Operation Manual

ZD22

Transmitter for the measurement of oxygen

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Table of Contents

1. INTRODUCTION

1.1 For your safety

This operating manual points out in accordance with the law, the provision of products to the market (Product Safety Act – ProdSG), on the intended use of the product and serves to protect the safety and health of people. It must be read and followed by all persons that utilise this product or use, service, maintain, and control it. This product can only perform its duties for which it is intended, when it utilised, used, maintained, serviced and controlled according to instruction given by the GfG company.
The warranty provided by GfG, is not valid if it is not used, maintained, controlled or serviced according to the instructions issued by GfG. The above does not alter the information on warranty and liability in the terms and conditions of the GfG.

1.2 Operating instructions

Gas warning devices must, according to the national regulations, be inspected for correct operation after installation, but before any measuring operation is carried out (commissioning). In Germany the following applies: "DGUV Information 213-056 (data sheet T 021 / previously BGI 836 section 8.1)".

The transmitter has been tested for correct operation and display prior to delivery. The calibration and adjustment was carried out with appropriate testing or calibration gases.
This does not absolve from a calibration and if necessary adjustment after installation.

The transmitter ZD22 is not **approved for use in potentially explosive atmospheres.**

CAUTION
The supply voltage may not exceed 30V DC!
The same applies to voltage peaks!

2. GENERAL INFORMATION ON THE TRANSMITTER

2.1 General Description

A stationary gas warning system consists of a transmitter and a gas measurement and evaluation unit (GME, not included in the scope of delivery). Transmitter and GME are connected via a remote sensor cable. The transmitter converts the concentration of gas into an electrical signal for measuring and sends it to the unit for further processing.

ZD22 transmitter can be optionally equipped with an additional graphic display with control buttons and acoustic signal generator. The display has a "green" background lighting when in the measuring mode. With an incident or alarm event, the display colour changes to "Red" to give an optical alarm. In addition there is a horn to sound an acoustic alarm with the display version.

Each of the 22 series transmitters has two status LEDs, which indicate the operating status of the device. A "green" LED to indicate the operational readiness, and a "yellow" LED to display an fault or a special condition.
The 22 series transmitter can be delivered either with an analogue output current interface or a digital RS485 interface. The current interface can output the measurement information by default with 4-20mA or alternatively with 0.2-1mA. The communication of the digital RS485 interface uses the Modbus (RTU) protocol.

The electronics takes over many tasks that facilitate the operation and maintenance, and also to significantly increase the reliability and accuracy. The transmitter is characterised by:

- Concentration indicator (with display version)
- Settings by pressing a button without having to open the housing (with display version)
- Compensation of temperature influences
- Permanent status indicator (measuring mode, fault or special status) on the transmitter

2.2 Measurement procedure and measurement gas feed

The ZD22 transmitter is equipped with an amperometric oxygen sensor based on an electrochemical oxygen pump cell made of zircon dioxide. If a voltage is applied to the cell, oxygen ions are pumped from the cathode to the anode. Since the cathode is covered by a gas diffusion barrier, a saturation current occurs when increasing the voltage. This saturation current is a measure for the ambient oxygen concentration. The measurement principle is characterized by a high long-term stability and selectivity.

Normally, the measurement gas passes through diffusion to the gas sensor. However, if a calibration adapter is attached to the sensor for calibration or adjustment purposes, the following particularities can be noted on the ZD22.

2.3 Particularities when using a calibration adapter

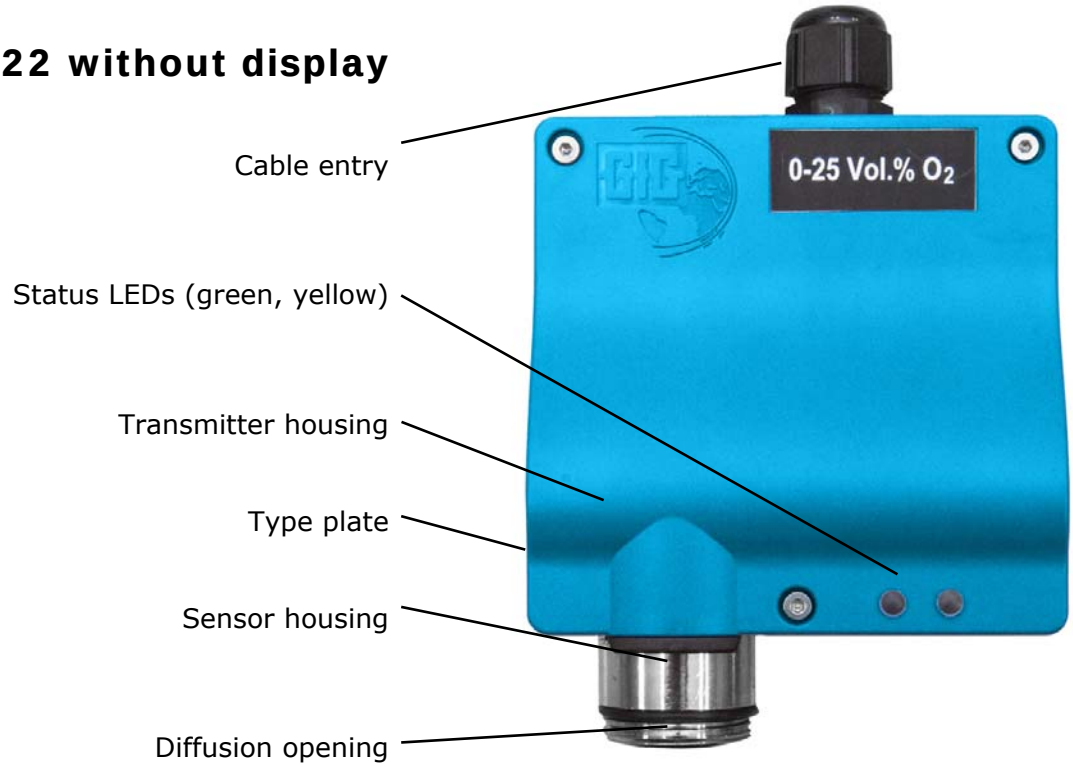
Especially for measuring ranges having an oxygen content of less than 5 % vol. , a gas hose of at least 30 cm in length has equally to be connected to the gas outlet of the calibration adapter for avoiding falsified display values. This is the only way to prevent any oxygen molecules from flowing "backwards" to the sensor with a flow rate of 0.5 l/min. The partial oxygen pressure outside of the calibration adapter is the reason for possibly wrong display values with low concentrations.

2.4 Transmission response

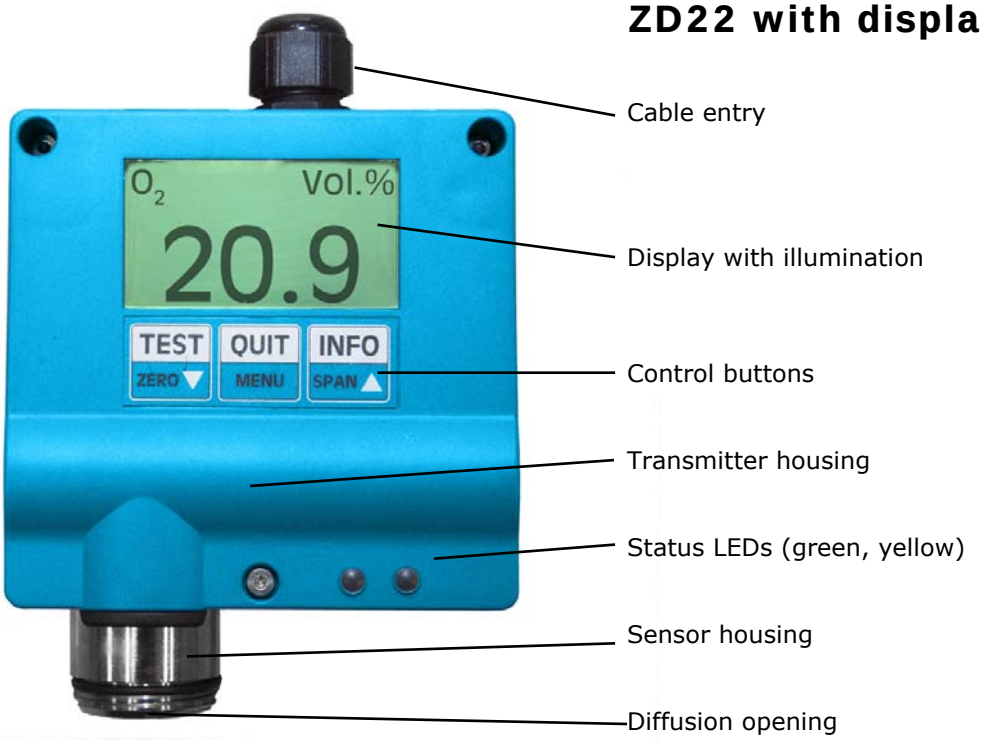
The gas indicator and signal delivery are always proportional to the concentration of gas. The set times can be different depending on the sensor type used.

2.5 Unit design

ZD22 without display



ZD22 with display



The gas sensor and the transmitter electronics are installed in the transmitter housing. The electronics transforms the measurement signal into a gas concentration and this is signalled through an analogue current signal of 4-20mA or 0.2-1mA or a digital RS485 bus signal using the MODBUS RTU protocol. Gas concentration and status information are displayed in the display variant.

The adjustment of the transmitter can be done using a multimeter and two integrated potentiometers or - if available - via the display and the buttons.

3. ASSEMBLY AND INSTALLATION INSTRUCTIONS

3.1 Installation location

In determining the place of installation, it is important to know the environmental conditions and to take this into account when selecting the location. To achieve representative measurement results, the ventilation conditions must be considered.

The transmitter must be installed in the room so that the gases reach the sensor, even with unfavourable ventilation. If necessary, a measurement must be made, for example with smoke tubes.

In determining the place of installation always ensure that the transmitter is always freely accessible for service and calibration work.

Outside influences are also to be noted:

- Rain water, splash water, dripping water, condensation
- The dust in the atmosphere

The transmitter is largely protected against the ingress of water and dust. In very difficult conditions, special accessories can be used to protect the transmitter from damage. GfG will be happy to advise you on appropriate measures.

If the sensor is exposed to environmental conditions, which were not known to GfG during planning or delivery, the warranty may become invalid.

3.2 Installation

In determining the place of installation ensure that the transmitter is always freely accessible for service and calibration work. The transmitter must be positioned vertically with the sensor pointing downward.
The transmitter is connected to the evaluation unit in accordance with the connection diagram (see *connections and terminal assignment*). To install, release the three Allen bolts and remove the housing cover. The housing is fastened with three screws. The printed circuit board is inside the housing. The terminals for the connection to the evaluation unit are on the top of the circuit board.

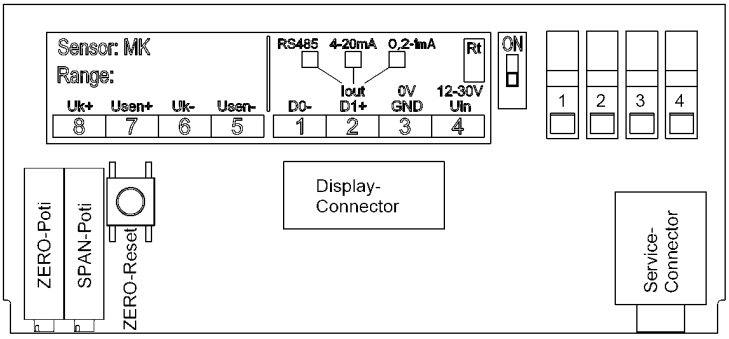
3.3 Installing electrical connections

The laying of cables and connection of the electrical installation may only be carried out by an expert taking into consideration the relevant provisions. The cross-section depends on the length of the connection cable and the transmitter version. At this point, check with the bus variant, that the operating voltage is sufficient to also supply the last transmitter on the transmitter bus. If necessary, the power supply must be extended with an additional power source.
For analogue data transmission a cable can be used with the wire diameter of 0.75mm², this is suitable for short distances up to 500m. For longer distances the wire cross-section has to be 1.5mm². The cable length should not exceed 1200m.

Wiring diagram:

Terminal for cable connection
1: Data– D0
2: Data+ D1 / 4-20mA / 0.2-1mA
3: 0V GND
4: 24V DC (15-30V DC)

Slide switch (Rt)
Terminating resistor for RS485
(Factory setting = OFF)



After installation, the cover must be closed and screwed again.

4. OPERATING INSTRUCTIONS

4.1 Commissioning

The ZD22 transmitter has been tested for correct operation and display prior to the delivery. The adjustment is carried out with appropriate testing or calibration gases. Deviations can occur dependent on the transport, installation and environmental conditions.
Therefore, the gas detection system must be installed by a competent person and checked for correct operation.

After switching on, the transmitter requires a 2–3 minutes for:

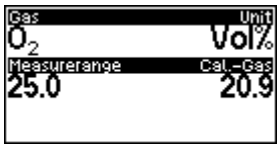
- the self-test, for checking the program and memory
- reading and evaluating the device parameters with concurrent memory testing
- reading and evaluating the sensor parameters with concurrent memory testing
- the stabilising of the sensor

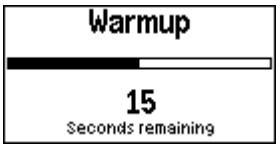
Version with analogue current interface (0.2-1mA):
Directly after switching in, the current interface delivers 0.0mA and after 4 seconds 0.08mA. The green and yellow LEDs are on.

Version with analogue current interface (4-20mA):
Directly after switching in, the current interface delivers 0.0mA and after 4 seconds 1.6mA. The green and yellow LEDs are on.

Version with digital Modbus interface (RS485):
With the Modbus version, "Start-up" can be read on the connected evaluation device, e.g. GMA200. If necessary also see the Modbus system for the TRM22 operating instructions.

In the display of the ZD22 the information on the *Firmware Version appears.* Then, the measuring range, the measurement unit, type of gas and the calibration gas concentration is shown. The remaining seconds of the run-in phase are counted down in the display. After the run-in phase the ZD22 automatically switches the sensor to measuring mode.





If a device failure is detected in the start-up phase, the device switches into fault mode.

Version with analogue current interface (0.2-1mA):
The current interface then emits 0.06mA. An error message appears in the display
(see indicators of special conditions and malfunctions).
The yellow fault LED lights up permanently.

Version with analogue current interface (4-20mA):
The current interface emits 1.2mA. An error message appears in the display
(see indicators of special conditions and malfunctions).
The yellow fault LED lights up permanently.

Version with digital Modbus interface (RS485):
With the Modbus version an error message is displayed in the display of the transmitter and/or the GME (see indicators of special conditions and malfunctions).
The yellow fault LED lights up permanently.

Note:
After the initial commissioning of the transmitter and the run-in period, a check and perhaps an adjustment of the zero point (ZERO) should take place, subsequently also the sensitivity (SPAN).

4.2 Measurement mode

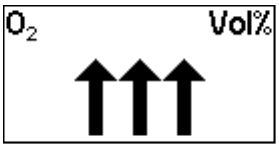
With trouble-free operation the green LED is permanently on, and the yellow fault LED off. The functionality of the electronics is constantly monitored through various tests, such as sensor, processor and storage tests. The measurement of gas concentration is continuous and is updated every second.

The digital display shows the currently detected gas concentration when in the measurement mode.

In normal measurement mode, a bar graph is displayed in the display of the transmitter showing the current gas concentration with the set measuring range, and in 5 seconds intervals the type of gas and gas unit, too.

4.2.1 Measuring range exceeded

Exceeding the measuring range between 100% and 112% of the measuring range the arrows ↑↑↑ are displayed alternately with the measured value.



Transmitter with analogue current interface 0.2-1mA:
The current interface outputs a signal in the range of 1.0-1.1mA corresponding to the reading.

Transmitter with analogue current interface 4-20mA:
The current interface outputs a signal in the range of 20-22mA corresponding to the reading.

Transmitter with digital Modbus interface (RS485):
With the Modbus version a corresponding measurement value alternating with ↑↑↑ is displayed in the display of the transmitter and/or the GME (see indicators of special conditions and malfunctions).

Exceeding by even more than 112% of the measurement range, the display shows permanent arrows ↑↑↑ and a fast blinking yellow status LED.

Transmitter with analogue current interface 0.2-1mA:
The current interface emits 1.1 mA.

Transmitter with analogue current interface 4-20mA:
The current interface emits 22mA.

Transmitter with digital Modbus interface (RS485):
With the Modbus version, ↑↑↑ is displayed in the display of the transmitter and/or the GME (see indicators of special conditions and malfunctions).

4.2.2 Measuring range underflow

Readings below the zero point are shown in the display as a number preceded with a negative sign. Where the underflow of the measured value from 0 to -5% of the measuring range the measured value remains in the display of the transmitter or the evaluation unit (e.g. GMA200).

With an underflow of the measured value from -5 to -7.5% the arrows ↓↓↓ are shown in alternation with the measured value in the display of the transmitter.

With an underflow of the measured value below the measuring range of -7.5%, the arrows ↓↓↓ appear permanently on the display.

Transmitter with analogue current interface 0.2-1mA:
The current interface outputs a signal in the range of 0.14 to 0.2mA corresponding to the reading.

Transmitter with analogue current interface 4-20mA:
The current interface outputs a signal in the range of 2.8 to 4.0mA corresponding to the reading.

Transmitter with digital Modbus interface (RS485):

With the Modbus version a corresponding measurement value is displayed in the display of the transmitter and/or the GME (see indicators of special conditions and malfunctions).

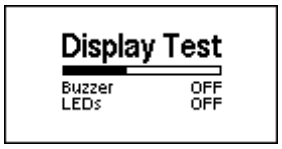
4.2.3 Operating buttons

Using the buttons on the transmitter TEST ZERO ▼ QUIT MENU INFO SPAN ▲, the unit can be calibrated and settings adjusted via the menu.

4.2.4 Display, LED and horn test [TEST]

With the transmitter with display when in the measuring mode, a short press on the button TEST ZERO ▼ initiates the display and LED test.

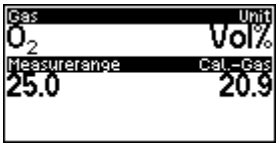
This actuates all LEDs, all segments of the display are shown and also briefly the status LEDs are actuated and there is an audible beep.



4.2.5 Display of operating parameters [INFO]

During the measurement mode, pressing the button INFO SPAN ▲ briefly shows the following important operational parameters in sequence automatically.

- Measurement gas
- Measurement unit
- Measurement area
- Calibration or test gas concentration



These indicators also appear during the device start-up phase.

4.2.6 Sensor service life

Zircon dioxide sensors have a limited service life. The expected service life of the ZD22 sensors used amounts up to 5 years depending on the operating conditions. Upon reaching the expected service life, the transmitter indicates that the sensor should be replaced at the next maintenance. The display illuminates red and a corresponding message is shown and the yellow LED appears briefly every five seconds. This does not affect the measurement operation and the remaining service life of the sensor.

4.3 Calibration and adjustment

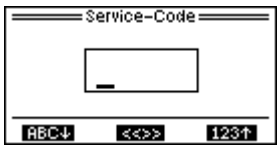
4.3.1 Zero point calibration

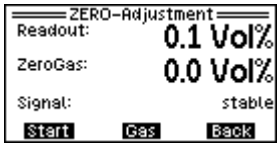
When calibrating (control) or adjusting (setting) the zero point, 100 vol% nitrogen, for instance, can be used as zero gas. Please refer also to section 2.3 "Particularities when using a calibration adapter".

Calibration (check):
In this case, a calibration adapter has to be screwed on the sensor housing. Via the calibration adapter, the zero gas can be applied to the sensor without pressure with a flow rate of approx. 0.5 $^{l}/_{min}$. If the display value moves away from zero, the deviation can be adjusted.

Adjusting the display:
The adjustment of the zero point can be performed in different ways depending on the transmitter version. These possibilities are described below.

4.3.2 Zero point adjustment with display and keyboard [ZERO]





To perform the zero point adjustment, press and hold the button TEST / ZERO ▼ (>3sec.) to change to the service code query. After entering the default service code "0011" (factory setting), the programme "ZERO calibration" is activated. This is signalled by a flashing yellow status LED and transmitters with analogue interface (4-20mA or 0.2-1mA) by an output signal of 2.4mA or 0.12mA.

The display shows the current gas reading (indicated value) and displays the adjusted zero gas concentration. If the measured gas value is no more than 10% of the measuring range, the zero point adjustment can be started with the left button [start]. If the current measured gas value remains constant during a defined interval of time, the new zero point is taken over and displayed. Using the right button, the program "ZERO adjustment" can be completed and a change back to measuring mode can be made.

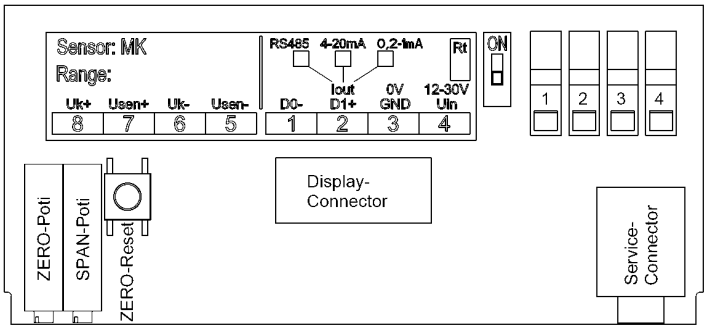
4.3.3 Zero point adjustment using the ZERO reset button

For transmitters without display, the easiest way to adjust the zero point is to actuate the ZERO reset button. For actuating this button, the transmitter cover has to be removed. Afterwards press and hold the button for 3 seconds in order to start the adjustment procedure. The adjustment procedure is signalled by a flashing yellow status LED and a power output signal of 2.0mA (or 0.1mA). If the measured value remains constant during a defined interval of time, the new zero point is taken over. Afterwards, the adjustment is automatically finished.

Notes:

While waiting for a constant measurement value, the adjustment procedure can be shortened by pressing and holding the ZERO reset button. The hardware immediately starts the zero point adjustment now.

If the current measured value is over 25% of the measuring range, the transmitter switches back to measurement mode without having performed the adjustment.



4.3.4 Zero point adjustment with the ZERO potentiometer

For transmitters without display the zero point adjustment can be carried out when the transmitter cover is open via the ZERO potentiometer using a small screwdriver, a multimeter and with a test lead with service connector (see section "Accessories and spare parts"). The test lead should be connected to the voltage measuring jacks of the multimeter and the service socket inside the service connector of the transmitter. (See also note.)

As long as the ZERO potentiometer is not turned, a voltage value is shown on the multimeter between 0.2-1V DC, this indicates the current gas measurement in the range of 0-100% of the measuring range proportional.

Once the ZERO potentiometer is turned the setpoint can be read on the multimeter for the zero point adjustment. This is signalled by the flashing yellow status LED. It must be turned until a voltage value of 0.200V is displayed. As long as this setpoint remains unchanged for a considerable time, the zero point adjustment is started by the transmitter. The yellow status LED goes off once the adjustment is complete.

The zero point adjustment with the ZERO potentiometer can be performed for display values up to 25% of the measuring range. If the transmitter, despite correct task of the calibration gas, jumps back to the original (unadjusted) measurement value after the adjustment, this could mean that the adjustment was not successful due to exceeding the tolerable signal limits or there was excessive signal noise. This can be a sign that the sensor is defective and should be replaced so as soon as possible.

Note:
If no test lead is available with service socket, the output current (Iout) of the transmitters with analogue interface (4-20mA and 0.2-1mA) can be measured directly between terminal 2 and terminal 3 (GND). During this current measurement nothing may be connected to terminal 2 except the multimeter.

4.3.5 Sensitivity calibration

For calibration (control) or adjusting the gas sensitivity, a calibration adapter has to be screwed on the sensor housing. Via the calibration adapter, the test or calibration gas is fed to the sensor without pressure at a flow rate of approx. 0.5 $^{l}/_{min}$. Depending on the measuring range, fresh air or synthetic air can also be used.

The indicated value can be observed on the display. If the indicated value deviates from the calibrated gas concentration, a sensitivity adjustment is necessary.

Calibration of the display:

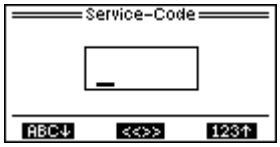
Before any adjustment of the sensitivity, the zero point should be checked and if necessary readjusted. The adjustment of the sensitivity can be done in different ways depending on the transmitter version. Both possibilities are described below.

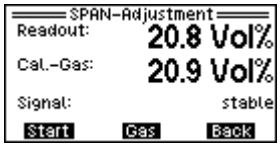
4.3.6 Sensitivity adjustment with display and keyboard [SPAN]

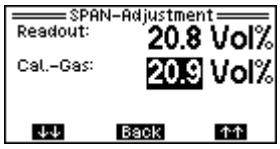
To perform the sensitivity adjustment, press and hold the button INFO / SPAN ▲ (>3sec.) to change to the service code query. After entering the default service code "0011" (factory setting), the programme "SPAN calibration" is activated. This is signalled by a flashing yellow status LED and transmitters with analogue interface (4-20mA or 0.2-1mA) by an output signal of 2.4mA or 0.12mA.

The display shows the current gas reading (indicated value) and displays the adjusted test gas concentration (cal. gas). After pressing the middle button [gas] the test gas concentration can be changed with the left or right buttons, and saved with the centre button.

If the measured gas value is at least 7% of the measuring range, the sensitivity adjustment can be started with the left button [start]. Once a stable reading is detected for a defined period, the sensitivity is adjusted and the new measured value is displayed. Using the right button, the program "SPAN adjustment" can be completed and a changed back to measuring mode can be made.







4.3.7 Sensitivity adjustment with the SPAN potentiometer

For transmitters without display the sensitivity adjustment can be carried out when the transmitter cover is open via the SPAN potentiometer using a small screwdriver, a multimeter and with a test lead with service connector (see section "Accessories and spare parts"). The test lead should be connected to the voltage measuring jacks of the multimeter and the service socket inside the service connector of the transmitter. (See also note.)

As long as the SPAN potentiometer is not turned, a voltage value is shown on the multimeter between 0.2-1V DC, this indicates the current gas measurement in the range of 0-100% of the measuring range proportional.

Once the SPAN potentiometer is turned the setpoint can be read on the multimeter for the sensitivity adjustment. This is signalled by the flashing yellow status LED. It must be turned until a voltage value of for example 0.600V (for 50% MR) is displayed. As long as this setpoint remains unchanged for a considerable time, the sensitivity adjustment is started by the transmitter. The yellow status LED goes off once the adjustment is complete.

If the transmitter, despite correct task of the calibration gas, jumps back to the original (unadjusted) measurement value after the adjustment, this could mean that the adjustment was not successful due to exceeding the tolerable signal limits or there was excessive signal noise. This can be a sign that the sensor is defective and should be replaced so as soon as possible.

Note:
If no test lead is available with service socket, the output current (Iout) of the transmitters with analogue interface (4-20mA and 0.2-1mA) can be measured directly between terminal 2 and terminal 3 (GND). During this current measurement nothing may be connected to terminal 2 except the multimeter.

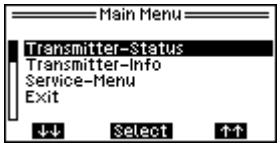
4.4 Main and service menu [MENU]

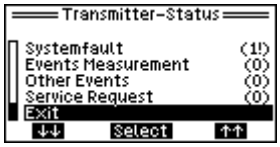
To get to the main menu, and from there to change to the service menu, the middle button [MENU] must be pressed and held for at least 3 seconds. Access to the main menu is not protected by an access code.

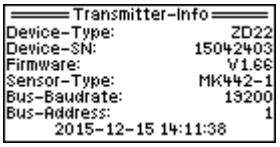
4.4.1 Main menu

In the main menu itself and when changing to the individual menu items, the transmitter remains in measuring mode. This means that the data acquisition, processing, and output continues to work in the background. There is an exception with the service menu, which is described in the next section. The main menu is structured as follows:

- Transmitter status
- Transmitter info
- Service menu
- Leave

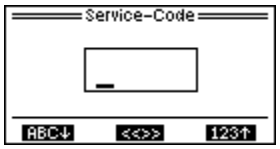






The following information is available with the transmitter status, current system error, error in the measuring process, service needed, and events. Behind these groups, there are figures in brackets. These figures indicate the number of the existing information.

4.4.2 Service menu



To access the service menu, a special access code must be entered. For the default service menu the code is "1100". Additional functions are available in an advanced service menu. GfG service personnel only is permitted to access the advanced service menu.

The service menu is subdivided as follows:

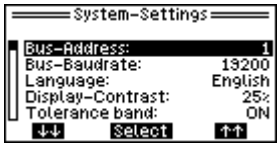
System settings: This menu contains general settings for the RS485 bus interface and/or analogue interface, language, display contrast, tolerance range and acoustic alarm.

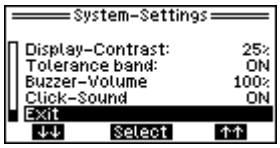
Sensor settings: This menu contains the settings required for sensor replacement as well as the selection of the measurement range.

Measurement value simulation: This menu allows to generate measurement values without test gas for checking the output signal interface and the subsequent signal processing.

Within the following subsections, these setting options are described in detail.

4.4.2.1 System settings



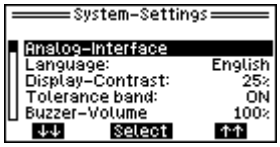


If the transmitter includes a RS485 bus interface, the **bus address** can be set to a range from 1 to 247 (0 = inactive). However, you are not allowed to use this bus address several times within the same bus segment.

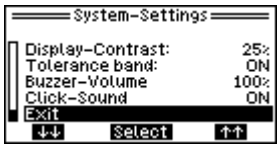
Bus baud rate can be set to 9600, 19200 or 38400 bauds. By default it is set to 19200 bauds. The baud rate can be reduced to 9600 bauds for very long bus lines and increased to 38400 bauds for very many participating bus stations. The same baud rate has to be set for all bus stations within one bus segment.

Language can be set to German or English and is relevant for all display outputs for the menus in particular.

Display contrast can be set from 0 to 100%. This value can vary depending on the display type and is typically set to 25…40%.

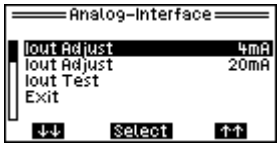


Tolerance range can be set to "ON" or "OFF". If it is set to "ON" (standard), minor signal deviations of fresh air are indicated as 20.9 vol % O_2. The actual measurement value is only indicated when exceeding or falling below the tolerance range. If this item is set to "OFF", the actual measurement value is always indicated.



Volume of acoustic alarm can be set from 0 to 100%, but is only relevant, if the transmitter is used to trigger an alarm in case of hazardous gas levels.

Click sound can be set to "ON" or "OFF". If it is set to "ON" (standard), the internal acoustic alarm produces a short clicking each time a button is actuated.

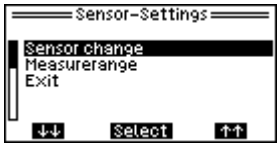


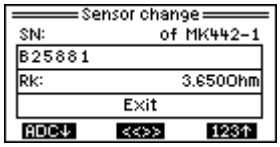
If the transmitter is provided with an analogue 4-20mA (0.2–1mA) interface, the menu item **Analogue interface** of the advanced service menu can be used to adjust and check the current interface.

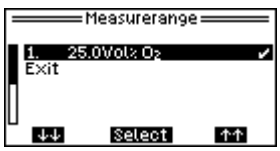
Iout adjustment: Caution!!! The current interface may only be adjusted with the help of a very precise ammeter.

Iout test: The current output can be checked in a range from 0.5 to 24.5mA using this item. Caution!!! It is possible that connected control devices respond to these test levels.

4.4.2.2 Sensor settings







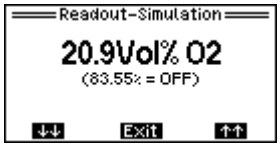
The following sensor-related settings can only be set in the advanced service menu:

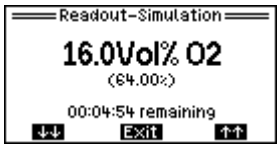
Sensor replacement: If a gas sensor has been used up and is to be replaced by a new gas sensor of the same type (MK…), this menu item has to be used to enter the serial number of the new gas sensor. The sensor resistance Rk must also be set for certain sensor types (e.g. MK442-1). When all data are entered, the calibration data of the former sensor are deleted and replaced by new standard values. In any case, the zero point and the gas sensitivity of the new gas sensor need to be adjusted.

Measurement range Upon delivery, GfG already provides the transmitter with the measuring range requested by the customer. However, if another measuring range is requested later and further measuring ranges are available for the respective sensor, this menu item can be used to select another measuring range.

Due to the different limit values of the measuring ranges, the calibration data of the former measuring range are not adopted. Thus, if another measuring range is selected, the zero point and the gas sensitivity possibly need to be adjusted.

4.4.2.3 Measurement value simulation





Thanks to the measurement value simulation, the output signal interface, transmission of measurement value and subsequent signal processing can be checked. Over a restricted period of time, measurement values can be generated without an appropriate test gas being available.

At the beginning, the display still shows the current measured value. Simulation mode is only started upon actuation of the left or right key. The maximum remaining simulation time is then indicated above the keyboard labelling. If the simulation value is modified with the help of the left or right key, the remaining simulation time is again set to 5 minutes. The simulation mode can be terminated by pressing the centre key. If no key is pressed, the simulation mode is terminated upon expiry of the remaining simulation time and the device automatically switches over to measurement mode.

4.5 Indicators and messages

4.5.1 Overview of the status LED states and current output signals

The following table lists the different display states of the two status LEDs and the power output signals with reference to their meanings.

green LED	yellow LED	Current output	See description in section ...	
Off	Flashes with 1Hz	0.0mA	Display of special conditions...	No. 001
Off	On	0.0mA	Display of special conditions...	No. 002
Off	On	1.2mA	Display of special conditions...	No. 103-113
Single pulse every 5s	On	1.2mA	Display of special conditions...	No. 101
Flashes with 1Hz	On	1.6mA	Display of special conditions...	No. 002, 003
On	Flashes with 1Hz	2.0mA	Display in service mode...	No. 204, 205
On	Flashes with 1Hz	2.4mA	Display in service mode...	No. 203
On	Flashes with 1Hz	4-20mA	Display in service mode...	No. 201, 202
On	Single pulse every 5s	2.8-22mA	Display in measurement mode	No. 309
On	On	2.8mA	Display in service mode	No. 307, 308
On	Off	2.8-22mA	Display in service mode...	No. 303-306
On	Flashes with 5Hz	22mA	Display in service mode	No. 301, 302

4.5.2 Indicating special conditions (device start and fault)

The following table shows the states with a description in which the yellow fault LED lights up and the 4-20mA current output transmits a signal ≤1.6mA.
For the 0.2-1mA current output the value of the output signal is shown in brackets (≤0.08mA).

Behaviour when starting the device:

No.	Display	green LED	yellow LED	Current output	Cause	Note / Explanation
001	Boot V1.07 GfG ZD22 Error:Flash	Off	Flashes with 1Hz	0.0mA	During the memory test, a fault was encountered in the program memory.	Restart the transmitter. If the fault message occurs again a firmware update is necessary.
002	Boot V1.07 GfG ZD22 Verify	Off	On	0.0mA	Program and memory tests during the first few seconds of the device start-up	after approx. 4 seconds automatic transition during the initialisation phase
003	V1.66 GfG ZD22	Flashes with 1Hz	On	1.6mA (0.08mA)	Initialisation phase of the transmitter	after approx. 3 seconds automatic transition during the sensor run-in phase
004	Warm up XX Seconds remaining	Flashes with 1Hz	On	1.6mA (0.08mA)	Sensor run-in phase	after the time has elapsed automatic transition in the measurement mode

Behaviour in case of failure:

No.	Display	green LED	yellow LED	Current output	Cause	Note / Explanation
101	Sensor defective	Single pulse every 5s	On	1.2mA (0.06mA)	Sensor no longer properly reacts to gas. The sensor may be too old.	The sensor must be replaced.
102	Supply voltage incorrect	Off	On	1.2mA (0.06mA)	The transmitter supply voltage is too small or too large.	Check the power supply and adjust
103	Sensor Uk wrong	Off	On	1.2mA (0.06mA)	The heating voltage for the sensor is wrong.	
104	Sensor Ik < MIN Sensor Ik > MAX	Off	On	1.2mA (0.06mA)	The heating current for the sensor is too small or too large.	
105	Temp.signal < MIN Temp.signal > MAX	Off	On	1.2mA (0.06mA)	Temperature measurement is probably faulty.	
106	Watchdog error	Off	On	1.2mA (0.06mA)	When testing the external watchdog a hardware fault was detected.	Restart the device. If the error message occurs again exchange the device.
107	FLASH fault	Off	On	1.2mA (0.06mA)	During the memory test, a fault was encountered in the program memory.	
108	RAM fault	Off	On	1.2mA (0.06mA)	During the memory test, a faulty memory was discovered.	
109	EEPROM fault 1 EEPROM fault 2 EEPROM fault 2c EEPROM fault 1 + 2 EEPROM fault 1 <> 2	Off	On	1.2mA (0.06mA)	Fault in parameter memory or when accessing the external Parameter memory module.	
110	Wrong type of PCB	Off	On	1.2mA (0.06mA)	An incorrect printed circuit board type or a printed circuit board fault was detected.	
111	Digital potentiometer fault	Off	On	1.2mA (0.06mA)	A hardware fault was detected with the digital potentiometer.	
112	ADC error 1 ADC error 2	Off	On	1.2mA (0.06mA)	A fault was detected in the analogue/digital converter.	
113	Program runtime error	Off	On	1.2mA (0.06mA)	A logical sequence error was encountered during the program execution.	

4.5.3 Indications during service mode and during sensor adjustment

The following table shows the states with a description in which the green operation LED lights up and the 4-20mA current output transmits a signal 2.0-2.4mA. For the 0.2-1mA current output the value of the output signal is shown in brackets (0.10-0.12mA).

No.	Display	green LED	yellow LED	Current output	Cause	Note / Explanation
201	Adjustment Zero point (ZERO-Poti)	On	Flashes with 1Hz	4-20mA (0.2-1mA)	AutoCal program for zero point adjustment has been activated with ZERO potentiometer	Zero gas setting is made with the ZERO potentiometer
202	Adjustment Sensitivity (SPAN-Poti)	On	Flashes with 1Hz	4-20mA (0.2-1mA)	AutoCal program for sensitivity adjustment has been activated with SPAN potentiometer	Calibration gas setting is made with the SPAN potentiometer
203	Menu item	On	Flashes with 1Hz	2.4mA (0.12mA)	Service menu has been activated using the keyboard	Select the menu item. If there is no input for one minute, automatic return to measuring mode
204	Adjustment Zero point	On	Flashes with 1Hz	2.0mA (0.10mA)	Zero point adjustment has been activated using the keyboard	AutoCal-adjustment of the zero point
205	Adjustment Sensitivity	On	Flashes with 1Hz	2.0mA (0.10mA)	Sensitivity adjustment has been activated using the keyboard	AutoCal-adjustment of the sensitivity

4.5 Indications during measuring mode

The following table shows the states with a description in which the green operation LED lights up and the 4-20mA current output transmits a signal 2.8-22mA.
For the 0.2-1mA current output the value of the output signal is shown in brackets (0.14-1.1mA).

No.	Display	green LED	yellow LED	Current output	Cause	Note / Explanation
301	↑↑↑ permanent	On	Flashes with 5Hz	22mA (1.1mA)	The gas concentration has exceeded the measuring range of the transmitter electronics.	
302	↑↑↑ permanent	On	Flashes with 5Hz	22mA (1.1mA)	The gas concentration has clearly exceeded the measuring range (Gas ≥ 112.5% MR)	
303	↑↑↑ alternating with reading	On	Off	20-22mA (1.0-1.1mA)	The gas concentration has exceeded the measuring range (100 to 112% MR)	
304	Measurement value	On	Off	4-20mA (0.2-1mA)	Trouble-free measuring operation	
305	Measurement value	On	Off	3.2-4.0mA (0.16-0.2mA)	Underflow of the measuring range (-5.0 to 0.0% MR)	
306	Measurement value alternating with ↓↓↓	On	Off	2.8-3.2mA (0.14-0.16mA)	Underflow of the measuring range (-7.5 to -5.0% MR)	Zero point calibration is useful
307	Permanent ↓↓↓	On	On	2.8mA (0.14mA)	Underflow of the measuring range (below -7.5% MR)	Zero point calibration is necessary
308	Permanent ↓↓↓	On	On	2.8mA (0.14mA)	Measuring signal has fallen below the measuring range of the transmitter electronics	Zero point calibration is necessary and check the sensitivity
309	*Sensor replacement required*	On	Single pulse every 5s	2.8-22mA (0.14-1.1mA)	Expected service life of the sensor is exceeded.	Sensor replacement or adjustment required

4.5.5 Priority of indicators and messages during measurement mode

The indicators of conditions with low priority are overwritten with the indicators that have a higher priority. The conditions of lower priority are not reset.

Priority	Status	See description in section ...
▼	significant measuring range overflow **(ambiguity)**	Display in service mode No. 301, 302
	slight measuring range overflow	Display in measurement mode No. 303
	Measurement range underflow	Display in service mode No. 305-308
	Sensor replacement	Display in measurement mode No. 309

The sensor fault No. 101 and the transmitter interference No. 102-113 stop the measuring operation with their respective messages.

4.6 Fault, cause, remedy

Fault	Cause	Remedial action
Zero point can no longer be set	Sensor defective	Replace sensor
Sensitivity can no longer be set	Sensor defective	Replace sensor
Output current has dropped to 0 mA	Defective fuse or electronics	Replace circuit board
	Line disconnected	Re-connect

5. ATTACHMENTS

5.1 Cleaning and care

External contamination of the transmitter's housing can be removed with a damp cloth. Do not use any solvents or cleaning agents!

5.2 Maintenance and repair

The maintenance and servicing includes regular visual inspection, functional check and the system control as well as the repair of the gas warning system. In Germany the following applies: "DGUV Information 213-056 (data sheet T 021 / previously BGI 836 section 9)".

5.2.1 Visual inspection

The visual inspection should be regular, with a maximum time interval of one month, and must include the following activities:

- Check the indicator light and the status messages,
  e.g. operation indicator "On", alarm and fault indicators "Off"
- Check for mechanical damage and external contamination

5.2.2 Functional check

The functional check can be carried out at intervals dependent on the risk of the gas to be monitored. For gas detection systems used for the measurement of toxic gases and oxygen, there should be a control period of 4 months, according to the regulation T 021 of the Employer's Liability Insurance Association BG RCI.

This includes the following activities:

- Visual inspection according to section 5.2.1 of this operating manual
- Check and evaluation of measured value indicated
- Triggering the alarm thresholds
- Triggering of test functions for display elements, visual and audible signalling device without triggering the switching functions
- Check of stored messages, malfunctions and maintenance requirements

5.2.3 System check

The system check must be carried out at regular intervals. The period must not exceed 1 year. This includes the following activities:

- Functional check according to section 5.2.2 of this operating manual
- Check of all safety features including the release of the switching functions.
- Check of the parameterisation through a target / actual comparison
- Check of the messaging and logging devices

5.2.4 Repair

The repair includes all repair and replacement work. They may only be performed by the manufacturer and by persons who have been authorised by the manufacturer GfG Gesellschaft für Gerätebau mbH. Only approved and released original spare parts from the manufacturer as well as original components may be used.

5.3 Sensor replacement

The transmitter cover must be removed to replace the sensor. When power is removed, the sensor cables can be removed from the terminals 5…8. Afterwards the circuit board must be pulled out of the guide such that the old sensor can be unscrewed. The replacement sensor is mounted in reverse order. Only a sensor of the same type may be used to replace the sensor, its serial number must be entered in the service menu after the installation and commissioning of the transmitter.

5.4 Notes on the environmentally friendly disposal of used parts

Pursuant to § 11 of the general terms and conditions of the GfG the purchaser of the device is responsible for the environmentally friendly disposal of the device or device components according to §§ 11, 12 ElektroG (Electrical and Electronic Equipment Act). On request, the proper disposal can be taken care of by the GfG in Dortmund.

5.5 Accessories and spare parts

	Designation	Item no.
1.	Calibration adapter für transmitters CC22, ZD22, CS22, CI22	2000209
2.	Service test cable for transmitters EC22, CC22, ZD22, CS22, CI22	2220201
3.	MK410-1 Replacement sensor for 0..96 vol.% O_2 (oxygen)	on request
4.	MK413-1 Replacement sensor for 0..1000 ppm O_2 (oxygen)	2220703
5.	MK435-1 Replacement sensor for 0..2 vol.% O_2 (oxygen)	2220702
6.	MK442-1 Replacement sensor for 0..25(30) vol.% O_2 (oxygen)	2220701

5.6 Sensor specification

MK395-1 Zircon dioxide sensor for oxygen O_2

Measuring range / resolution:		0.1...25 vol.% / 0.1 vol.%
Measuring accuracy:		±0.25 vol.%
Reproducibility:		±0.1 Vol.%
Time setting	t_{90}:	< 5 sec
Pressure influence	80...500 kPa:	< 0.05 % of measurement value per 100kPa
	15...80 kPa:	< 2.0% of measurement value per 10kPa
Influence of humidity	0...99 % r.h.:	negligible
Temperature influence	-20 to +50°C:	negligible
Cross sensitivities:		CH_4≈-200%; NO_2≈110%; CO≈-100%; SO_2≈-30%; CO_2≈-3%; H_2S=NH_3=0%
Expected service life:		4 - 5 years

MK410-1 Zircon dioxide sensor for oxygen O_2

Measuring range / resolution:		1.0...96 vol.% / 0.2 vol.%
Measuring accuracy:		±1.0 vol.%
Reproducibility:		±0.2 Vol.%
Time setting	t_{90}:	< 5 sec
Pressure influence	80...500 kPa:	< 0.05 % of measurement value per 100kPa
	15...80 kPa:	< 2.0% of measurement value per 10kPa
Influence of humidity	0...99 % r.h.:	negligible
Temperature influence	-20 to +50°C:	negligible
Cross sensitivities:		CH_4≈-200%; NO_2≈110%; CO≈-100%; SO_2≈-30%; CO_2≈-3%; H_2S=NH_3=0%
Expected service life:		4 - 5 years

MK413-1 Zircon dioxide sensor for oxygen O_2

Measuring range / resolution:		10...1000 ppm / 5 ppm
Measuring accuracy:		±20 ppm
Reproducibility:		±10 ppm
Time setting	t_{90}:	< 10 sec
Pressure influence	80...500 kPa:	< 0.05 % of measurement value per 100kPa
	15...80 kPa:	< 2.0% of measurement value per 10kPa
Influence of humidity	0...99 % r.h.:	negligible
Temperature influence	-20 to +50°C:	negligible
Expected service life:		4 - 5 years

MK435-1 Zircon dioxide sensor for oxygen O_2

Measuring range / resolution:		0.01...2 vol.% / 0.01 vol.%
Measuring accuracy:		±0.02 vol.%
Reproducibility:		±0.01 vol.%
Time setting t_{90}:		< 5 sec
Pressure influence	80...500 kPa:	< 0.05 % of measurement value per 100kPa
	15...80 kPa:	< 2.0% of measurement value per 10kPa
Influence of humidity	0...99 % r.h.:	negligible
Temperature influence	-20 to 50°C:	negligible
Expected service life:		4 - 5 years

MK442-1 Zircon dioxide sensor for oxygen O_2

Measuring range / resolution:		0.1...25(30) vol.% / 0.1 vol.%
Measuring accuracy:		±0.5 vol.%
Reproducibility:		±0.1 Vol.%
Time setting t_{90}:		< 30 sec
Influence of humidity	0...99%r.h.:	negligible
Temperature influence	-20 to +50°C:	negligible
Expected service life:		4 - 5 years

5.7 Technical specifications

Type designation:	**ZD22**
Ambient conditions	
Operating temperature:	-20 to +50°C (sensor dependent)
Storage temperature	-25 to +60°C (recommended 0 to +30°C)
Humidity:	5 - 95%r.h. (sensor dependent)
Pressure:	80 - 120kPa (sensor dependent)
Power supply	
Operating voltage:	24V DC (15-30V DC allowable)
Power consumption :	typ.120mA / max.140mA @ 24V DC (MK442, MK413) typ.130mA / max.160mA @ 24V DC (MK395, MK410, MK435) typ.150mA / max.180mA @ 24V DC (4…20mA version with MK395, MK…)
Fuses:	250mA (not changeable)
Sensors	
Measuring range and measurement gas:	sensor dependent
Measurement gas feed	Diffusion
Display and operating elements	
Status LEDs:	green for operation and yellow for fault or service
Display, buttons:	2.2"-Graphic display and 3 function buttons (with display version)
Auto ZERO key:	for ZERO adjustment
Potentiometer:	for ZERO and SPAN adjustment (optional)
Service connector	
Design:	3.5mm stereo jack (internal)
Analogue output:	0.2-1.0V corresponding to 0-100% MR for sensor calibration
Digital input:	for configuration and firmware update
Signal output	
analogue:	4-20mA (max. load: 150Ω/400Ω/650Ω @12V/18V/24V supply)
or analogue:	0.2-1mA (max. load: 4K5/9K3/14K1 @12V/18V/24V supply)
or digital:	RS485; half duplex; max. 38400 bauds; Modbus protocol, Sliding switch for 120Ω termination resistor
Connection cable	
Cable entries:	1 or 2 piece M16 x 1.5 (for cable diameter 4.5 - 10 mm)
Terminals:	4 pieces (for 0.08-2.5mm^2 Conductor cross-section)
Cable (analogue):	3-wire e.g. LiYY 3 x 0.75 to 1.5mm^2 or LiYCY
Cable (digital):	4-wire e.g. LiYY 4 x 0.75 to 1.5mm^2 or bus line Y(St)Y 2x2x0.8 ***1**
Housing	
Protection class:	IP54 according to IEC 60529
Material:	Plastic
Measurements:	96 x 140 x 49mm (W x H x D) with sensor
Weight:	175g or 220g (with display version)
Authorisations / tests	
Electromagnetic compatibility:	DIN EN 50270:2006 Interference: Type class I Immunity: Type class II

Explanation on*1: Bus line cable Y(St)Y 2x2x0.8 is only suitable for supplying several bus transmitters with power using the same cable via short cabling distances. The possible distance depends on the number and local arrangement of the transmitters on the bus cable.

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EU- Declaration of Conformity

Transmitter

ZD22

Edited: 09.02.2015 Amended: 15.06.2016

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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**, audited by the notified body, DEKRA EXAM GmbH, 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 ignition protection classes explosion- proof encasing, increased safety, encapsulation and intrinsic safety, as well as their measuring function.

The Transmitter **ZD22** complies with **council directive 2014/30/EU** for electromagnetic compatibility.

The guidelines have been complied with under consideration of the standard mentioned below:

- **Electromagnetic compatibility**
  - Electrical apparatus for the detection and measurement of combustible gases, toxic gases and oxygen. EN 50270 :2006
    Radio shielding: Type class 1
    Interference resistance: Type class 2

The EMC testing laboratory EM TEST GmbH, Kamen has been charged with testing and evaluation of the electromagnetic compatibility.

Always adhere to the safety notes of the operation manual 219-000.31

Dortmund, 15.June 2016

.....
H.J. Hübner
President CEO

EG-Kon053.1/Siebrecht

SIL- Declaration of Conformity

ZD22

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Issued: 2016-04-25 Changed:

The transmitter **ZD22** with 4 - 20mA analogue output signal respectively with RS 485 digital output signal complies with the following European Standards for Functional Safety:

Functional safety of electrical/electronic/programmable electronic safety-related systems
EN 61508-2: 2011

The following parameters for single channel and dual channel use of **transmitter ZD22** with analogue respectively digital output have been determined:

	Single channel use	**Redundant use**
Safety function	Oxygen measurement e.g. to inerting monitoring	
Sensor type / Metering range	MK395-1: 0–25Vol.% O_2 (dangerous: signal too low) MK395-1: other O_2 measuring ranges (dangerous: signal too low)	
SIL level hardware	2	3
Device type	B	
SFF	92.55% resp. 92.60%	
HFT	0	1
β factor	—	10%
PFD	6.01×10^{-4} resp. 5.97×10^{-4} (per annum)	6.05×10^{-5} resp. 6.01×10^{-5} (per annum)
λ_{du}	1.31×10^{-7} resp. 1.30×10^{-7} (per h)	
λ_{dd}	2.53×10^{-7} resp. 2.61×10^{-7} (per h)	
λ_{su}	1.36×10^{-6} resp. 1.35×10^{-6} (per h)	
λ_{sd}	1.63×10^{-8} resp. 1.62×10^{-8} (per h)	
Proof Test interval	1 Year	
MTTR	72 h	

The calculation of the parameters was done by GWW GasWarn Dr. Wenker GmbH, and the accuracy of the statement is confirmed by the conformity statement of GWW GasWarn Dr. Wenker GmbH as independent expert.

Always consider the following operational conditions and safety notes of the operation manual 219-000.31.

Dortmund, 25. April 2016

H. J. Hübner
President CEO

SIL- Declaration of Conformity

ZD22

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Issued: 2016-04-25 Changed:

Operational Conditions

The SIL level of the transmitter in combination with the determined error rate is only valid, if the following operational conditions are adhered:

The FMEDA for determining the hardware failure rate was worked out assuming that a too low gas signal represents a dangerous failure. A too high signal is an assured error because an alarm is triggered surely, but at a lower gas concentration as necessary. Therefore the error rate is **not valid** for the monitoring of lack of oxygen where a too high gas signal represents a dangerous failure.

The transmitter must be mounted in a position which is suitable for the detection task, must be properly connected to a controller and must be put into operation by the manufacturer GfG or by an authorised representative.

Transmitter with analogue output signal:

The following status signals must be detected by the used controller. This is automatically made sure when controllers are used which are produced by GfG Gesellschaft für Gerätebau mbH.

≤ 2.8 mA	Fault low = transmitter fault or disconnection
> 2.8 to < 4 mA	Under range (in measuring mode)
> 20 to < 22 mA	Over range (in measuring mode)
≥ 22 mA	Fault high = transmitter fault or short-circuit on line

Transmitter with digital output signal:

The safety function is a digital RS485 output signal with a proprietary protocol. Status signals from the detector including fault messages are implemented in the digital protocol. The functional safety of the digital protocol is part of the SIL-examination of the associated evaluation unit, e.g. the GMA200.

The ambient conditions e.g. referring temperature, humidity and pressure, which are specified in the manufacturer's documentation, have to be observed.

According to the manufacture's statements the transmitter has to be regularly serviced by an expert and must be calibrated with a certified test gas.

The appropriate calibration interval depends on the risk potential of the particular field of application. In Germany the calibration interval is determined in bulletin T 023 of the BG-RCI (= DGUV Information 213-057 of the German Social Accident Insurance).

Annual Proof Test

At least once a year a Proof Test of the complete safety chain has to be effected. For the transmitter the Proof Test is equivalent to a system check according to the Ordinance on Industrial Safety and Health and includes the regular calibration / adjustment without additional requirements.