

OPERATING MANUAL

ECO 410 / ECO 410T

**O₂-Analyser / oxygen
meter**



B-H86.0.31.DK2-2.1



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1 About this documentation

1.1 Foreword

Read this document carefully and familiarize yourself with the operation of the product before you use it.

Keep this document ready to hand and in the immediate vicinity of the product so that it is available to the personnel/user for reference at all times in case of doubt.

The user must have carefully read and understood the operating manual before beginning any work.

1.2 Legal notices

The liability and warranty of the manufacturer for damages and consequential damages are voided with misuse, disregarding this document, disregarding safety notices, assignment of inadequately qualified technical personnel and arbitrary modifications of the product.

This document is entrusted to the recipient for personal use only. Any transmission, duplication, translation into other languages or excerpts from this operating manual require the consent of the manufacturer.

The manufacturer assumes no liability for print errors.

1.3 Further information

Software version of the product:

- V1.0 or later

For the exact product name, refer to the type plate on the rear side of the product.

Note

For information about the software version, press and hold the ON button for longer than 5 seconds. The series is shown in the main display and the software version of the product is shown in the secondary display.

2 Safety

2.1 Explanation of safety symbols



Danger!

This symbol warns of imminent danger, which can result in death, severe bodily injury, or severe property damage in case of non-observance.



Caution!

This symbol warns of potential dangers or harmful situations, which can cause damage to the device or to the environment in case of non-observance.

Note

This symbol indicates processes, which can have a direct influence on operation or can trigger an unforeseen reaction in case of non-observance.

2.2 Foreseeable misuse

The fault-free function and operational safety of the product can only be guaranteed if applicable safety precautions and the device-specific safety instructions for this document are observed.

If these notices are disregarded, personal injury or death, as well as property damage can occur.



Danger! Incorrect area of application!

In order to prevent erratic behavior of the product, personal injury and property damage, the product must be used exclusively as described in the chapter Description in the operating manual.

- ▶ Do not use in safety / emergency stop devices!
- ▶ The product is not suitable for underwater use (rebreather)!
- ▶ The product is not permitted as the sole measuring device for controlling submersible gas mixtures - The fundamental safety of the gas mixture must be ensured, for example, by calculating the pressure ratios during filling or by safe membrane filter systems or comparison with safe references!
- ▶ The product is not suitable for use in explosion-prone areas!
- ▶ The product must not be used for diagnostic or other medical purposes on patients!
- ▶ Not suitable for use with requirements on functional safety, e.g. SIL!

- ▶ This device may only be used for control purposes when monitoring life-support or other systems important to the user.
- ▶ It must not be used instead of compulsory approval monitoring devices and it is not designed for that purpose. If this device is used for the monitoring of such systems on its own, the manufacturer will not assume liability for damages whatsoever.

2.3 Safety instructions



Danger!

- ▶ Use caution when handling oxygen at levels above 40 vol. % O₂ - high oxygen levels can cause ignition of materials and explosion if not handled properly



Caution!

Empty batteries and batteries of inferior quality can leak more easily, which can destroy the device. Please also observe the instructions in the chapter "Operation and maintenance".

Note

This device does not belong in children's hands!



Danger!

The sensor contains potassium hydroxide (GOEL 381 at ECO 410..-MAX) or acid (GOEL 370 at ECO 410..-35).

- ▶ Potassium hydroxide and acids cause chemical burns!
- ▶ In case of leaking liquid, avoid contact at all costs!

In case of contact:

- ▶ with skin: wash off immediately with plenty of water for several minutes.
- ▶ with clothing: remove contaminated, soaked clothing immediately.
- ▶ with eyes: rinse under running water for several minutes, consult a doctor.

If swallowed:

- ▶ drink plenty of water immediately, do not induce vomiting!
- ▶ Consult a doctor.

2.4 Intended use

The device is to be used exclusively for measuring the oxygen concentration in gas mixtures and air. The measurement is made at the sensor opening.

The device must be calibrated regularly (in fresh air = 20.95% vol. % O₂) to obtain accurate readings.

The ECO 410T is also suitable for displaying the calculated maximum operating depth (MOD) from the measured oxygen concentration.

For the MOD display, only air and NITROX mixtures with an oxygen concentration between 20.9 ... 36.0 vol. % O₂ may be used as dry gases!



Danger!

For safe measurements, the function of the sensor and device must be checked regularly:

- ▶ Regular calibration on ambient air (20.9 vol. % O₂) in accordance with the instructions
- ▶ In the case of higher oxygen values, check the function with a known gas concentration, preferably in the area of the gas to be measured (e.g. pure oxygen, NITROX50 or similar, "bump test")

The MOD function (calculated maximum operating depth for diving) is designed only for use in recreational diving from 20.9 to 36.0 vol. % O₂. It does not replace necessary calculations and application of the rules for planning and performing a safe dive according to NITROX training.

The MOD function is not designed for depth calculation of gas mixtures other than those mentioned above (no "tech-diving", NITROX50, TRIMIX, ...).

Any use of the device in this area requires appropriate training and additional safety measures.

3 Qualified personnel



LCD Display



Device



Sensor in
protective cover



Sensor (top)
flowdiverter
(bottom)



T-piece (mounted)

3.1 Display elements

Display



Battery indicator

Evaluation of the battery status



Unit display

Display of units or min*/max*/hold



Main display

Current measured value or value for min*/max*/hold



Auxiliary display

ECO 410: Measuring value while in min/max/hold

ECO 410T: MOD-value with additional unit text

Note

*= min/max functions are not supported by ECO 410T.

All functions described in this manual for min/max display are not available with this device variant.

3.2 Operating elements



On / Off button

Press briefly Switch on the device
 Activate / deactivate lighting

Long press Switch off the device
 Reject changes in a menu



Up / Down button



Press briefly ► Display of the min/max value
 (not available on ECO 410T)
 Change value of the selected parameter

Long press ► Reset the min/max value of the current measurement
 (not available on ECO 410T)

Both simultaneously Rotate display, overhead display
 ►



Function button

Press briefly ► Freeze measurement (Hold)
 Return to measurement display

Long press, 2s ► Start menu "configuration", (ONF is displayed

Long press, 5s ► Start sensor calibration, (AL A,R is displayed

Operating status ► device is in measured value display
 device is in the min-, max- or hold display
 device is in the configuration menu

4 Operation

4.1 Opening the configuration menu

- 1 Press the Function button for 2 seconds to open the Configuration menu.
- 2 (ONF appears in the display. Release the Function button.

Parameter	Values	Meaning
	 	
<i>InP</i>	Auxiliary display (only available at ECO 410T)	
	% <i>02</i>	No auxiliary display, only display of the oxygen concentration in [vol. %]
	m <i>80d</i>	Auxiliary display: maximum operational depth MOD in meter [m] sea water (for explanation of MOD see #1).
	FT <i>80d</i>	Auxiliary display: maximum operational depth MOD in feet [ft] sea water (for explanation of MOD see #1).
<i>P,Pa5</i>	Air pressure	
	500 ... 12000	Air pressure in [hPa] corresponds to [mbar] (note explanation #2)
<i>Po2</i>	Max. Oxygen partial pressure (only available at ECO 410T)	
	0.2 ... 1.6	Partial pressure in [bar] (Observe extended notes #3 !!)
<i>PaFF</i>	Shut-off time	
	<i>aFF</i>	No automatic shut-off
	0:15, 0:30, 1:00, 4:00, 12:00	Automatic shut-off after a selected time in hours:minutes, during which no buttons have been pressed
<i>L, tE</i>	Backlight	
	<i>aFF</i>	Backlight deactivated
	0:15, 0:30, 1:00, 2:00, 4:00	Automatic shut-off of the backlight after a select-ed time in minutes:seconds, during which no buttons have been pressed

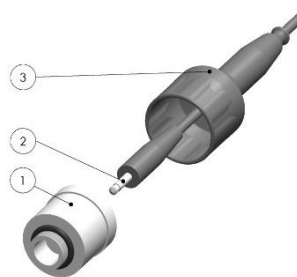
Parameter	Values	Meaning
	on	No automatic shut off of the backlight
init	Factory settings	
	no	Use current configuration
	YES	Reset device to factory settings. After confirming with the function-button, the display shows: init done

Extended notes on the setting parameters:

- 1 Operational depth: max. depth in meters at which, with the mixture used (e.g. Nitrox 32), the set maximum oxygen partial pressure "Po2" (usually 1.4 bar) is reached.
- 2 Air pressure: is necessary for correct calibration and calculation.--
- 3 Max. Partial pressure: Due to the toxicity of oxygen, it is recommended not to be exposed to an oxygen partial pressure above 1.4 bar. This applies under optimal conditions and health. De-pending on the condition of the day and stress (e.g. cold water), this limit should be reduced further down (e.g. 1.2 bar)!

4.2 Changing the sensor

- 1 sensor
- 2 sensor cable
- 3 protective sensor cover



- ▶ Pull the sensor with the connected sensor cable out of the protective sensor cover.
- ▶ Disconnect the used sensor and dispose it properly.
- ▶ Open the tin can with the new sensor.
- ▶ Remove the sensor from the tin can.
- ▶ Connect the sensor to the plug of the sensor cable.
- ▶ Then push the connected sensor into the protective sensor cover.



Caution! Risk of injury!

The lid of the opened tin can is sharp-edged!

Note

The sensor, in particular the sensor membrane, must be protected from dirt and moisture. If the sensor gets wet or falls into water, the sensor should be pulled out of the protective sensor cover to dry. Measurement can only be resumed after drying.

Disconnecting the T-piece and pulling the flow diverter makes it easier to grip the sensor.

4.3 Adjustment to the sensor signal

Note

Before calibration, the current air pressure should be entered in the device menu. The entry is made in the PAbS parameter and is entered in hPa without decimal place.

For safe measurements, the function of the sensor and device must be checked regularly:

- ▶ Regular calibration on ambient air (20.9 vol. % O₂) in accordance with the instructions
- ▶ In the case of higher oxygen values, check the function with a known gas concentration, preferably in the area of the gas to be measured (e.g. pure oxygen, NITROX50 or similar, "bump test")

The device displays a sensor evaluation after calibration.

This can give conclusions about the durability of the sensor.

If the evaluation is below 30 %, for example, the sensor should be replaced.

Carrying out the calibration:

- 1 Press the *Function button* for approx. 5 seconds until CAL appears in the display to call up the **Sensor Calibration**.
- 2 Release the button, CAL Air appears and after completion for approx. 5 seconds the sensor evaluation in 10% steps.

4.4 Measurement on immersion gas cylinders

Note

The combination adapter for compressed air and NITROX (GZ-5826) as well as the T-piece are not included in the standard accessories of every instrument version, but can be purchased separately (see chapter 10.2 Accessories on page 22).

The instrument should be calibrated first, after that a concentration of about 20.9 % must be displayed.

- 1 Screw the combination adapter (GZ-5826) onto the immersion valve of the immersion gas cylinder and tighten hand-tight.
- 2 Screw the flow diverter onto the sensor and hand-tighten (make sure that there is an O-ring on both the sensor and the flow diverter).
- 3 Plug the T-piece (middle connection) onto the flow diverter.
- 4 Plug the T-piece (right or left connection) onto the combination adapter.
- 5 If no combination adapter is available, hold the T-piece directly on the diving valve of the diving gas cylinder.
- 6 Slightly open the valve of the diving gas cylinder until a slight outflow noise can be heard.
- 7 Wait until a stable measured value is displayed. This value is then the desired measured value of the oxygen concentration or the MOD value (only adjustable with the ECO 410T variant).



5 Measurement Basics

5.1 Oxygen principles

The sensor provides a signal which is proportional to the oxygen partial pressure (p_{O_2}).

5.1.1 Oxygen partial pressure and oxygen concentration

The partial pressure is the pressure of one component in a mixture of different components. The sum of all partial pressures is the same as the total pressure of the mixture (Dalton's law). For air, the absolute air pressure (P_{abs}), e.g. 1013 hPa, would be the sum of the partial pressures of each individual component (N_2 , O_2 , Ar , ...). The oxygen concentration is the percentage by volume of oxygen in the air mixture.

As a rule, this is 20.95 % by volume for dry air.

5.1.2 Maximum operational depth (MOD)

In order to slow down the accumulation of nitrogen in the body and thus reduce the risk of decompression sickness, nitrogen-air mixtures with enriched oxygen concentration (NITROX) is used in diving. However, with these mixtures, the maximum possible diving depth is reduced (the oxygen partial pressure increases extremely at depth).

The oxygen partial pressure should be within the limits of 0.16 ... 1.40 bar.

The following calculation is performed in the device based on the measurement and the user inputs of oxygen partial pressure (p_{O_2}) and the absolute air pressure (P_{abs}):

$$MOD [m_{seawater}] = 10 \left[\frac{m_{seawater}}{bar} \right] \times \left(\frac{p_{O_2}}{c} - p_{abs} \right) \left[\frac{bar}{\%O_2} \right]$$



Caution! Incorrect measurement possible!

The device should display about 20.9 % in ambient air.

If this is not the case, it can be corrected as follows:

- ▶ If the air pressure has changed since the last calibration:
Set parameter P_{abs} to the current air pressure.
- ▶ If this does not result in a display of about 20.9 %:
Perform adjustment on ambient air.

The air pressure entered in the P_{abs} parameter is always used to calculate the oxygen concentration. If the air pressure changes after calibration, incorrect measured values will result.

In the ECO 410T version, this also affects the calculation of the MOD display.

6 Operation and maintenance

6.1 Operating and maintenance notices

Note

The device and sensor must be handled with care and used in accordance with the technical data. Do not throw or strike.

Sensor opening must be clean and dry, otherwise incorrect measurements are possible.

Plugs and sockets must be protected from soiling.

If the device is not used for an extended period of time, the batteries must be removed.

Leaks from the batteries are avoided as a result.

6.2 Battery

6.2.1 Battery indicator

If the empty frame in the battery display blinks, the batteries are depleted and must be replaced. However, the device will still operate for a certain length of time.

If the BAT display text appears in the main display, the battery voltage is no longer adequate for operation of the device. The battery is fully depleted.

6.2.2 Changing battery

Danger! Danger of explosion!

Using damaged or unsuitable batteries can generate heat, which can cause the batteries to crack and possibly explode!

- ▶ Only use high-quality and suitable alkaline batteries!

Caution! Damage!

If the batteries have different charge levels, leaks and thus damage to the device can occur.

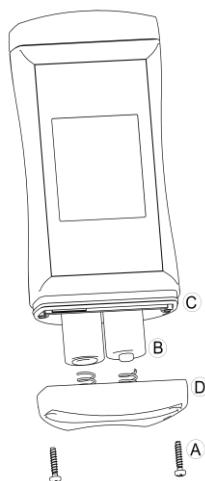
- ▶ Only use high-quality and suitable alkaline batteries!
- ▶ Do not use different types of batteries!
- ▶ Remove depleted batteries immediately and dispose of them at a suitable collection point.

Note

Unnecessary unscrewing endangers the protection against moisture and should therefore be avoided.

Read the following handling instructions before replacing batteries and follow them step by step.

If disregarded, the device could be damaged or the protection from moisture could be diminished.



- 1 Unscrews the Phillips screws (A) and remove the cover.
- 2 Carefully replace the two Mignon AA batteries (B). Ensure that the polarity is correct! It must be possible to insert the batteries in the correct position without using force.
- 3 The O-ring (C) must be undamaged, clean and positioned at the intended depth.
- 4 Fit the cover (D) on evenly. The O-ring must remain at the intended depth!
- 5 Tighten the Phillips screws (A).

7 Error and system messages

Display	Meaning	Possible causes	Remedy
5En5 Erra or strongly changing measuring values	Sensor contact not present. Sensor cable defective Sensor defective or used up	• Sensor not plugged in correctly • Cable breakage • Defective sensor or sensor end of lifetime	► Check sensor connection ► Send in for repair ► Replace sensor or send in for repair
No display, unclear characters or no response when buttons are pressed	Battery depleted System error Device is defective	• Battery depleted • Error in the device • Device is defective	► Replace battery ► Send in for repair
bAt	Battery depleted	• Battery depleted	► Replace battery
Err.1	Measuring range exceeded	• Measured value too high (possibly due to pressurization) • Faulty parameter setting or calibration • Sensor or device defect	► Stay within permissible measuring range - Avoid dynamic pressure ► Check parameter or recalibrate sensor ► Replace sensor or send in for repair
Err.2	Measuring range is undercut	• Faulty parameter setting or calibration	► Check parameter or recalibrate sensor
Err.9	Value could not be calculated	• Measured O2 value too high/low or with error message. • Incorrect parameter entry	► Adhere to measuring range (see also Err.1 / Err.2) ► Check settings ► Send in for repair
545 Err	System error	• Error in the device	► Switch device on/off ► Replace batteries ► Send in for repair
cAL Err.3	Calibration failed: value too low	• Sensor not connected correctly, used up or defective • Incorrect air pressure input	► Check sensor connection. ► Replace sensor ► Check P.Abs value

Display	Meaning	Possible causes	Remedy
cRL Err.4	Calibration failed: value too high	• Sensor not connected correctly, used up or defective • Incorrect air pressure input	▶ Check sensor connection. ▶ Replace sensor ▶ Check P.Abs value

8 Disposal

Separation by material and recycling of device components and packaging must take place at the time of disposal. The valid regional statutory regulations and directives applicable at the time must be observed.

Note



The device must not be disposed of with household waste. Return it to us, freight prepaid. We will then arrange for the proper and environmentally-friendly disposal.

Private end users in Germany have the possibility of dropping off the device at the municipal collection center. Batteries must be removed beforehand!

Please dispose of empty batteries at the collection points intended for this purpose

9 Technical data

Measuring range device	ECO 410(T)-35	ECO 410(T)-MAX
O ₂ concentration	0.0 ... 100.0 Vol.-% O ₂ recommended for 0.2 ... 35 vol. % O ₂	0.0 ... 100.0 Vol.-% O ₂ (also for values ≤0.2 and above 35 vol. % O ₂)
MOD	0 ... 60 m / 0 ... 196 ft (only available at ECO 410T)	
Sensor	GOEL 370	GOEL 381
Application	Standard for diving gas for recreational diving, inert gases with increased CO ₂ content, etc.	e.g. for inert gases with low O ₂ content or high-percentage oxygen mixtures with low CO ₂ content.
Sensor connection	Approx. 0.95 m long cable with jack plug and elastic sensor protective cover	
Process connection	Thread M16x1	
Measurement precision	adjusted to ambient air, constant conditions for measurement, sufficient measurement duration.	
< 35 vol.-% O ₂ :	-0.2 ... +0.35 vol.-% O ₂	± 0.25 vol.-% O ₂
35-100 vol.-% O ₂ :	not specified	± 2.0% * (value-20.9 vol. % O ₂)
Response time sensor	90% in approx. 10 seconds	90% in approx. 12 seconds
Measuring cycle device	approx. 1 measurement per second	
Display	3-line segment LCD, additional symbols, illuminated (white, luminous duration adjustable), Display orientation 180° rotatable (overhead display)	
Housing	Break-proof ABS housing	
Protection rating	IP65 / IP67 (device housing) IP54 (sensor)	
Dimensions	108 * 54 * 28 mm (device, without sensor cable, ...)	
Weight	Approx. 175 g, incl. batteries and sensor	
Nominal temperature	25 °C	

Operating conditions device	-20 to 50 °C; 0 to 95 %RH (temporarily 100 %RH)
Operating conditions sensor	0 to 45 °C (recommended 5 to 30 °C), 600 ... 1750 hPa abs. Permissible differential pressure diaphragm / environment: max ± 0.25 hPa
Storage temperature	-20 bis 50 °C
Current supply	2 * AA batteries (mignon)
Current requirement	approx. 0.8 mA, approx. 2.8 mA with backlight
battery life	Service life > 3000 hours with alkaline batteries (without backlighting)
Battery indicator	4-stage battery status indicator, Replacement indicator for depleted batteries: "BAT"
Auto-power-OFF function	The device switches off automatically if this is activated
Additional functions	Min/max/hold (ECO 410), hold (ECO 410T)
Directives and standards	The devices conform to the following Directives of the Council for the harmonization of legal regulations of the Member States: • 2014/30/EU EMC Directive • 2011/65/EU RoHS Applied harmonized standards: • EN IEC 61326-1:2021 Emission limits: Class B Immunity according to Table 1 Additional errors: < 1 % FS • EN IEC 63000:2018 The device is intended for mobile use and/or stationary operation in the scope of the specified operating conditions without further limitations.

10 Service

10.1 Manufacturer

If you have any questions, please do not hesitate to contact us.

10.2 Accessories

Spare parts:

GB-AA-2	art. no. 479249	Spare batteries AA (2 pcs.)
GOEL 370	art. no. 601490	Spare sensor GOEL 370
GOEL 381	art. no. 610035	Spare sensor GOEL 381

Further accessories:

ESA 369	art. no. 603058	Flow diverter
ZOT 369	art. no. 603094	t-piece for plugging unto EAS 369
GZ-11	art. no. 603144	Flow adaptor for 6 mm hose
GZ-5826	art. no. 482473	Combination adaptor for compressed air (G5/8") and Nitrox (DIN M26)
ST-G1000	art. no. 611373	Protective bag with belt clip
GCLIP 1000	art. no. 475820	Metal belt clip, self-adhesive
G1000_BASE	art. no. 481885	Table stand, wall holder
GKK 1000	art. no. 611603	Case (235 x 185 x 48 mm), with punched lining for 1 device of the G1xxx-/ECO-series
GKK 252	art. no. 601056	Case (235 x 185 x 48 mm), with foam lining for universal use
GS 150	art. no. 610005	Gas pump for sampling

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