

Operating Manual

Water-Proof oxygen meter
for dissolved oxygen with
Integrated temperature and
pressure measuring and data
logger

GMH 5650



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Contents

1	SAFETY	3
1.1	GENERAL NOTE	3
1.2	INTENDED USE	3
1.3	QUALIFIED STAFF	3
1.4	SAFETY SIGNS AND SYMBOLS	3
1.5	REASONABLY FORESEEABLE MISUSE	4
1.6	SAFETY GUIDELINES	4
2	PRODUCT DESCRIPTION	5
2.1	SCOPE OF SUPPLY	5
2.2	OPERATION AND MAINTENANCE ADVICE	5
3	START OF OPERATION	5
4	OPERATION	6
4.1	DISPLAY ELEMENTS	6
4.2	PUSHBUTTONS	7
4.3	CONNECTIONS	7
4.4	POP-UP CLIP	8
5	CONFIGURATION	9
6	THE OXYGEN SENSOR	11
6.1	DESIGN OF SENSOR GWO 5610	11
6.2	FIRST START OF OPERATION / FILLING OF SENSOR GWO 5610	13
6.3	SENSOR MAINTENANCE OF SENSOR GWO 5610	14
7	DISSOLVED OXYGEN MEASURING - PLEASE NOTE	14
7.1	CORRECTION OF SALINITY 'SAL'	14
7.2	AMBIENT PRESSURE AND MEASURING DEPTH OF THE SENSOR	14
8	CALIBRATION OF THE SENSOR	15
8.1	ONE POINT CALIBRATION „CAL 1-PT“	16
8.2	2 / 3-POINT CALIBRATION „CAL 2-PT“, „CAL 3-PT“	17
8.3	EVALUATION OF SENSOR STATE „ELEC“	17
9	DATA LOGGER	18
9.1	GENERAL	18
9.2	RECORDING MANUAL "Func Stor"	18
9.3	AUTOMATIC RECORDING WITH SELECTABLE CYCLE TIME "Func CYCL"	19
10	ADJUSTMENT OF TEMPERATURE INPUT	20
11	GLP	20
11.1	CALIBRATION/ADJUSTMENT INTERVAL "CInt"	20
11.2	CALIBRATION/ADJUSTMENT MEMORY "rEAd CAL"	20
12	ALARM "AL"	21
13	REAL TIME CLOCK "CLOC"	21
14	UNIVERSAL OUTPUT	21
14.1	INTERFACE	21
14.2	ANALOG OUTPUT	22
15	INSPECTION OF THE ACCURACY / ADJUSTMENT SERVICES	22
16	BATTERY CHANGE	23
17	ERROR AND SYSTEM MESSAGES	23
18	RESHIPMENT AND DISPOSAL	24
18.1	RESHIPMENT	24
18.2	DISPOSAL	24
19	SPECIFICATION	25

1 Safety

1.1 General Note

Read this document attentively and make yourself familiar to the operation of the device before you use it. Keep this document in a ready-to-hand way in order to be able to look up in the case of doubt. Mounting, start-up, operating, maintenance and removing from operation must be done by qualified, specially trained staff that have carefully read and understood this manual before starting any work. The manufacturer will assume no liability or warranty in case of usage for other purpose than the intended one, ignoring this manual, operating by unqualified staff as well as unauthorized modifications to the device. The manufacturer is not liable for any costs or damages incurred at the user or third parties because of the usage or application of this device, in particular in case of improper use of the device, misuse or malfunction of the connection or of the device. The manufacturer is not liable for misprints.

1.2 Intended use

The instrument is measuring dissolved oxygen in water. The measuring is performed by means of a suitable oxygen sensor (included in supply in standard instrument) connected to the 7-pole bayonet socket, the sensor measures at the membrane at the tip of the sensor. Due to the properties of the sensor, it has to be calibrated regularly (e.g. at fresh air = 20.95 % Vol O₂) to get precise values. If the sensor is used up, this will be detected during the calibration, the sensor has to be regenerated or replaced before continuing with measuring. The safety requirements (see below) have to be observed. The device must be used only according to its intended purpose and under suitable conditions. Use the device carefully and according to its technical data (do not throw it, strike it ...). Protect the device from dirt.

1.3 Qualified staff

All instructions have to be well understood and complied with. To be sure that there is no risk arising due to misinterpretation of measured values, the operator must have further knowledge in case of doubt - the user is liable for any harm/damage resulting from misinterpretation due to insufficient knowledge.

1.4 Safety signs and symbols

Warning notices are marked in this manual as shown below:



Caution! This symbol warns of imminent danger, death, serious injuries and significant damage to property at non-observance



This symbol warns of danger to living tissue and many materials, that can be damaged or destroy by exposure to that chemical



Attention! This symbol warns of possible dangers or dangerous situations, which can provoke damage to the device or environment at non-observance.



Note! This symbol point out processes, which can indirectly influence operation or provoke unforeseen reactions at non-observance.



Note! This symbol refers of using a eye protection, which protects the eyes from strong light, UV radiation, laser, chemicals, dust, splitter or weather conditions



Note! This symbol refers of using protective gloves, which protects for mechanical-, thermal-, chemical-, biological- or electrical hazards

1.5 Reasonably foreseeable misuse



This device must not be used at potentially explosive areas!

Do not use these products as safety or emergency stop devices or in any other application where failure of the product could result in personal injury or material damage. Failure to comply with these instructions could result in death or serious injury and material damage.



This device must not be used at a patient for diagnostic or other medical purpose.

1.6 Safety guidelines

This device has been designed and tested in accordance with the safety regulations for electronic devices. However, its trouble-free operation and reliability cannot be guaranteed unless the standard safety measures and special safety advises given in this manual will be adhered to when using the device.

Caution, acid! The electrode contains KOH
KOH can cause severe chemical burns!

If there was contact:

- To skin: Flush contacted area with large amounts of water for several minutes.
- To clothing: remove contaminated clothing.
- To eyes: Flush with large amounts of water for at least 15 minutes, obtain medical treatment.

After swallowing:

- Give large volumes of water. Do not induce vomiting!



Trouble-free operation and reliability of the device can only be guaranteed if the device is not subjected to any other climatic conditions than those stated under 19 Specification. If the device is transported from, a cold to a warm environment condensation may cause in a failure of the function. In such a case, make sure the device temperature has adjusted to the ambient temperature before trying a new start-up.

If there is a risk whatsoever involved in running it, the device has to be switched off immediately and to be marked accordingly to avoid re-starting.

Operator safety may be a risk if:

- there is visible damage to the device
- the device is not working as specified
- the device has been stored under unsuitable conditions for a longer time.

In case of doubt, please return device to manufacturer for repair or maintenance.



Internal connections of other devices e.g. from ground with protective earth may lead to prohibited voltage levels that could disturb the function, damage or even destruct the device or any connected equipment. Never run the device with a damaged or faulty power supply. Risk of death by electrocution!

2 Product description

With this measuring device, you can easily detect how much oxygen is contained in a liquid. The oxygen content is indicated in milligrams per litre (mg/l). At the same time the multi-display indicates the temperature of the measured liquid. For calibration purposes, the device can also indicate the oxygen content in the air in % Vol O₂. Along with being indicated on the display, the measured values can also be sent to a PC via an interface converter USB 5100 (accessory). To save battery power, the device shuts off automatically (Auto-Power Off) if none of the keys is pressed (1...120 min).

2.1 Scope of supply

The scope of supply includes:

- Handheld instrument GMH 5650 with 2 AAA- Batteries
- Oxygen sensor GWO 5610
- Operating manual
- Short form manual
- Test report
- Silicone protective cover

2.2 Operation and maintenance advice

Battery operation:

If „bAt“ is shown in the lower display the battery has been used up and needs to be replaced. However, the device will operate correctly for a certain time

If „bAt“ is shown in the upper display the voltage is too low to operate the device; the battery has been completely used up. Battery change see chapter 16 Battery change.



The battery has to be taken out, when storing device above 50°C. We recommend taking out battery if device is not used for a longer period. After recommissioning, the real-time clock has to be set again.



Use device and sensor carefully and according to its technical data (do not throw it, strike it, etc.). Protect the device from dirt.

USB or mains operation:



When connecting a mains cable or USB interface cable, please take care to connect only allowed components. The output voltage of a connected power supply unit has to be between 4.5 and 5.5 V DC. Do not apply overvoltage! We recommend operation with interface cable USB 5100. Then device is supplied by the USB interface of the connected PC or USB power supply adapter.

3 Start of operation

In the case, the sensor was delivered 'dry', it has to be filled prior to operation. Please refer to chapter 6.2 First start of operation / filling of sensor GWO 5610.

Connect sensor, switch instrument on with .



After the segment test the instrument shows „Corr“ shortly, if it was user adjusted. The device starts measurement afterwards.

4 Operation

4.1 Display elements



Main display

Display of the current oxygen level,

- 1 please refer to chapter 5 Configuration *Lcd.2*.

Choice via  -Taste

Secondary display

- 2 sensor temperature, absolute pressure or depth (alternating, please refer to chapter 5 Configuration *Lcd.2*)

3 Main display units

- 4 State of battery or sensor, if  was pressed

- 5 Shows, if minimum/maximum/memorized measuring value is in display

- 6 Arrow „ok“: Measured value is stable

- 7 Arrow „CAL“: Calibration

- 8 Arrow „SAL“: Salinity correcting active

- 9 Arrow „Logg“: Logger function is chosen
Is blinking, if cyclic logger is running

- 10 Arrow „hPa“: Pressure unit of internal sensor

4.2 Pushbuttons



On / off key, backlight

"press shortly":
Activate backlight or switch on instrument
"press longer":
Switch off instrument



Set/Menü

"press for 2 s" (menu):
Invoke configuration menu
"press shortly":
Change oxygen display unit



min / max

"press shortly":
Min. or max. value is displayed
"press for 2 s":
The corresponding value is deleted



Configuration

See chapter 5 Configuration:
Confirm settings, return to measuring



Store/Enter

"Measuring":
with Auto-Hold off:
Hold and save current measuring value, ('HLD' is displayed).
with Auto-Hold on:
Start new measuring, It is finished , when "HLD' shows in display please refer to chapter 5 Configuration
Or calling the logger functions see chapter 9 Data logger



Configuration

See chapter 5 Configuration:
Confirm settings, return to measuring.

CAL:

"press shortly":
Shown the sensor state of the last calibration
"press for 2 s":
Start of the oxygen calibration

4.3 Connections



Universal output

Interface, supply, analog output see chapter 14
Universal Output

7-pole bayonet socket

Connection for sensor and temperature probe

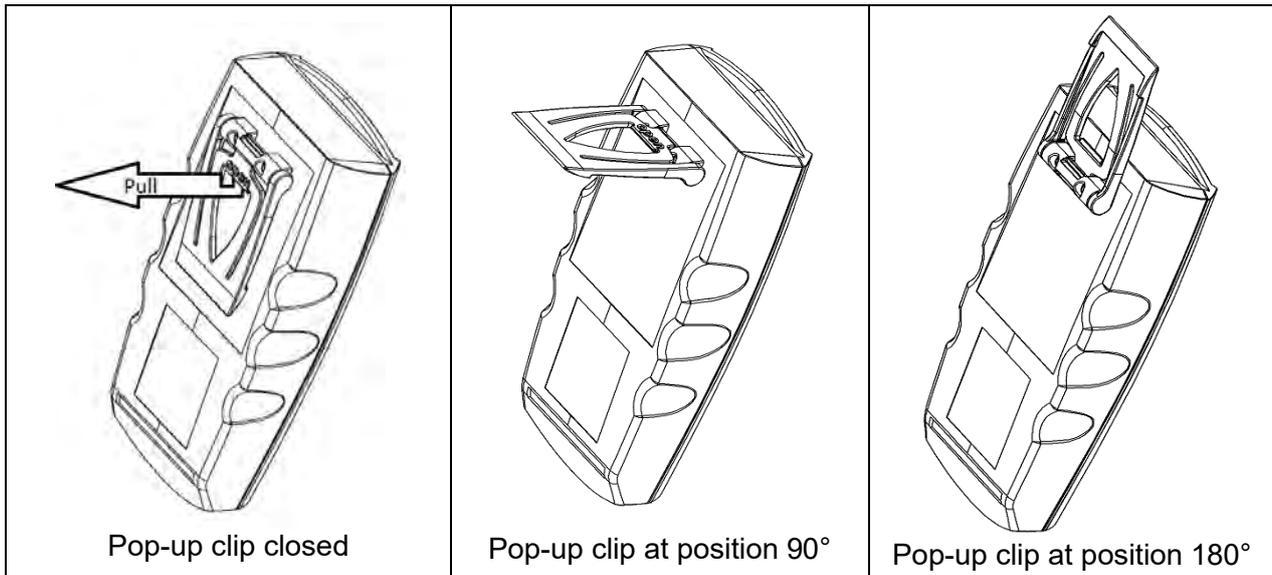
Pressure Port

Tube Connection for ambient pressure compensation
of oxygen sensor.

4.4 Pop-up clip

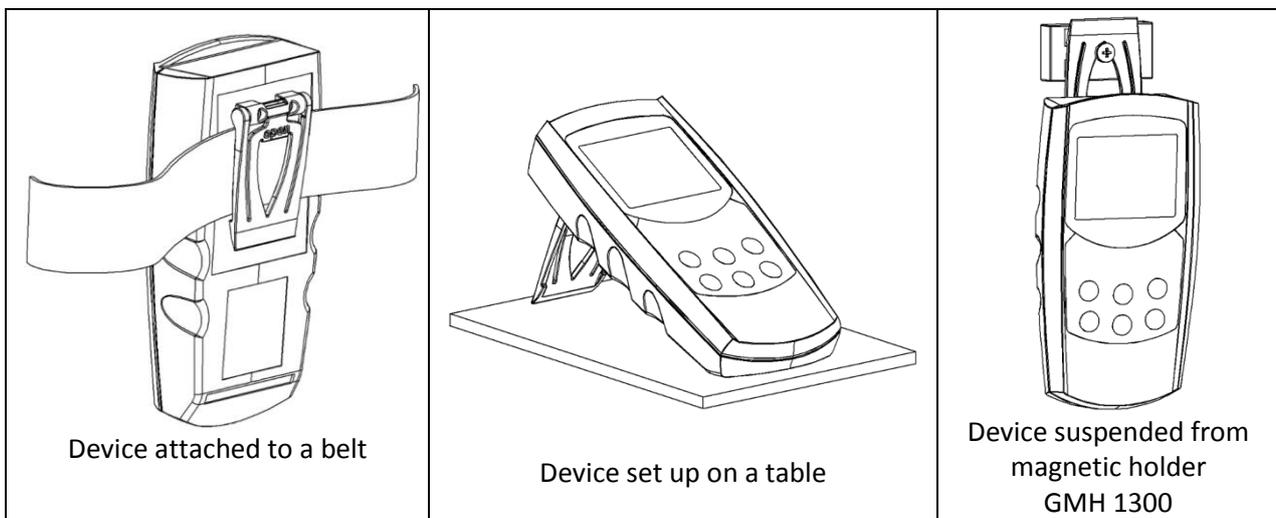
Handling

- Pull at label “open” in order to swing open the pop-up clip.
- Pull at label “open” again to swing open the pop-up clip further.



Function:

- The device with a closed pop-up clip can be plainly laid onto a table or attached to a belt, etc.
- The device with pop-up clip at position 90° can be set up on a table, etc.
- The device with pop-up clip at position 180° can be suspended from a screw or the magnetic holder GMH 1300.



5 Configuration



Some menu points depend on current device settings (e.g. some points are locked if logger memory contains data sets).

To change device's settings, press  for 2 s. This will activate the configuration menu (main display "SEt"). Pressing  changes between the menus points, pressing  jumps to the referring parameters, which can be selected with key ).

The parameter value can be changed with  or . Pressing  again jumps back to the main configuration menu and saves the settings. Pressing  finishes the configuration.



Pressing "menu" and "store" at the same time for more than 2 seconds will reset the device to factory defaults.

If there are data sets stored (Logger: "Func Stor"), the first menu point displayed is "rERd L066" see chapter 9 Data logger.

If no key is pressed for more than 2 minutes the configuration will be aborted. All changes will be discarded!

Menu	Parameter	Value	Description		Chapter
		 or 			8,11
Set Configuration: General configuration					
SEt Conf	Unit Conc	Conc ppm	Display unit of O ₂ -concentration ppm (identical values like mg/l)		
		Conc mg/l	Display unit of O ₂ -concentration mg/l (identical values like ppm)		
Ch 2	SAt	%O ₂	Main display shows O ₂ -concentration (mg/l or ppm) or O ₂ -Saturation in % Sat O ₂ (<i>ex works setting</i>)		
		P O ₂ hPa	Main display shows O ₂ -concentration or O ₂ -partial pressure in hPa		
		P O ₂ mmHg	Main display shows O ₂ -concentration or O ₂ -partial pressure in mmHg		
RES	H _i	Lo	Best O ₂ resolutions		
		Lo	Low O ₂ resolution, calm value display (standard)		
SAL	aFF	0.1 ... 70.0	Salinity correction deactivated (<i>ex works setting</i>)		
		0.1 ... 70.0	Salinity correction activated, Unit ‰ = PSU, e.g. sea water ~35.0		
Lcd.2	t	t	Secondary display always temperature		
		P	Secondary display always absolute pressure		
		P t	Secondary display alternates between temperature and abs. pressure		
		dEP. t	Depth measuring activated, Second. display alternates between temperature and depth in meter (only with depth accessory TMV 3600)		
		dEP	Depth measuring activated, Second. display always shows depth in meter (only with depth accessory TMV 3600)		
Unit t	°C	°F	All temperatures in degree Celsius (<i>ex works setting</i>)		
		°F	All temperatures in degree Fahrenheit		
CAL	R _i r	R ₉ UR	The sensor will be calibrated at air or gas (<i>ex works setting</i>)		
		R ₉ UR	The sensor will be calibrated in water		
CAL.P	1-Pt	2-Pt, 3-Pt	Simple one point calibration at air (R _i r) or at air saturated water (R ₉ UR)		
		2-Pt, 3-Pt	2 or 3-point calibration at air (R _i r)/air saturated water (R ₉ UR), or in oxygen/oxygen saturated water or in nitrogen/zero solution		
C. Int	1 ... 365	aFF	Calibration reminder period (in days)		
		aFF	No calibration reminder		
Auto HLD	on	aFF	Auto stable value determining freezing (when logger = off)		
		aFF	Standard hold function on key press (when logger = off)		

	P.off	1...120 oFF	Power-off delay in minutes. Device will be automatically switched off as soon as this time has elapsed if no key is pressed/no interface communication takes place. (ex works setting 20min) Automatic power-off function deactivated (continuous operation)		
	L.tE	oFF 5...120 oN	Backlight deactivated Turn off backlight after 5... 120 s (factory settings: 10 s) Backlight always on		
	Out	oFF SEr dAC	Interface off -> minimal power consumption Serial interface activated (ex works setting) Analog output activated		
	Adr	01,11,21, ... 91	Base address for serial interface communication (ex works setting 01)		
	dA,n	Conc SRE or P O2	Analog output is corresponding to concentration in ppm or mg/l Analog output is corresponding to setting of [h ²		
	dA.C.0	0.0...100.0 %O ₂	Measuring value that should correspond to output 0 V e.g. for 0.0 %		
	dA.C.1	0.0...100.0 %O ₂	Measuring value that should correspond to output 1 V e.g. for 100.0 % Vol O ₂		
	Set Corr: Input adjustment			**	
SEt	Corr	OFFS °C or °F	-5.0 °C .. 5.0 °C or -9.0 °F .. 9.0 °F oFF	The zero point of the temperature measuring is shifted for the entered value. This can be used to compensate sensor and instrument deviations No zero adjustment for temperature measurement (=0.0°)	**
		SCAL °C or °F	-5.00 ... 5.00 % oFF	The slope of the temperature measurement is corrected by this value. This can be used to compensate sensor and instrument deviations No slope adjustment for temperature measurement (=0.00)	**
		OFFS hPa	-20 .. 20 hPa oFF	The zero point of the pressure measuring is shifted for the entered value. This can be used to compensate sensor deviations No zero adjustment for pressure measurement (=0 hPa)	**
	Set Alarm: Configuration of the alarm settings				12
SEt	AL	AL.1	oN / no.5o oFF	Monitoring Oxygen: Alarm on with buzzer / Alarm on without buzzer No alarm monitoring for oxygen	
		AL,n	Conc P.O2	Monitoring Oxygen: Concentration in % Vol O ₂ Monitoring Oxygen: Partial pressure in hPa or mmHg	
		AL.Lo	e.g. 0.0..100.0 %	Min alarm limit oxygen (not if AL. 1. oFF)	
		AL.hi	e.g. 0.0..100.0 %	Max alarm limit oxygen (not if AL. 1. oFF)	
		AL.2	oN / no.5o oFF	Temperature monitoring : Alarm on with buzzer / Alarm on without buzzer No alarm monitoring for temperature	
		AL.Lo	-5.0..+50.0 °C	Min alarm limit temperature (not if AL. 2. oFF)	
		AL.hi	-5.0..+50.0 °C	Max alarm limit temperature (not if AL. 2. oFF)	
	Set Logger: Configuration of the logger functions			**	9
SEt	LoGG	Func	CYCL Stor oFF	Cyclic Automatic logger function Store: manual recording No logger activated	*
		CYCL	0:01 ... 60:00	Cycle time in [minutes:seconds] for cyclic logger	**
	Set Clock: Configuration of the real time				13
SEt	CLOC	CLOC	HH:MM	Clock: set time hours:minutes	
		YEAR	YYYY	Year: set year	
		DATE	TT.MM	Date: set date day.month	



- (*) If logger memory contains data sets parameters marked with (*) cannot be called. You have to clear memory to change these parameters!
- (**) If logger is running parameters marked with (**) cannot be called

6 The oxygen sensor

6.1 Design of sensor GWO 5610

6.1.1 General notes

The oxygen sensor GWO 5610 is an active electrode consisting of a platinum cathode and a lead anode with the electrolyte being potassium hydroxide (KOH). In case of oxygen being present it will be reduced at the platinum cathode, i.e. the electrode supplies a current. No oxygen means no current either. The oxygen measurements uses up the lead anode. The sensor is subject to ageing. Also the e sensor may lose electrolyte due to high temperature or dry operation. Therefore, we recommend to maintain the electrode at monthly intervals. See chapter 6.3 Sensor maintenance of sensor GWO 5610)



Attention when working with electrolyte!

The electrolyte is caustic! (strong base, KOH)

Avoid contact with skin and eyes.

Protective equipment is necessary!

Irritates skin and mucous membranes, caustic.

In the case of contact with the eyes, immediately clean with clear water about 15 minutes.

Consult a doctor!



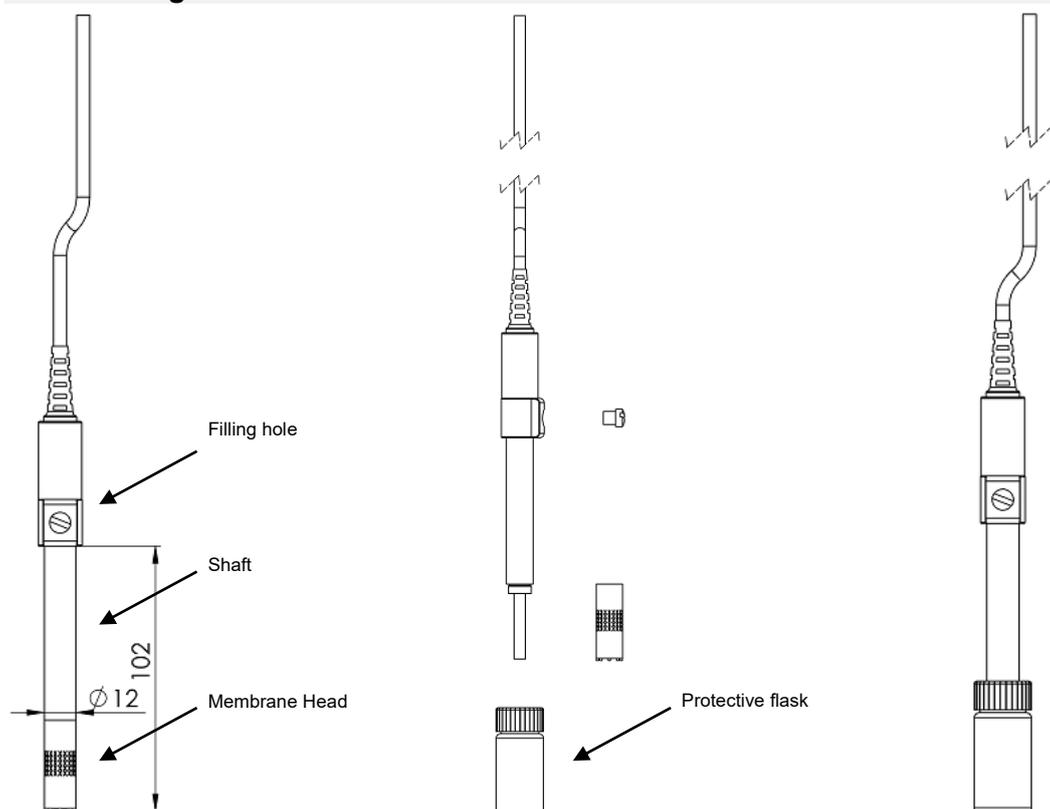
Make it a rule to always store the oxygen sensor GWO 5610 in a humid environment.

- in the storage flask filled with water

- in another container filled with water

If electrode has not been used for some time, clean membrane with soft cloth and remove deposits, if any (algae, bacteria etc.).

6.1.2 Design



The sensor needs to be maintained regularly and be replaced if necessary.

o Protective flask: The protective flask is used to moisten the membrane. This prolongs service life of the electrode. The protective flask contains water, do not fill any other liquid!

o Membrane head: The membrane head is covered with a Teflon membrane. It will be filled with KOH electrolyte and screwed onto the electrode shaft (no air bubbles). Damages in the membrane, large air bubbles or air bubble rings in the membrane head will result in erroneous measurements. This may also be the reason for errors in the calibration. The membrane head is a spare part and can be ordered individually. (GWOK 02)

o Filling hole: If the electrode is used at high temperatures or if it has been stored without its protective flask for a longer period of time, some electrolyte will be lost due to evaporation. See chapter 6.2.2 First filling.

6.1.3 Life time

At the end of the Life time, the signal of the sensor is dropping rapidly. The sensor evaluation in % therefore can only be taken as a relative measure. An evaluation of 70% does not mean that 70% of lifetime is left, but that the electrode signal has 70% of a good state reference.



The sensor state evaluation will be stored after a successful calibration of the oxygen sensor

The nominal life time may be reduced due to the application. Negative effecting are:

- Extreme storage and operation temperature
- Dirty water during measuring
- Mechanical stress to sensor membrane
- Dry storage of filled sensor
- Permanent use at higher CO₂-concentrations

6.1.4 Mounting/operation position

The optimum position is with sensor membrane pointing downwards.

6.1.5 Measuring precision

The precision can be influenced due to:

- To less flow
- Water and sensor temperature have to be the same, most exact measuring is done, when calibrated at measuring temperature.

6.1.6 Visible residues in the inner of membrane head

As a reaction product in operation there will be lead oxide (red and brown – from the reaction with oxygen) and lead carbonate (white – from the reaction of carbon dioxide) in the inner of the sensor.

These substances may accumulate visibly at the membrane, but usually have now negative effect on the operability. Within a maintenance cycle the residues can be washed off the membrane nearly completely. Before screwing the membrane head on sensor body again they should be washed off, to avoid them getting in between platinum cathode and membrane.

A fast occurrence shortly after first filling or an unusual high amount of them (e.g. within some days) may be a sign of air in the sensor – either because of incorrect filling (bubbles), not sufficiently closing Cap or filling screw or a leaking membrane.

6.2 First start of operation / filling of sensor GWO 5610



Attention when working with electrolyte:
The electrolyte is caustic. (strong base, KOH)
Skin and eye protection is necessary!



Eye protection is necessary!



Wear suitable gloves when filling the electrolyte! Do not touch the electrolyte with bare skin, if there was contact rinse sufficiently with water for at least 15 minutes.

The state of delivery of the sensor is “dry”. Therefore the sensor is easily storable over a long time. The sensor has to be filled timely towards the measuring. After filling a time of ~ 2 hours has to be considered, until the sensor has stabilized.

6.2.1 Material



Figure: Filling with pipette

- Sensor GWO 5610 with membrane head
- Filling-pipette
- Electrolyte KOH
- Flat blade screw driver
- Paper towel
- Suitable gloves *)
- Wash basin

6.2.2 First filling

- Check membrane head GWOK 02: is it in good state? Is Membrane undamaged?
- Open filling screw

- Fill pipette with KOH
- First fill the membrane head up to $\frac{3}{4}$ of its height
- Screw on membrane head tightly, rinse excess KOH with water
- Then carefully fill the sensor, try to flick at the shaft from time to time, helping air bubbles coming out. In sum the sensor filling takes around 5 ml.
- If there are no more air bubbles and the filling hole is full, close with filling screw.
- Rinse excess KOH with water
- Turn sensor upwards: Are air bubbles visible below the membrane? If so: Refill once again.
- Wait approximately 2 hours for the sensor to stabilize, afterwards calibrate the sensor – the electrode state evaluation should deliver 100%.

6.3 Sensor maintenance of sensor GWO 5610

If the sensor can no more be calibrated or only unstable values are displayed, it has to be maintained or even the membrane head has to be exchanged.

Material:

- Sensor GWO 5610, eventually spare membrane head GWOK 02
- Filling pipette
- Electrolyte KOH
- Flat blade screw driver
- Paper towel
- Suitable gloves *)
- Wash basin



Old electrolyte is leaked out.

The maintenance is performed similar to the first filling, at first the membrane head is screwed off and the old electrolyte is washed out.

Mount new membrane head. (If the membrane head is undamaged, it may be reused)

The filling of the sensor is like described above.

*) suitable gloves: Acc. to DIN EN 420, e.g. natural latex, natural rubber, butyl rubber, nitrile rubber, polychloroprene, fluorinated rubber.

7 Dissolved oxygen measuring - please note

Please observe the following points when measuring dissolved oxygen:

- For measuring remove the protective flask.
- Sensor needs to be calibrated.
- The temperatures of the sensor and of the liquid to be measured have to be identical
- (if necessary, wait till temperatures match)
- The sensor has to be submerged at least 3 cm into the liquid to be measured.
- The measured liquid has to stream along the sensor membrane with at least 30 cm/sec: For measurements to be sufficiently accurate: either stir continuously or use agitator!
- The sensor measurement is sensitive against shocks!
- By stirring of the sensor in the measured liquid be careful that the sensor does not hit the container. A vibration of the sensor has an effect to the measured value.
- The optimum operation position is: with the sensor inlet pointing downwards.
- The instrument calculates the oxygen concentration [mg/l], the oxygen saturation [%] and the oxygen partial pressure [hPa] from the sensor signal and the temperature. According to DIN38408-C22 all measurements refer to steam saturated air.

7.1 Correction of Salinity 'SAL'

The higher the salinity (salt content) the lower the solubility of oxygen in water, i.e. although the partial oxygen pressure is the same, the quantity of oxygen dissolved in water (mg/l) is lower. Therefore, determination of the oxygen concentration requires entering the salinity of the medium (p.r.t. 'Configuration'). The correction of salinity is based on media on a water basis, whose chemical content is similar to sea water. The corrections are based on the 'International Oceanographic Tables' (IOT).

7.2 Ambient pressure and measuring depth of the sensor

The pressure at the sensor membrane is important for:

- The calculation of the oxygen saturation (% Sat).
At air water can get 100 % saturation. Assumed that there are no oxygen consuming processes (biological degradation, chemical effects) and that there are no oxygen enriching processes (e.g. excessive ventilation or photosynthesis).
- The calculation of oxygen concentration (mg/l or ppm).
- The sensor evaluation at calibration.

Therefore it is necessary to compensate the pressure influence via integrated sensor or, like practised with more primitive instruments via tables and manual input of pressure or elevation above sea level values..

7.2.1 Standard measurement without water depth measuring assembly: Menu „dEP t = OFF“

The integrated pressure sensor is permanently measuring the ambient pressure to:

- Compensate the pressure for the concentration [mg/l or ppm] or saturation [% Sat O₂]
- Pressure compensate the calibration.

7.2.2 Measurement without water depth measuring assembly TMV 3600 „dEP t = on “

Necessary accessory:

Water depth measuring assembly TMV 3600 (Zubehör).

The pressure sensor measures the hydrostatic pressure to evaluate the measuring depth of the sensor with a resolution of 0.1m.

(E.g. for comfortable logging of oxygen profiles in lakes).

Before starting the measuring (during segment test) and during calibration the pressure port has to be at ambient pressure:

The reference ambient pressure is taken (display **P_{REF}** and pressure) and memorized for calculation of saturation [Vol O₂], and as reference for the hydrostatic depth.



The hydrostatic pressure does not really play a significant role for the calculation of concentration (mg/l or ppm) or saturation [% Vol O₂] up to 100m depth, but it is an important unit to evaluate oxygen layering in waters. Combined with the logger function evaluation can be performed very comfortably!

More detailed Info: Please refer to manual of TMV 3600

8 Calibration of the sensor



In order to compensate for ageing of the sensor, the sensor has to be calibrated at regular intervals.

The device is equipped with easy-to-use calibration functions: Standard 1-point calibration, sufficient for the most applications and special 2 or 3-point calibration, if high accuracy is needed in extreme measuring.

We recommend to calibrate the sensor at least all 7 days, or to get maximum precision, before each measuring series.



If the electrode was dry for one or more days it has to be 'watered' for at least 30 minutes before carrying out a new calibration.

Remove protective flask prior to calibration and wipe membrane with a soft piece of cloth.

8.1 One point calibration „CAL I-PE“

The 1-point calibration adjusts the sensor to the oxygen content of the atmosphere (20.95 % Vol O₂).

You can choose between three modes of calibration for which the electrode has to be prepared accordingly.:

8.1.1 Air calibration without accessories „CAL R, r“

The electrode will be exposed to **ambient air**. To protect it from draughts, wrap electrode in a paper towel. (Before calibration, expose sensor at least 15 minutes to the ambient air, to let the temperature adjust and to dry membrane)

Depending on the rel. atmospheric humidity [%] and the temperature [°C] a small calibration error cannot be avoided and will have to be accepted. The cooler the air is, the smaller the deviation.

Recommended temperature: < 25°C.

For error compensation please refer to the opposite table

Calibration takes place in air saturated with water vapour. The GCAL 3610 calibration container or the storage bottle can be used for this purpose. The membrane of the electrode must be dry for the calibration. Prior to performing the calibration of the membrane, dab away water droplets from the membrane with a soft, dry cloth. The following must be observed when using the storage bottle:

Only insert the electrode far enough into the storage bottle that the membrane does not come into contact with the water in the bottle.

Unscrew the lid of the storage bottle and only position it so that a small exchange of air and pressure equalisation can take place

Place the electrode in the calibration container. If necessary, wait until the temperature has equalised and a stable value has been achieved.

Press the  -key for 2 seconds to open the Calibration menu. The display shows CAL.

Release the  -key.

The product determines the correct value automatically.

After successful completion of the calibration the assessment of the electrode condition is displayed briefly in percent. An aged or contaminated electrode, incorrect adjustment of the pressure, contamination of the platinum electrode or a damaged membrane can be the cause for a lower evaluation.

If the calibration is not completed successfully an error message is displayed. CAL Err. appears in the display See 17 Error and System Messages. Confirm the error message pressing the Function key. The product restarts and the value of the last successful calibration is restored.



A correctly calibrated sensor GWO 5610 shows 102 % Sat O₂ (or 106 - 109% with GWO 5600) at air and at room temperature

8.1.2 Calibration in air saturated water „CAL R9UR“

This mode of calibration is more difficult than the ones already described. As water is easily oversaturated it quickly results in calibration errors. In order to generate air saturated water, pure water (25-30°C) is poured into another container from a height of 50 cm. This process is repeated 20 times. In order to let an oversaturation evaporate, wait approx. 5 min. before carrying out the calibration (do not forget to stir).

Start calibration: press:  - key for 2 seconds.

The display will show R, r PE. 19, and as soon the values for oxygen and temperature are stable, the calibration will be finished.

Then the electrode state resulting of the successful calibration will be shown for a short time (evaluation in 10 % steps xx% ELEC).

8.2 2 / 3-point calibration „CAL 2-Pt“, „CAL 3-Pt“

The sensor will be automatically calibrated to the oxygen content of the atmosphere (20.95 %) and one or two additional concentrations.

The calibration can be performed in gases (CAL Air: Air, 100% Oxygen and/ or 0% oxygen like nitrogen) or in saturated water solutions (CAL AQUA) The water solutions therefore have to be "gased" sufficiently with the referring gases. Another alternative for 0 % is a Sodium sulphite solution (can also be used at CAL Air).

1. **Start calibration: press:**  **for 2 seconds.**
2. **First calibration reference: (Pt.1)**

As first reference at a 3-point calibration, the zero reference has to be applied (NULL).
at a 2-point calibration either 100 % Vol O₂ or 0 % Vol O₂.

The display will show **Pt. 1**, and the referring reference which should be applied:

- **NULL** for 0 % Vol O₂.
- **0.2** for pure oxygen or oxygen saturated water.

As long as the display blinks, no valid reference is recognised by the instrument.

As soon the values for oxygen and temperature are stable, the calibration of the first point will be finished. The instrument tells you to apply the next reference (possible references are blinking in the display)

3. **Second calibration reference : (Pt.2)**

The display will show **Pt.2**, and the referring reference which should be applied.

- **Air** for ambient air or **AQUA** for air saturated water.
- **0.2** for pure oxygen or oxygen saturated water.
- **NULL** for 0 % Vol O₂.

As long as the display blinks, no valid reference is recognised by the instrument.

As soon the values for oxygen and temperature are stable, the calibration of the second point will be finished. At 2-point calibration the calibration will be finished and the electrode state resulting of the successful calibration will be shown for a short time (evaluation in 10 % steps : „xx% ELEC“.

At 3-point calibration the instrument tells you to apply the next reference (possible reference is blinking)

1. **Third calibration reference: (Pt.3)**

The display will show **Pt.3**, and the referring reference which should be applied.

As soon the values for oxygen and temperature are stable, the calibration of the second point will be finished. At 2-point calibration the calibration will be finished and the sensor state resulting of the successful calibration will be shown for a short time (evaluation in 10 % steps: „xx% ELEC“.



In case of error messages being displayed during the calibration process, please refer to our notes at the end of this manual! If a calibration cannot be carried out after an extended period of time, at least one of the measuring values is unstable (oxygen partial pressure, temperature).

Please check your measuring arrangements!

8.3 Evaluation of Sensor State „ELEC“

Watch sensor state: press  shortly once display shows „xx% ELEC“ for a short time.

This shows the electrode state resulting of the last successful calibration carried out.

The evaluation is displayed in 10 percent steps: 100 % means optimal sensor condition. Lower values are indicating that the sensor life time will be reached soon.



But also an erroneous pressure may be the cause of low valuation values

9 Data logger

9.1 General

The device supports two different logger functions:

"**Func Stor**": Manual recording by key press . Additional input of measuring point (L-Id) is needed.

"**Func CYCL**": Automatic recording at intervals of set cycle time.

A recording consists:

- Oxygen concentration in mg/l oder ppm.
- Oxygen saturation in % oder oxygen partial pressure in hPa or mmHg.
- Temperature in °C oder °F.
- Absolute pressure in hPa abs oder mmHg abs or. Measuring depth in m.
- Measuring point L-Id (nur bei "**Func Stor**").
- Time and date of the recording.

For the evaluation of the data the software GSOFT3050 (version V3.0 or higher) has to be used. The software also allows easy configuration and starting of the logger.

When the logger is activated ("**Func Stor**" or "**Func CYCL**") the hold function is no more available, the key "**store**" is solely used for the operation of the logger functions.

9.2 Recording manual "**Func Stor**"

9.2.1 Recording the measured values manually

1000 measurements can be saved if the logger function "**Func Stor**" where chosen, see chapter 5 Configuration.



Press shortly: Recording is stored. It will be displayed for a short time "**St .XX**"
XX represents the number of the recording.



Measuring point choice

A Number of 0...19999 or text, who is assigned to a measurement point number of 1...40, (comfortable assignment of texts can be done with gratis software GMHKonfig)



Confirm input



Logger memory full

9.2.2 Call manual recording

Saved recording can be selected with PC-Software GSOFT3050, also considered in the display device.



Press 2 seconds: The display is shown: 



If recording are saved  is appeared. Without recording the configuration menu

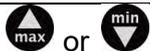
 is appeared.



Last recording

Press again 

Change between the data of the recording (O₂-concentrate, O₂-parial pressure, absolute pressure, date and time)



Changing the measurement

9.2.3 Delete manual recording

If there are data saved, they could be deleted by pressing the button store:

	Press 2 seconds: Call "delete-menu"
Change the recording:  or 	
	Clear nothing (cancel menu)
	Clear all recordings
	Clear the last recording
	Confirm the selection, end „delete-menu“

9.3 Automatic recording with selectable cycle time "Func CYCL"

If the logger function "Func CYCL" is chosen, after the start, the logger automatically records at the adjusted cycle time.

The logger cycle time is adjustable from 1 s to 60 min, see chapter 5 Configuration .

Storable records: 8000.

9.3.1 Start logger recording

 **Press 2 seconds:** Start selection

After that, press again  : automatic recording is starting.

Whenever a measuring is recorded the display shows 'St.XXXXX'.

XXXXX is the number of the measuring. If the logger memory is full, the display will show .

The recording automatically will be stopped.

9.3.2 Stopping the recording manually

 **Press 2 seconds:** If there runs an recording, "stopp-menu" is shown.

Change the selection:  or 	
	Do not stop the recording (cancel menu)
	Stop the recording
	Confirm the selection, end "stopp-menu"



If you try to switch off the instrument in the cyclic recording operation you will be asked once again if the recording should be stopped.
The device can only be switched off after the recording has been stopped!
The Auto-Power-Off-function is deactivated during recording!

9.3.3 Clear Recordings

 **Press 2 seconds:** If there are data available, and the recording is stopped, "delete-menu" is shown

Change the selection:  or 	
	Clear nothing (cancel menu)
	Clear all recordings
	Delete the last recording
	Confirm the selection, end "delete-menu"

10 Adjustment of temperature input

The temperature input can be adjusted with offset and scale. A reasonable adjustment presumes reliable references (e.g. ice water, controlled precision water bath, etc.). If the inputs are adjusted (i.e. offset and scale are different from default settings) the device will shortly display "Corr" after turned on. Default setting for offset and scale are 'off' = 0.0, i.e. inputs are not changed.

Zero point correction: Displayed value = measured value **OFFS**.

Zero point and slope correction: Displayed value = (measured value - **OFFS**) • (1 + **SCAL** / 100).
 Displayed value °F = (meas. value °F - 32°F - **OFFS**) (1 + **SCAL** /100).

11 GLP

GLP (Good Laboratory Practice) includes regular check of devices and accessories. For oxygen measurements, it is highly important to ensure correct sensor calibration/adjustment. The device provides the following functions to help with this.

11.1 Calibration/Adjustment interval "Int"

You can input the interval after which the device reminds you to recalibrate.

The interval times should be chosen according to the application and the stability of the sensor „CAL“ flashes on the display as soon as the interval has expired.

11.2 Calibration/Adjustment memory "rEAd CAL"

The last 16 calibrations are stored with results, date, and can be read out.

11.2.1 Show Memory

Historical calibration data can be comfortably read out via PC software GMHKonfig and GSOFT3050 or displayed directly at the device:



Press for 2 seconds:

The display will show

rEAd

LaBb oder

SEt

Conf

(configuration level)



Press several times until this is

rEAd
CAL.

displayed:

rEAd CAL = " read calibration data "



Press shortly: switch between::

- ELEc = Overall evaluation in %
- SL.1 = Slope 0% - Air *1)
- SL.2 = Slope Air – 100%*1)
- Display of date+time of data set



or



Change between the different calibration data sets



Quit calibration data set display

*1at the 1 and 2-Punkt-calibration is SL.1 = SL. 2

at 3-point calibration there are in dependent slope for the two segments.

12 Alarm "AL"

There are 3 possible settings:

off "AL_{oFF}", on with buzzer "AL_{on}", on without buzzer "AL_{noSo}".

Alarm is given in the following cases if alarm active (**on** or **noSo**):

- Lower alarm boundary (**AL_{Lo}**) under-run
- Upper alarm boundary (**AL_h**) over-run.
- Sensor error.
- Low battery (**bALt**)
- Err.7: system error (always with buzzer).

In case of an alarm and when polling the interface the ,**PRIO**-flag is set in the returned interface message.

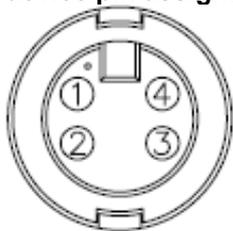
13 Real time clock "CLDC"

The real time clock is used for chronological assignment of the logger data and calibration points. Please check the settings when necessary.

14 Universal Output

The output can be used as serial interface (for USB5100 interface converter). If the output is not needed, it is strongly recommended to deactivate it (**Out oFF**), to lower power consumption. This increases battery life time.

If the device is used together with interface adapter USB 5100 the device is supplied from the interface **device pin assignment**



1: external supply +5V, 50mA

2: GND

3: TxD/RxD (3.3V Logic)

4: +U_{DAC}, analog output



Only suitable adaptor cables are permitted (accessories)!



Increased measuring values or measuring faults may occur when operating the device by external power supply or with connected interface. In case of doubt, disconnect the device from the power supply/interface

The same is valid for the analogue output, depending on how the analogue output is being evaluated, (e.g. without electrical isolation), In case of doubt do not measure in grounded solutions.

14.1 Interface

The device can be directly connected to a PC at the USB interface, with an electrically isolated interface converter USB 5100 (accessory). The transfer takes place via a binary coded format and is protected for transmission errors, by elaborated security mechanisms.

The following standard software packages are available:

- **GSOFT3050:** Operating and evaluation software for the integrated logger function
- **EBS20M / -60M:** 20-/60-channel software for measuring value display
- **GMHKonfig:** Configuration Software (for free on internet)

In case you want to develop your own software, we offer a **GMH3000- development package** including:

- a universally applicable Windows functions library ('GMH3000.DLL') with documentation, can be used by all 'established' programming languages, suitable for, Windows XP™, Windows Vista™, Windows 7™, Windows 8 / 8.1™, Windows 10™
- Programming examples Visual Studio 2010 (C#, C++ und VB), Testpoint™, LabVIEW™ etc.

The device has 4 channels:

- oxygen concentration in % Vol O₂
- oxygen partial pressure in hPa or mmHg
- temperature value at the time of recording in °C or °F
- absolute pressure in hPa abs or mmHg abs or water depth in m

14.1.1 Supported interface-functions:

1	2	3	4	Code	Name/Function	1	2	3	4	Code	Name/Function
x	x	x	x	0	read nominal value	x	x	x	x	199	read measuring type in display
x	x	x	x	3	read system status	x	x	x	x	200	read min. display range
x				12	read ID-no.	x	x	x	x	201	read max. display range
x	x	x		22	read min alarm limit	x	x	x	x	202	read unit of display
x	x	x		23	read max alarm limit	x	x	x	x	204	read decimal point of display
x	x	x	x	176	read min. measuring range	x				208	read channel count
x	x	x	x	177	read max. measuring range	x				222	read turn-off-delay
x	x	x	x	178	read measuring range unit	x				223	Set turn-off-delay
x	x	x	x	179	read measuring range decimal point	x				240	Reset
x	x	x	x	180	read measuring type	x				254	read program identification



The measuring and range values read via interface are always in the selected display unit!

14.2 Analog output

An analog voltage 0-1V can be tapped at the universal output socket (mode: "Out dAC"). The analog output can be easily scaled with DAC.0 and DAC.1).

Please take care not to load the analog output too heavily, otherwise the output value will be distorted and the power consumption will rise. Loads up to approx. 10 kOhm are unproblematic.

If the displayed value goes beyond DAC.1 the output voltage will be 1V.

If the displayed value falls below DAC.0 the output voltage will be 0V.

In error case (Err.1, Err.2, ----, etc.) the output voltage will be slightly higher than 1V.

15 Inspection of the accuracy / adjustment services

The instrument can be sent to the manufacturer for adjustment and function test.

Only the manufacturer can check all systems on correct them if necessary.

Calibration certificates – DKD-certificates – other certificates:

There it is actually not possible to certificate the device for solved oxygen measurement, only for temperature and pressure measurement.

16 Battery change

Before changing batteries, please read the following instruction and follow it step by step.

Not following the instruction may cause harm to the instrument or the protection against ingress of water and dust may be lost!

Avoid unnecessary opening of the instrument!

1. Open the 3 Phillips screws at the backside of the instrument.
2. Lay down the still closed instrument, so that the display side points upwards.
The lower half of the housing incl. the electronics should be kept lying down during battery change.
This avoids loss of the 3 sealing rings placed in the screw holes.
3. Lift off upper half of housing. Keep an eye on the six function keys, to be sure not to damage them.
4. Change carefully the two batteries (Type: AAA).
5. Check: Are the 3 sealing rings placed in the housing?
Is the circumference seal of the upper half sound and clean?

Close the housing, taking care that it is positioned correctly, otherwise the sealing may be damaged. Afterwards press the two halves together, lay the instrument with display pointing downwards and screw it together again



Take care to screw only until you feel increasing resistance, higher screwing force does not result in higher water protection!

17 Error and System Messages

Display	Meaning	Remedy
	low battery voltage, device will continue to work for a short time If mains operation: wrong voltage	replace battery replace power supply, if fault continues to exist: device damaged
	low battery voltage If mains operation: wrong voltage	replace battery Check/replace power supply, if fault continues to exist: device damaged
No display or weird display	low battery voltage If mains operation: wrong voltage	replace battery check/replace power supply, if fault continues to exist: device damaged
Device does not react on keys	system error	disconnect battery or power supply, wait some time, re-connect
	device defective	return to manufacturer for repair
	sensor error: no sensor cable connected	connect suitable sensor
	Sensor, cable or instrument defect	return to manufacturer for repair
	Value exceeding measuring range	Check: Is the value exceeding the specified measuring range? ->value too high!
	Wrong sensor connected	Check sensor
	Sensor, cable or instrument defect	return to manufacturer for repair
	Value below display range	Check: Is the value below the specified measuring range? ->value too low!
	Wrong sensor connected	Check sensor
	Sensor, cable or instrument defect	return to manufacturer for repair
	system error	return to manufacturer for repair

If "bat" is flashing, the battery will be exhausted soon. Further measurements are possible for short time.

If "bat" is displayed continuously the battery is ultimately exhausted and has to be replaced. Further measurements aren't possible any more.

Messages During Calibration/Adjustment

>CAL< CAL flashing in display	either preset calibration interval has expired or last calibration is not valid	Device has to be calibrated!
CAL Err.1	wrong reference point at air	check sensor and reference gas / solution
CAL Err.2	slope too low	
	reference gas / solution wrong sensor is defect	check sensor and reference gas / solution replace sensor / perform maintenance
CAL Err.3	slope too high	
	reference gas / solution wrong sensor is defect	check sensor and reference gas / solution replace sensor / perform maintenance
CAL Err.4	incorrect calibration temperature	calibration can only be done at 0...40 °C
CAL Err.5	Zero value to low/negative sensor is defect	replace sensor / perform maintenance
	zero value to high	
CAL Err.6	reference gas / solution wrong	check sensor and reference gas / solution
	sensor is defect	replace sensor / perform maintenance
CAL Err.7	incorrect calibration pressure	check calibration pressure
CAL Err.8	signal not stable / timeout	check sensor and reference gas / solution
CAL Err.9	sensor not known: cannot be calibrated	check sensor and wiring

18 Reshipment and disposal**18.1 Reshipment**

All devices returned to the manufacturer have to be free of any residual of measuring media and other hazardous substances. Measuring residuals at housing or sensor may be a risk for persons or environment



Use an adequate transport package for reshipment, especially for fully functional de-vices. Please make sure that the device is protected in the package by enough pack-ing materials.

Add the completed reshipment form of the GHM website <http://www.ghm-messtechnik.de/downloads/ghm-formulare.html>.

18.2 Disposal

The device must not be disposed in the unsorted municipal waste! Send the device directly to us (sufficiently stamped), considering the above if it should be disposed. We will dispose the device appropriate and environmentally sound.

WEEE-Reg.-Nr. DE 93889386

19 Specification

Measuring ranges	O ₂ - concentration	0.00 ... 70.00 mg/l or ppm	electrochemical sensors GWO 5600/5610														
	O ₂ - saturation	0.0 ... 600.0 Sat. O ₂															
	O ₂ - partial pressure	0 ... 1200 hPa O ₂ (0.0 .. 427.5 mmHg) ^{*)}															
	Sensor temperature	-5.0 ... + 50.0 °C	-5.0 ... + 50.0 °C														
	Absolute pressure	300 ... 5000 hPa abs. 0 ... 40.0 m water column ^{*)}	300 ... 5000 hPa abs. 0 ... 40.0 m water column ^{*)}														
Accuracy at 25°C, 1000 hPa abs	O ₂	±1.5 % of measured value ±0,2 mg/l (0-25 mg/l) or ±2.5 % of measured value ±0,3 mg/l (25-70 mg/l)															
	Sensor temperature	± 0.1 °C															
Accuracy	Absolute pressure	3 hPa or 0.1% of measured value (the higher one to be applied)															
Working conditions	Sensor 0 .. 40 °C / Instrument -25 .. 50°C; 0 .. 95 % rel.H. (non condensing)																
Nom. temperature	25°C																
Storage temp.	Sensor 0 .. 40 °C / Instrument -25 .. 70 °C																
Connections	O ₂ & temperature	7 pole waterproof bayonet connector															
	Absolute pressure	Universal pressure port for tubes with 4 or 6mm inner-Ø															
	Interface / analog output / ext. supply	4 pole waterproof bayonet connector (USB adapter USB 5100)															
Display	LCD, white backlight, two 4½ digits 7-segment (main and auxiliary display) with additional symbols																
Calibration	automatic	1 -, 2- or 3-point calibration, 0%, 100% or ambient air (20.95 Vol. O ₂) or air saturated water															
Alarm	Buzzer / visual / interface 2 channels: selectable oxygen unit and temperature																
Additional functions	Min / max / hold / auto hold Analog output 0-1V, adjustable																
Data logger	Real-time clock Cyclic: 10000 data sets, cycle time 1s to 60 minutes Single: 1000 data sets, with measuring point input																
GLP	calibration memory adjustable calibration intervals (1 to 365 days, CAL warning after expiration)																
Housing	Non-breakable ABS housing, incl. silicone protective cover																
	Protection class	IP65 / IP67															
	Dimensions L*W*H	Without pressure connection: 160 * 86 * 37 incl. silicone protective cover, pressure connection: length 11mm															
	Weight	approx. 250 g incl. battery and cover															
Power supply	2*AAA batteries (included in scope of supply) or external																
	Current consumption	0.9 mA (for Out = oFF, equivalent to 1000 h), backlight ~10mA (auto-off)															
	Battery indicator	4-stage battery state indicator, Change battery display for exhausted battery: "bAt", warning: "bAt" flashing															
Auto-off function	Device will be automatically switched off if no key is pressed/no interface communication takes place for the time of the power-off delay. The power-off delay can be set to values between 1 and 120 min																
Directives and standards	<p>The device confirm to following European directives:</p> <table style="margin-left: 40px;"> <tr> <td>2014/30/EU</td> <td>EMV directive</td> </tr> <tr> <td>2011/65/EU</td> <td>RoHS</td> </tr> </table> <p>Applied harmonized standards:</p> <table style="margin-left: 40px;"> <tr> <td>EN 61326-1:2013</td> <td>Emission level: Class B</td> </tr> <tr> <td></td> <td>EMI immunity according to table 3 and A.1</td> </tr> <tr> <td></td> <td>Additional fault during perturbation:</td> </tr> <tr> <td></td> <td>< 0.5 % FS</td> </tr> <tr> <td>EN 50581:2012</td> <td></td> </tr> </table> <p>The device is for the mobile application or for the stationary operation in the course of specified working conditions without further restrictions construed.</p>			2014/30/EU	EMV directive	2011/65/EU	RoHS	EN 61326-1:2013	Emission level: Class B		EMI immunity according to table 3 and A.1		Additional fault during perturbation:		< 0.5 % FS	EN 50581:2012	
2014/30/EU	EMV directive																
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EN 61326-1:2013	Emission level: Class B																
	EMI immunity according to table 3 and A.1																
	Additional fault during perturbation:																
	< 0.5 % FS																
EN 50581:2012																	

^{*)} with accessory, please refer to chapter 7.2.2

