

Water-Proof Oxygen Meter for Dissolved Oxygen With Integrated Temperature and Pressure Measuring and Data Logger

As of Version 1.0 Operating Manual

GMH 5650



-  Please carefully read these instructions before use!
-  Please consider the safety instructions!
-  Please keep for future reference!



WEEE-Reg.-Nr. DE 93889386

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1 General Note

Read this document carefully and get used to the operation of the device before you use it. Keep this document within easy reach near the device for consulting in 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.

2 Safety

2.1 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%) 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.

2.2 Safety signs and symbols

Warnings are labeled in this document with the followings signs:



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



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.

2.3 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.

1. 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 "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.

2.  **DANGER** 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.
3. When connecting the device to other devices the connection has to be designed most thoroughly as internal connections in third-party devices (e.g. connection GND with protective earth) may lead to undesired voltage potentials that can lead to malfunctions or destroying of the instrument and the connected devices.
4.  **DANGER** 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.
5.  **DANGER** This device must not be used at potentially explosive areas! The usage of this device at potentially explosive areas increases danger of deflagration, explosion or fire due to sparking.

3 Product Description

3.1 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

3.2 Operation and maintenance advice

1. 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: p.r.t. chapter 17



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 of time.

After recommissioning the real-time clock has to be set again.

2. Treat device and sensor carefully. Use only in accordance with above specification. (do not throw, hit against etc.). Protect plug and socket from soiling.

3. 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. Don't 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.

4 Start of Operation

In the case, the sensor was delivered 'dry', it has to be filled prior to operation. Please refer to chapter 7.2 First Start of Operation of Sensor GWO 5610 / Filling

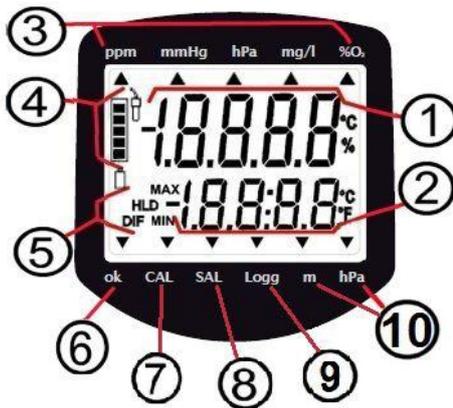
Connect sensor, switch instrument on with .



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

5 Operation

5.1 Display elements



Main display:

Display of the current oxygen level, please refer to chapter 6, [h 2])

1

(choice via -key)

2

Secondary display: sensor temperature, absolute pressure or depth (alternating, please refer to chapter 6 [cd.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

OK: Signals, if oxygen and temperature is stable

7

CAL: Signals, if automatic calibration is in progress

8

SAL: Signals, if salinity correction is activated

9

Shows, if logger function is chosen.

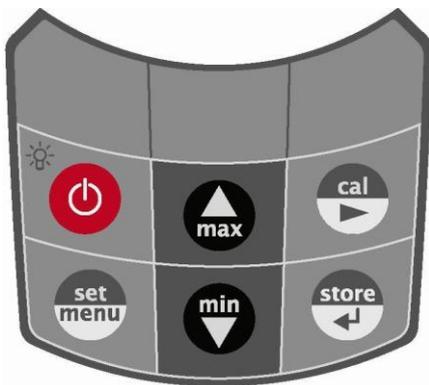
10

Is blinking, if cyclic logger is running

10

Secondary display units

5.2 Pushbuttons



On / off key, backlight

press shortly: activate backlight or switch on instrument
press longer: switch off instrument



Set / Menu:

press shortly: Change oxygen display unit
press for 2 sec. (menu): invoke configuration menu



min / max:

press shortly: min. or max. value is displayed
press for 2 sec: the corresponding value is deleted



Configuration (please refer to chapter 6):

enter values, or change settings



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 6

or if logger activated: calling the logger functions (please refer to chapter 10)

Configuration (please refer to chapter 6):

confirm settings, return to measuring



cal:

press shortly: display of sensor state rating

press for 2 sec: start sensor calibration

5.3 Connections



Universal output: interface, supply, analog output (see chapter 11)

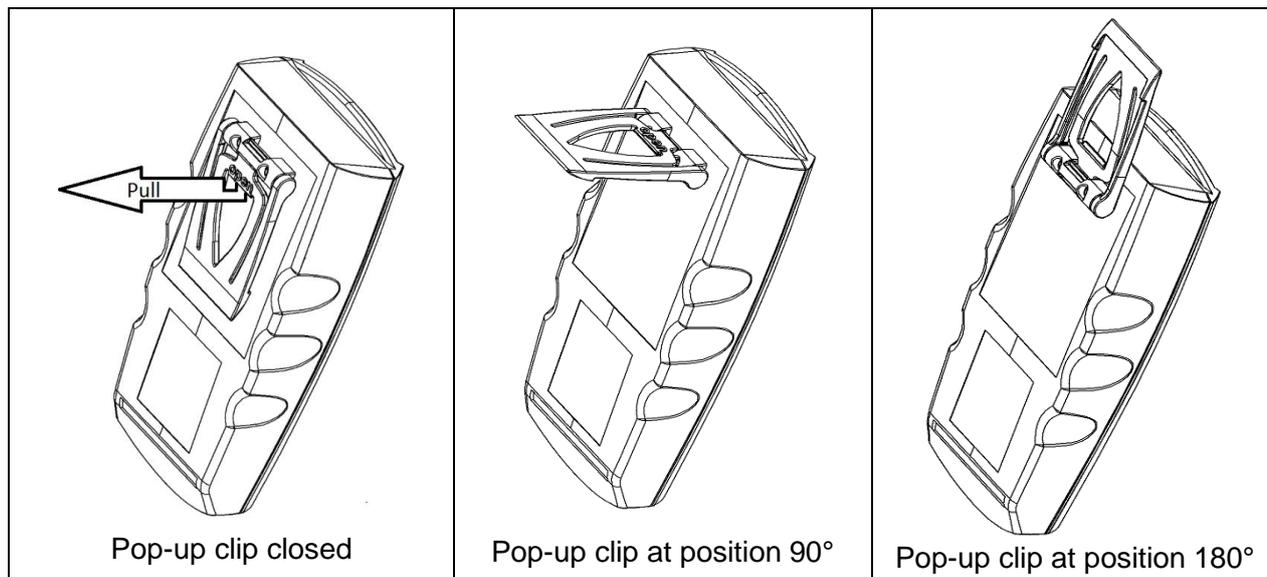
7-pole bayonet socket: connection for sensor and temperature probe

Pressure Port: Tube Connection for ambient pressure compensation of oxygen sensor

5.4 Pop-up clip

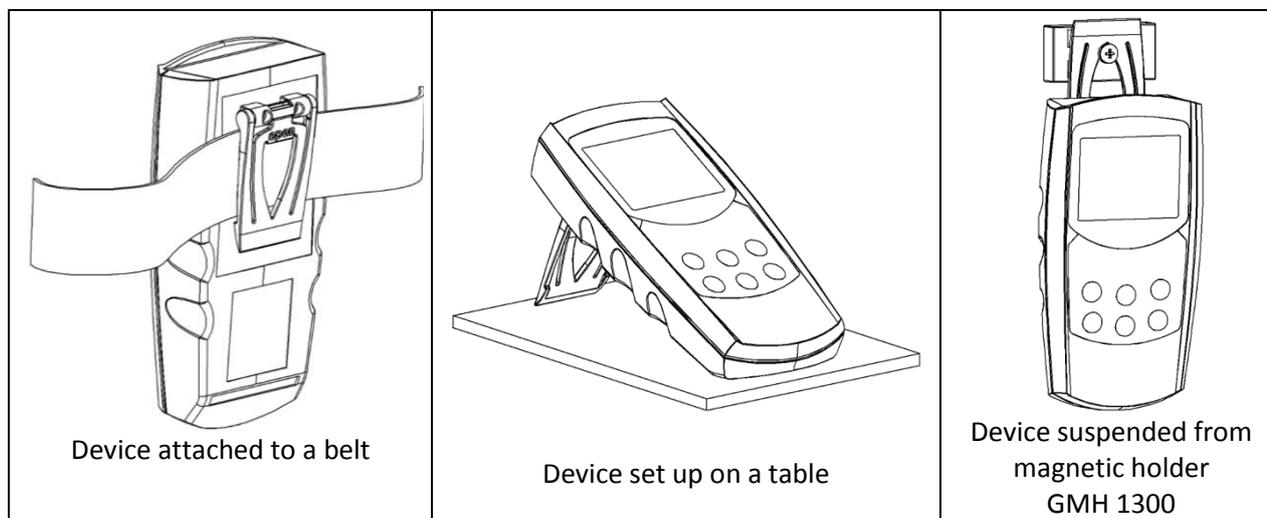
Handling:

- 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.



6 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 "menu" for 2 seconds. This will activate the configuration menu (main display: "SET"). Pressing "menu" 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 "menu" again jumps back to the main configuration menu and saves the settings.

Pressing "enter" 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 and logger is set to "manual recording" ("Func Stor") the first menu point displayed is "rEAd Logg" (p.r.t. chapter 10)

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

Menu	Parameter	Value or	Description		see
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 PO2	%O ₂	Main display shows O ₂ -concentration (mg/l or ppm) or O ₂ -Saturation in % (ex works setting)		
		hPa	Main display shows O ₂ -concentration or O ₂ -partial pressure in hPa		
		mmHg	Main display shows O ₂ -concentration or O ₂ -partial pressure in mmHg		
rES		H ₁	Best O ₂ resolutions		
		L ₀	Low O ₂ resolution, calm value display (standard)		
SAL		oFF	Salinity correction deactivated (ex works setting)		
		0.1 ... 70.0	Salinity correction activated, Unit ‰ = PSU, e.g. sea water ~35.0		
Lcd.2		t	Second. display always temperature		
		P	Second. display always absolute pressure		
		P t	Second. 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	All temperatures in degree Celsius (ex works setting)		
		°F	All temperatures in degree Fahrenheit		
CAL		Air	The sensor will be calibrated at air or gas (ex works setting)		
		AQUA	The sensor will be calibrated in water		
CAL.P		1-PE	Simple one point calibration at air (Air) or at air saturated water (AQUA)		
		2-PE, 3-PE	2 or 3-point calibration at air (Air)/air saturated water (AQUA), or in oxygen/oxygen saturated water or in nitrogen/zero solution		
C. Int		1 ... 365	Calibration reminder period (in days)		
		oFF	No calibration reminder		
Auto HLD		on	Auto measuring value identification Auto Hold (when logger = off)		
		oFF	Standard hold function on key press (when logger = off)		
P.oFF		1 ... 120	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)		
		oFF	Automatic power-off function deactivated (continuous operation)		

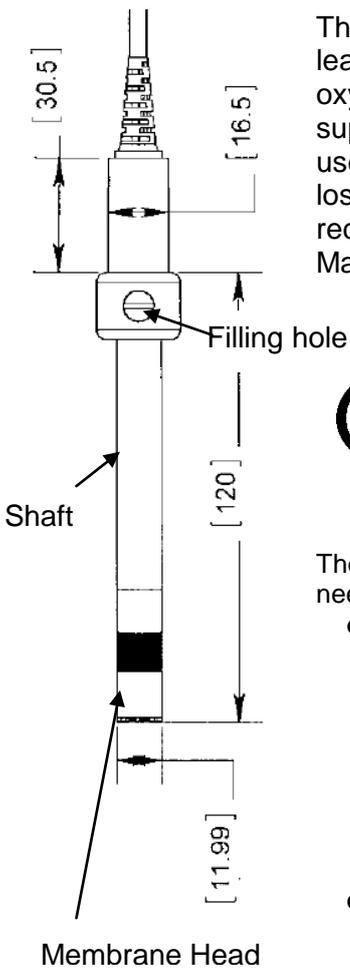
	LITE	oFF	Background Illumination deactivated		
		5...120	Turn off illumination after 5... 120s (factory settings: 10 s)		
		oN	Illumination always on		
	Out	oFF	Interface off -> minimal power consumption		
		SEr	Serial interface activated (ex works setting)		
		dAC	Analog output activated		
Adr	01,11,21, ... 91	Base address for serial interface communication (ex works setting 01)			
dA,n	Conc	Analog output is corresponding to concentration in ppm or mg/l			
	SAR or P O2	Analog output is corresponding to setting of [h2]			
dARC0	0.0...100.0 %O ₂	Measuring value that should correspond to output 0 V e.g. for 0.0 %			
dARC1	0.0...100.0 %O ₂	Measuring value that should correspond to output 1 V e.g. for 100.0 %			
SEt Corr	Set Corr: Input adjustment			**	
	OFFS °C or °F	-5.0 °C .. 5.0 °C or -9.0 °F .. 9.0 °F	The zero point of the temperature measuring is shifted for the entered value. This can be used to compensate sensor and instrument deviations	**	
		oFF	No zero adjustment for temperature measurement (=0.0°)		
		SCAL °C or °F	-5.00 ... 5.00 %	The slope of the temperature measurement is corrected by this value. This can be used to compensate sensor and instrument deviations	**
	oFF		No slope adjustment for temperature measurement (=0.00)		
OFFS hPa	-20 .. 20 hPa	The zero point of the pressure measuring is shifted for the entered value. This can be used to compensate sensor deviations	**		
	oFF	No zero adjustment for pressure measurement (=0 hPa)			
SEt AL	Set Alarm:				
	AL. 1	oN / no.5o	Monitoring Oxygen: Alarm on with buzzer / Alarm on without buzzer		
		oFF	No alarm monitoring for oxygen		
	AL,n	Conc	Monitoring Oxygen: Concentration in %		
		P O2	Monitoring Oxygen: Partial pressure in hPa or mmHg		
	ALLo	e.g. 0.0..100.0 %	Min alarm limit oxygen (not if AL. 1. oFF)		
	ALh	e.g. 0.0..100.0 %	Max alarm limit oxygen (not if AL. 1. oFF)		
	AL. 2	oN / no.5o	Temperature monitoring : Alarm on with buzzer / Alarm on without buzzer		
oFF		No alarm monitoring for temperature			
ALLo	-5.0 ..+50.0 °C	Min alarm limit temperature (not if AL. 2. oFF)			
ALh	-5.0 ..+50.0 °C	Max alarm limit temperature (not if AL. 2. oFF)			
SEt LoGG	Set Logger			**	
	Func	CYCL	Cyclic logger function	*	9
		Stor	Store: manual recording		
oFF		No logger activated			
CYCL	0:01 ... 60:00	Cycle time in [minutes:seconds] for cyclic logger	**		
SEt CLOC	Set Clock				
	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.

7 The Oxygen Sensor

7.1 Design of Sensor GWO 5610



The oxygen electrode 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 (p.r.t. 7.3 Sensor Maintenance of GWO 5610)

Make it a rule to always store the electrode 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.).

Attention: The membrane is delicate – if damaged, caustic electrolyte gets lost and the sensor shows wrong signal

The electrode housing is made of ABS. With the exception of the electrode shaft all parts need 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. Attention! Use water only; never use potassium chloride (KCl); this is only required for storage of pH-electrode.
- 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.
- 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. Please refer to Refilling description below.



Attention when working with electrolyte! The electrolyte is caustic! (strong base, KOH)
Avoid contact to skin, protect Your eyes!

Life Time:

At the end of the Lifetime, 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 life time is left, but that the electrode signal has 70% of a good state reference.

Note: 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

Mounting/Operation Position:

The optimum position is with sensor membrane pointing downwards.

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.

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.

7.2 First Start of Operation of Sensor GWO 5610 / Filling

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.

Wear suitable gloves*) and protect your eyes when filling the electrolyte! Do not touch the electrolyte with bare skin, if there was contact rinse sufficiently with water.

Material:

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

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 his 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%.



Figure: Filling with pipette

7.3 Sensor Maintenance of GWO 5610

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

Wear suitable gloves*) when filling the electrolyte! Do not touch the electrolyte with bare skin, if there was contact rinse sufficiently with water.

Material:

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

The maintenance is performed similar to the first filling, at first the membrane head is screwed off and the old electrolyte is washed out. Attention! Do not touch the electrolyte with bare skin!

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.

8 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** (p.r.t. 'How to calibrate oxygen sensor')
- **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.

8.1 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).

8.2 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.

8.2.1 Standard measurement without water depth measuring assembly: Menu dEPt = OFF

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

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

8.2.2 Measurement without water depth measuring assembly TMV 3600 (dEPt = On)

Necessary accessory: Water depth measuring assembly TMV 3600.

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 [%O₂], and as reference for the hydrostatic depth measuring.

Info: The hydrostatic pressure does not really play a significant role for the calculation of concentration (mg/l or ppm) or saturation [%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.

9 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

9.1 One Point Calibration ('CAL 1-PT')

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

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

Air calibration without accessories ('Cal Air')

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.

	20%	40%	60%	80%	100%
5 °C	1.007	1.005	1.003	1.002	1.00
10 °C	1.01	1.007	1.005	1.002	1.00
15 °C	1.014	1.01	1.007	1.003	1.00
20 °C	1.019	1.014	1.009	1.005	1.00
25 °C	1.026	1.019	1.013	1.006	1.00
30 °C	1.035	1.026	1.017	1.009	1.00
35 °C	1.047	1.035	1.023	1.012	1.00
40 °C	1.063	1.047	1.031	1.016	1.00

*Deviations when carrying out an air calibration without accessories,
O₂-saturation= display value*corr. factor*

Air calibration for highly accurate measurements ('Cal Air')

The electrode is exposed to **air with a relative atmospheric humidity of 100%**.

Proceed as follows: Put some distilled water in a bottle. Close bottle and generate water steam saturation (100% rel. atmospheric humidity) in the remaining air by shaking it vigorously for approx. 3 minutes. Both water and air temperatures should be identical. Open bottle and insert electrode so that the membrane is in the air chamber.

Attention: By no means must the membrane get wet or be immersed in water. The bottle neck opening should only be slightly larger than the electrode diameter; make sure to avoid over pressure in the container.

Note: A correctly calibrated sensor **GWO 5610** shows **102 % O₂ sat** (or 106 - 109% with GWO 5600) at air and at room temperature.

Calibration in air saturated water (configuration: 'Cal AqUA')

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 'R1 r Pt. 1.0' 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.).

9.2 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 -key 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% or 0%(NULL).

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

- NULL for 0% oxygen
- 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% oxygen

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)

4. **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!

9.3 Evaluation of Sensor State (ELEC)

Watch sensor state: press key " shortly once display show for a short time xx% ELEC.

It will show the electrode state resulting of the last successful calibration carried out.

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

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

10 Operation of the Logger

The device supports two different logger functions:

- „Func-Stor“: each time when „store“ (key 6) is pressed a measurement will be recorded.
- „Func-CYCL“: measurements will automatically be recorded at each interval, which was set in the logger menu ‚CYCL‘ until the logger will be stopped or the logger memory is full.
The recording is started by pressing „store“ 2 seconds.

For the evaluation of the data the software GSOF3050 (V3.5 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 and auto hold functions are no longer available, key 6 is solely used for the operation of the logger functions.

10.1 „Func-Stor“: Storing Single Measurement Sets

Each time when „store“ (key 6) is pressed a measurement and its time stamp will be recorded. The recorded data can be viewed either in the display (when calling the configuration an additional menu „REAd LoGG“ is displayed, see below) or by means of the interface and a PC with GSOF3050-software.

The logger stores the current measuring, independent from the stability of the value.

Max. number of data sets: 1000

A data set contains:

- oxygen concentration in mg/l or ppm
- oxygen saturation in percent or 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
- measuring point L-Id (only for „Func-Stor“)
- time and date of the recording

After each recording „St. XX“ will be displayed for a short time. XX represents the number of the recording.

Input of the measuring point „L-Id“: Selection of measuring point via keys ▲ or ▼.

Number 0...19999 or text assigned to number 1...40

(Comfortable assignment of texts can be done with gratis software GMHKonfig)

Confirm input with „store“.

When logger memory contains recordings already:

When „store“ is pressed for 2 seconds, the choice for clearing the logger memory will be displayed:



Clear all recordings



Clear the last recording



Clear nothing (cancel menu)

The selection can be made by ▲ (key 2) and ▼ (key 5). „Quit“ (key 6) enters the choice.

If the logger memory is full, the display will show:



Viewing Recorded Data

Within the „LoGG Stor“ function the logger data can be viewed directly in the display not only by means of a computer (like at „Func CYCL“): press 2 seconds „set“ (key 4): The first menu displayed now is „REAd LoGG“ (read logger data). After pressing ▶ (key 3) the measurement recorded last will be displayed, changing between the different data referring to the measurement also is done by pressing ▶.

Changing the measurement is done by pressing the keys ▲ or ▼.

10.2 "Func-CYCL": Automatic Recording With Selectable Logger-Cycle-Time

The Logger-Cycle-Time is selectable (p.r.t. Configuration). For example "CYCL" = 1:00: A measuring set is recorded after each 60 seconds.

Max. number of data sets:	10000
Cycle time:	0:01...60:00 (minutes:seconds, min 1s, max 1h), selectable in the configuration
A data set contains:	<ul style="list-style-type: none"> - oxygen concentration in mg/l or ppm - oxygen saturation in percent or 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
Recording time:	<p>> 20 days with fresh battery (with output activated: OUT = SEr).</p> <p>With mains adapter: limited just by memory and cycle time, up to 333 days</p>

Starting a recording:

By pressing "Store" (key 6) for 2 seconds the recording will be initiated. After that the display shows 'St.XXXX' for a short time whenever a measuring is recorded. XXXXX is the number of the measuring 1..9999.

If the logger memory is full, the display will show:  The recording automatically will be stopped.

Stopping the recording manually:

By pressing "Store" (key 6) the recording can be stopped manually. Then the following choice appears:



The selection can be made by ▲ (key 2) and ▼ (key 5). "Quit" (key 6) enters the choice.



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!

Clear Recordings:

When "store" is pressed for 2 seconds, the choice for clearing the logger memory will be displayed:



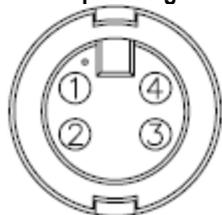
The selection can be made by ▲ (key 2) and ▼ (key 5). "Quit" (key 6) enters the choice.

11 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)!

11.1 Interface

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 ('GMH3x32e.DLL') with documentation, can be used by all 'established' programming languages, suitable for: Windows XP™, Windows Vista™, Windows 7™, Windows 8™
- Programming examples Visual Studio 2010 (C#, C++ and VB), Testpoint™, LabView™, etc.

The device has 4 channels:

- oxygen concentration in mg/l or ppm
- oxygen saturation in percent or 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

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!

11.2 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.

12 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)

13 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.

13.1 Calibration/Adjustment Interval (C.Int)

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

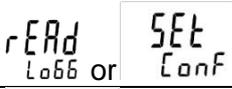
The interval times should be chosen according to the application and the stability of the sensor. "CAL" flashes on the display as soon as the interval has expired.

13.2 Calibration/Adjustment Memory (rEAd CAL)

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

Show Memory:

Historical calibration data can be comfortably read out via PC software GMHKonfig and GSOF3050 or displayed directly at the device:

	Press for 2 seconds: The display will show:		(configuration level)
	Press several times until this is 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	
	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.

14 Alarm (“AL.”)

There are 3 possible settings:

off (AL.oFF), on with buzzer (AL.on), on without buzzer (AL.no.So).

Alarm is given in the following cases (if alarm active, AL.on or AL.no.So):

- Lower alarm boundary (AL. Lo) under-run
- Upper alarm boundary (AL. Hi) over-rum
- Sensor error
- Low battery (bAt)
- 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.

15 Real Time Clock (“CLOC”)

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

16 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:

If device should be certificated for its accuracy, this is not possible for dissolved oxygen measuring, only for abs. pressure and temperature.

17 Replacing Batteries

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?
6. 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!



18 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 device defective	disconnect battery or power supply, wait some time, re-connect return to manufacturer for repair
	sensor error: no sensor cable connected Sensor, cable or instrument defect	connect suitable sensor return to manufacturer for repair
	Value exceeding measuring range Wrong sensor connected Sensor, cable or instrument defect	Check: Is the value exceeding the specified measuring range? ->value too high! Check sensor return to manufacturer for repair
	Value below display range Wrong sensor connected Sensor, cable or instrument defect	Check: Is the value below the specified measuring range? ->value too low! Check sensor 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!
	wrong reference point at air	check sensor and reference gas / solution
	slope too low reference gas / solution wrong sensor is defect	check sensor and reference gas / solution replace sensor / perform maintenance
	slope too high reference gas / solution wrong sensor is defect	check sensor and reference gas / solution replace sensor / perform maintenance
	incorrect calibration temperature	calibration can only be done at 0...40 °C
	Zero value to low/negative sensor is defect	replace sensor / perform maintenance
	zero value to high reference gas / solution wrong sensor is defect	check sensor and reference gas / solution replace sensor / perform maintenance
	incorrect calibration pressure	check calibration pressure
	signal not stable / timeout	check sensor and reference gas / solution
	sensor not known: cannot be calibrated	check sensor and wiring

19 Reshipment and Disposal

19.1 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 devices. Please make sure that the device is protected in the package by enough packing materials.

19.2 Disposal instructions



Batteries must not be disposed in the regular domestic waste but at the designated collecting points. The device must not be disposed in the unsorted municipal waste! Send the device directly to us (sufficiently stamped), if it should be disposed. We will dispose the device appropriate and environmentally sound.

20 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 % O ₂		
	O ₂ partial pressure	0 ... 1200 hPa O ₂ (0.0 .. 427.5 mmHg) ^{*)}		
	Sensor temperature	-5.0 ... + 50.0 °C		NTC 10k (integrated in GWO 3600)
	Absolute pressure	300 ... 5000 hPa abs. 0 ... 40.0 m water column*)		integrated pressure sensor with pressure port
Accuracy at 25°C, 1000 hPa abs	Oxygen	±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%) or air saturated water		
GLP	calibration memory adjustable calibration intervals (1 to 365 days, CAL warning after expiration)			
Data logger	Real-time clock Cyclic: 10000 data sets, cycle time 1s to 60 minutes Single: 1000 data sets, with measuring point input			
Alarm	Buzzer / visual / interface 2 channels: selectable oxygen unit and temperature			
Additional functions	Min / max / hold / auto hold Analog output 0-1V, adjustable			
Housing	Break-proof 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 battery (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			
EMC	The device corresponds to the essential protection ratings established in the Regulations of the Council for the Approximation of Legislation for the member countries regarding electromagnetic compatibility (2004/108/EG) Additional fault: <1%			

*) with accessory, please refer to chapter 8.2.2