results evaluation

4.8.5 Metrological technology

×	Designation	Application
1	Multimeter	Adjustment
2	ESD wristband (with crocodile clip)	Protection against electrostatic damage
3	Pressure gauge (6050323)	Checking the air pressure during zero gas measurement
4	Flowmeter “Test tool” (2065740)	Testing purge air volume

4.8.6 Tools/general aids

×	Designation
1	Standard tools case
2	Platform for the gas test unit, approx. 210 mm high [1]

[1] Make with temporary materials, e.g. transport boxes or stable cartons.

5 Usage at the test location

5.1 Disassembling the sender/receiver unit of the gas analyzer

At the gas analyzer installation location:

1 Disassemble the sender/receiver unit of the gas analyzer.
2 Transport the sender/receiver unit to the workplace.

It may be advantageous to disconnect the power voltage cable of the sender/receiver unit at an external point so that it can be used on the test setup (see gas analyzer Operating Instructions).

5.2 Creating the test setup

Workplace requirements, see “Organizing the workplace at the test location”, page 20.

5.2.1 Fit the reflector

▶ Fit the suitable reflector on the right side of the GMK03 gas test unit.

Reflectors explanation, see “Transport case for GMK03”, page 54.

The reflector must be heated together with the GMK03 gas test unit.
▶ Do not fit the reflector afterwards.

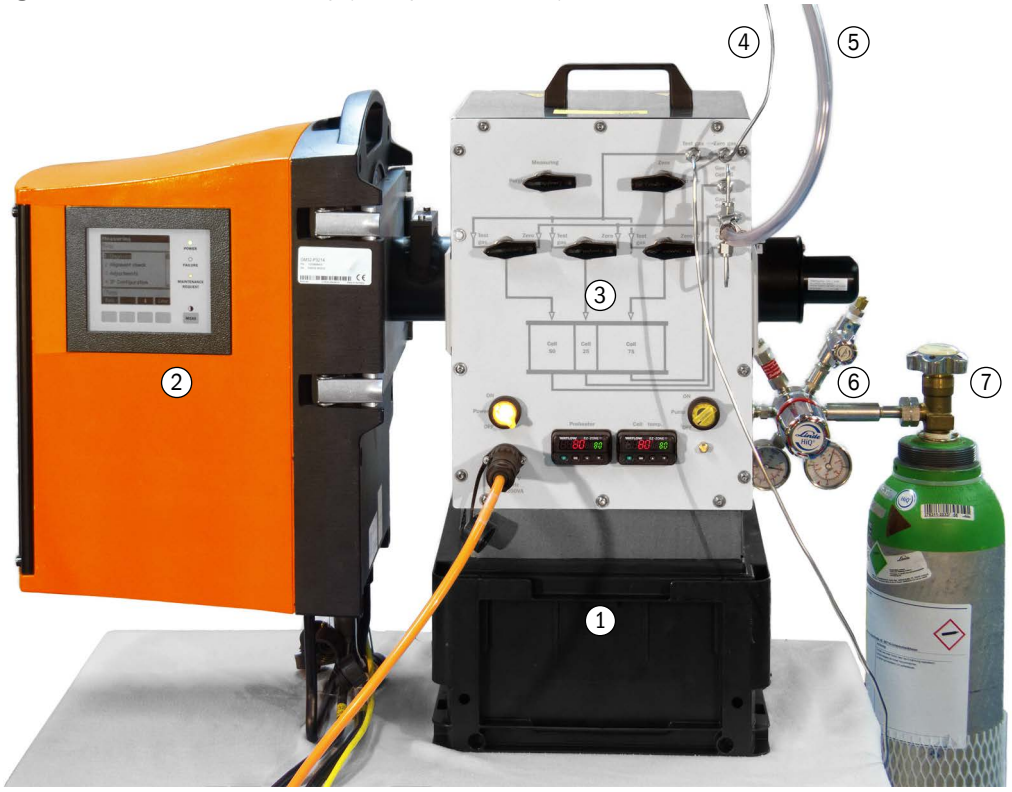
Fig. 9: Reflectors

5.2.2 Make a temporary platform

▶ Make a stable platform out of transport boxes or stable cartons, on which the GMK03 gas test unit can be placed (see Fig. 10). Tension straps for securing the GMK03 gas test unit on the platform are part of the scope of delivery.

The unit comprising the GMK03 + sender/receiver unit + connecting lines should stand safely on the platform.

Fig. 10: Demonstrative test setup (example with GM32)



1	Temporary platform
2	Sender/receiver unit of the gas analyzer
3	GMK03 gas test unit
4	Zero gas feed
5	Gas outlet
6	Pressure reducer
7	Test gas pressure cylinder

Not shown:	
•	Mobile PC

5.2.3 Fit the sender/receiver unit

1 Fit the suitable adapter on the left side of the GMK03 gas test unit.
   - ▶ Available adapters, see “Transport case for GMK03 accessories”, page 15.
   - ▶ Fit the GM32 adapter, see Fig. 11.
   - ▶ For fitting the GM35/GM700 adapter, see the gas analyzer Operating Instructions.
2 Fit the sender/receiver unit on the adapter.

Fig. 11: Adapter for GM32

5.2.4 Connect gas outlets

▶ Discharge gas outlets (see Fig. 12) at a safe location: Connect one hose each and connect to an exhaust gas connection line.

WARNING: Potentially dangerous test gas
The test gas may be harmful to health and/or the environment.
▶ Discharge the gas outlet to a safe location.
▶ Ensure all gas paths are leak tight.

Fig. 12: Gas connections

1	Test gas feed
2	Zero gas feed
3	Gas outlet
4	3-in-1 adapter (installation variant) [1]

[1] The 3-in-1 adapter can be used in most cases to connect the single gas outlets. *Restriction of use:* No back pressure which could falsify the test measurements may exist at the individual gas outlets. This is especially true when several cell chambers are to be used at the same time.

NOTE: Measurement falsification through pressure effects
▶ Make sure the gas outlet is unobstructed and uninterrupted (no back pressure, no pressure fluctuations).

5.2.5 Connect zero gas and test gas

1 Fix the pressure cylinders for zero gas and test gas in a safe place (close to the test setup).

Alternatives for zero gas from a pressure cylinder:
- When an inert gas supply is available at the workplace, this inert gas can be used as zero gas (*Exception:* Measuring component NH_3, see “Determining the suitable zero gas”, page 21). *Prerequisite:* The inert gas is dust-free and oil-free. Compressed air from a compressor or similar is generally not suitable.
- Ambient air can be used as the zero gas when the ambient air at the workplace is free of gases measured by the gas analyzer used. The built-in gas pump can be used for suction.

2 Fit the pressure reducer on the pressure cylinders.
3 Set the outlet pressure of the pressure reducer to the appropriate value (maximum permissible pressure, see “Gas technical data”, page 53).
4 Connect the zero gas feed to the **Zero gas** gas connection.
5 Connect the test gas feed to the **Test gas** gas connection.

5.2.6 Create electrical connections

▶ Devices must be flanged on both sides before making electrical connections (see “Make a temporary platform”, page 27 and “Fit the sender/receiver unit”, page 28) in order to prevent contact with the cuvette, as it may be live in the event of a fault..

▶ Connect the power cable of the GMK03 gas test unit (see “Exterior view”, page 16).
▶ Connect the sender/receiver unit and evaluation unit (→ Gas analyzer Operating Instructions).
▶ Connect the power voltage supply of the sender/receiver unit.

▶ Observe the power voltage specification on the type plate.

5.2.7 Establish data communication

▶ Connect the PC to the sender/receiver unit (gas analyzer Operating Instructions).

5.3 Putting the test setup into operation

5.3.1 Safety information for the test setup

WARNING: Potentially dangerous test gas
The test gas may be harmful to health and/or the environment.
- ▶ Discharge the gas outlet to a safe location.
- ▶ Ensure gas paths are gas-tight.
- ▶ Do not exceed the permissible gas pressure (see “Technical data”, page 53).

WARNING: Open laser- or UV-beam in disassembled state
A laser- or UV-beam emits out when the sender/receiver unit is operated alone or when no reflector is fitted on the GMK03 gas test unit. Eye contact with the laser- or UV-beam can cause serious eye injuries.
- ▶ Only operate the test setup when the sender/receiver unit and GMK03 are connected (see “Fit the sender/receiver unit”, page 28) and a reflector is fitted (see “Fit the reflector”, page 26).

WARNING: Poisoning hazard through escaping sample gases
Is a pressure greater than 1,1 bar(g) applied, toxic gases may escape through cell windows bursting and lead to severe poisoning.
- ▶ Do not apply a pressure greater than 1 bar(g).
- ▶ Do not heat the cell with dummy plugs.

5.3.2 Check/ensure the safety of the test setup

Check	Criterion
• The test setup is complete	Sender/receiver unit + GMK03 + reflector are integrated together.
• Gas tightness	Tightness of all gas connections is tested. [1]
• Gas outlets:	Connected correctly.
• Gas feed pressure	Set correctly. [2]

[1] As taught in the corresponding specific training.
[2] Maximum allowable pressure see “Gas technical data”, page 53.

5.3.3 Prepare the test setup ready for operation

1 Switch device on:	▶ GMK03: **Power** → **ON**. ▶ Activate the power voltage supply of the sender/receiver unit. ▶ Boot the PC.
2 Check/adjust GMK03:	▶ Check/adjust setpoint for **Preheater** (standard: 80 °C). ▶ Check/adjust setpoint for **Cell temp.** (standard: 80 °C).
3 Prepare the PC:	▶ Boot the PC. ▶ Check/establish network connection with sender/receiver unit (LAN via Ethernet).
4 Wait for warm-up time:	▶ Wait until GMK03 and sender/receiver unit have reached the operating temperature and are ready for operation.
5 Activate gas feeds.	1 Check/adjust: Feed pressure for zero gas and test gas ≈ 100 kPa (1.0 bar(g)). [1] 2 Open external supply valves (e.g. pressure cylinder valves).

[1] Not exceeding 110 kPa (1.1 bar(g)).

Usual warm-up time: Approx. 2 hours.

5.3.4 Prepare the sender/receiver unit

These measures are not necessary when an additional purge air attachment is connected to the sender/receiver unit which provides the current values for temperature and pressure.

In the sender/receiver unit:

- ▶ Activate the use of default values for temperature and pressure.
- ▶ Set the default pressure value to 1013 hPa
- ▶ Set the default temperature value to **Cell temp.** (setpoint) in Kelvin.

Instructions for these worksteps:
- *For GM32:* see “Performance with GM32”, page 33.
- *For GM35/GM700:* See the gas analyzer Operating Instructions.

5.3.5 Purge the cell with zero gas

1 Activate zero gas feed:

Basic purge settings:	▶ **Measuring/Purging → Purging**
	▶ **Test gas/Zero gas → Zero gas** for all cell chambers (3x)

For: • Zero gas pressure cylinder • Inert gas feed on site	1 **Zero/Ext. → Ext.**
	2 **Pump → OFF**
	3 Open zero gas pressure cylinder *or* open external zero gas valve.
Illustration see Fig. 6, page 19	

For: Ambient air via built-in gas pump	1 **Zero/Ext. → Zero**
	2 **Pump → ON**
Illustration see Fig. 7, page 19	

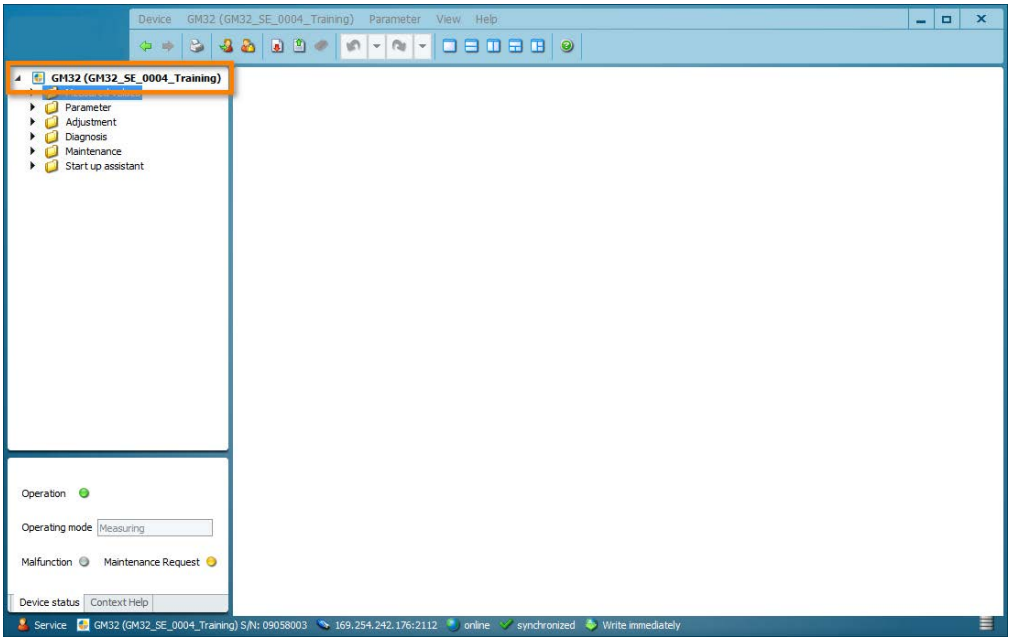
2 Let the test setup run for about 60 minutes in this state.
3 Wait until the measured value of the sender/receiver unit remains constant at “0”.
4 *Recommendation for GM35/GM700:*
If the measured value in this state deviates from “0.0” by more than 2% of the measuring range end value: Carry out a zero adjustment (see gas analyzer Operating Instructions).
5 Deactivate zero gas feed:
– For all 3 cell chambers: **Test gas/Zero gas** → *Neutral position*
– Stop zero gas feed externally (e.g. close the valve of the zero gas pressure cylinder).

6 Performance with GM32

6.1 Preparing the test measurements

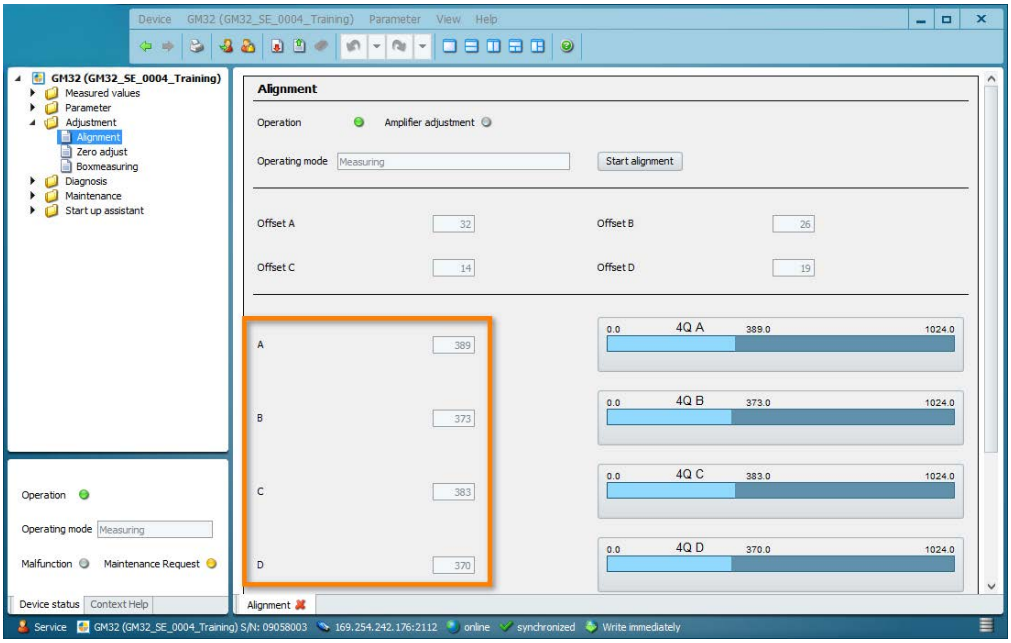
Step 1: Start	
PC:	1 Start SOPAS.
SOPAS:	2 Connect to the sender/receiver unit.
	3 Login to “Service” function area.

Fig. 13: Program window with a sender/receiver unit (after step 1, example)



Step 2: Check the sender/receiver unit status	
SOPAS:	1 Call up **Adjustment** → **Alignment**.
	2 Read off the values for **A B C D** (see “Window “Alignment” (Step 2, example)”, page 34): – *If one value is less than* **300***:* Carry out corrective measures (see gas analyzer Service Manual). Then restart the test measurements. – *Otherwise:* Continue with the test measurement.

Fig. 14: Window “Alignment” (Step 2, example)

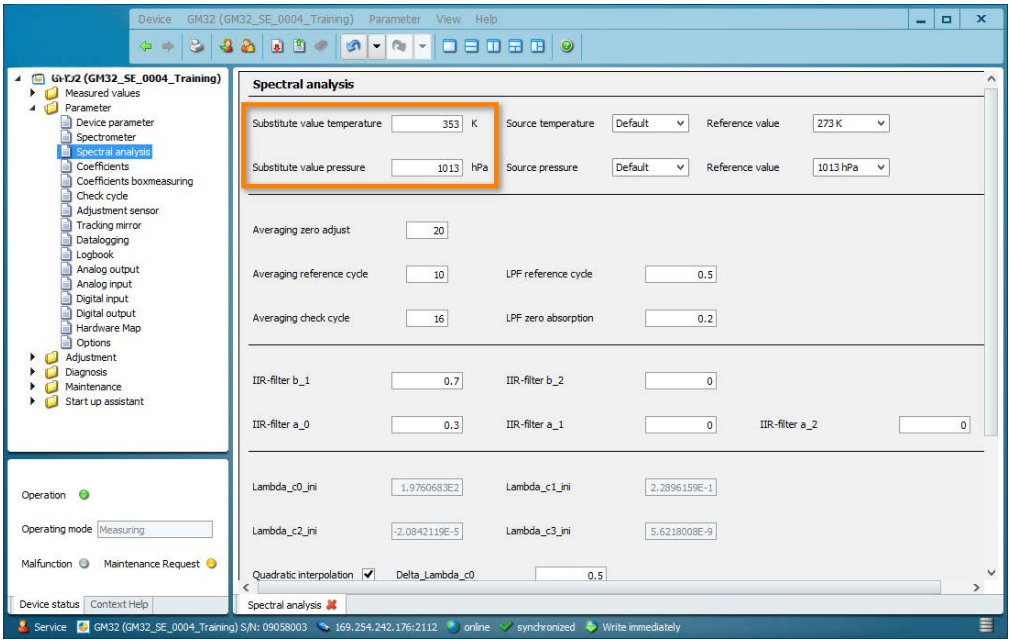


Step 3: Purge with zero gas	
GMK03:	1 **Test gas**/**Zero gas** → **Zero gas** for all cell chambers (3x).
	2 Select zero gas feed: **Zero** (ambient air) or **Zero gas**. – *If* **Zero** *is selected:* **Pump** → **ON**. – *If* **Zero gas** *is selected:* Activate the zero gas feed (open external valve).
Test setup:	3 Let the test setup run for about 5 minutes in this state (purge time).

Possible during the purge time:

Step 4: Set substitute values	
SOPAS:	1 **Parameters** → **Spectral analysis**. – see “Window “Spectral analysis” (Step 4, example)”, page 35
	2 Set **Substitute value temperature** to **Cell temp.** (setpoint value). – Specify the temperature in Kelvin. – Standard value: 353 Kelvin (**Cell temp.** = 80 °C).
	3 Set **Substitute value pressure** to the pressure on the gas outlets on the GMK03 gas test unit. – *If not measured:* Enter the current atmospheric pressure. – *If not known:* Use 1013 hPa.

Fig. 15: Window “Spectral analysis” (Step 4, example)

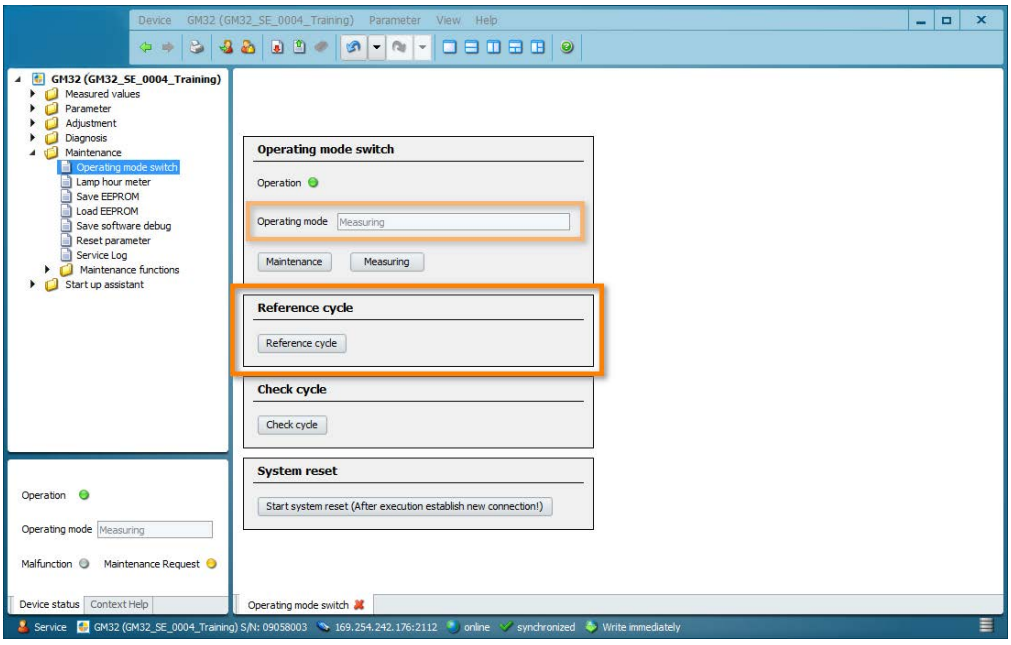


After the purge time:

Step 5: Run a reference cycle[1]	
SOPAS:	1 **Maintenance → Operating mode switch**. – see “Window “Operating mode switch” (Step 5, example)”, page 35
	2 Start **Reference cycle** (click the button).
	3 Wait until **Measuring** is shown as **Operating mode** again.

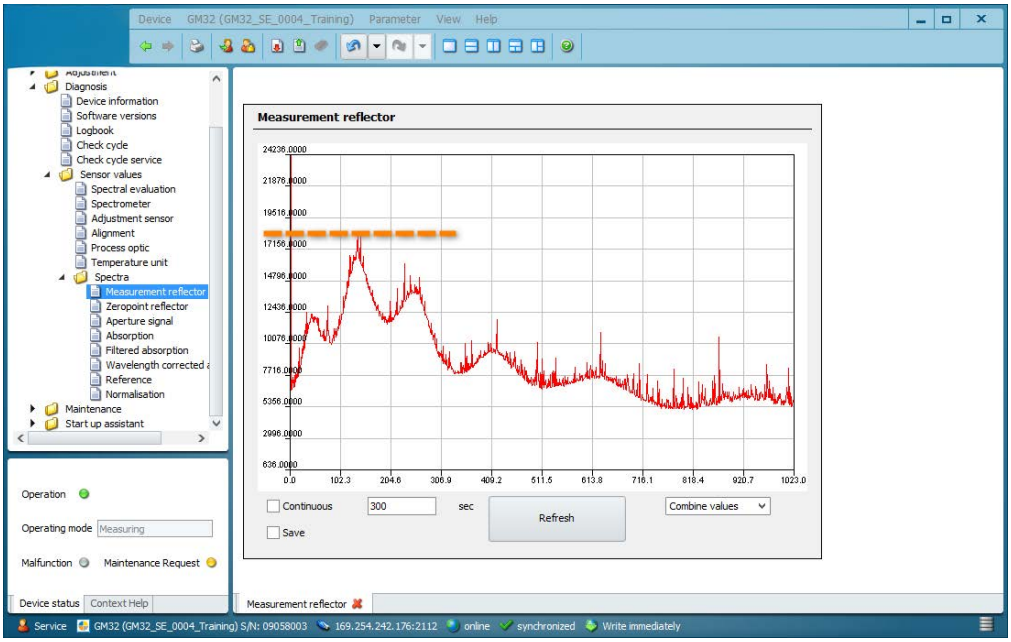
[1] Explanation see the gas analyzer Service Manual.

Fig. 16: Window “Operating mode switch” (Step 5, example)



Step 6: Check light intensity	
SOPAS:	1 **Diagnosis → Sensor values → Spectra → Measurement reflector**. ››› The graph shows the light intensity of the gas analyzer lamp. – see “Window “Measurement reflector” (Step 6, example)”, page 36
	2 Read off the highest value (peak). – *If this value is less than* **14000***:* Carry out corrective measures (see gas analyzer Service Manual, e.g. replace lamp). Then restart the test measurements. – *Otherwise:* Continue with the test measurement.

Fig. 17: Window “Measurement reflector” (Step 6, example)



Step 7: Activate Test mode	
SOPAS:	1 Activate Operating mode for this test in the sender/receiver unit (“Boxmeasuring”/“Filter boxmeasurement” → see gas analyzer Operating Instructions). ››› The sender/receiver unit automatically starts an electronic zero adjustment.
	2 Wait until the sender/receiver unit automatically switches to “Boxmeasuring” mode.
	1 **Adjustment → Boxmeasuring**. – see “Window “Boxmeasuring 1 – 8” for a test measurement (Step 8, example)”, page 37 2 Wait until **Operating mode “Filling”** is displayed. 3 Click **Start boxmeasuring**.

6.2 Performing test measurements

Step 8: Perform a single test measurement	
GMK03:	*Fill with test gas:* 1 **Test gas/Zero gas → Test gas** for the cell chamber(s) to be filled with test gas for this test measurement. 2 **Test gas/Zero gas → Zero gas** for the cell chamber(s) not used in this test measurement. 3 **Measuring/Purging → Purging**
SOPAS:	4 Observe the displayed measured value progression. Wait until the measured value progression remains constant.
GMK03:	*Start the test measurement:* 5 **Measuring/Purging → Measuring** This throttles the test gas volume flow in order to reduce the gas pressure in the cell chamber.
SOPAS:	6 Wait again until the measured value progression remains constant. 7 Note the last 3 measured values (actual values).

Use the linearity test computer (see “Evaluating the test measurements”, page 23) to determine the test gas values and create the protocol for the customer.

Fig. 18: Window “Boxmeasuring 1 – 8” for a test measurement (Step 8, example)

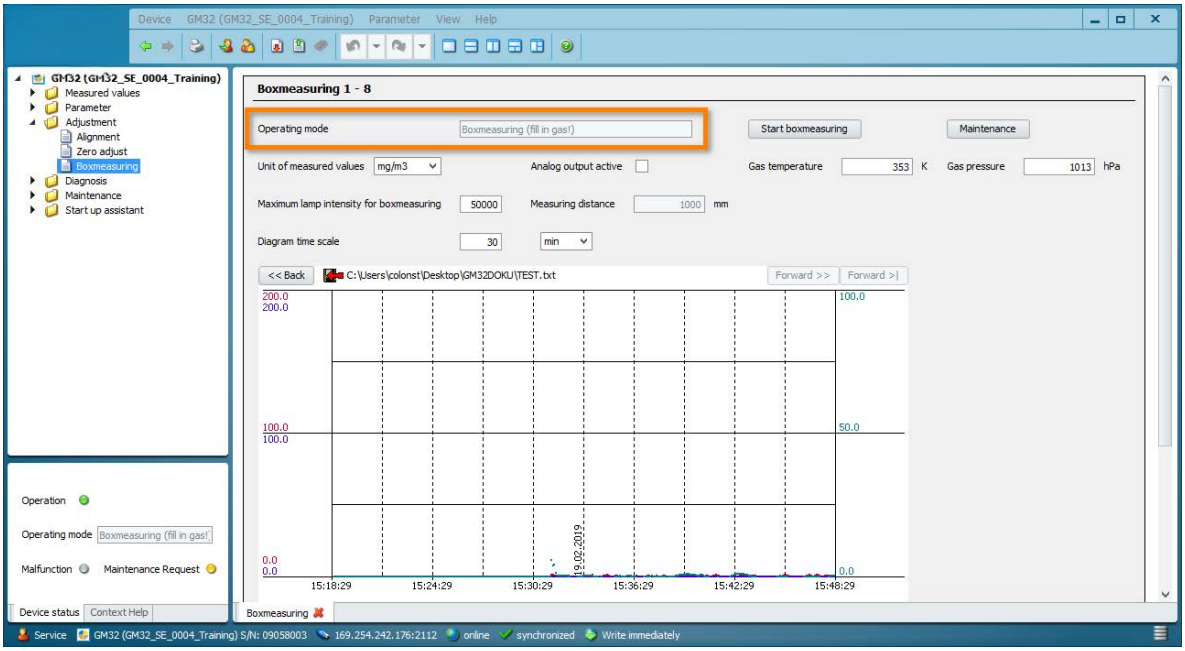
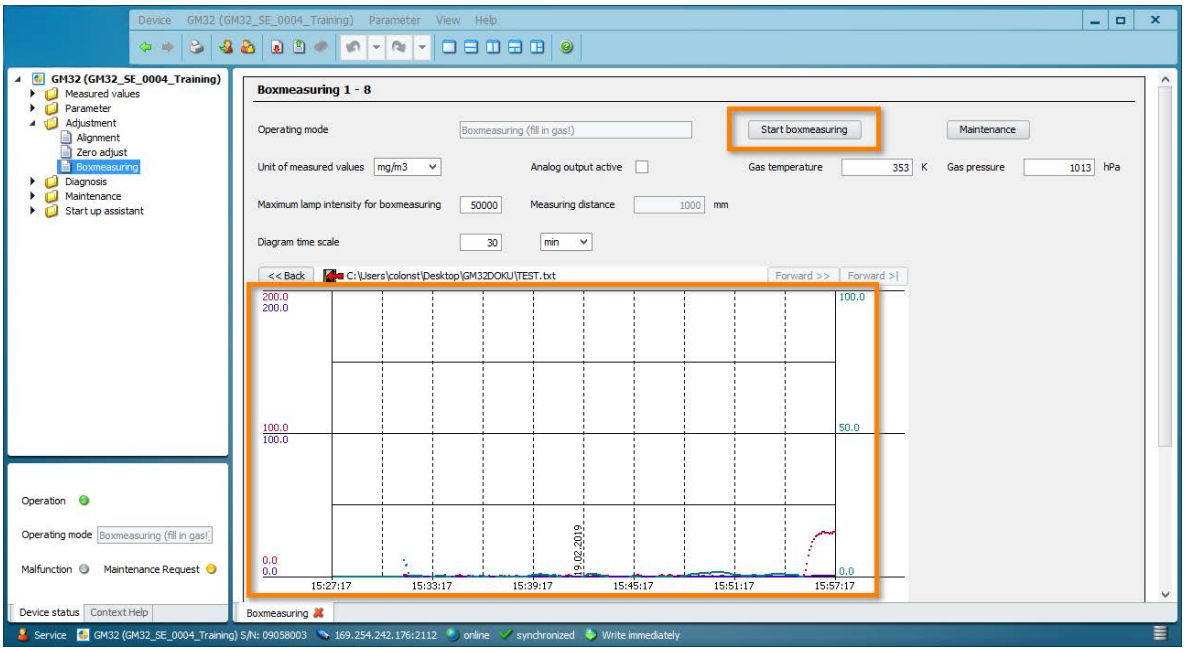


Fig. 19: Window "Boxmeasuring 1 – 8" during a test measurement (Step 8, example)



Step 9: Repeat the test measurements with other setpoints.	
GMK03 + SOPAS:	▶ Repeat „Step 8: Perform a single test measurement“ with other cell chambers until all desired actual values are determined.

6.3 After the test measurements: Establishing a neutral state

GMK03:	1 Stop test gas feed (close external valve). 2 Purge the cell with zero gas (see “Purge the cell with zero gas”, page 32). [1]
Sender/receiver unit:	1 Activate the normal operating mode (see gas analyzer Operating Instructions).

[1] Observe note (see below).

NOTE: Possible damage through test gas residues

- Test gas residues can damage the cell, gas paths and gas seals during storage.
- Test gas residues can falsify later test measurements.

The appropriate purging times depend on the measuring component and the concentration of the measurement component in the test gas.

▶ Ask your local Helpdesk for the recommended purge times for the current application.

7 Performance with GM35

7.1 Measurement for checking the CO/N_2O and CO_2 measuring duct

The gas adjustment unit serves to check the CO/ N_2O and CO_2 measuring duct of the GM35 with test gases; for CO_2 up to a concentration-measuring path product of 15 Vol.% **x** m.

Requirements

Components required:

- Reflector enclosure with built-in gold-coated hollow triple; Part No. 2 030 206
- Gas adjustment unit adapter plate with cutout for the humidity sensor (front of the SR-unit)

CO or N_2O measured values are displayed on the EvU in **mg/m³ x m** (operation)
CO_2 measured values are displayed in **g/m³ x m** (operation).

7.1.1 Carry out measurement

- ▶ Remove the sender/receiver unit.
- ▶ Attach the GMK03 gas test unit with adapter plate on the sender/receiver unit and fasten using the quick-release fasteners: Do not damage the humidity sensor of the sender/receiver unit.
- ▶ Fit the reflector for the GM35.

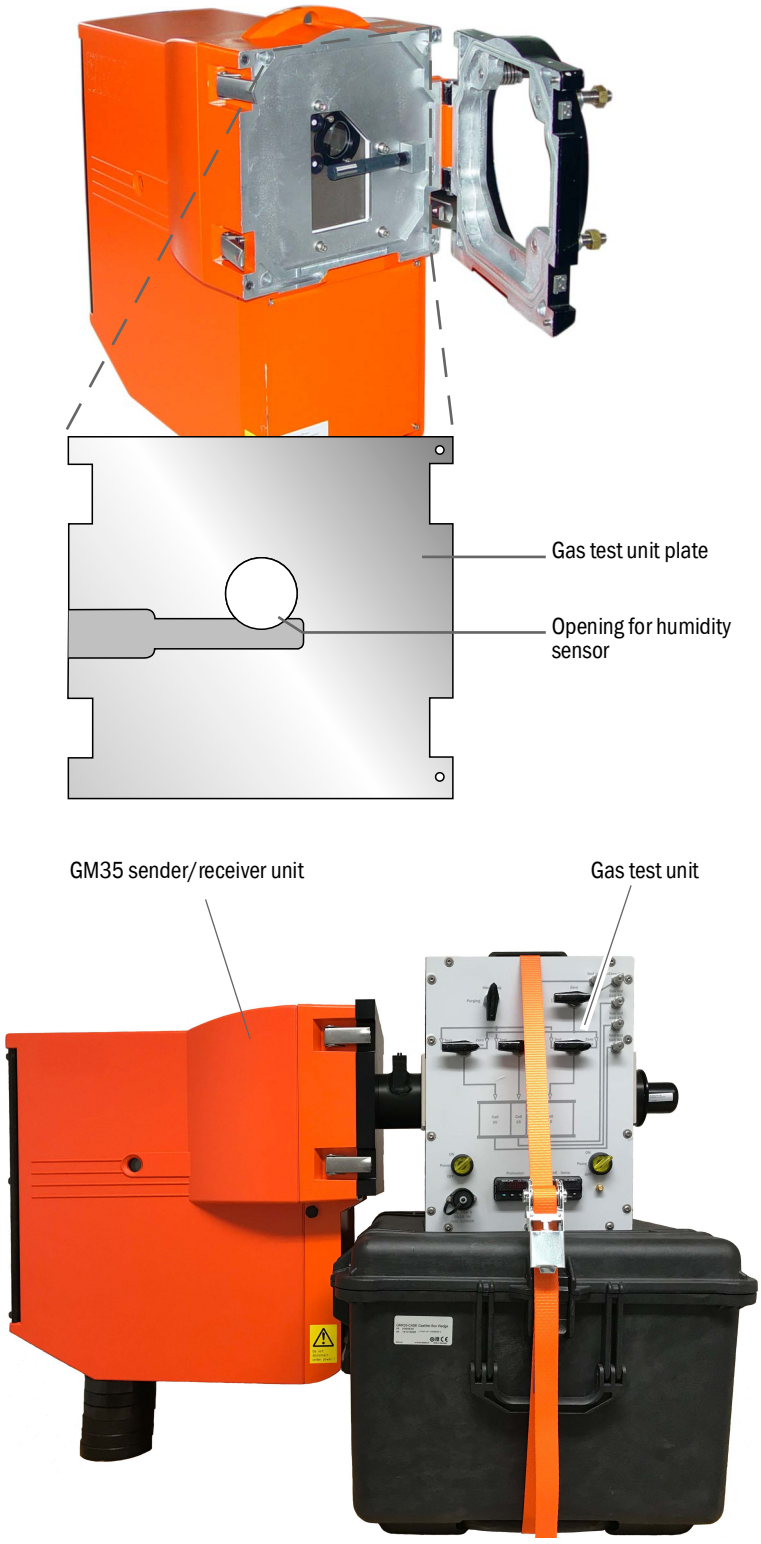


Fig. 20: Fitting the gas test unit

- ▶ Switch the gas test unit on; the warming-up phase takes about 2 hours.
- ▶ Connect zero gas (N_2).
- ▶ Switch all chamber valves to “Zero gas” and switch the **Measuring/Purging** valve to “Purging”.

- ▶ After 3 minutes, select menu **Box measuring** in menu **cal** (**cal** button), then option “**gas**”.
- ▶ Enter password “**1 2 3 4**”.

  The measuring device carries out a zero adjust and then switches to operating mode “**Box measuring**”.

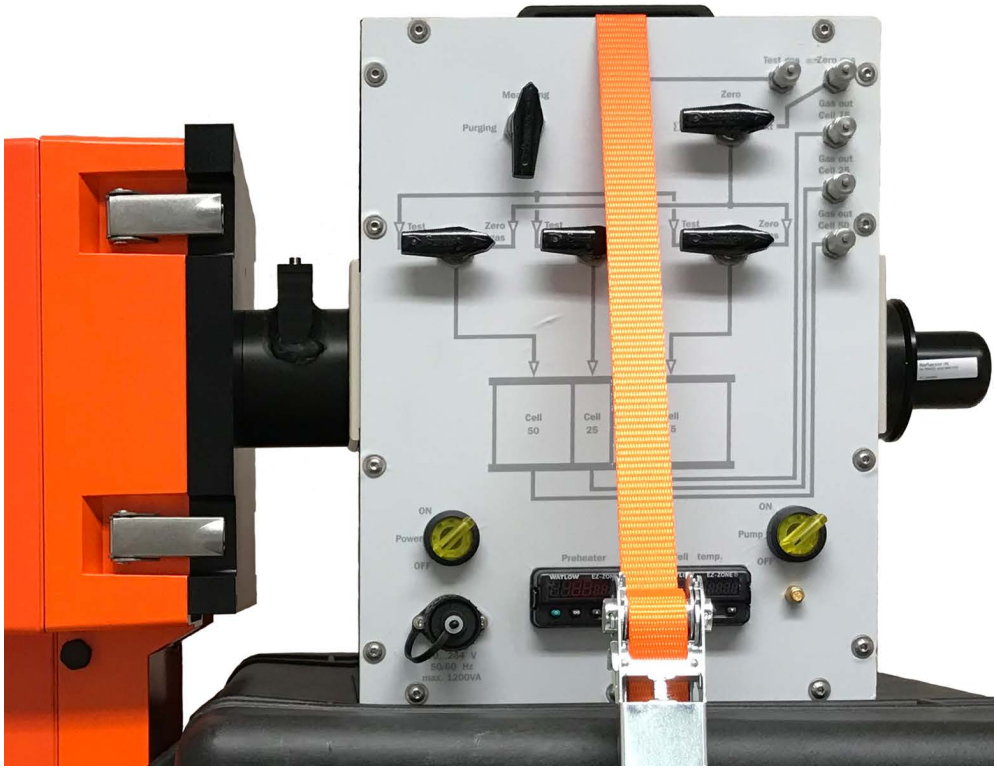


Fig. 21: Control elements on the gas adjustment unit

- ▶ Connect test gas; set the primary pressure to approx. 1000 hPa (1 bar).
- ▶ Measure the individual chambers/chamber combinations in the gas test unit and note the concentration values (observe sequence in Conversion Table).
  - ▶ When doing so, set the valves for the relevant chambers to “**Test gas**”.
  - ▶ Switch the **Measuring**/**Purging** valve to “Purging” for 2 to 3 minutes (until the measured value has stabilized) and then to “Measuring”.

    The overpressure from the purge phase is reduced.
  - ▶ When the measured value has stabilized again, read off and note the value.

Use the linearity test computer (see “Evaluating the test measurements”, page 23) to determine the test gas values and create the protocol for the customer.

7.1.2 Restart Measuring mode

- ▶ Purge gas test unit with zero gas.
- ▶ Exit operating mode “**Box measuring**” by pressing **back**.
- ▶ Disassemble the gas test unit with plate and reflector from the SR-unit and store safely.
- ▶ Refit the sender/receiver unit back correctly onto the measuring point in the correct position.

7.2 Measurement for checking the H_2O measuring ducts

The grid filter unit serves to check the H_2O measuring duct (for products with very high concentration measuring paths) of the GM35. Measurement with the grid filter unit is based on light absorption by grid filters (output of measured extinction).

Requirements

Components required:

- Gas test unit GMK03.
- Gas test unit adapter plate with threaded holes to attach the grid filter unit.

Measured values are displayed as extinction for the measuring duct (H_2O).

7.3 Grid filters (application information)

- The grid filters are only used for GM35 gas analyzers.
- The grid filters are not used for GM32/GM700.

Fig. 22: Grid filter set

Fig. 23: Smallest grid filter – largest grid filter

7.3.1 Nominal values

The grid filters are calibrated. The setpoint values for the individual filters are shown on the label on the enclosure. Filters with extinction values up to 0.8, suitable for the application range of the GM35, are used. Higher extinction values exceed the warning or malfunction threshold for not sufficient signal level.

7.3.2 Carry out measurement

- ▶ Open the sender/receiver unit and swivel to the side.
- ▶ Attach the GMK03 with adapter plate on the sender/receiver unit and fasten using the quick-release fasteners: Do not damage the humidity sensor of the sender/receiver unit.

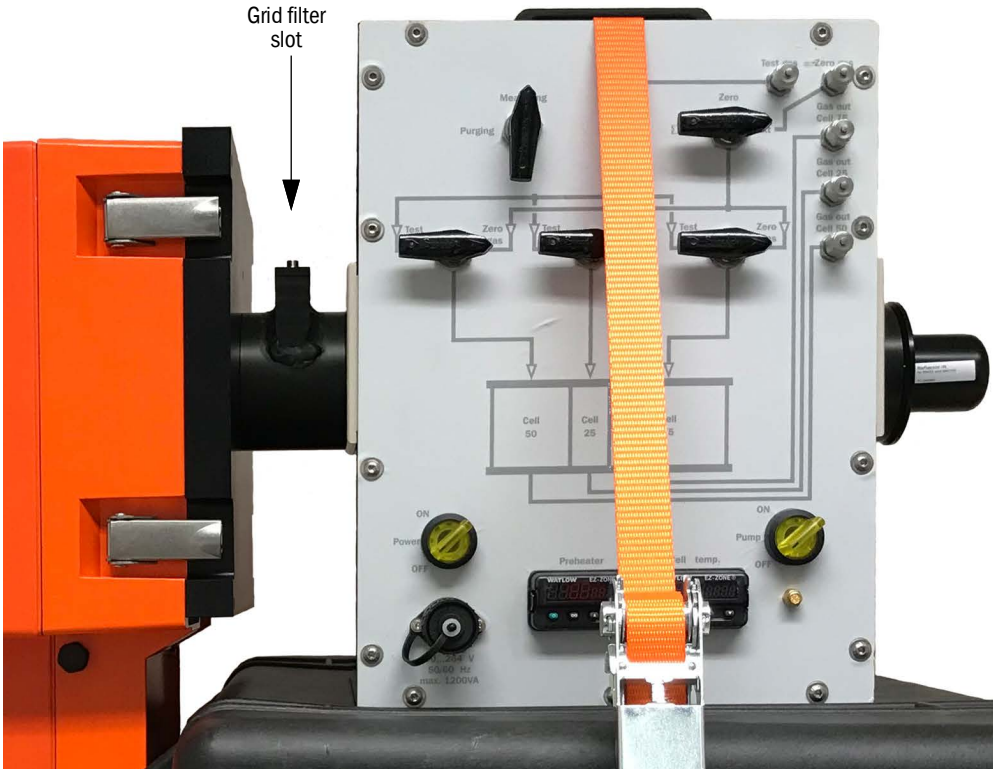


Fig. 24: Grid filter slot

- ▶ Insert the push rod for filter selection completely; at the same time, make sure the filter is swiveled out.

On the EvU:

- ▶ Select “**Grid**” mode on the gas adjustment unit
- ▶ Enter the password “**1 2 3 4**” and wait for scaling to complete.

Measurement can start as soon as the display shows the extinction values for H_2O and CO_2.

- ▶ Select the different positions of the push rod sequentially and swivel the appropriate filter in
- ▶ When the measured value has stabilized again, read off and note the value.

Use the linearity test computer (see “Evaluating the test measurements”, page 23) to determine the test gas values and create the protocol for the customer.

Fig. 25: Measured value display on the EvU

7.3.3 Restart Measuring mode

On the EvU:

- Exit operating mode “**Box measuring**” by pressing **back**.
- Disassemble the gas adjustment unit with plate and reflector from the sender/receiver unit and store safely.
- Refit the sender/receiver unit back correctly onto the measuring point in the correct position.

8 Performance with GM700

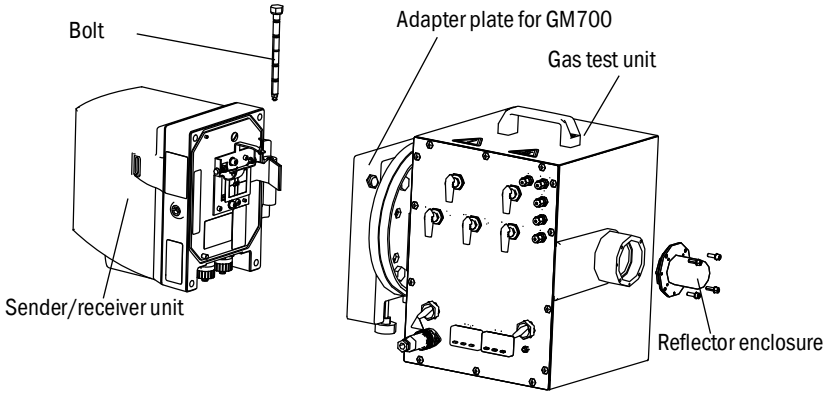
8.1 Checking the measuring ducts of NH_3

The gas test unit serves to check the GM700 with test gases.

Components required:

- Reflector enclosure with built-in gold-coated hollow triple; Part No. 2030206.
- Gas test unit with adapter plate for the GM700.

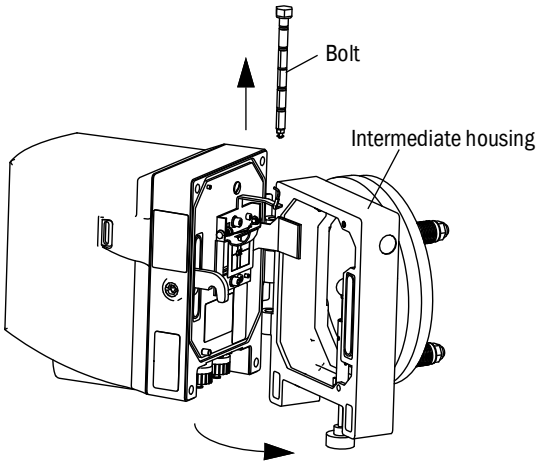
Fig. 26: Components required: Gas test unit for GM700



Measured values are displayed on the EvU in mg/m³ **x** m (operation).

8.1.1 Fit the gas test unit

Fig. 27: Gas test unit



1 About this Manual

1.1 Target group of this Manual

Group of persons

All actions and measures described in this Manual may only be carried out by service technicians of SICK AG and representatives of SICK AG who are qualified and authorized to do so, as well as qualified and trained external personnel.

Basic technical qualifications

- Working with gas analyzers
- Mechanical installations
- Electrical installations
- Making and testing gas-tight connections
- Handling pressure vessels and technical gases
- Knowledge of risks through flue gases/exhaust gases

1.2 Knowledge requirements for this product

Additional technical qualifications for this product

- Safe handling of gases with health risk
- Safe handling of combustible gases
- Protection against the dangers of invisible laser radiation
- Service training for the respective gas analyzer
- *For applications with "Ex" versions of the gas analyzers:* Basic knowledge of explosion protection

Further knowledge requirements see "Other applicable documents", page 7.

Consequences of unauthorized interventions

CAUTION: Hazards through incorrect measures

Possible consequences of improper interventions and changes:

- Electrical safety is incomplete. This can endanger life.
- Sample gas paths are no longer tight. Sample gas released can be hazardous to health or form a dangerous gas mixture with air (depending on the application).
- Overpressure can cause the windows to burst (splinters and gas released).
- Dangerous artificial optical radiation may be emitted from the connected measuring devices.
- Measurement accuracy is impaired.
- Device functions are impaired or defective.
- The ex protection becomes void.

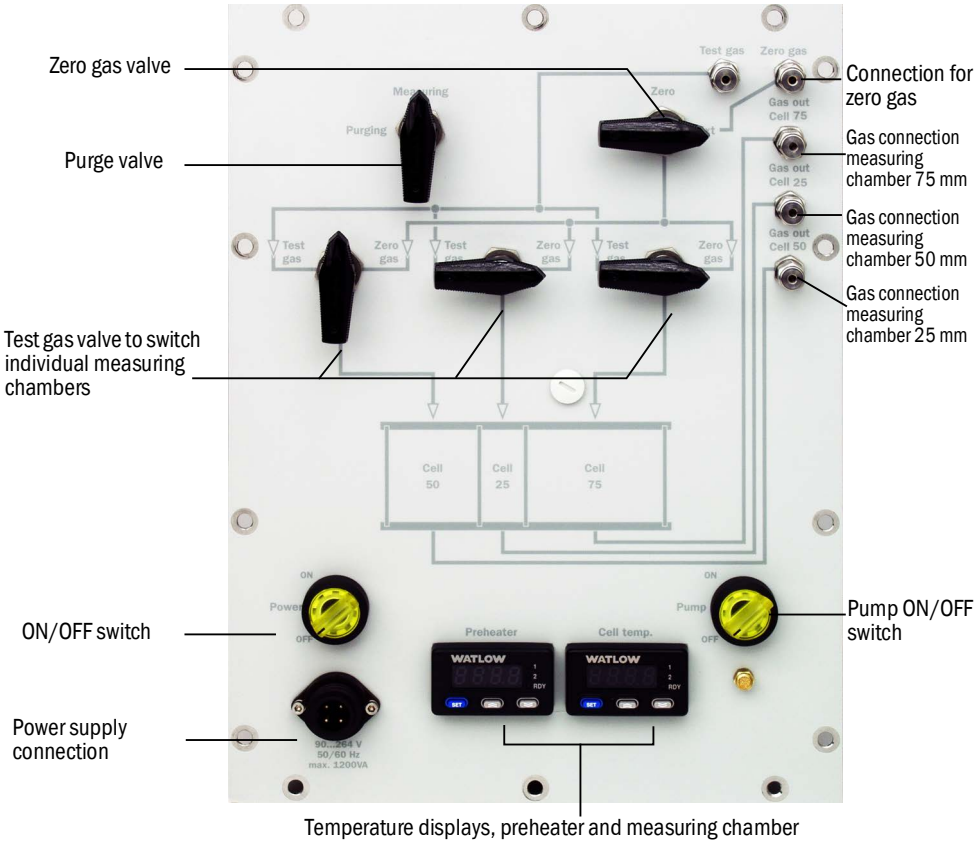
▶ Interventions and modifications must only be carried out according to the technical information provided by the manufacturer.

▶ Check and observe local regulations.

WARNING: Special hazards with this product

see "Special safety information for this product", page 12

Fig. 30: Control elements on the gas test unit



4 Connect test gas; set the primary pressure to approx. 1000 hPa (1 bar).
5 Note the diameters of the individual chambers/chamber combinations in the filter box and the concentration values.
   a) At the same time, set the respective filter chambers to “Test gas”.
   b) Switch the Measuring/Purging valve to “Purging” for 2 to 3 minutes (until the measured value has stabilized) and then to “Measuring”.
   c) The overpressure from the purge phase now dissipates.
   d) When the measured value has stabilized again, read off and note the value.

Use the linearity test computer (see “Evaluating the test measurements”, page 23) to determine the test gas values and create the protocol for the customer.

8.1.3 Restart Measuring mode

On the EvU:

1 Exit operating mode “Box measuring” by pressing back.
2 Disassemble the filter box with plate and reflector from the SR-unit and store safely.
3 Refit the SR-unit back correctly onto the measuring point in the correct position.

9 Dismantling and reassembling

9.1 Dismantling the test setup

WARNING: Hazards through condensate
If the test gas contains vapors (humid test gas), condensate may form in the device during cooling, which can be corrosive and harmful to health.
- Corrosive condensate can damage the cell and gas lines.
- Condensate that remains in the device could escape unexpectedly later. This could lead to health risks.

▶ *Before packing:* Purge the test gas from the device (see “After the test measurements: Establishing a neutral state”, page 39).

CAUTION: Hot surfaces
In the operating state, the reflector and the connections for the sender/receiver unit and reflector are hot (**Cell temp.** Standard: 80 °C).
▶ *Before disassembly:* Allow the GMK03 gas test unit to cool down.

1 Put the gas analyzer and test gas system out of operation.
2 Switch the GMK03 gas test unit off (**Power** → **OFF**).
3 Wait until the GMK03 gas test unit has cooled down.
4 Disconnect all connections. Protect open gas connections with closure caps.
5 Dismantle and pack the test setup.
   – Replace the protective cap on the reflector.
   – Use the existing transport cases.

Protect the optical windows (use closing caps provided).

9.2 Reinstalling the gas analyzer

1 Reassemble the gas analyzer at the installation location.
2 Put the gas analyzer back into operation there (→ gas analyzer Operating Instructions).
   »» The measured value is now displayed again as configured.

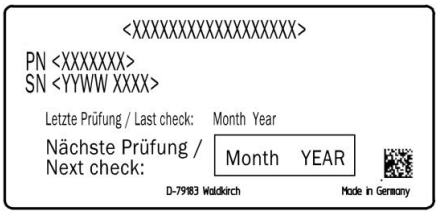
10 Maintenance (information)

All components of the GMK03 gas test unit must be sent to the manufacturer's factory for maintenance after a period of use of 2 years.

NOTE: Accuracy cannot be guaranteed if the test interval is exceeded.

- ▶ *Before each use:* Check the “Next check” label on the housing (see Fig. 31).
- ▶ Check the date and schedule maintenance in good time.
- ▶ Always send both transport cases with their respective contents.

Fig. 31: Label "Next check" (schematic)



11 Troubleshooting

11.1 If the GMK03 gas test unit does not function

Possible cause	Action
Power cable is not connected.	▶ Check the power cable and its connections.
Main power supply has failed.	▶ Check the main power supply (e.g. socket, external fuses).
An internal overtemperature fuse has tripped.	▶ Put the GMK03 gas test unit out of operation and let it cool down.

- The switched-on state is indicated by the “Power” switch being on and the illuminated digits of the temperature controllers are active.
- An internal power fuse is not available.

11.2 When measured values are obviously incorrect

Possible cause	Action
The sample gas outlet is blocked.	▶ Check the hose at the sample gas outlet. ▶ *If connected to a collection point:* Check whether back pressure is present.
An internal heater is not working.	▶ Check whether the temperature controllers are active. ▶ *When one of the temperature controllers is out of action:* Check whether an internal overtemperature fuse could have tripped (check temperature in housing).
Other cause	▶ Please contact your local Helpdesk for further possible malfunction causes.

12 Technical data

General data	
Operating temperature:	+5 ... +40 °C
Heating time: [1]	Approx. 2 hours
Storage temperature:	0 ... +40 °C
Protection class:	IP40
Humidity (ambient air):	Non-condensing
Maximum surface temperature:	70 °C [2]
Weight:	17 kg
Altitude	Max. 2000 m (above sea level)
Use inside or outside buildings	Indoor and outdoor
Industrial plants	Outdoor, weather protected
Degree of contamination	3

[1] At 25 °C ambient temperature.
[2] At cell temperature = 80 °C, ambient temperature = 40 °C.

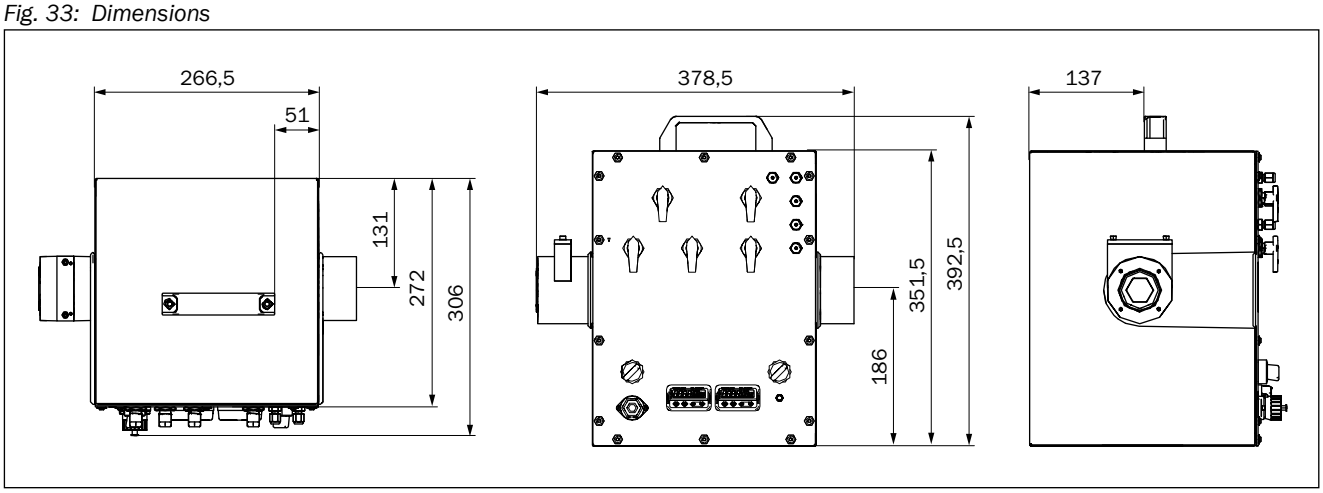
Power supply	
Supply voltage:	90 ... 264 V AC, 50/60 Hz
Power consumption (max.):	1200 VA
Connection:	– Plug on the front panel – Suitable power cable with exchangeable power plug

Gas technical data	
Permissible gases:	SO_2, NO, NO_2, CO, CO_2
Inlet pressure	
– Standard pressure:	1.0 bar (g)
– Maximum allowable pressure:	1.1 bar (g)
Leak tightness:	10^{-4} mbar · l/s

Cell	
Length (inside):	25 mm + 50 mm + 75 mm
Inner diameter:	36 mm
Volume:	150 ml [1]
Standard temperature: [2]	80 °C
Maximum permissible temperature [2]	
– At 115 V power voltage:	115 °C
– At 230 V power voltage:	140 °C

[1] Total volumes of the cell chambers.
[2] Also applies to preheating.

Fig. 33: Dimensions



13 Order data

Transport case for GMK03

Complete transport case with contents	Part No.
GMK03 gas test unit case	*Contact the local Helpdesk*

Single parts	Part No.
Power connection cable for GMK03 gas test unit [1] [Line, rd. BUC/AEH 4M000 3*1.5]	2023688
Schuko power plug, black, flexible [Plug, Ge.Ltg.Sh 2P+E Schuko, rubber, sw]	6023739
Reflector UV/VIS for GM32 and GM35 [2] – for active measuring path up to 5 m *(Reflector, glass triple, R=–1982)*	2042867
Reflector UV/VIS for GM32 and GM35 [2] – for active measuring path longer than 5 m *(Reflector, glass triple, R=–5000)*	2042869
Reflector IR for GM35 and GM700 [3] *(Reflector, hollow triple)*	2042892
Filter box, gas test unit, wedge	2046355
Transport case [Case-ABS 650*500*360 sw]	5326661

[1] Without power plug.
[2] Older lettering: “for GM31 and GM32”.
[3] Older lettering: “for GM31 and GM700”.

Fig., see “Transport case for GMK03”, page 14.

Transport case for GMK03 accessories

Complete transport case with contents	Part No.
Accessories case for GMK03 [EPSP gas test unit]	*Contact the local Helpdesk*

Single parts	Part No.
Pressure measurement device	6050323

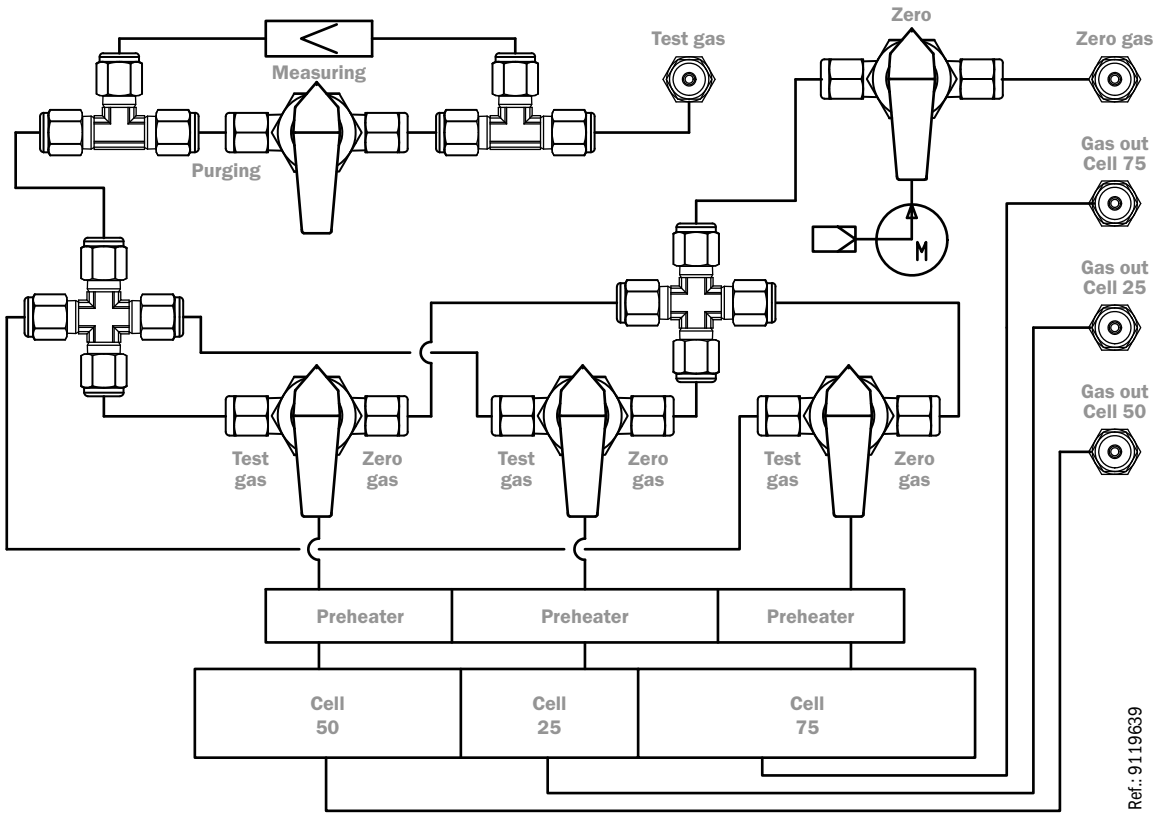
Fig., see “Transport case for GMK03 accessories”, page 15.

Further Part Nos., see “Packing lists”, page 24.

14 Annex

14.1 Internal gas flow

Fig. 33: Internal gas flow (schematic)



14.2 Volume concentration/mass concentration conversion

Refresher

Volume concentrations:
1 Vol.% = 1 m^3/100 m^3
1 ppm = 1 m^3/10^6 m^3

Mass concentrations:
1 mg/m^3 = 1 kg/10^6 m^3

Three parameters are relevant for conversions between the concentration types:
- Gas molar mass (determines the molar volume)
- Gas temperature
- Gas pressure

Specified conversion factors usually apply to standard conditions:
- Standard temperature = 273.16 K (0 °C; in gas chromatography: 25 °C)
- Standard pressure = 1013.25 hPa (in chemistry: 1000 hPa)

Temperatures must be calculated in [Kelvin].

C_{UNIT2} →	1 g/m^3 =	1 mg/m^3 =	1 Vol.% =	1 ppm =	
CO	800 ppm	0.80 ppm	12.5 g/m^3	1.25 mg/m^3	C_{UNIT1} ↓
CO_2	510 ppm	0.51 ppm	19.6 g/m^3	1.96 mg/m^3	
NH_3	1320 ppm	1.32 ppm	7.6 g/m^3	0.76 mg/m^3	
NO	750 ppm	0.75 ppm	13.4 g/m^3	1.34 mg/m^3	
NO_2	490 ppm	0.49 ppm	20.5 g/m^3	2.05 mg/m^3	
N_2O	510 ppm	0.51 ppm	19.6 g/m^3	1.96 mg/m^3	
SO_2	350 ppm	0.35 ppm	28.6 g/m^3	2.86 mg/m^3	
– Values valid for 0 °C and 1013 hPa –					

Conversion factor:	$f_{UNIT1→UNIT2} = C_{UNIT1} / C_{UNIT2}$

Usage:	$C_{UNIT2} = C_{UNIT1} \cdot f_{UNIT1→UNIT2}$

Example:	C_{UNIT1} = 300 ppm NO_2
	$f_{UNIT1→UNIT2}$ (NO_2) = 2.05 (mg/m^3) / 1 ppm
	C_{UNIT2} = 300 ppm NO_2 · 2.05 (mg/m^3)/ppm = 615 mg/m^3 NO_2 [1] *– at 0 °C and 1013 hPa –*

[1] Calculated with: Molar mass = 46 g/mol. Absolutely exact: 46.055 g/mol → C_{UNIT2} = 615.61 mg/m^3 NO_2

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