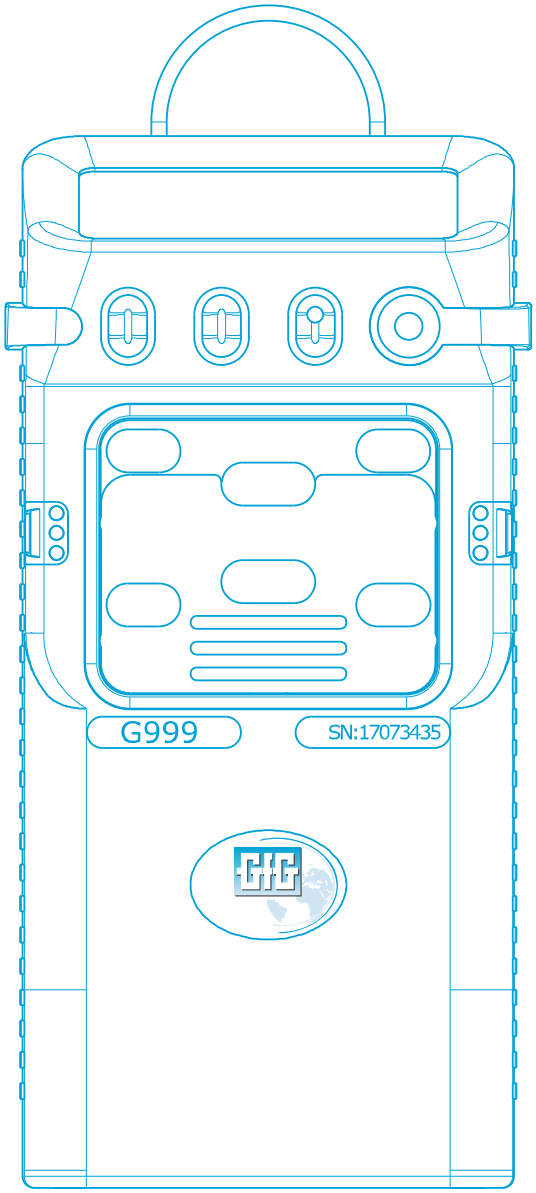
Operation Manual

Polytector III G999



smart
GasDetection
Technologies

Congratulations!

You have chosen a precision instrument made by GfG.
A very good choice!

Reliability, safety, optimum performance and efficiency distinguish our devices.

They comply with the national and international directives.

These operating instructions will help you to rapidly and safely operate the device.

Please strictly follow our operating instructions before using!

Our employees will be at your service at any time in case of inquiries.

Yours truly,

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Table of Contents

1 Introduction

1.1 For Your Safety

In accordance with § 3 of the Product Safety Act (ProdSG), this operating manual refers to the proper use of the product and is designed to prevent hazards. It must be read and observed by everyone who operates services, maintains and inspects this product. This particularly applies for the safety notes in this operating manual, which are marked with this symbol⚠. This device can serve its intended purpose only if it is operated, serviced, maintained and inspected according to the instructions given by the Gesellschaft für Gerätebau mbH. The warranty issued by the company GfG Gesellschaft für Gerätebau mbH shall be void, if it is not used, cared for, maintained and checked in accordance with GfG's specifications.

The previously mentioned does not change the statements about the Warranty and Liability in the Sales and Delivery Terms of GfG. Any repair works may only be performed by professionals or assigned employees. Modifications and changes to the product may only be performed with the approval of GfG. Any unauthorized modifications to the product void a liability for damages. Only GfG accessories may be used with the product. For repairs, the spare parts approved by GfG must be used.

A functional test **has to** be performed on every working day before each use - a calibration and, if applicable, an adjustment needs to be performed every 4 months.

1.2 Area of Use and Application

The G999 is a hand-held measuring device for personal protection against the hazards of toxic or explosive gases and vapors as well as oxygen deficiency or excess. The G999 continuously measures in the diffusion mode or by sucking the gas with the integrated pump and warns the employee carrying the device in case of an occurring gas hazard by a visual and acoustical alarm.

The three variants of the G999 have been tested by the DEKRA EXAM GmbH concerning the use in potentially explosive atmospheres and possesses a corresponding EU type examination certificate according to the directive 2014/34/EU as well as an IECEx certificate.

Certificates:	**BVS 15 ATEX E 064 X**			
	IECEx BVS 15.0056 X			
Labelling:	**G999C**	⟨Ex⟩ I M2 Ex ia db I Mb	⟨Ex⟩ II 2G Ex ia db IIC T4 Gb	-20°C≤Ta≤+50°C
	G999E	⟨Ex⟩ I M1 Ex ia I Ma	⟨Ex⟩ II 1G Ex ia IIC T4 Ga	-20°C≤Ta≤+50°C
	G999P	⟨Ex⟩ I M1 Ex ia I Ma	⟨Ex⟩ II 1G Ex ia IIC T4 Ga	-20°C≤Ta≤+50°C

1.3 Special Conditions for the Safe Use

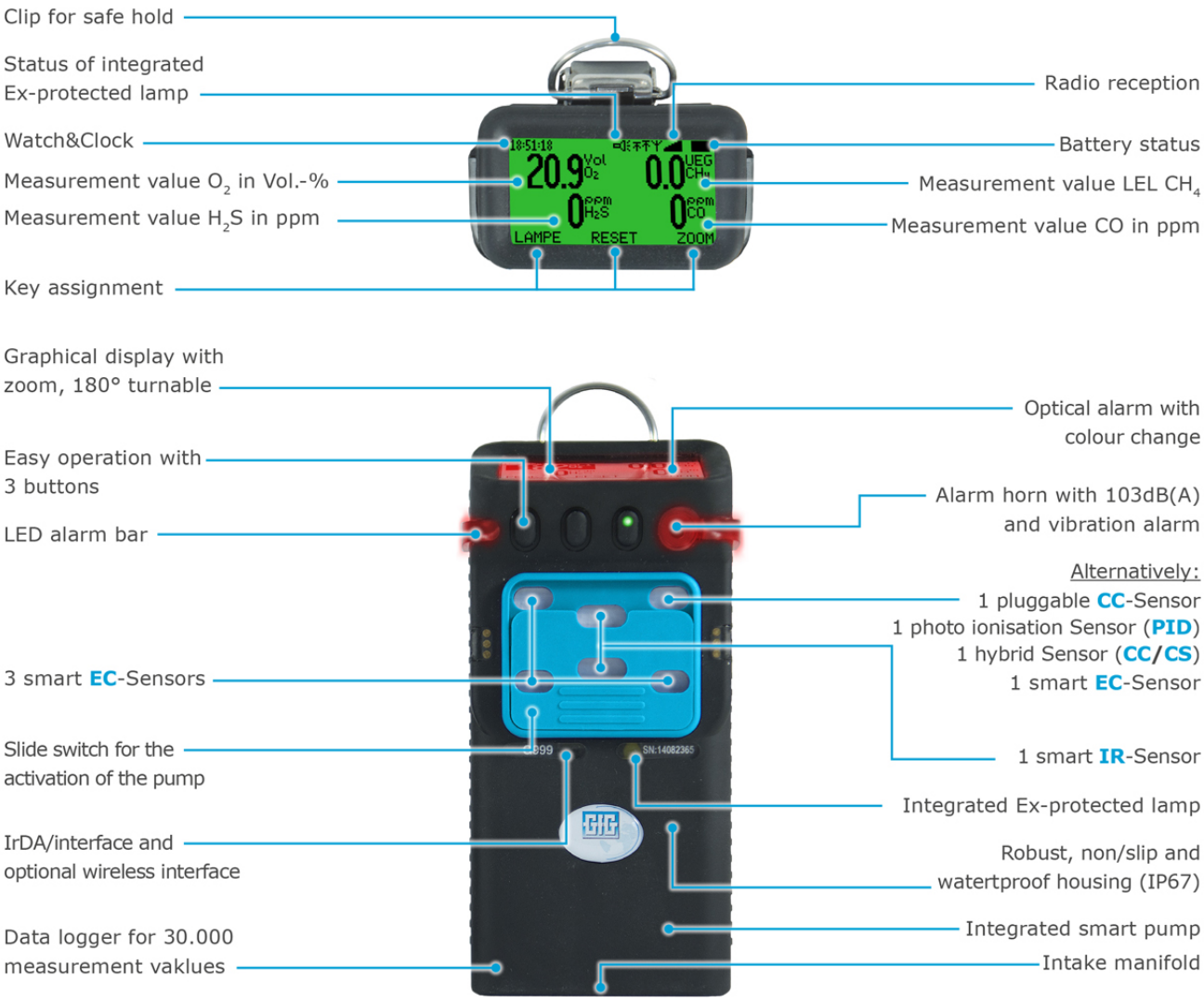
Caution: For use in hazardous areas of Group I (mining), the G999C must be used as intended. The device must be worn on the body and must not be left unattended so that mechanical stress due to impact is avoided. It is intended for low level mechanical hazards according to EN 60079-0.
The gas meter must be removed from the hazardous area and has to be cleaned immediately, if it is contaminated with oils and greases or hydraulic fluid.

Before each use, it is necessary to check the gas readings of flammable gases and vapors for zero gas and for test gas. If the gas readings show a continuous zero offset in a measuring gas-free environment (fresh air), then a zero point adjustment should be carried out.

The zero points of the sensors must be checked and, if necessary, readjusted, especially after a heavy impact. if the catalytic combustion sensor has triggered an exceeding of the measurement range "  "due to the impact stress, this alarm must be reset with fresh air and the if necessary, readjustment of the zero point.

If the G999 is operated continuously for more than one day, it should be switched off and on after 24 hours at the latest.

1.4 Design


Clip for safe hold
Status of integrated Ex-protected lamp
Watch&Clock
Measurement value O_2 in Vol.-%
Measurement value H_2S in ppm
Key assignment
Radio reception
Battery status
Measurement value LEL CH_4
Measurement value CO in ppm
18:51:18
20.9 Vol O_2
0.0 UEG CH_4
0 ppm H_2S
0 ppm CO
LAMPE
RESET
ZOOM
Graphical display with zoom, 180° turnable
Easy operation with 3 buttons
LED alarm bar
3 smart EC-Sensors
Slide switch for the activation of the pump
IrDA/interface and optional wireless interface
Data logger for 30.000 measurement vaklues
Optical alarm with colour change
Alarm horn with 103dB(A) and vibration alarm
Alternatively:
1 pluggable CC-Sensor
1 photo ionisation Sensor (PID)
1 hybrid Sensor (CC/CS)
1 smart EC-Sensor
1 smart IR-Sensor
Integrated Ex-protected lamp
Robust, non/slip and watertproof housing (IP67)
Integrated smart pump
Intake manifold
SN:14082365

2 Operating Instructions

2.1 Commissioning

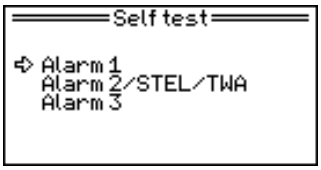
2.1.1 Switching the Device On and Off

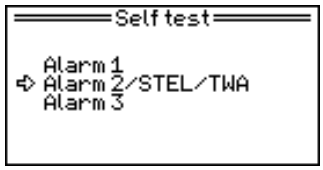
Switch on the device by briefly pressing the right button ◆.

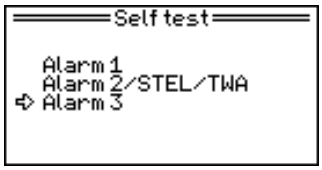
Switch off the device by pressing the right button ◆ for about 5 seconds. Release the button when the display "Switch off / 0" is shown.

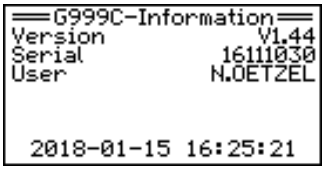
When charging the device, the normal measuring mode is automatically switched off and the elapsed charging time will be displayed.

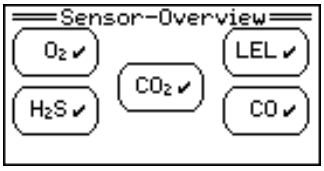
After having switched off the device, it performs a **self-test** and gives information about the Firmware version, the built-in sensors with their measuring ranges and the alarm thresholds as well as the date of the next maintenance. During the self-test, the optical and acoustic signaling devices are controlled in such a way that they can be perceived by the user as a gas alarm.

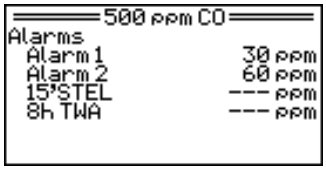


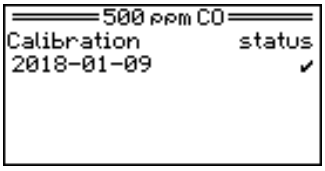


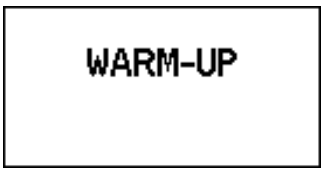










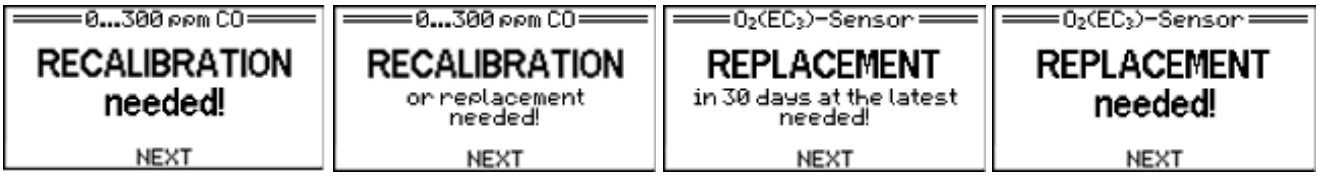


Alarm thresholds and calibration data will be displayed for all available sensors. Please find an example of CO below. Depending on the condition of the sensors, other messages will be output, which possibly need to be acknowledged. Please find more detailed information in the chapter “Other messages when starting the device”.

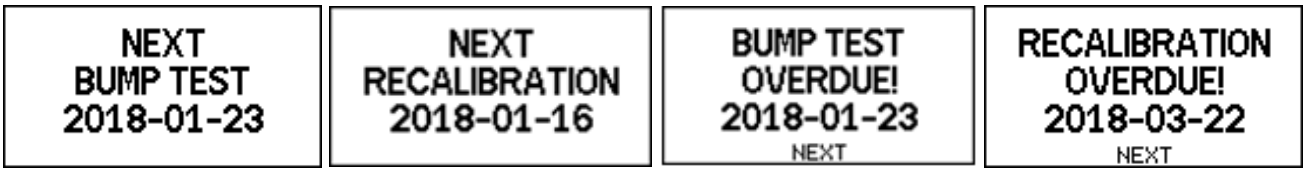
After the device has switched on and the messages have expired, the device will be ready for operation after about one minute. By pressing the center button, it is possible to acknowledge displays and messages.

2.1.2 Other Messages when Starting the Device

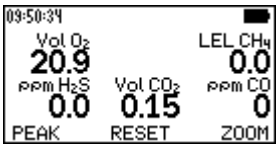
The G999 when starting will test the sensors and monitor the adjustment data. For a sensor, which had not been adjusted yet or had been adjusted more than one year ago, the message “Sensor adjustment required!” will be displayed. Because relatively used sensors have a shortened adjustment interval, the message "Sensor adjustment or sensor change required" could be output in this event. In case of used up sensors, the message “Sensor replacement required!” will be the output when the device is started. These messages need to be acknowledged by pressing the button.



If a docking station is used to check the device, the G999 may have intervals set for the function test and sensor adjustment. The dates for the next function test or the next sensor adjustment are automatically determined by the times of the last checks. Depending on what will be due next, the date of the next functional test or of the next sensor adjustment will be displayed when the device is started. If a date has been exceeded, the G999 will display “overdue”. These messages need to be acknowledged by pressing the button.



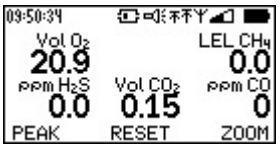
2.2 Measuring Mode



The G999 is ready for operation, when all measured values, the measuring gas or the unit, the battery capacity and the time are displayed.
The measured gas concentrations will now be monitored regarding exceeding or falling below (O_2) the preset limit values.

2.2.1 Display of the Measured Values, Icons and Key Functions

Depending on the selected function or on the activated device option, also other icons can be displayed in the upper display row.

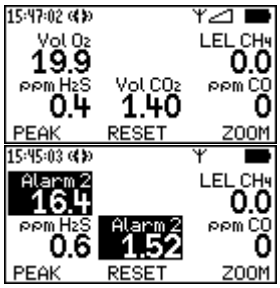


- Motion detection (see section 2.2.5)
- pump operation (see section 2.2.10)
- Flashlight (see section 2.2.11)
- Peak display of peak values (see section 2.2.8)
- Radio and field strength (see section 2.2.16)
- Battery capacity (see section 2.2.4)

The current functions of the three keys are always shown in the bottom display row. In this case, it is possible to switch the **PEAK** mode on and off by briefly pressing the left key. The gas alarms can be acknowledged by briefly pressing the center key (**RESET**). It is possible to change over to the **ZOOM** display or to the detail view by briefly pressing the right key.

2.2.2 Monitoring and Gas Alarms

If the measured gas concentration exceeds (falling below O_2) a pre-set limit value, an acoustical and visual alarm will be immediately emitted. It is possible to read from the display which gas has triggered the alarm. The alarm-triggering measured value is displayed inverted every second.



On the left in the picture, the alarm is triggered by a high CO_2 reading. In addition to the inverted display alternates "Vol CO_2" / "Alarm 2".
An extremely loud acoustical alarm (103 dB(A) at 30 cm) and a bright visual all round alarm provide for a safe warning in case of a gas hazard. In case of a gas alarm, the whole display will be colored orange or red, depending on the alarm condition. The device has up to three alarm levels. The pre Alarm 1 is not latched, whereas the main alarms Alarm 2 and Alarm 3 are latched (factory setting). The G999 makes three limit value alarms available for oxygen and flammable gases (e.g. CH_4) and it makes two momentary value alarms available for toxic gases (e.g. CO, H_2S).

An alarm can additionally be emitted for the toxic gases if the long-term and the short term exposure value (TWA and STEL have been exceeded. Also refer to the chapters “Alarm limit value - Basic setting” and “Alarms - Alarm setting”.

Type of Alarm	Sensors	Number of Alarms	Description
Limit value (AL)	Oxygen Flammable gases Toxic gases	3 3 2	A momentary value alarm is immediately being triggered, if the gas concentration exceeds or falls below a pre-set value (O_2). The momentary value alarms can be set.
Short-term value (STEL)	Toxic gases	1	The short-term value (STEL) a reference time of 15 minutes is taken which is averaged over this period. The STEL alarm is not self-holding. It switches off automatically as soon as the value falls below the short time limit again.
Long-term value (TWA)	Toxic gases	1	The long-term value (TWA) refers to a period of time of a working shift of 8 hours and the mean will be taken over this period of time. The TWA alarm cannot be reset. It will only be switched off, if the device is being switched off.

The alarms will be prioritized as follows: Power error, exceeding the measuring range, AL3, TWA > AL2, STEL > AL1, falling below the measuring range > temperature error.

2.2.3 Acknowledging the Gas Alarms

The momentary value alarms 2 and 3 are self-holding (factory setting) and can only be reset by pressing the button **RESET**, if it falls below or exceeds the preset limit values (O_2). The momentary value alarm 1 is not self-holding and will be automatically reset as soon as the alarm condition does no longer exist.
If the measuring range is exceeded on the catalytic combustion sensor (e.g. CH_4), for gas concentrations above 110 % LEL or above 5.5Vol% CH_4 arrows ↑↑↑↑ showing upwards will be displayed instead of the gas display. The sensor will be deactivated in order to protect it from damages. The alarm signaling and the arrows ↑↑↑↑ showing upwards will be maintained. The alarm signaling can only be terminated by pressing the button **RESET**. Then, the following questions will be displayed:

Only if it is made sure that **there is no flammable gas on the sensor, but only fresh air, the question may be answered with YES.** In this case, the sensor will be reactivated and will display measured values after a short running-in period!

Please find further details in the chapter “Peculiarities when monitoring the LEL range”.

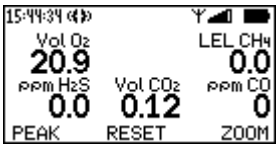
2.2.4 Battery Capacity and Battery Alarm

In the measuring mode, the capacity of the battery can be read from the state of charge battery icon on the right of the display. The black filling represents the remaining capacity. By pressing the right button (**ZOOM**) it is also possible to display the remaining capacity as a figure. (*1)

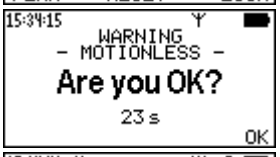
Generally, the fully charged battery would have a capacity for a continuous operation of more than 10 hours (11...130 hours depending on the sensor combination - also refer to the technical data). The service life can be reduced by alarms. If the state of charge drops to such a low level that the state of charge icon is no longer filled out, the device will switch to the “Energy-saving mode”. From this moment on, the green display lighting will no longer be activated when pressing a button. In case of a gas alarm, the red display lighting will also no longer be used. Then, the alarm signaling only occurs with the red alarm LEDs with a maximum horn volume of 90dB (A). If the state of charge drops even further, the battery alarm would be triggered and signaled acoustically. In this condition, the state of charge icon will flash. The maximum remaining service life is displayed in minutes. After 15 minutes, the device will automatically switch off with a clear acoustical signal. Then, the message “OFF” will be displayed for 5 minutes. If the function “Anti-Lazy-Battery” has been activated in the option menu, the device will not be automatically switched off after 15 minutes, but only when the minimum voltage falls below.

2.2.5 Motion Detection and Man-Down-Alarm

The G999 offers the option to monitor the movement of the device user. This option can be used for situations where there are no other personnel in proximity.



If the device user cannot act for himself any more, he can rapidly call for help by the acoustical alarm signaling or by radio.
If the motion detection is switched on, it is displayed in the top display row by the motion icon 🕪.



If the internal motion sensor does not detect any motion during a defined period of time, an optical and acoustical MAN-DOWN-ALARM will be triggered after a warning time of 30 seconds. Then, this alarm can be reset by a keystroke. During the warning time, the timer can be reset by moving the device or by a keystroke.

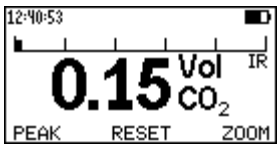
If the device is equipped with a radio module, the motionless time and, if applicable, a triggered MAN-DOWN-ALARM will be transmitted together with the gas measurement values.

The motion detection is set in the service menu under System / System options / Man-Down-Alarm (see section 2.3.2.1.5).

2.2.6 Short Term, Long Term, Maximum, Minimum Values

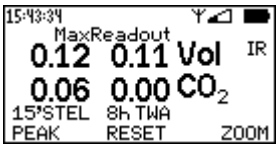
After having switched on the device, it will continuously measure in the diffusion mode. All concentrations will be displayed in this operating mode. In addition, short-term and long term values (STEL and TWA) are formed for toxic gases and the maximum values (MAX) or the minimum value (MIN) for oxygen are stored. These saved values can be displayed on the screen if the screen is switched over to the corresponding display mode by pressing the right button **ZOOM**.

2.2.7 Zoom Display and Detail View



In order to be able to see the measured values on the **Zoom** display, press the **right button** (**ZOOM**). Briefly press the button in order to zoom a displayed value. By pressing the right button several times, you can zoom the display of the measured values of the individual sensors one after another.

When the display of a value is zoomed, you can long press the button **ZOOM** and change over to the following detailed view:

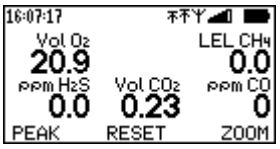


Example: Zoom display for H_2S

Top left:	Maximum value (since switching on or since the last RESET)
Top right:	Current gas concentration
Bottom left:	Short-term value (15 minutes)
Bottom right:	Long-term value (8 hours)

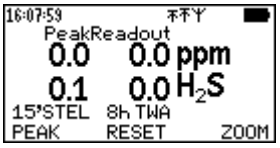
Within one session you can change between the two zoom modes by long pressing the button **ZOOM** . After having activated a zoom display, the display generally skips to the normal view after about 10 seconds, depending on the configuration (system options). If the button **RESET** is pressed in the zoom display, the maximum/minimum value memory will be reset to the current gas concentration.

2.2.8 Peak Display of the Peak Values



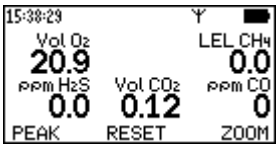
It is possible to display peak values in the peak mode which is activated by pressing the button **PEAK**. On the screen in the top row, the icon with the arrows is being displayed.

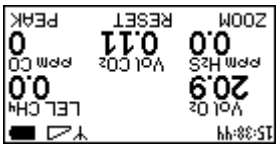
The peak mode will be deactivated by pressing the button **PEAK**.



In the zoom display on the top left the corresponding peak value is displayed instead of the max. or min gas concentration. If the button **RESET** is pressed in the detail view, the peak memory will be reset to the current gas concentration.

2.2.9 Turning the Display





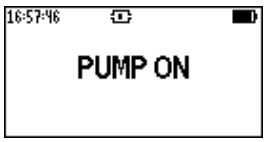
The G999 allows turning the measured value display by 180°. To do so, keep the left and right button pressed simultaneously and release it. In this way, the display can be easily read when the device is attached to the belt.

2.2.10 Operation with an Integrated Suction Pump

The integrated electrical suction pump can be used to suck in gases. If the G999 is switched to the operating mode, information and messages of the pump will be displayed on the screen of the G999 and malfunctions will be signalized visually and acoustically.

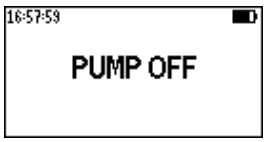
2.2.10.1 Switching the Pump On and Off

The pump will be switched on by pushing the sensor cover up. Then, the operating status of the pump will be displayed on the screen of the gas measurement device.



In case of a sufficient battery capacity the pump motor will switch on after a short delay of about 1 second. Then, the animated pump icon for the pump is displayed in the top row.

The pump will be switched off by pushing the sensor cover down.

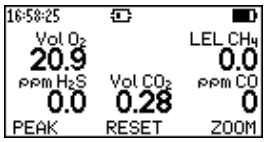


In doing so, the pump icon will fade out on the screen of the G999 gas measurement device.

In order for the batteries to not be unnecessarily discharged, the pump should be switched off after each measurement.

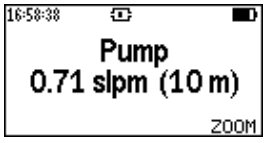
2.2.10.2 Status Signal of the Pump and Flow Monitoring

During the pump operation, an additional pump icon which indicates the operating status of the pump will be displayed on the standard screen display of the G999 gas measurement device.

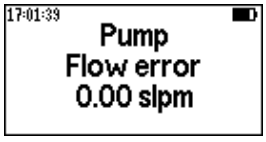


The undisrupted pump operation will be displayed at the top of the screen of the gas measurement device with a mobile pump icon. This icon flashes if the pump is no longer fully functional.

Any other alarm and fault statuses will be acoustically and visually displayed on the alarm system of the G999 gas measurement device. In the normal pump operation, the supplied gas volume amounts to about0.50…0.60slpm (slpm = standard litre per minute).



When the pump is switched on, the zoom mode of the display shows the currently aspirated distance of the suction hose in brackets, in addition to the current flow rate (in slpm = standard liters per minute). For the calculation of the suction section, a standard suction hose with 5mm inner diameter is assumed.



If the supplied gas volume is too low (< 0.30slpm) or in case of an interruption of the internal motor circuit, a visual and acoustical alarm will be emitted via the alarm system of the G999 gas measurement device. In addition to that, the pump icon blinks and the message “PUMP Flow error!” will be displayed on the screen. A clogging of the gas path to the pump might be the cause for the malfunction. The hose is eventually pinched off or the filter is clogged. The problem needs to be fixed so it can start operating properly.

Caution: In case of a flow error,
a proper measurement operation is no longer guaranteed.

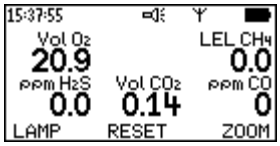
2.2.10.3 Minimum Pumping Time

Gas samples are sucked e.g. from wells, rooms or channels by means of a hose with or without the GfG telescopic suction pipe. Since the response time largely depends on the inner volume of the suction device, its length should be kept as short as possible. The following rule applies for the minimum pumping time (t_{min} in seconds):

$$t_{min} = 10s + 3s/m * L_{Hose} + t_{Tele}$$

L_{Hose} = Hose length in meters with an inner diameter of 5 mm
t_{Tele} = 10s with GfG telescope, 0s without telescope

2.2.11 Use of the Flash Light



The integrated flash light can be switched on by long time pressing the left button (about 3 seconds) or switched off (press briefly). It is reasonable to use the flash light e.g. if the device is lowered in to a sewer shaft or if it is used as a safe light source in dark, potentially explosive areas. The switched on flashlight is shown in the upper display line by the flashlight icon.

2.2.12 Display Lighting

The display lighting is switched on by pressing any key for about 10 seconds and then it will automatically switch itself off. If the battery is heavily discharged, the display lighting will no longer be switched on when pressing a key.

2.2.13 Peculiarities when Monitoring in the LEL Range

For the monitoring of the LEL range, the G999C can be equipped with a sensor, which works according to the catalytic process (CC). Due to the measurement method, the G999C measured values in the LEL range cannot be distinguished from values in the increased Vol. % range (e.g. >20 Vol.% CH_4). Furthermore, the sensor would be damaged by concentrations above 110%LEL. In order to avoid such a damage, the sensor will be switched off if gas concentration above 110%LEL is being detected. Only by pressing the button **RESET** and confirming the question "Fresh air?" by pressing the button **YES** the sensor will be switched on again.

At an oxygen concentration of less than 10 Vol. % it would be no longer possible to measure flammable gases and vapors with the catalytic process (CC) without errors. Please find more details about this topic in the chapter "Influence of oxygen and interference gases".

2.2.14 Influence of Oxygen and Interference Gases

For using the G999C with a pellistor it is necessary to pay attention that the measurement for gas and / or vapor concentrations in the measurement range below 100% LEL can't exactly be performed, if the oxygen concentrations are at the same time less than 10 Vol%. In this case, the oxygen which is necessary for the "catalytic combustion" is missing for the heat tone sensor. If the oxygen sensor would measure such a low concentration, question marks "????" will be displayed instead of the measured value in %LEL. If the oxygen concentration would increase above 10 Vol.%, the measured value will be displayed correctly.
The Ex approval does not apply for the use of the device in an oxygen-enriched atmosphere.
Certain substances, which are designated as "Sensor or catalytic toxin" in the technical vocabulary, can impair the catalytic combustion sensor (CC) with regards to its signal behavior. The "sensitivity", i.e. the ability of the sensor to emit signals, decreases. Substances of this kind are for instance Sulphur, lead and silicon compounds.

2.2.15 HI% Measurement of Methane or Natural Gas

In the normal measurement operation, it is possible to measure methane (CH_4) in the range from 0...100% LEL with a catalytic combustion sensor or an infrared sensor. In this operating mode, all preset gas alarm thresholds are being monitored.
If the device has been equipped with a special HI%-IR sensor (MK245-1 or MK249-8), even higher concentrations of up to 100Vol% CH_4 can be measured. By simultaneously pressing the left and center button, the system changes over to the HI% range. In this operating mode no gas alarms are being monitored. Besides the deactivated gas alarm, the readiness signal and, if applicable, also the catalytic combustion sensor will be switched off. At the top left a **HI%** icon is displayed on the screen. Then, the measured value of the infrared sensor will be displayed in Vol% CH_4 and afterwards the screen is empty at the position of the catalytic measured value. However, the pressure dependency of the IR sensor which are indicated in the sensor specifications need to be complied with.
If the gas concentration is less than 5Vol% CH_4, it is possible to change back to the %LEL range for monitoring by pressing the left and center button once again. By monitoring the gas alarm thresholds, the readiness signal will be reactivated and, if applicable, the catalytic combustion sensor will be switched on again.

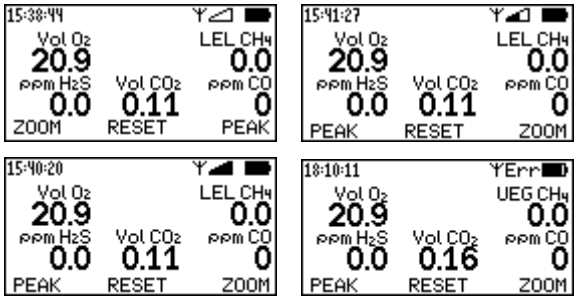
2.2.16 Recording of Measurement Data with the Data Logger

The measurement data can be recorded on the G999 with an internal data logger. No special activation of the data logging is required.

30.000 measuring points each can be recorded for up to 12 different measured values and other information. This includes date, time, measuring point, alarm triggering and special events.
In the menu item "data logger" of the service menu it is possible to set different functions of the data saving. It is possible to select the recording of average values, peak values or instantaneous value as well as the recording interval between 1 second and 60 minutes. The memory type is set to a ring memory at the factory. I.e. the oldest measured values will be overwritten as soon as the data logger is full. Measured data can be read with the help of a test station TS888/999 and a docking station DS400. The configuration of the data logger can be modified with the operating menu.

2.2.17 Wireless Data Transfer

If a corresponding radio module is built in the G999 and switched on, the current gas measurement values can also be requested and transferred by radio.



If the radio module is activated, the icons for radio and field strength are displayed in the upper display row. The stronger the field strength icon is filled in, the better is the radio connection. A flashing field strength icon signalizes that currently no measured values are requested or that the radio connection is interrupted. If the icon Err is displayed, the radio module is either defective or switched on but not existing at all.

Generally, the reach of the radio connection extremely depends on the structural circumstances between the sender and the receiver. At free visibility, a reach of 700m is possible with the 868MHz radio module. In buildings, the reach can considerably fall below 100m depending on the material, number and thickness of walls and other metallic components.

The device-specific setting of the radio address and also the radio channel is performed in the service menu under System / System options / Radio (refer to the paragraph 2.3.2.1.5).

2.3 Service Mode

Access the service mode by pressing the center button for about 3 seconds long **RESET**. In the service mode it is possible to set the G999 by modifying the program parameters. Some menu items can only be accessed via an access code "0011". The access code prevents that important functions might be accidentally modified or modified by unauthorized persons. Alarming cannot be performed in the service mode.

The main menu is the first menu item in the service mode.

2.3.1 Main Menu

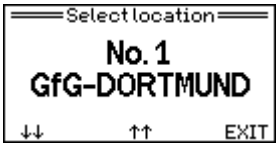
Menu control: The individual key functions will always be displayed by the labelling via the individual buttons on the screen.

Left button	↓↓	= Scrolling one menu item downward
Centre button	**SELECT**	= Choosing the highlighted menu item
Right button	**DETECT**	= Back to the measurement operation

The individual menu items in the main menu are:

2.3.1.1 Place – Choice of a Measuring Point

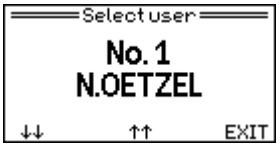
From a table stored in the device, it is possible to select one of 100 possible places. All table entries can only be edited with a PC. In a table entry it is possible to save up to 15 letters / figures, which are saved as "**Job site**" in the G999.



By pressing the left and center button a stored place is being selected. The choice is automatically completed, when the selected value is confirmed with the right "Back" button.

2.3.1.2 Name – Choice of a Device User

From a table stored in the device, it is possible to select one of 20 possible entries. All table entries can only be edited with a PC. In table entries it is possible to save up to 15 letters / figures, which are saved as "**Identification**" in the G999.



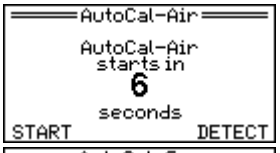
By pressing the left and center button stored user is being selected. The choice is automatically completed, when the selected value is confirmed with the right "Exit" button.

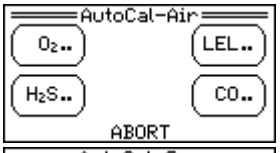
2.3.1.3 AutoCal – Menu for AutoCal Adjustment

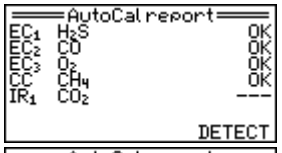
In the menu item AutoCal several sensors can be simultaneously adjusted with fresh air (AIR) or test gas (GAS). Except for the CO_2 sensor, all sensors can be adjusted with fresh air without any further settings. When adjusting with test gas (KAL) the sensors need to be released depending on the used test gas / mixture. (Also refer to the paragraphs "AutoCal air . . ." and "AutoCal gas . . .")
The menu item AutoCal can be selected in the main menu or alternatively by simultaneously pushing the button in the middle and on the right one.

Then, the following functions can be chosen:

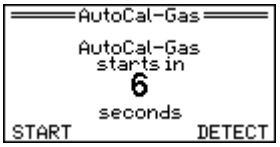
AIR = AutoCal adjustment with fresh air
GAS = AutoCal adjustment with test gas
EXIT = Back to the main menu

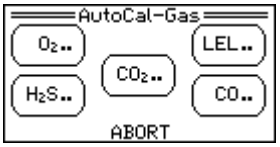


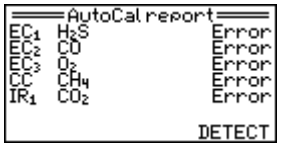




AutoCal adjustment with fresh air has been successful.



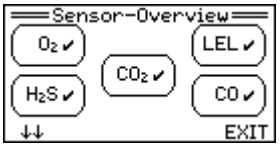




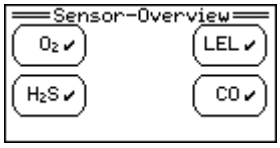
AutoCal adjustment with test gas mixture has not been successful. (e.g. Due to wrong test gas concentration)

An AutoCal adjustment with fresh air is only performed if the sensor reading of the set point 0.0 (except for O_2) does not deviate more than ±10% from the measuring range or if the set point 20.9Vol.%O_2 does not deviate more than ±5.2Vol.%O_2. An AutoCal adjustment with test gas is only performed if the sensor reading of the "Cal.Gas" set point (in the sensor menu "Calibrate") does not deviate more than 25%. In case of larger deviations, the corresponding sensor will then be marked with "Error" in the subsequently indicated AutoCal report. In this case, adjust the sensor in the sensor menu "Zero" or "Calibrate" or with the docking station.
The adjustment can be performed in the diffusion mode with fresh air exempt from measuring gas. However, no ambient air should be used for the zero point adjustment of the CO_2 sensor, since the ambient air always contains a small portion of carbon dioxide (CO_2) which would then result in wrong CO_2 measured values. For this reason, the zero point of the CO_2 sensor should only be adjusted in the sensor menu "Zero" or with the docking station with CO_2-exempted zero gas. It could be e.g. synthetic air, 100Vol.%N2 or specially purified air (CO_2-free). Zero gas (air exempted from measurement gas) and test gas can be supplied via the calibration cap "SMART CAP" with a volume flow from 0.5 to 0.6 slpm (l/min).

2.3.1.4 Sensor Overview

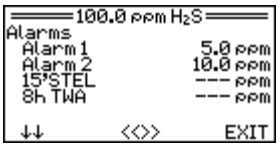


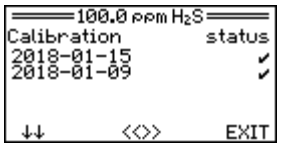
or



The sensors which are represented in the overview are located in the corresponding plug-in locations of the device.

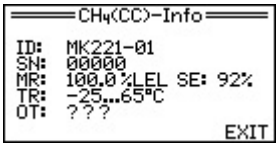
Display of the alarm settings as well as date and status of the last calibration





The data of the last three sensitivity adjustments can be displayed in the sensor menu "Calibration data". The status display indicates if they have been successful (√) not faulty (↗).

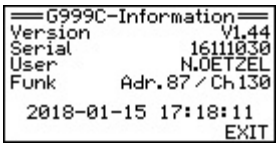
Sensor information



In this menu item, specific information for each individual sensor is displayed:

- ID = Number of the measuring chamber
- SN = Serial number
- MR = Measuring range
- SE = Gas sensitivity of the sensor (100% = nominal)
- TR = Temperature range
- OT = Operating time of the sensor, e.g. 125 of 791 days

2.3.1.5 System Information



In the system menu item **Information** you will find information about the device type, the firmware version, the serial number of the device.

2.3.2 Service Menu

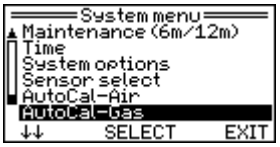
Access the service menu by selecting the main menu item **Service**. In the service menu it is possible to set the G999 by modifying the program parameters.
The menu items can only be accessed via an access code "0011". The access code prevents that important functions might be accidentally modified or modified by unauthorized persons. Alarming cannot be performed in the service mode.

ABC = Go to the next letter in the alphabet
< < > > = Confirm letters (The cursor automatically skips to the next position). By long pressing the key, the last entry will be deleted, the cursor will skip one position back.
012↑↑ = Go to the previous letter in the alphabet

After having entered the code 0011, the following will be displayed:

In the menu item **System** it is possible to perform general settings (refer to the chapter "System menu"). In the menu item **Sensors** it is possible to set sensor-specific functions (zero point and sensitivity adjustment). It is possible to retrieve information or to set alarm thresholds.
By pressing the button **DETECT** you quit the service menu and go back to the measuring mode.

2.3.2.1 System Menu for System Settings

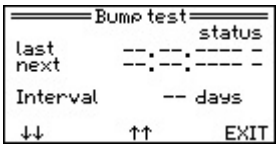


These menu items are explained in the following paragraphs:

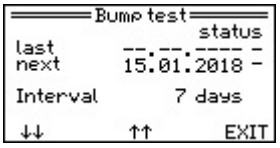
- Bump test (see section 2.3.2.1.1)
- Sensor adjustment (zero point + calibration) (see section 2.3.2.1.2)
- Maintenance, setting the next date (see section 2.3.2.1.3)
- Time, setting date and time (see section 2.3.2.1.4)
- System options for diverse settings (see section 2.3.2.1.5)
- Sensor choice – Activation / deactivation (see section 2.3.2.1.6)
- AutoCal air, Sensor release for AutoCal adjust (see section 2.3.2.1.7)
- AutoCal gas, Sensor release for AutoCal adjust (see section 2.3.2.1.8)

2.3.2.1.1 Bump Test

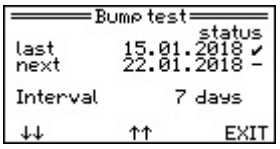
The functional test (inspection of the sensor values and alarms) can be easily and rapidly performed with the docking station DS400. The functional test is performed automatically, the intervals for the test will be stored in the G999. The functional test interval will be activated in the docking station after the first test.



Functional test has not yet been performed.
Functional test interval is not activated.



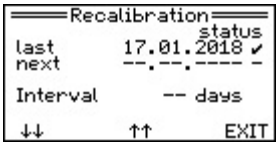
By setting a function test interval, the next function test is due immediately.



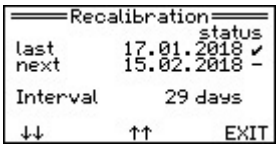
Functional test on January 15th, 2018 was correct
Next functional test will be due 7 days later

2.3.2.1.2 Sensor Adjustment (zero point + calibration)

The sensor adjustment (zero point and sensitivity adjustment) can be easily and rapidly performed fully automatic with the docking station DS400. The intervals for the sensor adjustment will be saved in the G999 and activated from the docking station after the first sensor adjustment.



Sensor adjustment on March 19th, 2018 was correct.The interval for the sensor adjustment is not activated.



Sensor adjustment on March 19th, 2018 was correct.
The next sensor adjustment will be due 28 days later.

2.3.2.1.3 Maintenance

In order not to forget the date for the next maintenance, it is possible to enter a date which the G999 will automatically alarm if exceeded. After having exceeded the date, the G999 will inform the user that a maintenance needs to be performed as soon as the device is switched on.
To do so, it is necessary to select first **Maintenance** in the service menu.

It is possible to first select which parameter needs to be changed (year, month and day):

EXIT = Back to the system menu
SELECT = Selecting the parameter to be flashing
> > = Change over to the next parameter

The following options are available in order to modify a parameter:
↓↓ = Reduce value
EXIT = Confirm value
↑↑ = Increase value

2.3.2.1.4 Time

The device has a clock for date and time. This clock is buffered by a lithium cell, which is designed for a service life of 20 years. An automatic changeover to daylight saving time can be switched on or off. Since the time changeover is regulated differently from region to region, you can choose between Europe, North America or no changeover.

In the **Time menu** the corresponding flashing parameter is selected with

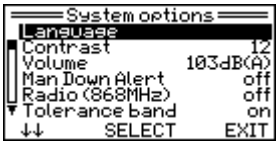
SELECT = Select.
>> = Skip to the next parameter.
EXIT = Go back to the system menu.

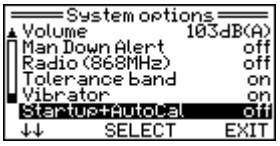
The following options are available in order to modify a parameter:

↓↓ = Reduce value
EXIT = Confirm value
↑↑ = Increase value

2.3.2.1.5 System Options

If "**System options**" is selected in the service menu, the following will be displayed:

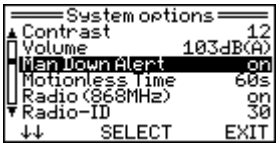




- **Language** (language options. i.e. German, English)
- **Contrast** (setting the contrast values)
- **Volume** (Horn with103dB(A), 90dB(A), 0dB(A))
- **Man-Down-Alert** (see below)
- **Radio** (see below)
- **Tolerance band** (see below)
- **Vibrating Alarm** (on/off)
- **Startup+AutoCal** (on/off)

Man-Down-Alarm

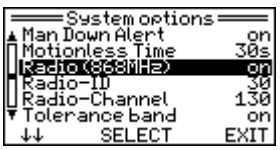
In the menu item “Man-Down-Alarm”, it is possible to switch the motion detection on and off.

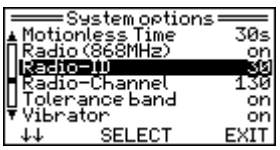


The “Motionless time” can be set from 20…300s. After the expiration of this time, the device user will be warned for 30 seconds. Only afterwards, the “Man-Down-Alarm” will be triggered in the measuring mode.

Radio-Adjustment

If a radio module is integrated in the G999, it is possible to switch the radio function on and off in the menu item “**Radio**”. Depending on the radio module, it will be displayed as (868MHz) or as (915MHz). If the radio module is switched on, it is possible to individually set the radio address and the radio channel. Therefore, the last two figures of the serial number of the device are used as identification. This corresponds to the setting (auto). Alternatively, the radio address can also be set from 0…254 (fixed). On the 868MHz radio module, the radio channel, which is by default set to 130, can also be set in the range from 101…111 or from 129…132. On the 915MHz radio module, no radio channel is being set, since this radio module is working with frequency hopping.





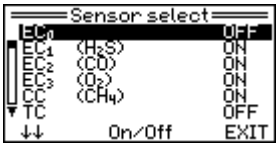
Switch Tolerance Band On/Off

In the measuring mode, the G999 suppresses low measured value fluctuations in the range of the zero point on sensors for toxic and flammable gases. In case of the oxygen measurement, low fluctuations about 20.9Vol% O_2 (fresh air range) will be suppressed. In order to avoid skips, the display value will be adjusted to the double value of the tolerance band up to the real measured value.

This tolerance band is activated by the manufacturer, but it can generally be switched off as well. For this purpose, it is necessary to enter the shortcut <REAL> for the deactivation or the shortcut <BAND> for the activation instead of the access code. Please find detailed information about the size of the tolerance band in the chapter “Sensor types and measuring ranges”.

2.3.2.1.6 Sensor Choice – Activation / Deactivation of Sensors

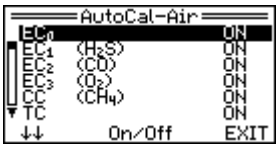
Each sensor can be individually switched on or off for the measurement. This function is always used when a gas is no longer being measured or a sensor is removed from the instrument without replacement.



On = Sensor active
Off = Sensor inactive
If no (gas) is indicated behind the sensor, the sensor is not available or it is not being identified.

↓↓ = Scroll downward to the next sensor
On / Off = Activate / deactivate the corresponding sensor
EXIT = Back to the service menu

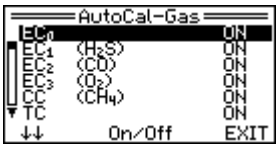
2.3.2.1.7 AutoCal Air – Sensor Release for AutoCal Adjustment



Here it is possible to set which sensors should be used for the automatic adjustment with fresh air. Except for the IR sensor, for CO_2 by default all sensors are set to "ON" and are thus released for the automatic fresh air adjustment.

↓↓ = Scroll downward to the next sensor
On / Off = Adjustment / Non-adjustment of the sensor in the AutoCal program
EXIT = Back to the service menu

2.3.2.1.8 AutoCal Gas – Sensor Release for AutoCal Adjustment

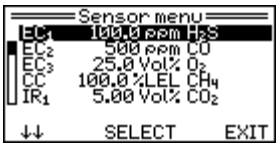


Here it is possible to set which sensors should be calibrated for the automatic adjustment with test gas. By default, all sensors are set to "OFF". If several sensors need to be adjusted simultaneously with a test gas mixture, these sensors can be selected here.

↓↓ = Scroll downward to the next sensor
On / Off = Adjustment / Non-adjustment of the sensor in the AutoCal program
EXIT = Back to the service menu

2.3.2.2 Sensor Menu for Sensor Settings

The following functions refer to the individual sensors in the G999. In the sensor menu, each sensor can be selected individually. Then, the settings apply for each selected sensor.
For the description of the functions of the sensor-specific settings the CH_4 sensor resp. the O_2 sensor are mentioned as an example for reference. However, the setting options apply for all sensors in the same way.



Input options:

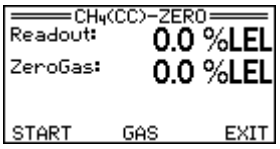
↓↓ = Changing over to the next sensor
SELECT = Selecting the sensor
EXIT = Back to the service menu

The following settings are available for each sensor:

Zero = Adjusting the zero point
Calibrate = Adjusting the sensitivity
Alarms = Setting the alarm thresholds
Calibration data = Data and status of the last calibration and zeroing
Information = Sensor information: MK number, serial number, measuring range, temperature range
Unit and Type of gas = Selecting the CH_4 unit to be displayed (%LEL / Vol%) or selection of the type of gas to be displayed
↓↓ = Changing over to the next menu option
SELECT = Selecting the menu option
EXIT = Back to the service menu

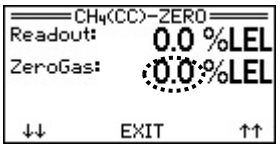
2.3.2.2.1 Zero – Adjusting the Zero Point

When adjusting the zero point, the sensors should be gassed with air exempt from measuring gas or the carbon dioxide and the oxygen sensor (*1) with 100Vol.% nitrogen. In this case, the zero gas can be supplied via the “SMART CAP” with a flow from 0.5 to 0.6slpm (l/min). In order to adjust the zero point, it is necessary to select the sensor menu item “Zero”. Then, the following will be displayed:



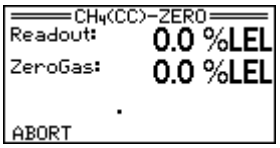
START = Starting the zero point adjustment
GAS = Inputting the zero gas concentration
EXIT = Back to the “CH_4” menu”

Generally, the zero gas is 0.0 so that it is not necessary to modify this concentration. However, in special cases, the zero gas concentration can be slightly raised after having pressed the button GAS. After having input **GAS** the following screen will be displayed:



↓↓ = Reducing the zero gas concentration by one unit
EXIT = Confirming the value and back to the menu item “Zero”
↑↑ = Increasing the zero gas concentration by one unit

By inputting **Start** the zero point adjustment is being started:



ABORT = Cancelling the adjustment and changing over to the “CH_4” menu.

If a constant measured value is registered after a stabilization time of 10 seconds, the adjustment will be performed and conformed by pressing the button “OK”. For CC, IR and O2 sensors the stabilization time is a bit longer but generally limited to 3 minutes.

For (*1): The zero point adjustment of the oxygen sensor will be performed with 100Vol% nitrogen at the factory. For the monitoring of the usual alarm thresholds of ≥17Vol%O_2 no readjustment of the user is required. In this case, it is sufficient to adjust the sensitivity.

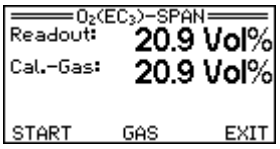
2.3.2.2.2 Calibrating – Sensitivity Adjustment

The gas sensitivity of the sensor is adjusted for the calibration. Before performing the sensitivity adjustment, a zero point adjustment needs to be performed. A corresponding test gas is required for the sensitivity adjustment. Test gases are e.g.:

Measuring range	Test gas
TX	Carbon monoxide (CO), hydrogen sulphide (H_2S) or other gases
OX	Fresh air or test gas with 20.9 Vol% oxygen (O_2) in nitrogen (N_2)
EX	Methane (CH_4), propane (C_3H_8) or any other flammable gases (*2)

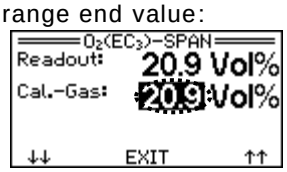
The test gases to be used can be learned from the test log. For the sensitivity adjustment, the concentration of the test gas should amount to from 30% to 70% of the measuring range end value. However, for IR sensors with measuring ranges of >5Vol.CO_2 t the concentration of the test gas must be between 25% and 75% of the measuring range end value. The test gas can be supplied with the “SMART CAP” with a flow from 0.5 to 0.6slpm (l/min).

In order to adjust the sensitivity, it is necessary to select the sensor menu item “Calibrate”.



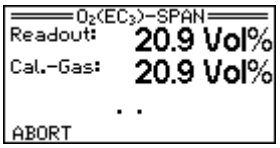
START = Starting the sensitivity adjustment
GAS = Inputting the test gas concentration
EXIT = Back to the “O_2” menu

By inputting **GAS** the test gas concentration can be set in the range from 10 to 105% of the measuring range end value:



↓↓ = Reducing the test gas value by one unit
↑↑ = Increasing the test gas value by one unit
EXIT = Confirming the value and back to the “O_2” menu

However, by inputting **Start** the sensitivity adjustment is being started:



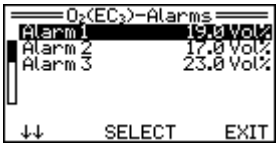
ABORT = Cancelling the adjustment an change over to the "O_2" menu.

If a constant measured value is registered after a stabilization time of 25 seconds, the adjustment will be performed and conformed by pressing the button "OK". Generally, the stabilization time is limited to 3 minutes.

For (*2): The sensitivity adjustment of sensors which measure certain flammable gases in the %LEL range, such as e.g. n-hexane, n-nonane or similar "heavy" vapors, is not unproblematic. Apart from the availability of such a test gas, it has to be assumed with a long stabilization time in the range of several minutes for the gas supply. Alternatively, the sensitivity adjustment can be performed with a suitable reference gas (e.g. propane). The IR sensor MK249-8 can be adjusted e.g. with a reference gas of 0.85Vol%C_3H_8 (propane) to 67%LEL n hexane or 80%LEL n nonane. The cross-sensitiveness for such sensors are indicated in the chapter "Sensor specifications".

2.3.2.2.3 Alarms – Alarm Setting

The G999 has 3 momentary value alarms for the non-toxic gases (O_2, CH_4) each, for the toxic gases (e.g. H_2S, CO, CO_2) there are 2 momentary value alarms each. The alarms are triggered if the gas concentration exceeds or falls below the corresponding limit value. An alarm can additionally be emitted for the toxic gases if the long-term and the short term value (LZW and KZW) are being exceeded.
After having selected the sensor menu item **Alarms** the following screen is displayed (here: Selecting O_2):



↓↓ = Scrolling downwards
SELECT = Selecting the menu item
EXIT = Back to the sensor menu

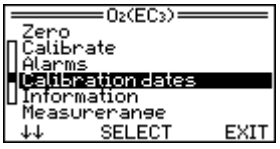
After having selected the alarm limit value (in the example: Alarm 1) it is possible to enter the value:

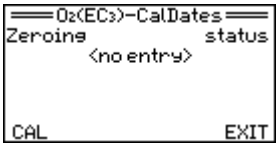
The selected alarm limit value flashes and can only be changed, if:

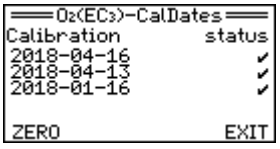
↓↓ = Reducing the alarm value by one unit
EXIT = Back to the sensor menu
↑↑ = Increasing the alarm value by one unit

With the exception of %LEL measuring ranges all limit values can be freely set or completely deactivated (0 or "---") over the whole measuring range. For %LEL measuring ranges, the limit values can be set to up to maximum 60%LEL.

2.3.2.2.4 Calibration Data of the Sensor Sensitivity



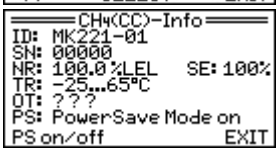




In this menu item, the data of the last calibration will be displayed. It is a pure information display.

2.3.2.2.5 Information About the Sensor

The individual data of the sensors which are built-in this device, have been displayed here.

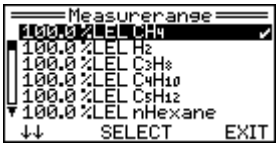


The individual data of the sensors which are built-in the device, are displayed here.

ID: The MK number corresponds to the sensor type
SN: Serial number of the sensor
MR: Measuring range of the sensor
SE: Gas sensitivity of the sensor (nominal=100%)
TR: Temperature range in which the sensor can be used
OT: Operating time the sensor has already been used
PS: The **P**ower**S**ave mode from the Catalytic Sensor can be turned **on** or **off** with the left button. This mode cannot be activated if the sensitivity of the sensor is too low and on "heavier" gases (such as hexane, nonane or similar) due to the smaller sensor signal.

2.3.2.2.6 Measuring Range

Under the menu item measuring range, different pre-defined measuring ranges are listed for smart GfG sensors. They can be selected.



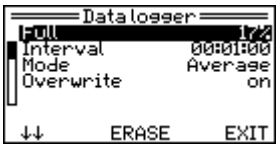
In this menu item (here CC sensor) it is possible to select the type of gas to be displayed or to set the CH_4 unit to %LEL or Vol%. The volume concentration in brackets corresponds to the final value of the measuring range. Hereby it is possible to set the measuring range to the country-specific LEL value.

If the unit or the type of gas has been changed, the device needs to be restarted after quitting the service program, before performing a functional test or an AutoCal adjustment with a docking station.

2.3.2.3 Data Logger Settings

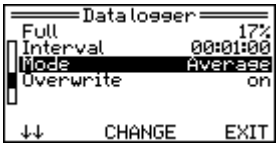
In the menu item **Data logger** it is possible to make different settings:

Complete - Deleting the data from the data logger (display of the memory usage)
Mode - Selection of instantaneous values, mean values or peak values
Interval - Interval of the data logging (selectable from 1 second to 60 minutes)

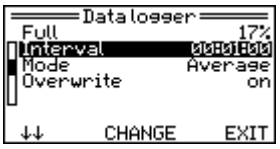


The **FULL** parameter indicates how much memory is used on the data logger.

↓↓ = Scrolling downward to the next parameter
ERASE = Deleting the data. A security query will follow "**Delete data?**". Confirm by pressing the button **YES** (right button), cancel by pressing the button **NO** (left button)
EXIT = Back to the main menu



If the parameter **Mode** is selected by pressing the button **CHANGE**, it would be possible to choose between the instantaneous value, mean value and peak value (Peak). After having input **EXIT** the system will skip back to the logger menu. The selected mode will be taken over.



Interval: The interval of the data logging can be selected by pressing the buttons on the left and right from 1 second to 60 minutes.

The data of the data logger can be read and transferred to a PC with the help of the charging tray or of the charging cap and an optional USB adapter cable.

2.4 Power Supply

The G999 has an NiMH battery module. In this supply module, the battery is an integral part of the back of the housing. A dangerous dendrite growth, as e.g. in lithium-polymer or lithium-ion batteries are excluded in the G999 battery module.

2.4.1 Charging the Battery

Caution:

The device must not be charged in potentially explosive atmospheres.
The charging contacts must not get dirty. (Refer to the chapter “Maintenance”)

The battery module in the G999 can be charged in the **charging tray**. Perfect functioning is only guaranteed if the charging tray is lying or is fixed horizontally and the mounting bracket is correctly clammed in. Caution: Do not mount vertically!

The charging tray will be supplied by a plug-in power supply made by GfG or alternatively via a vehicle charging cable made by GfG. The charging tray limits the charging voltage for the G999 to max. 9V. The charging process is subdivided in normal and trickle charging. The green LED signalizes the operational readiness of the charging tray. The green LED indicates the charging process (Off: No device in the charging tray, constantly illuminated: Charging, Flashing: Trickle charging).

Charging tray with mounting bracket

Ensure that the charging process will be indicated by the yellow LED and on the display after having inserted the G999 into the charging tray and closing the mounting bracket (otherwise there might possibly be contact problems).

In case of a completely discharged battery, the charging process will take about 6 to 7 hours. Then, the charging tray will automatically switch over to the trickle charging so that an overloading of the battery will be excluded. Both states of charge will be displayed on the screen of the G999. After having switched over to the trickle charge, the battery will have at least 95% of its capacity. In order to attain a capacity of 100%, the battery module needs to be charged another 2 hours with trickle charging.

With the help of the charging tray and an optional USB adapter cable, the data of the G999 data logger can be read and transferred to a PC.

In order to permanently maintain the capacity of the NiMH battery, make sure that the battery is only charged by using the charger depending on the useful life and frequency and the charger is not used as a storage place for weeks for the gas measurement device. Please find recommendations in the following table for the charging depending on the device usage.

	Device Usage	**Recommendation for the Charging of the Battery**
1.	Daily for more than 3h	Charge after use
2.	Daily for less than 3h	Charge every 2nd or 3rd day
3.	Once per week	Charge 1 day before the next use
4.	Once per month for more than 3h	Charge after use as well as 1 day before the next use
5.	Once per month for less than 3h	Charge 1 day before the next use
6.	Once per calendar quarter or rarer	Charge after use as well as 1 day before the next use

For 4,5,6: If the device is rarely used, then the battery needs to be charged after use, since one part of the sensor electronics also needs to be supplied with energy even when the device is switched off. If the device has not been used for a very long period of time and the battery is completely discharged, then the device needs to be recharged about 1 day before the next use. A normally discharged battery will generally be charged to 95% of its normal capacity within about 6 hours charging mode. After another 2h trickle charging mode, the battery will be charged to 100% of its normal capacity. If in spite of the completely charged battery the normal device service life would not be attained, this might be caused due to the “lazy battery effect” (effect of the inertia of the battery). The discharge behavior changes in such a way that in spite of the completely charged battery the battery icon is empty relatively quickly however, the device can be operated for a long time.

2.4.2 Lazy Battery Effect on the NiMH Battery and its Removal

On the NiMH supply units, the “lazy battery effect” and thus a reduction of the service life of the device might occur due to temperature influences above 50°C, after longer non-use, due to unfavorable device use or due to wrong charging behavior. This may occur if the battery of the device has never been completely discharged or if the battery is charged too often or too long. It has to be avoided to start the charging process several times per day and that the device is permanently deposited in the charger for several days or weeks. The “lazy battery effect” can often be remedied by completely discharging the NiMH battery. However, in order that the battery would not be completely discharged, the device must not be manually switched off.

2.4.3 Changing the Battery Module

Caution: The device must not be opened in potentially explosive areas and therefore the battery module is not being changed. The battery is an integral part of the back of the housing, it must only be replaced outside of potentially explosive areas and only by a NiMH battery module of the same type.

Before replacing the battery module, the device needs to be switched off. In order to remove the supply module, the six screws at the back of the device need to be unscrewed and the whole module needs to be pulled off to the rear.

3 Annex

3.1 Maintenance

Soiling of the device housing can be removed using a cloth dampened with water. Do not use solvents or cleaning agents! Particularly make sure that the outer charging contact surfaces of the G999 and the charging contact pins of the charging adapters are clean. In case of bad/incorrect contacting of the charging adapter, the NiMH battery will only be charged incompletely or not at all.

3.2 Maintenance and Inspection

The maintenance and inspection includes a regular review and adjustment of the sensitivity and of the zero point. Moreover, the functionality of the device needs to be checked. Gas warning devices can behave in different ways depending on the environmental conditions. Thus, it is important to perform a test and an adjustment, if applicable, independent from the maintenance works (refer to the DIN EN 60079-29-2 paragraph 9.2 as well as the DGUV Information 213-057 (T 023) and DGUV Information 213-056 (T 021) of the BG RCI in Germany).

3.2.1 Visual inspection and display or function test

The purpose of the visual inspection and the display or function test is to ensure that the device is in an operational state. It is strongly recommended that this be performed daily.

It includes the following activities:

- Visual inspection of the device and the accessories used for mechanical damage
- Visual inspection of the gas inlet openings (e.g. for contamination by dust and dirt)
- Functional test of the pump for flow and tightness including the sampling accessories
- Tests of the display elements and alarm function
- Battery charge status
- Display with zero gas as well as alarm triggering with test gas
- The response behaviour of most sensors and the triggering of alarms can be checked with suitable test gas and with the aid of a docking station or a test station (see sections3.4 and 3.6). For certain sensors for very reactive gases, however, the „SMART CAP“ calibration cap or the integrated pump must be used for checking.

3.2.2 Function control and sensor adjustment

The purpose of the function check and sensor adjustment is to ensure that the device is in an operational and proper condition. This must be carried out before the first use and (in Germany according to T 021 as well as T 023) at least every 4 months. Please observe the respective national regulations.

It includes the following activities:

- Visual inspection and tests according to section 3.2.1
- Supply of zero and test gas for checking the measured value display (calibration) and adjustment
- Control and evaluation of the response behaviour or the setting times
- Alarm signal triggering, e.g. with alarm test gas

The accessories required for these activities are already listed in section 3.2.1.

3.2.3 Maintenance (system control) and servicing

The purpose of service and maintenance is to ensure that the device can be used again according to the specified operating behaviour until the next maintenance date, if possible. In Germany, maintenance according to T 021 and T 023 should be carried out at least once a year. Please comply with the respective national regulations.

It includes the following activities:

- Function check and sensor adjustment according to section 3.2.2
- Checking the pump performance and adjusting the flow measurement if necessary
- Assessment of the battery capacity and if necessary replacement of the over-aged battery
- If necessary, replace worn sensors and renew the sensor seal
- If necessary, replace dirtied or damaged sensor membranes

Maintenance and servicing includes all repair and replacement work. They may only be carried out by the manufacturer and by persons authorized by the manufacturer GfG Gesellschaft für Gerätebau mbH. Only original spare parts and original assemblies tested and approved by the manufacturer may be used.

3.3 Calibration Device

The device has to be supplied with test gas in order to control the sensitivity of the display. The diffusion openings can be covered with the help of the “Smart Cap”, so that the test gas can be supplied to the sensors with a flow from 0.5 to 0.6l/min. Alternatively for certain test gases, this inspection can also be performed with the docking station DS400.

Caution: Test gases, in particular toxic gases may pose hazards. Make sure that test gases are not inhaled. Working places, where devices are calibrated with test gas, need to be sufficiently ventilated depending on the type of gas, concentration and gas quantity. In particular cases, a gas extraction or a gas discharge is suitable. The safety notes on the test gas bottles as well as the safety data sheets of the test gases need to be observed in any case.

3.4 Inspection with the Docking Station DS400

The functional test required in the DGUV Information 213-057 (T 023) and 213-056 (T 021) as well as the adjustment of the G999 can be easily and rapidly performed with the docking station.
The functional test will be automatically started and performed fully automated. The effective time for a functional test amounts to about 20 seconds. The adjustment (sensor adjustment) will be started at an individual push of a button and completed within a few minutes. A green or red LED will indicate the test result. The detailed values are displayed on the device screen (functional test report, AutoCal air report, AutoCal gas report). No PC is required to perform the functional tests and the adjustment; all relevant data will be automatically saved on an SD card which is inserted in the docking station.
The first time, the functional test of the G999 needs to be performed; the interval for the functional test and the adjustment can be automatically activated on the docking station.

Before using the docking station, it is necessary to read and follow its operating instructions.

3.5 Malfunction, Cause, Remedy

	Malfunction / Message	Cause	Remedy
1.	Simultaneously flashing alarm LEDs and display off	Insufficient voltage supply	Charge battery
		Hardware or program execution error	Call the GfG service
2.	Permanent “Boot loader” with red display lighting	Program memory defective	Transfer Firmware to the device Call GfG service, if necessary
3.	“ERROR! RAM”	Working memory defective	Switch device off and on Call GfG service, if necessary
4.	“ERROR! EEP”	Device parameter memory defective	
5.	“ERROR! BAT”	Battery voltage metering defective	
6.	“ERROR! ALG”	Program execution error / Algorithm	
7.	“Clock clip does not work!” “Time reset to ...”	Hardware defect	Acknowledge message Call GfG service, if necessary
8.	“Reset time to ...”	Clock not set or buffer battery is empty	Acknowledge message, set time Call GfG service, if necessary
9.	“Sensor defective!”	Sensor defective or not available	Switch device off and on Call GfG service, if necessary
10.	“Data incorrect!”	Sensor data are incorrect	Switch device off and on Call GfG service, if necessary
11.	“Reconnect sensor to EC1!”	EC sensor is connected to the wrong slot	Open device, reconnect sensor, then switch the device on again
12.	“Reconnect sensor to EC2 or EC3!”		
13.	“Sensor not available. Deactivate sensor in the system menu!”	Sensor not available.	Acknowledge message and switch off sensor in the service program Call GfG service, if necessary
14.	“CHECK ALARMS”	Sensor was replaced by another type	Check alarm setting in the service program and change it, if necessary
15.	“Gas type is not supported”	Gas type is not supported by the device	Remove sensor

		or old Firmware version	perform Firmware update, if necessary
16.	"No sensors"	No sensors activated in the service program	Activate available sensors in the service program
17.	Gas display "START" ("STRT")	Sensor is still in the activation phase	Wait for some seconds
18.	Gas display "????"	Measuring with CC sensor is not possible, since oxygen display <10Vol%	If this occurs with fresh air, it is necessary to adjust or replace the oxygen sensor
19.	Gas display "----" / Error	No gas display, since the sensor is defective or the sensor data are incorrect	Deactivate the sensor in the service program Call GfG service, if necessary
20.	Gas display "↓↓↓↓"	Measured value under range Clearly falling below the measuring range	Perform zero point adjustment
21.	Gas display "↑↑↑↑"	Measured value over range/excess available gas concentration is too high or high cross sensitivity (for EC sensor) or protective circuit activated (for CC sensor)	Quit range of high gas concentration and acknowledge message for the CC sensor and confirm in the fresh air range
22.	Gas display "FAULT" ("FLT")	IR sensor signal is incorrect	If this happens repeatedly Call GfG service
23.	Gas display "TEMP" or "TEMP ERROR"	Sensor is operated outside the specified temperature range or hardware defect at 0°C<Ta<30°C	Go to a normal environmental temperature range Call GfG service, if necessary
24.	Gas display "POWER" or "POWER ERROR"	Energy supply of the sensor is disturbed	If this happens repeatedly Call GfG service
25.	Gas display "P+T"	See gas display "TEMP" and "POWER"	See above
26.	"Gas concentration is too high!"	When changing from the HI% range to the %LEL range the gas concentration is still above 5Vol%	Wait until the gas concentration has reduced to less than 5Vol% and repeat switchover.
27.	"No sensors released for AutoCal air (gas)"	No sensors released for the automatic fresh air or test gas adjustment	Release for the automatic adjustment in the service program Sensor(s)
28.	"Zeroing failed measured value too high" (too low)	Possibly measuring gas available or too positive (negative) zero point deviation	Perform zero point adjustment in the environment exempt from measuring gas / Call GfG service, if necessary
29.	"Calibration failed Measured value too low" (too high)	Wrong test gas concentration or sensor sensitivity too low (too high)	Check test gas and set point Call GfG service, if necessary
30.	"Zeroing (calibration) failed Signal cannot be detected"	Extreme sensor signal deviation or hardware defect	Repeat process and call GfG service, if necessary
31.	"Saving failed"	Parameters cannot be saved when quitting the service program	Switch device off and on, then repeat the settings in the service program Call GfG service, if necessary

3.6 Accessories and Spare Parts

	Description	**Order No**
1.	G888/G999 SMART CAP (calibration cap)	1990210
2.	G888/G999 SMART CAP with USB cable (calibration cap and data transfer)	1990211
3.	DIC888/999-B Charging tray with brackets and EU plug-in power supply (12VDC/700mA)	1990221
4.	DIC888/999-B Charging tray with brackets and vehicle charging cable	1990222
5.	DIC888/999 USB interface cable	1990229
6.	DS400 Docking station for G888/G999-D with EU plug-in power supply (12VDC/1300mA)	1990231
7.	DS404 Docking station for G888/G999-D with EU plug-in power supply (12VDC/1300mA)	1990236
8.	TS888/999 Test station without fitting without plug-in power supply	1990240
9.	TS888/999 Test station with fitting without plug-in power supply	1990241
10.	TS888/999-DIC Test station with charging function w/o fitting without plug-in power supply	1990245
11.	TS888/999-DIC Test station with charging function with fitting without plug-in power supply	1990246
12.	G999 Sensor cover light-blue (or traffic-yellow / traffic-red / bright-light-red / light-green)	1990290-94
13.	G999C NiMH Battery pack A21 (back housing)	1990301
14.	G999E NiMH Battery pack A21 (back housing)	1990302
15.	G999P NiMH Battery pack A21 (back housing)	1990303
16.	G999 Hose connectors with filter insert	1990305
17.	G999 Filter element for hose connector (VPE=10 pce., each 20mm)	1990306
18.	G999 Spare sensors ➔ refer to the chapter "Sensor types and measuring ranges"	
19.	Telescopic probe CrNi-steel 1.36 m	1000205

20.	Dust/water filter for special sampling hose (pack of three)	1000207
21.	Special sampling hose 3 m, anti-static, with dust/water filter	1000208
22.	Vitonhose, resistant to solvents and H_2S	1000217
23.	Float probe	on request

The spare parts and the accessories need to be stored at an environmental temperature from 0° to 30°C. The storage time must not exceed 5 years. For NiMH supply units a shorter storage time of one year applies. The battery must be charged before the storage. If the device might be stored for more than ½ year, the battery should be removed.

3.7 Indications Regarding the Environmentally Friendly Disposal

According to Section 11 of the General Terms and Conditions of GfG, the purchaser of the device agrees to dispose of the device or device components in an environmentally sound manner in line with Sections 11 and 12 of the German Electrical and Electronic Equipment Act (ElektroG). If desired, GfG in Dortmund, Germany, can also carry out correct disposal.

3.8 Sensor Types and Measuring Ranges

The spare sensors need to be stored at an environmental temperature from 0° to 30°C. The storage time must not exceed one year. For electrochemical sensors a shorter storage time of ½ year applies. When storing oxygen sensors, the expected service life will be reduced. When storing the spare sensors, make sure that the environmental atmosphere is not aggressive and free from sensor toxins.

Slot	Sensor Type	Display Range	Measuring Gas and Additional Information	Order No
EC1	MK380-8	0 ... 500ppm 0 ... 100ppm	CO Carbon monoxide and H_2S hydrogen sulphide	1990710
EC1 **EC2** **EC3** **EC4** (*E)	MK390-8	0 ... 10ppm (*1)	Cl_2 Chlorine	1990725
	MK391-8	0 ... 2ppm	ClO_2 Chlorine dioxide	1990730
	MK349-8	0 ... 2ppm	COCl2 Phosgene	1990800
	MK443-8	0 ... 500ppm (*1)	CO Carbon monoxide	1990705
	MK445-8	0 ... 100ppm (*1)	H_2S Hydrogen sulphide	1990700
	MK396-8	0 ... 2000ppm	H_2 Hydrogen	1990785
	MK402-8	0 ... 1Vol.%	H_2 Hydrogen	1990790
	MK403-8	0 ... 4Vol.%	H_2 Hydrogen	1990795
	MK409-8	0 ... 50ppm (*1)	HCN Hydrogen cyanide	1990760
	MK412-3	0 ... 10ppm	HF Hydrogen Fluoride (EU Version)	1990765
	MK412-9	0 ... 10ppm	HF Hydrogen fluoride (resolution 0.5ppm)	1990766
	MK453-8	0 ... 300ppm (*1)	NH_3 Ammonia	1990735
	MK454-8	0 ... 1000ppm(*1)	NH_3 Ammonia	1990740
	MK458-8	0 ... 30ppm (*1)	NO_2 Nitrogen dioxide	1990750
	MK383-8	0 ... 25Vol.%	O_2 Oxygen (2 years)	1990715
	MK427-8	0 ... 25Vol.%	O_2 Oxygen (3 years)	1990716
	MK353-8	0 ... 10ppm (*1)	PH_3 Phosphine	1990770
	MK460-8	0 ... 20ppm (*1)	SiH_4 Silane	1990780
	MK440-8	0 ... 10ppm (*1)	SO_2 Sulphur dioxide	1990720
EC2 **EC3** **EC4** (*E)	MK379-8	0 ... 20ppm (*1)	C_2H_4O Ethylene oxide	1990775
	MK392-8	0 ... 30ppm (*1)	HCl Hydrogen chloride	1990755
	MK432-8	0 ... 25Vol.%	O_2 Oxygen (5 years)	1990717
	MK457-8	0 ... 100ppm (*1)	NO Nitrogen monoxide	1990745
PID (*P)	MK222-0	0 ... 2000ppm	iC_4H_8 Isobutylene and other VOCs	1990980
CC (*C)	MK221-0	0 ... 100%LEL	Flammable gases and vapors (*2)	1990850
		0 ... 5Vol.%	CH_4 Methane	
	MK221-1	0 ... 100%LEL	Flammable gases (*2) (increased contamination resistance)	1990851
		0 ... 5Vol.%	CH_4 Methane (increased contamination resistance)	
IR (Infrared)	MK245-1	0 ... 5Vol.% 0 ... 100%LEL	CO_2 Carbon dioxide Flammable gases and vapors (*2)	1990920
		0 ... 5Vol.% 0 ... 100%LEL 0 ... 100Vol.%	CO_2 Carbon dioxide Flammable gases and vapors (*2) CH_4 Methane	1990024

MK248-8	0 ... 5Vol.%	CO_2 Carbon dioxide	1990900
	0 ... 15Vol.%	CO_2 Carbon dioxide	1990901
	0 ... 25Vol.%	CO_2 Carbon dioxide	1990902
MK249-8	0 ... 100%LEL	Flammable gases and vapors (*2)	1990905
	0 ... 100%LEL 0 ... 100Vol.%	Flammable gases and vapors (*2) CH_4 Methane	1990906

For (*1): The sensor can also be set to other measuring ranges (refer to the sensor specification)
For (*2): CH_4 Methane or one of the below mentioned flammable gases and vapors
For (*E, *P, *C): EC4 is only in the G999E, PID is only in the G999P, CC is only in the G999C available

Sensor Type	Flammable Gases and Vapors
MK221-0	CH_4(methane), C_3H_8(propane), C_4H_{10}(butane), C_5H_{12}(pentane), C_6H_{14}(n hexane), H_2(hydrogen), C_2H_2(acetylene), C_2H_4(ethylene), CH_4O(methanole), C_2H_6O(ethanole), C_3H_8O(isopropanole), $C_4H_{10}O$(n butanole), C_3H_6O(acetone), $C_3H_6O_2$(methylacetate), $C_4H_8O_2$(ethylacetate), C_4H_8O(methylethylketone MEK), C_7H_8(toluene), $C_6H_{12}O$(methylisobutylketone MIBK), C_7H_{16}(heptane), C_9H_{20}(n nonane)
MK221-1	CH_4(methane), C_3H_8(propane), C_4H_{10}(butane), C_5H_{12}(pentane), C_6H_{14}(n hexane), H_2(hydrogen), C_2H_2(acetylene), C_2H_4(ethylene)
MK245-1 MK249-8	CH_4(methane), C_3H_8(propane), C_6H_{14}(n hexane), C_9H_{20}(n nonane), ETF (ethyl formate)

3.9 Sensor Specification

MK221-0 Catalytic Combustion Sensor for Flammable Gases and Vapors

Measuring ranges:	0.0...100%LEL		0.00...5.00Vol.% CH_4	
Resolution / tolerance band:	0.5 / ±2.5%LEL		0.02 / ±0.14Vol.% CH_4	
Response time:	t_{50} ≤ 10 sec	t_{90} ≤ 20 sec	@ CH_4 (methane)	
	t_{50} ≤ 12 sec	t_{90} ≤ 30 sec	@ C_3H_8 propane)	
	t_{50} ≤ 25 sec	t_{90} ≤ 65 sec	@ C_6H_{14} (n Hexane)	
Pressure (70)80....120(130)kPa:	max. ±5(7)%LEL or ±10% of the display			(regarding 100kPa)
Humidity 0%...95% RH:	max. ±3%LEL or ±10% of the C_3H_8 display			(regarding 0% RH @40°C)
	or ±30% of the CH_4display			(regarding 0% RH @40°C)
Temperature(-20)-10...+40(55)°C:	max. ±3%LEL or ±10(15)% of the display			(regarding 20°C)
Flow velocity 0...6m/s:	max. ±1%LEL or +15% of the display @Flow velocities ≥1.5m/s			

Cross sensitivities @ 50% LEL:

Gas supply	CH_4 display	C_3H_8 disply	n hexane display
2.00Vol.% H_2	about 65%LEL	about100%LEL	about 135%LEL(theor.)
2.20Vol.% CH_4	= 50%LEL	about 75%LEL	about 100%LEL
1.15Vol.% C_2H_4	about 48%LEL	about 58%LEL	about 77%LEL
0.85Vol.% C_3H_8	about 33%LEL	= 50%LEL	about 65%LEL
0.70Vol.% C_4H_{10}	about 31%LEL	about 47%LEL	about 62%LEL
0.55Vol.% C_5H_{12}	about 28%LEL	about 40%LEL	about 52%LEL
0.50Vol.% C_6H_{14}	about 27%LEL	about 38%LEL	= 50%LEL
0.45Vol.% C_7H_{16}	about 19%LEL	about 28%LEL	about 35%LEL
0.40Vol.% C_8H_{18}	about 15%LEL	about 23%LEL	about 29%LEL

They can vary from one sensor to another and depend on the gas concentration as well as on the age of the sensor.

Expected service life: 3 years in pure air

MK221-1 Catalytic Combustion Sensor for Flammable Gases (with increased contamination resistance)

Measuring ranges:	0.0...100%LEL		0.00...5.00Vol.% CH_4	
Resolution / tolerance band:	0.5 / ±2.5%LEL		0.02 / ±0.14Vol.% CH_4	
Response time:	t_{50} ≤ 10 sec	t_{90} ≤ 20 sec	@ CH_4 (methane)	
	t_{50} ≤ 12 sec	t_{90} ≤ 30 sec	@ C_3H_8 (propane)	
	t_{50} ≤ 40 sec	t_{90} ≤ 105sec	@ C_6H_{14} (n Hexane)	
Pressure (70)80....120(130)kPa:	max. ±5(7)%LEL or ±10% of the display			(regarding 100kPa)
Humidity 0%...95% RH:	max. ±3%LEL or ±10% of the C_3H_8 display			(regarding 0% RH @40°C)
	or ±20% of the CH_4 display			(regarding 0% RH @40°C)
Temperature(-20)-10...+40(55)°C:	max. ±3%LEL or ±10(15)% of the display			(regarding 20°C)
Flow velocity 0...6m/s:	max. ±1%LEL or +20% of the display @Flow velocities ≥1.5m/s			

Cross sensitivities @ 50% LEL:

Gas supply	CH_4 display	C_3H_8 display	n hexane display
2.00Vol.% H_2	about 65%LEL	about100%LEL	about 135%LEL(theor.)
2.20Vol.% CH_4	= 50%LEL	about 75%LEL	about 100%LEL
1.15Vol.% C_2H_4	about 48%LEL	about 58%LEL	about 77%LEL
0.85Vol.% C_3H_8	about 33%LEL	= 50%LEL	about 65%LEL
0.70Vol.% C_4H_{10}	about 30%LEL	about 47%LEL	about 62%LEL
0.55Vol.% C_5H_{12}	about 26%LEL	about 40%LEL	about 52%LEL
0.50Vol.% C_6H_{14}	about 25%LEL	about 38%LEL	= 50%LEL

They can vary from one sensor to another and depend on the gas concentration as well as on the age of the sensor.

Expected service life: 3 years in pure air

MK222-0 Photoionization Sensor for Toxic Flammable Vapors or VOCs

				MIBK Acetone Diethyl ether Propene Petrol	c-Hexane Heptane Octane n nonane Vinyl chloride	
		Trichlor- ethylene Benzene				n butanol Ethyl acetate
	Styrene	Toluene	MEK	**Isobutylene**	Methyl	n hexane
Measuring gases:	Kerosene	Xylene	Diesel		bromide	Ammonia
Measuring ranges:	0-800ppm	0-1000ppm	0-1500ppm	**0-2000ppm**	0-3000ppm	0-6000ppm
Resolution (<100ppm):	0.2ppm	0.2ppm	0.5ppm	0.5ppm	0.5ppm	1ppm
Tolerance band:	±0.5ppm	±0.6ppm	±0.9ppm	±1.2ppm	±1.8ppm	±3ppm
Response time:	t_{90} < 30sec					
Ionization potential:	10.6 eV					

Cross sensitivities (**iC_4H_8=100%**): Kerosene: about 250%; C_8H_8:250%; C_7H_8:190%; C_6H_6:190%; Diesel: about 110%; Petrol: about 90%; C_3H_60:83%; C_8H_{18}:45%; C_7H_{16}:40%; H_2S:30%; C_6H_{14}:22%; NO:14%; NH_3:11%; C_5H_{12}:10%; C_4H_{10}:0%; C_3H_8:0%; CH_4:0%; H_2:0%;

Response factors **RF**:

1-Butanol = 3.40	Cyclohexane = 1.50	Heptane = 2.50	n-nonan = 1.60
1-Propanol = 5.70	Decane = 1.60	Isobutanole = 4.70	n-pentane = 9.70
Acetone = 1.20	Diesel fuel 1 = 0.90	**Isobutylene = 1.00**	NO = 7.20
Ammonia = 9.40	Diesel fuel 2 = 0.75	Isopropanole = 5.60	Octane = 2.20
Arsine = 2.60	Diethyl ether = 1.20	Jet A fuel = 0.40	Phosphine = 2.80
Petrol = 1.10	Ethyl acetate = 4.20	JP5 fuel = 0.48	Propylene = 1.30
Benzene = 0.53	Ethyl acrylate = 2.30	Methyl acetate = 7.00	Styrene = 0.40
Butadiene = 0.69	Ethyl mercaptan = 0.60	Methyl mercaptan = 0.60	Toluene = 0.53
Butyl acetate = 2.40	H2S = 3.20	n-hexane = 4.50	Xylene = 0.50

Expected service life: 2...3 years in pure air

MK248-8 / MK245-1 Infrared Sensors for Carbon Dioxide CO_2

Measuring range:	0.02...5.00Vol.% oder 0.00...25Vol.%		
Resolution:	0.01...0.05Vol.% oder 0.01...0.5Vol.%		
Response time:	t_{50} ≤ 20sec t_{90} ≤ 50sec t_{10} ≤ 50sec @ CO_2		
Pressure 70...130kPa:	<1.6% of the display per 1% pressure change		(regarding 100kPa)
Humidity 0%...95% RH:	max. ±0.01 Vol.% or ±2% of the display		(regarding 50%RH @20°C)
Temperature -20...+55°C:	max. ±0.02 Vol.% or ±10% of the display		(regarding 20°C)
Long term stability per month:	max. ±0.01 Vol.% or ±2% of the display		(under laboratory conditions)
Expected service life:	6 years		

MK249-8 / MK245-1 Infrared Sensors for Flammable Gases and Vapors

Measuring range:	0,0...100%LEL	0.00...100Vol.% CH_4	
Resolution:	0.2...1.0%LEL	0.01...0.5Vol.% CH_4	
Tolerance band:	±1.2% LEL	±0.05Vol.% CH_4	
Response time:	t_{50} ≤ 20sec t_{90} ≤ 45sec @ CH_4 (methane)		
	t_{50} ≤ 25sec t_{90} ≤ 66sec @ C_3H_8 (propane)		
	t_{50} ≤ 30sec t_{90} ≤ 99sec @ C_6H_{14} (n hexane)		
	t_{50} ≤ 55sec t_{90} ≤ 37sec @ C_9H_{20} (n nonane)		
Pressure 70...130kPa:	<1.5% of the CH_4 display per 1% pressure change		(regarding 100kPa)
	<1.2% of the C_3H_8 display per 1% pressure change		(regarding 100kPa)
Humidity 0%...95% RH:	max. ±2,0 %LEL or ±15% of the display		(regarding 0%RH @40°C)
Temperature -20...+50°C:	max. ±2.0 %LEL or ±10% of the C_3H_8 display		(regarding 20°C)

Cross sensitivities @ 50%LEL:

Gas supply	CH_4 display	C_3H_8 display	n hexane display	nonane display.
0.85Vol% C_3H_8	about 145%LEL	= 50%LEL	about 67%LEL	about 80%LEL
1.20Vol% C_2H_6	about 138%LEL	about 48%LEL	about 65%LEL	about 78%LEL
0.70Vol% C_4H_{10}	about 110%LEL	about 42%LEL	about 57%LEL	about 69%LEL
1.00Vol% C_3H_8O	about 97%LEL	about 39%LEL	about 53%LEL	about 64%LEL
0.50Vol% C_6H_{14}	about 88%LEL	about 37%LEL	= 50%LEL	about 60%LEL
0.55Vol% C_5H_{12}	about 87%LEL	about 36%LEL	about 49%LEL	about 59%LEL
0.45Vol% C_7H_{16}	about 82%LEL	about 34%LEL	about 47%LEL	about 57%LEL
1.00Vol% $C_4H_8O_2$	about 69%LEL	about 31%LEL	about 41%LEL	about 50%LEL
0.35Vol% C_9H_{20}	about 65%LEL	about 31%LEL	about 41%LEL	= 50%LEL
2.20Vol% CH_4	= 50%LEL	about 26%LEL	about 35%LEL	about 42%LEL
0.75Vol% C_4H_8O	about 41%LEL	about 22%LEL	about 28%LEL	about 34%LEL
1.25Vol% C_3H_6O	about 26%LEL	about 16%LEL	about 22%LEL	about 27%LEL
0.50Vol% C_7H_8	about 26%LEL	about 16%LEL	about 22%LEL	about 26%LEL

They can vary from one sensor to another and are depending on the gas concentration.

Expected service life: 6 years

MK349-8 Electrochemical Sensor for Phosgene $COCl_2$ (PGN)

Measuring range:	0...2ppm		
Resolution / tolerance band:	0.01ppm / ±0.02ppm		
Response time:	t_{90} < 150sec		
Pressure 80...120kPa:	max. ±0.02ppm or ±10% of the display		(regarding 100kPa)
Humidity 10%...95% RH:	max. ±0.02ppm or ±10% of the display		(regarding 50%RH @20°C)
Temperature -20...+40°C:	max. ±0.02ppm or ±10% of the display		(regarding 20°C)
Cross sensitivities:	ClO_2: -300%; HCl: 250%; AsH_3: 90%; Cl_2: 40%; NO_2: -10%; O_3: 10%; (*1)		
Expected service life:	1...1.5 years in air		

MK353-8 Electrochemical Sensor for Phosphine PH_3			
Measuring ranges:	0…10ppm	0…20ppm	0…50ppm
Resolution / tolerance band:	0.05ppm / ±0.05ppm	0.05ppm / ±0.05ppm	0.05ppm / ±0.05ppm
Response time:	t_{50} < 20sec t_{90} < 60sec		
Pressure 80…120kPa:	max. ±0.05ppm or ±10% of the display		(regarding 100kPa)
Humidity 15%…90% RH:	max. ±0.05ppm or ±10% of the display		(regarding 50%RH @20°C)
Temperature -20…+50°C:	max. ±0.05ppm or ±10% of the display		(regarding 20°C)
Cross sensitivities:	SiH_4:90%; GeH_4:90%; AsH_3:65%; B_2H_6:35%; SO_2:20%; CO:0,5%; H_2:0.1%; (*1)		
Expected service life:	2…3 years in air		

MK379-8 Electrochemical Sensor for Ethylene Oxide C_2H_4O (ETO)			
Measuring ranges:	0…20ppm	0…50ppm	0…100ppm
Resolution / tolerance band:	0.1ppm / ±0.3ppm	0.1ppm / ±0.3ppm	0.1ppm / ±0.3ppm
Response time:	t_{50} < 30sec t_{90} < 120sec		
Pressure 80…120kPa:	max. ±1ppm or ±15% of the display		(regarding 100kPa)
Humidity 15%…90% RH:	max. ±2ppm or ±15% of the display		(regarding 50%RH @20°C)
Temperature (-20)0…+40[50]°C:	max. ±1[2]ppm or ±15(20)% of the display		(regarding 20°C)
Cross sensitivities:	CO≈40%; CH_4O≈150%; C_2H_2≈125%; CH_2O≈120%; CH_4S≈100%; C_2H_4≈80%; C_2H_6O≈55%; $C_4H_{10}O$≈40%; C_7H_8≈20%; MEK≈10%; among others		
Expected service life:	2…3 years in air		
Running-in period:	4 minutes up to 7 days – depending on the interruption time		

MK380-8 Electrochemical Sensor for Carbon Monoxide CO and Hydrogen Sulphide H_2S (COSH)			
Measuring ranges:	0…500ppm CO (at EC0)	0…100ppm H_2S (at EC1)	
Resolution / tolerance band:	1ppm / ±3ppm CO	0.2ppm / ±0.6ppm H_2S	
Response time:	t_{50} < 20sec t_{90} < 50sec		
Pressure 80…120kPa:	max. ±3(1)ppm or ±7(10)% of the CO (H_2S) display		(regarding 100kPa)
Humidity 15%…90% RH:	max. ±3(1)ppm or ±7(10)% of the CO (H_2S) display		(regarding 50%RH @20°C)
Temperature -20…+50°C:	max. ±3(1)ppm or ±15(10)% of the CO (H_2S) display		(regarding 20°C)
Cross sensitivities CO display:	H_2S:0…40%; H_2≈20%; SO_2<20%; NO_2<2%; NO<0.3%; Cl_2:0%; (*1)		
Cross sensitivities H_2S display:	CO<2%; NO_2≈-20%; SO_2:8…20%; NO<3%; H_2:0.03%; Cl_2:0%; (*1)		
Expected service life:	3 years in air		

MK383-8 Electrochemical Sensor for Oxygen O_2			
Measuring range:	0…25 Vol%		
Resolution / tolerance band:	0.1 Vol% / ±0.3 Vol%		
Response time:	t_{20} ≤ 6sec t_{90} ≤ 20sec		
Pressure 80…120kPa:	max. ±0.2 Vol% or ±2.5% of the measuring range		(regarding 100kPa)
Humidity 0%…90% RH:	max. ±0.2 Vol% or ±2.5% of the measuring range		(regarding 50%RH @40°C)
Temperature -20…+50°C:	max. ±0.5 Vol% or ±2.5% of the display		(regarding 20°C)
Expected service life:	2 years in air		

MK390-8 Electrochemical Sensor for Chorine Cl_2			
Measuring ranges:	0…10ppm	0…20ppm	0…40ppm
Resolution / tolerance band:	0.05ppm / ±0.10ppm	0.05ppm / ±0.10ppm	0.1ppm / ±0.1ppm
Response time:	t_{50} < 10sec t_{90} < 30sec		
Pressure 80…120kPa:	max. ±0.2ppm or ±10% of the display		(regarding 100kPa)
Humidity 10%…95% RH:	max. ±0.2ppm or ±10% of the display		(regarding 50%RH @20°C)
Temperature -20…+50°C:	max. ±0.2ppm or ±10% of the display		(regarding 20°C)
Cross sensitivities:	ClO_2:50%; F_2:40%; NO_2:20%; O_3:20%; SO_2:18%; CO_2:0%; CO:0%; H_2S:0%; H_2:0% (*1)		
Expected service life:	2…3 years in air		

MK391-8 Electrochemical Sensor for Chlorine Dioxide ClO_2 (CLO)			
Measuring range:	0…2ppm		
Resolution / tolerance band:	0.01ppm / ±0.03ppm		
Response time:	t_{90} < 120sec		
Pressure 80…120kPa:	max. ±0.05ppm or ±10% of the display		(regarding 100kPa)
Humidity 10%…95% RH:	max. ±0.05ppm or ±10% of the display		(regarding 50%RH @20°C)
Temperature -20…+50°C:	max. ±0.05ppm or ±10% of the display		(regarding 20°C)
Cross sensitivities:	Cl_2≈60%; O_3:-280%; H_2S:-25%; H_2: 0%; CO: 0%; (*1)		
Expected service life:	1…2 years in air		

MK392-8 Electrochemical Sensor for Hydrogen Chlorine HCl			
Measuring ranges:	0…30ppm	0…50ppm	
Resolution / tolerance band:	0.2ppm / ±0.4ppm	0.2ppm / ±0.4ppm	
Response time:	t_{50} < 30sec t_{90} < 90sec		
Pressure 80…120kPa:	max. ±1ppm or ±10% of the display		(regarding 100kPa)
Humidity 10%…95% RH:	max. ±1ppm or ±10% of the display		(regarding 50%RH @20°C)
Temperature -20…+50°C:	max. ±1ppm or ±10% of the display		(regarding 20°C)
Cross sensitivities:	AsH_3:350%; PH_3:300%; H_2S:65%; NO:45%; SO_2:40%; HCN:35%; Cl_2:6%; NO_2:3%; NH_3:0.1%; CO:0%; CO_2:0%; H_2:0%; (*1)		
Expected service life:	2…3 years in air		

MK396-8 Electrochemical Sensor for Hydrogen H_2 (*2)		
Measuring range:	0...2000ppm	
Resolution / tolerance band:	2ppm / ±50ppm	
Response time:	t_{50} < 30sec t_{90} < 90sec	
Pressure 80...120kPa:	max. ±10ppm or ±10% of the display	(regarding 100kPa)
Humidity 15%...90% RH:	max. ±10ppm or ±10% of the display	(regarding 50%RH)
Temperature -20...+50°C:	max. ±20ppm or ±20% of the display	(regarding 20°C)
Cross sensitivities:	C_2H_4≈80%; NO≈35%; HCN≈30%; CO<20%; H_2S<20%; NO_2=SO_2=Cl_2=HCl=0%; (*1)	
Expected service life:	2...3 years in air	

MK402-8 Electrochemical Sensor for Hydrogen H_2 (*2)		
Measuring range:	0...1.00 Vol%	
Resolution / tolerance band:	0.01 Vol% / ±0.02 Vol%	
Response time:	t_{50} < 40sec t_{90} < 70sec	
Pressure 80...120kPa:	max. ±0.01 Vol.% or ±10% of the display	(regarding 100kPa)
Humidity 15%...90% RH:	max. ±0.01 Vol.% or ±10% of the display	(regarding 50%RH)
Temperature -20...+50°C:	max. ±0,02 Vol.% or ±20% of the display	(regarding 20°C)
Cross sensitivities:	NO_2:-400%; CO:150%; H_2S:20%; C_2H_4:yes; NH_3=CO_2=Cl_2=SO_2=HCN=0%; (*1)	
Expected service life:	2...3 years in air	

MK403-8 Electrochemical Sensor for Hydrogen H_2 (*2)		
Measuring range:	0...4.00 Vol%	
Resolution / tolerance band:	0.01 Vol% / ±0.05 Vol%	
Response time:	t_{50} < 40sec t_{90} < 60sec	
Pressure 80...120kPa:	max. ±0.01 Vol.% or ±10% of the display	(regarding 100kPa)
Humidity 15%...90% RH:	max. ±0.01 Vol.% or ±10% of the display	(regarding 50%RH)
Temperature -20...+50°C:	max. ±0.02 Vol.% or ±25% of the display	(regarding 20°C)
Cross sensitivities:	H_2S:220%; C_2H_4:yes; NH_3=CO_2=CO=Cl_2=HCN=NO=NO_2=0%; (*1)	
Expected service life:	2...3 years in air	

MK409-8 Electrochemical Sensor For Hydrogen Cyanide HCN			
Measuring ranges:	0...50ppm	0...100ppm	
Resolution / tolerance band:	0.1ppm / ±0.5ppm	0.2ppm / ±1.0ppm	
Response time:	t_{50} < 25sec t_{90} < 60sec		
Pressure 80...120kPa:	max. ±0.5ppm or ±10% of the display		(regarding 100kPa)
Humidity 10%...95% RH:	max. ±0.5ppm or ±10% of the display		(regarding 50% RH @20°C)
Temperature -20...+50°C:	max. ±0.5ppm or ±15% of the display		(regarding 20°C)
Cross sensitivities:	NO_2≈-70%, NO≈-5%, H_2S≈0...200% (depending on the filter saturation) CO=CO_2=H_2=0% (*1)		
Expected service life:	2 years in air		

MK412-3 / MK412-9 Electrochemical Sensors for Hydrogen Fluoride HF			
Measuring ranges:	0...10ppm	0...10ppm	
Resolution / tolerance band:	0.1ppm / ±0.3ppm (MK412-3)	0.5ppm / ±0.5ppm (MK412-9)	
Response time:	t_{50} < 40sec t_{90} < 90sec		
Pressure 80...120kPa:	max. ±0,2ppm or ±10% of the display		(regarding 100kPa)
Humidity 10%...80% RH:	max. ±0.2ppm or ±10% of the display		(regarding 50%RH @20°C)
Temperature -20...+40°C:	max. ±0.2ppm or ±10% of the display		(regarding 20°C)
Cross sensitivities:	HCl:66%; Cl_2:40%; CO=CO2=NO2=H2S=H2=0% (*1)		
Expected service life:	1..2 years in air		

MK427-8 Electrochemical Sensor for Oxygen O_2		
Measuring range:	0...25 Vol%	
Resolution / tolerance band:	0.1 Vol% / ±0.3 Vol%	
Response time:	t_{20} ≤ 8sec t_{90} ≤ 25sec	
Pressure (70)80...120(130)kPa:	max. ±0.4(0.6)Vol.% or ±2(3)% of the measuring range	(regarding 100kPa)
Humidity 0%...95% RH:	max. ±0.5Vol.% or ±2.5% of the measuring range	(regarding 50%RH @40°C)
Temperature (-20)-10...+55°C:	max. ±0.5(0.8)Vol.% or ±2.5(4.0)% of the display	(regarding 20°C)
Expected service life:	3 years in air	

MK432-8 Electrochemical Sensor for Oxygen O_2		
Measuring ranges:	0...25 Vol%	
Resolution / tolerance band:	0.1 Vol% / ±0.3 Vol%	
Response time:	t_{20} ≤ 8sec t_{90} ≤ 25sec	
Pressure 70...130kPa:	max. ±0.3 Vol% or ±3,0% of the display	(regarding 100kPa)
Humidity 15%...90% RH:	max. ±0.5 Vol% or ±3,0% of the display	(regarding 50%RH @40°C)
Temperature -20...+50°C:	max. ±0.5 Vol% or ±3,0% of the display	(regarding 20°C)
Expected service life:	5 years in air	

MK440-8 Electrochemical Sensor for Sulphur Dioxide SO_2				
Measuring ranges:	0...10ppm	0...20ppm	0...50ppm	0...100ppm
Resolution:	0.05ppm	0.05ppm	0.1ppm	0.1ppm
Tolerance band:	±0.15ppm	±0.20ppm	±0.3ppm	±0.4ppm
Response time:	t_{50} < 10sec	t_{90} < 30sec		
Pressure 80...120kPa:	max. ±0.2ppm or ±5% of the display			(regarding 100kPa)
Humidity 15%...90% RH:	max. ±0.3ppm or ±3% of the display			(regarding 50%RH @20°C)
Temperature -20...+50°C:	max. ±0,3ppm or ±5% of the display			(regarding 20°C)
Cross sensitivities:	C_2H_2<300%; NO_2<-170%; C_2H_4<90%; HCN<50%; Cl_2<-40%; NO<10%; H_2S<0,4%; CO<0,4%; H_2<0,3%; NH_3=0%; (*1)			
Expected service life:	3 years in air			

MK443-8 Electrochemical Sensor for Carbon Monoxide CO			
Measuring ranges:	3...500ppm	3...1000ppm	3...2000ppm
Resolution / tolerance band:	1ppm / ±3ppm	1ppm / ±3ppm	1ppm / ±3ppm
Response time:	t_{50} < 10sec	t_{90} ≤ 30sec	t_{10} < 30sec (decay time)
Pressure 80...120kPa:	max. ±3ppm or ±10% of the display		(regarding 100kPa)
Humidity 15%...95% RH:	max. ±3ppm or ±5% of the display		(regarding 50%RH @20°C)
Temperature -20..+40(55)°C:	max. ±3ppm or ±5(10)% of the display		(regarding 20°C)
Cross sensitivities:	C_2H_4≈96%, C_2H_2≈90%, H_2<30%(typ.15%), NO<20%, Cl_2<7%, C_2H_6O<0.5%, SO_2=NH_3=H_2S=0% (*1)		
Expected service life:	3 years in air		

MK445-8 Electrochemical Sensor for Hydrogen Sulphide H_2S				
Measuring ranges:	0.2...50ppm	0.2...100ppm	0.2...200ppm	0.5...500ppm
Resolution:	0.1ppm	0.1ppm	0.2ppm	0.5ppm
Tolerance band:	±0.5ppm	±0.5ppm	±1.0ppm	±1.5ppm
Response time:	t_{50} < 10sec	t_{90} < 30sec	t_{10} < 30sec (decay time)	
Pressure 80...120kPa:	max. ±0.2ppm or ±5% of the display			(regarding 100kPa)
Humidity 15%...90% RH:	max. ±0.2ppm or ±5% of the display			(regarding 50%RH @20°C)
Temperature -20...+40(55)°C:	max. ±0.2ppm or ±5(10)% of the display			(regarding 20°C)
Cross sensitivities:	NO_2<10%, CO<2%, NO<1%, CO_2=SO_2=Cl_2=NH_3=C_2H_4=0% little Methanol cross sensitivity (*1)			
Expected service life:	3 years in air			

MK453-8 Electrochemical Sensor for Ammonia NH_3			
Measuring ranges:	0...300ppm	0...500ppm	
Resolution / tolerance band:	1ppm / ±3ppm	1ppm / ±3ppm	
Response time:	t_{90} < 45sec		
Pressure 80...120kPa:	max. ±1ppm or ±10% of the display		(regarding 100kPa)
Humidity 15%...90% RH:	max. ±1ppm or ±10% of the display		(regarding 50%RH @20°C)
Temperature -(20)10...+50°C:	max. ±1(2)ppm or ±15(20)% of the display		(regarding 20°C)
Cross sensitivities:	H_2S≈120%, NO_2≈-100%, SO_2≈-30%, CO=NO=CO_2=H_2=C_2H_6O=0% (*1)		
Expected service life:	2..3 years in pure air		

MK454-8 Electrochemical Sensor for Ammonia NH_3			
Measuring ranges:	0...500ppm	0...1000ppm	0...1500ppm
Resolution / tolerance band:	2ppm / ±5ppm	5ppm / ±10ppm	5ppm / ±10ppm
Response time:	t_{90} < 60sec		(at 20°C)
Pressure 80...120kPa:	max. ±5ppm or ±10% of the display		(regarding 100kPa)
Humidity 15%...90% RH:	max. ±5ppm or ±10% of the display		(regarding 50%RH @20°C)
Temperature -20...+55°C:	max. ±10ppm or ±20% of the display		(regarding 20°C)
Cross sensitivities:	H_2S≈140%, NO_2≈-100%, SO_2≈-30%, CO=NO=CO_2=H_2=C_2H_6O=0% (*1)		
Expected service life:	2..3 years in pure air		

MK457-8 Electrochemical Sensor for Nitrogen Monoxide NO			
Measuring ranges:	0...50ppm	0...100ppm	0...200ppm
Resolution / tolerance band:	0.2ppm / ±1.5ppm	0.5ppm / ±2.0ppm	0.5ppm / ±2.0ppm
Response time:	t_{50} < 15sec	t_{90} < 45sec	(at 20°C)
Pressure 80...120kPa:	max. ±1ppm or ±10% of the display		(regarding 100kPa)
Humidity 15%...90% RH:	max. ±1ppm or ±10% of the display		(regarding 50%RH @20°C)
Temperature -20...+40(50)°C:	max. ±2ppm or ±10% of the display		(regarding 20°C)
Cross sensitivities:	H_2S<50%; NO_2<40%; C_2H_6O ±10%; SO_2<5%; H_2<1%; NH_3<1%; CO<-1%; CO_2=CL_2=0; (*1)		
Expected service life:	3 years in air		
Running-in time:	3 minutes to 1 day – depending on the interruption time		

MK458-8 Electrochemical Sensor for Nitrogen Dioxide NO_2			
Measuring ranges:	0...30ppm	0...50ppm	0...100ppm
Resolution / tolerance band:	0.1ppm / ±0.3ppm	0.1ppm / ±0.5ppm	0.1ppm / ±0.5ppm
Response time:	t_{50} < 10sec	t_{90} < 30sec	(at 20°C)
Pressure 80...120kPa:	max. ±0.2ppm or ±10% of the display		(regarding 100kPa)
Humidity 15%...90% RH:	max. ±0.2ppm or ±10% of the display		(regarding 50%RH @20°C)
Temperature -20...+50°C:	max. ±0.2ppm or ±10% of the display		(regarding 20°C)
Cross sensitivities:	Cl_2≈100%; H_2S<-40%; NO<20%; $C_2H_6$0<1%; CO<-1%; SO2<-1%; H2<-1%; NH3<-1%, CO2=0; (*1)		
Expected service life:	3 years in air		

MK460-8 Electrochemical Sensor for Silane SiH_4			
Measuring ranges:	0...20ppm	0...50ppm	
Resolution / tolerance band:	0.1ppm / ±0.2ppm	0.1ppm / ±0.2ppm	
Response time:	t_{50} < 20sec	t_{90} < 60sec	
Pressure 80...120kPa:	max. ±0,1ppm or ±10% of the display		(regarding 100kPa)
Humidity 15%...90% RH:	max. ±0,2ppm or ±10% of the display		(regarding 50%RH @20°C)
Temperature -20...+50°C:	max. ±0.3ppm or ±10% of the display		(regarding 20°C)
Cross sensitivities:	H_2S≈160%, PH_3≈100%; SO_2≈20%; H_2=CO=0%; (*1)		
Expected service life:	2..3 years in air		

For (*1): Gas display regarding the supplied concentration in the range of AGW (MAK) values
For (*2): Not permitted for the monitoring of the lower explosion limit for applications of the primary explosion protection

3.10 Alarm Limit Values - Basic Setting

Basic setting of the alarm thresholds for toxic gases without exposure alert

Measuring Range	Alarm 1	Alarm 2	STEL (15')	TWA (8h)
0 ... 20ppm C_2H_4O (ETO)	2.0ppm	4.0ppm	-	-
0 ... 2000ppm C_4H_8	100ppm	200ppm	-	-
0 ... 10ppm Cl_2	0.5ppm	1.0ppm	-	-
0 ... 2ppm ClO_2 (CLO)	0.2ppm (*1)	0.4ppm		
0 ... 2ppm $COCl_2$ (PGN)	0.1ppm	0.2ppm		
0 ... 500ppm CO	30ppm	60ppm	-	-
0 ... 5,0Vol.% CO_2	0.5Vol.%	1.0Vol.%	-	-
0 ... 100ppm H_2S	5.0ppm	10ppm	-	-
0 ... 30ppm HCl	5.0ppm (*1)	10ppm	-	-
0 ... 50ppm HCN	5.0ppm (*1)	10ppm	-	-
0 ... 10ppm HF	1.0ppm	2.0ppm	-	-
0 ... 300ppm NH_3	20ppm	40ppm	-	-
0 ... 100ppm NO	2.5ppm (*1)	5.0ppm	-	-
0 ... 30ppm NO_2	2.0ppm (*1)	4.0ppm	-	-
0 ... 10ppm PH_3	0.3ppm (*1)	0.6ppm	-	-
0 ... 20ppm SiH_4 (SIL)	5.0ppm	10ppm	-	-
0 ... 10ppm SO_2	1.0ppm	2.0ppm	-	-

For (*1): A monitoring of the AGW value is not satisfactory possible with the available sensor technology.

Basic setting of the alarm thresholds for toxic gases with exposure alert

Measuring Range	Alarm 1	Alarm 2	STEL (15')	TWA (8h)
0 ... 20ppm C_2H_4O	2ppm	6ppm	4ppm	2ppm
0 ... 2000ppm C_4H_8	100ppm	400ppm	200ppm	100ppm
0 ... 10ppm Cl_2	1.0ppm	1.5ppm	1.0ppm	0.5ppm
0 ... 2ppm ClO_2	0.2ppm	0.4ppm	0.2ppm	0.1ppm
0 ... 2ppm $COCl_2$	0.1ppm	0.2ppm	0.2ppm	0.1ppm
0 ... 500ppm CO	30ppm	120ppm	60ppm	30ppm
0 ... 5.0Vol.% CO_2	0.5Vol.%	2.0Vol.%	1.0Vol.%	0.5Vol.%
0 ... 100ppm H_2S	5.0ppm	15ppm	10ppm	5.0ppm
0 ... 30ppm HCl	5.0ppm	10ppm	5.0ppm	2.0ppm
0 ... 50ppm HCN	5.0ppm	10ppm	5.0ppm	1.9ppm
0 ... 10ppm HF	1.0ppm	3.0ppm	2.0ppm	1.0ppm
0 ... 300ppm NH_3	20ppm	80ppm	40ppm	20ppm
0 ... 100ppm NO	2.5ppm	5.0ppm	2.5ppm	0.5ppm
0 ... 30ppm NO_2	2.0ppm	4.0ppm	2.0ppm	0.5ppm
0 ... 10ppm PH_3	0.3ppm (*1)	0.4ppm	0.2ppm	0.1ppm
0 ... 20ppm SiH_4	5.0ppm	15ppm	10ppm	5.0ppm
0 ... 10ppm SO_2	1.0ppm	3.0ppm	2.0ppm	1.0ppm

For (*1): A monitoring of the AGW value is not satisfactory possible with the available sensor technology.

Basic setting of the alarm thresholds for oxygen and for flammable gases and vapors

Measuring Range	Alarm 1	Alarm 2	Alarm 3
0 ... 25Vol.% O_2	19.0Vol.% (⇓)	17.0Vol. (⇓)	23.0Vol.% (⇑)
0 ... 2000ppm H_2 (*2)	1000ppm	1500ppm	2000ppm
0 ... 1.0/4.0Vol.% H_2 (*2)	0.40Vol.%	0.60Vol.%	0.80Vol.%
0 ... 5.0Vol.% CH_4	1.00Vol.%	2.00Vol.%	3.00Vol.%
0 ... 100%LEL CH_4 (*3)	20.0%LEL	40.0%LEL	60.0%LEL

For (*2): Not permitted for the monitoring of the lower explosion limit for applications of the primary explosion protection.
For (*3): or another of the following listed flammable gases and vapors

LEL Values According to the DIN EN 60079-20-1:2010					
4.0Vol.% H_2	hydrogen	(CAS-No.1333-74-0)	6.0Vol.% CH_4O	methanol	(CAS-No.67-56-1)
4.4Vol.% CH_4	methane	(CAS-No.74-82-8)	3.1Vol.% C_2H_6O	ethanol	(CAS-No.64-17-5)
2.3Vol.% C_2H_2	acetylene	(CAS-No.74-86-2)	2.5Vol.% C_3H_6O	acetone	(CAS-No.67-64-1)
2.3Vol.% C_2H_4	ethylene	(CAS-No.74-85-1)	3.1Vol.% $C_3H_6O_2$	methyl acetate	(CAS-No.79-20-9)
2.4Vol.% C_2H_6	ethane	(CAS-No.74-84-0)	2.7Vol.% $C_3H_6O_2$	ethyl formate ETF	(CAS-No.109-94-4)
1.7Vol.% C_3H_8	propane	(CAS-No.74-98-6)	2.0Vol.% C_3H_8O	isopropyl	(CAS-No.67-63-0)
1.4Vol.% C_4H_{10}	butane	(CAS-No.106-97-8)	1.5Vol.% C_4H_8O	methyl ethyl ketone MEK	(CAS-No.78-93-3)
1.1Vol.% C_5H_{12}	pentane	(CAS-No.109-66-0)	2.0Vol.% $C_4H_8O_2$	ethyl acetate	(CAS-No.141-78-6)
1.0Vol.% C_6H_{14}	n-hexane	(CAS-No.110-54-3)	1.4Vol.% $C_4H_{10}O$	n-butanol	(CAS-No.71-36-3)
0.85Vol.% C_7H_{16}	heptane	(CAS-No.142-82-5)	1,2Vol.% $C_6H_{12}O$	methyl isobutyl ketone MIBK	(CAS-Nr.108-10-1)
0.70Vol.% C_9H_{20}	n-nonane	(CAS-No.111-84-2)	1.0Vol.% C_7H_8	toluene	(CAS-No.108-88-3)

3.11 Technical Data

Type designations:	**G999C**	(with slot for a catalytic combustion sensor CC)	
	G999E	(with slot for a fourth electrochemical sensor EC)	
	G999P	(with slot for a photoionization sensor PID)	
Measuring principle:	Electrochemical (EC):	for toxic gases and oxygen	
	Photoionization (PID):	for toxic flammable gases and vapors	
	Catalytic combustion (CC):	for flammable gases and vapors (up to 100%LEL)	
	Infrared (IR):	for flammable gases and vapors and carbon dioxide	
Measuring ranges:	refer to the chapter “Sensor types and measuring ranges” and “Sensor specification”		
Response time:	refer to the chapter “Sensor specification”		
Sensor service life:	refer to the chapter “Sensor specification”		
Measuring gas supply:	via the diffusion opening while the pump is switched off or via the suction opening during the pump operation (sensor cover closed)		
Pump capacity:	0,5…0,6slpm @0kPa / 0,30slpm @-4kPa / 0,0slpm@-10kPa max.100m hose length (depending on the measuring gas and hose)		
Display:	illuminated LCD full graphics display, automatic size setting for optimum reading, display of the battery capacity, gas concentration as current value and peak value		
Alerting:	depending on the gas type 3 or 2 instantaneous value and 2 exposure level alarms, battery alarm with visual and acoustical signaling as well as display on the screen, color of the display depending on the alarm state (orange/red) Horn: 103 dB(A) (can be reduced to 90 dB(A))		
Zero point and sensitivity adjustment:	manual or automatic with an adjustment program, if necessary, test gas supply via the “SMART CAP” with 0.5…0.6slpm		
Radio:	optionally 868MHz for EU; Range about 700m (free field) optionally 915MHz for USA; Range about 300m (free field)		
Power supply:	5.2V 2100mAh NiMH battery module; rechargeable		
Service life (*1)			
without radio:	about 26h (EC+CC$_{PS}$+IR)	about 18h (EC+CC+IR)	about 11h (EC+CC+IR+Pmp)
	about 42h (EC+CC$_{PS}$)	about 25h (EC+CC)	about 13h (EC+CC+Pump)
	about 52h (EC+PID)	about 30h (EC+PID+IR)	about 14h (EC+PID+IR+Pmp)
	about 130h (EC)	about 47h (EC+IR)	about 17h (EC+IR+Pmp)
with radio:	about 20h (EC+CC$_{PS}$+IR)	about 15h (EC+CC+IR)	about 10h (EC+CC+IR+Pmp)
	about 28h (EC+CC$_{PS}$)	about 19h (EC+CC)	about 11h (EC+CC+Pmp)
	about 33h (EC+PID)	about 22h (EC+PID+IR)	about 12h (EC+PID+IR+Pmp)
	about 52h (EC)	about 30h (EC+IR)	about 14h (EC+IR+Pmp)
Climatic conditions			
for operation:	-20…+50°C | 5…95%RH | 70…130kPa		
for storage:	-25…+55°C | 5…95%RH | 70…130kPa (recommended 0…+30°C)		
Housing Material:	rubberized polycarbonate		
Dimensions:	68 x 136 x 39 mm (W x H x D)		
Weight:	up to 395g (deviating depending on the sensor equipment)		
Protection class:	IP67		
Approvals / Tests			
Markings and Ignition protection type:	**G999C**	⟨Ex⟩ I M2 Ex ia db I Mb	⟨Ex⟩ II 2G Ex ia db IIC T4 Gb -20°C≤Ta≤+50°C
	G999E	⟨Ex⟩ I M1 Ex ia I Ma	⟨Ex⟩ II 1G Ex ia IIC T4 Ga -20°C≤Ta≤+50°C
	G999P	⟨Ex⟩ I M1 Ex ia I Ma	⟨Ex⟩ II 1G Ex ia IIC T4 Ga -20°C≤Ta≤+50°C
EU Type examination certificate:	BVS 15 ATEX E 064 X		
IECEx Certificate of Conformity:	IECEx BVS 15.0056 X		
Electromagnetic Compatibility:	EN 50270:2015	Emitted interference: Type class I Interference resistance: Type class II	

For (*1): The service life is indicated for new battery modules at operating temperatures of +20°C. It will be reduced by pressing buttons (display lighting & lamp), by using the pump and by gas alarms. It is reduced with the age of the battery module, with the number of the charging / discharging cycles, by longer storage of the gas measurement device in the charging tray and the lazy battery effect. CC$_{PS}$= Catalytic sensor with activated PowerSave mode if a reading of 0% LEL is detected. This energy saving mode can only be activated for certain measuring ranges (see section 2.3.2.2.5).

GfG Gesellschaft für Gerätebau mbH
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smart GasDetection Technologies

EU Declaration of Conformity

G999C, G999S, G999E, G999P, G999M

Edited: 31.07.2017 Amended: 16.10.2019

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www.gasmessung.de

GfG Gesellschaft für Gerätebau mbH develops produces and sells gas sensors and gas warning devices which are subject to a **quality management system** as per DIN EN ISO 9001.
Subject to supervision by means of a **quality system**, surveilled by the notified body, DEKRA Testing and Certification GmbH (0158), is the production of electrical apparatus of instrumentation Group I and II, categories M1, M2, 1G and 2G for gas sensors, gas detectors, gas warning systems in types of protection flameproof enclosures, increased safety, encapsulation and intrinsic safety, as well as their measuring function.

The portable detector **G999C, G999S, G999E, G999P, G999M** complies with directive **2014/34/EU** (ATEX) for devices and protective systems for proper use in potentially explosive atmospheres, directive **2014/30/EU** for electromagnetic compatibility, directive **2014/53/EU** (RED) relating to the making available on the market of radio equipment and with directive **2011/65/EU** (RoHS) on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

For electrical explosion protection BVS 15 ATEX E 064 X

Labelling: G999C, G999S	Ⓔx II **2G** Ex ia db IIC T4 Gb / Ⓔx I **M2** Ex ia db I Mb	-20≤Ta≤+50°C
Labelling: G999E, G999P	Ⓔx II **1G** Ex ia IIC T4 Ga / Ⓔx I **M1** Ex ia I Ma	-20≤Ta≤+50°C
Labelling: G999M	Ⓔx II **2G** Ex ia db IIC T4 Gb / Ⓔx I **M2** Ex ia db I Mb	-20≤T_a≤+50°C
	Ⓔx II **1G** Ex ia da IIC T4 Ga / Ⓔx I **M1** Ex ia da I Ma	-20≤T_a≤+40°C

The directive 2014/34/EU is complied considering the following standards:

Explosive atmospheres		
- General requirements	EN 60079-0	: 2012 +A11 :2013
- Flameproof enclosure "d"	EN 60079-1	: 2014
- Intrinsic safety "i"	EN 60079-11	: 2012
- Group1, category-M1-equipment	EN 50303	: 2000

The rating of the danger of ignition was done and documented. The EC-Type Examination Certificate was issued by the notified body with ID number 0158 (DEKRA EXAM, Dinnendahlstraße 9, D-44809 Bochum).

The directive 2014/30/EU is complied considering the following standard:

- Electromagnetic compatibility - Electrical apparatus for the detection and measurement of combustible gases, toxic gases or oxygen	EN 50270	: 2015
Emitted interference	Type class 1	
Interference immunity	Type class 2	

The EMC test laboratory AMETEK CTS Germany GmbH at Kamen has tested and certified the electromagnetic compatibility.

The directive 2014/53/EU is complied considering the following standards:

- Short Range Devices (SRD) operating in the frequency range 25 MHz bis 1000 MHz
  EN 300220-2 V3.11 : 2017

Reference to the directive 2014/30/EU:

- ElectroMagnetic Compatibility (EMC) standard for radio equipment and services
  Common technical requirements EN 301489-1 V2.2.0 : 2017

Reference to the directive 2014/35/EU:

- Assessment of the compliance of low power and electronic and electrical equipment with the basic restrictions related to human exposure to electromagnetic fields (10 MHz – 300GHz)	EN 62479	: 2010
- Audio/video, information and communication technology equipment Part1: safty requirements	EN 62368-1 :2014 + AC :2015	

The test laboratory m.dudde hochfrequenz-technik, Bergisch Gladbach has tested and certified the compatibility.

The directive 2011/65/EU is complied considering the following standard:

- Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances	EN 50581	: 2012

Dortmund, 16 October 2019

i.V. .....
QMB B. Siebrecht

ATEX EU-Konf-2.00/siebrecht

Translation

EU-Type Examination Certificate Supplement 4

1

2 **Equipment intended for use in potentially explosive atmospheres Directive 2014/34/EU**

3 EU-Type Examination Certificate Number: **BVS 15 ATEX E 064 X**

4 Product: **Gas detector type G888C, G888S, G888M G999C, G999S, G999E, G999P, G999M**

5 Manufacturer: **GfG Gesellschaft für Gerätebau m bH**

6 Address: **Klönnestr. 99, 44143 Dortmund, Germany**

7 This supplementary certificate extends EU-Type Examination Certificate No. BVS 15 ATEX E 064 X to apply to products designed and constructed in accordance with the specification set out in the appendix of the said certificate but having any acceptable variations specified in the appendix to this certificate and the documents referred to therein.

8 DEKRA Testing and Certification GmbH, Notified Body number 0158, in accordance with Article 17 of Directive 2014/34/EU of the European Parliament and of the Council, dated 26 February 2014, certifies that this product has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of products intended for use in potentially explosive atmospheres given in Annex II to the Directive.
The examination and test results are recorded in the confidential Report No. BVS PP 15.2110 EU.

9 The Essential Health and Safety Requirements are assured in consideration of:

EN 60079-0:2012 + A11:2013	**General requirements**
EN 60079-1:2014	**Flameproof enclosure "d"**
EN 60079-11:2012	**Intrinsic Safety "i"**

10 If the sign "X" is placed after the certificate number, it indicates that the product is subject to the Special Conditions for Use specified in the appendix to this certificate.

11 This EU-Type Examination Certificate relates only to the design and construction of the specified product. Further requirements of the Directive apply to the manufacturing process and supply of this product. These are not covered by this certificate.

12 The marking of the product shall include the following:

II 2G Ex ia db IIC T4 Gb	**I M2 Ex ia db I Mb**	for type G888C, G999C, G999S
II 2G Ex ia db IIC T4 Gb	**I M1 Ex ia I Ma**	for type G888S
Ⓔx **II 1G Ex ia IIC T4 Ga**	**I M1 Ex ia I Ma**	for type G999E, G999P
II 2G Ex ia db IIC T4 Gb **II 1G Ex ia da IIC T4 Ga**	**I M2 Ex ia db I Mb** **I M1 Ex ia da I Ma**	for type G888M, G999M

Details see next page

DEKRA Testing and Certification GmbH
Bochum, 2019-10-09

Signed: Jörg-Timm Kilisch

Managing Director

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13 **Appendix**

14 **EU-Type Examination Certificate**

BVS 15 ATEX E 064 X
Supplement 4

15 **Product description**

15.1 **Subject, type, marking and ambient temperature range**

Gas detector type G888C, G999C, G999S	**II 2G Ex ia db IIC T4 Gb** **I M2 Ex ia db I Mb**	-20 °C ≤ T_a ≤ +50 °C -20 °C ≤ T_a ≤ +50 °C
Gas detector type G888S	**II 2G Ex ia db IIC T4 Gb** **I M1 Ex ia I Ma**	-20 °C ≤ T_a ≤ +50 °C -20 °C ≤ T_a ≤ +50 °C
Gas detector type G999E, G999P	**II 1G Ex ia IIC T4 Ga** **I M1 Ex ia I Ma**	-20 °C ≤ T_a ≤ +50 °C -20 °C ≤ T_a ≤ +50 °C
Gas detector type G888M, G999M	**II 2G Ex ia db IIC T4 Gb** **I M2 Ex ia db I Mb** **II 1G Ex ia da IIC T4 Ga** **I M1 Ex ia da I Ma**	-20 °C ≤ T_a ≤ +50 °C -20 °C ≤ T_a ≤ +50 °C -20 °C ≤ T_a ≤ +40 °C -20 °C ≤ T_a ≤ +40 °C

15.2 **Description**

Reason for the supplement:

The Gas detectors type G888M and type G999M were added.

Description of Product:

The Gas detector type G888C, type G888S, type G888M, type G999C, type G999S, type G999E, type G999P or type G999M is a portable instrument with a built in power-supply battery. It is used for the detection of gases in ambient air under atmospheric conditions.

The Gas detector type G888C, type G888S, type G888M, type G999C, type G999S or type G999M contains 3 electro-chemical cells, 1 IR-sensor and 1 sensor of flameproof enclosure.

The Gas detector type G999E contains 4 electro-chemical cells and 1 IR-sensor.

The Gas detector type G999P contains 3 electro-chemical cells, 1 IR-sensor and 1 PID-sensor.

The measurement values are shown on a built-in display. If the present limits are reached, a visual alarm, an audible alarm and a vibrating alarm are produced.

A radio module for wireless data transfer can be optionally used inside of the Gas detector type G888C, type G888S, type G888M, type G999C, type G999S, type G999E, type G999P or type G999M.

The gas detector type G888C, type G888S, type G888M, type G999C, type G999S, type G999E, type G999P or type G999M is powered by a NiMH battery which has to be charged only outside of the hazardous area.

The gas detector type G999C or type G999S or type G999E or type G999P or type G999M contains additionally a built-in pump.

Listing of all components used referring to older standards
(optionally used in type G888C, G999C, G999S)

Subject and type	Certificate	Standards
Gas Sensor type A	Sira 07ATEX1088X	EN 60079-0:2006 EN 60079-1:2004

DEKRA Testing and Certification GmbH, Handwerkstr. 15, 70565 Stuttgart, Germany
Certification body: Dinnendahlstr. 9, 44809 Bochum, Germany
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15.3 **Parameters**

15.3.1 Power supply battery in type G888C or type G888S or type G888M

Nominal voltage			2.6 V
Nominal capacity			2100 mAh
Maximum charging voltage	U_m	DC	6 V

15.3.2 Power supply battery in type G999C or type G999S or type G999E or type G999P or type G999M

Nominal voltage			5.2 V
Nominal capacity			2100 mAh
Maximum charging voltage	U_m	DC	9 V

15.3.3 Optionally radio module

Frequency range (depend on module type)			865.0 – 868.6 MHz or 865.0 – 870.0 MHz or 902.0 – 92.0 MHz
Nominal RF output power		<	35 mW
Maximum RF output power		<	250 mW

15.3.4 Ambient temperature range see section 15.1

16 **Report Number**

BVS PP 15.2110 EU, as of 2019-10-09

17 **Special Conditions for Use**

The measuring function according to annex II paragraph 1.5.5 of the directive 2014/34/EU is not part of this supplement to the EU-type Examination Certificate.

For Gas detector type G888C, G888M, G999C, G999M, G999S / usage Group I / mining:

The gas detector may only be used in potentially explosive atmospheres as intended. That means, that the device has to be carried on the body or has not be discarded unattended, so that mechanical stress by impact is avoided. It is intended for the low risk of mechanical danger according to EN 60079-0.

The gas detector has to be immediately removed from the hazardous area and has to be cleaned when it is contaminated with oils and greases or hydraulic fluids.

18 **Essential Health and Safety Requirements**

The Essential Health and Safety Requirements are covered by the standards listed under item 9.

19 **Drawings and Documents**

Drawings and documents are listed in the confidential report.

We confirm the correctness of the translation from the German original.
In the case of arbitration only the German wording shall be valid and binding.

DEKRA Testing and Certification GmbH
Bochum, 2019-10-02
BVS-Rip/Mu A 20190848

Managing Director

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