Instruction manual of breathing apparatus **T-REB®**

eCOiS® powered by CAN BUS

(CE Issue 1.4.2)

OTHER GRAVITY - sidemount CCR Systems

Copyright notice

Instruction manual of breathing apparatus T-REB®

Important notes and warnings

- Never use a breathing apparatus T-REB® without achieving an appropriate level of training.
- This instruction manual does not replace the skills acquired during the training and the content contained herein shall not be treated as guidelines for diving with a rebreathing apparatus.
- Like any device, breathing apparatus may at any time and without any warning cease to function properly. It is mandatory, during every dive, to have and autonomous breathing system with an open circuit. This system must allow for safely interrupting the use of breathing apparatus T-REB® in every phase of the dive, in case of the failure of the device.
- While using the breathing apparatus T-REB®, do not neglect exercising the skills acquired during the course and constantly deepen your knowledge of diving.
- Making changes to the device results in the immediate loss of the CE certification and cannot guarantee the safety during the dive. Likewise is in the case for negligence in the handling and servicing of the device.
- Making changes to the device results in the immediate loss of the warranty and cannot guarantee the safety during the dive. Only factory service of the device, or its modified parts, can restore the factory-made condition. All activities related to the need to restore the factory-made condition will be burdened by the cost.
- Spare parts, repairs and service of the device are available only to customers that can demonstrate appropriate training certificate authorizing the use of the breathing apparatus T-REB®.
- It is of utmost importance that you carefully read the instruction manual in its entirety.
- If you do not agree with the above cautions and warnings you should not dive with the breathing apparatus T-REB®
- In countries, which are not members the European Union, there may be additional requirements for use of the apparatus T-REB. Before using the apparatus manufactured by OTHER GRAVITY Sp. z o.o., please check the current requirements in force in the country, where you intend to use it.
- The content of this manual is based on the knowledge available at the time of going to print. OTHER GRAVITY Sp. z o.o. reserves the right to introduce amendments at any time.
- Apparatus manufactured by OTHER GRAVITY Sp. z o.o. may only be used with cylinders having legalization consistent with the current requirements applicable in the country, in which you plan to use it.
- Please note that deep diving increases the risk of decompression sickness and other diving diseases. To perform deep dives, you must take special training in an applicable diving center. Apparatus manufactured by OTHER GRAVITY Sp. z o.o. ensures reliable operation to a depth of 100m. Nevertheless, the divers shall adhere to the restrictions prescribed by local regulations in force at the dive site.

Table of contents.

1. Manufacturer.

T-REB®, a rebreathing apparatus with lateral installation system, was designed and is manufactured in Poland by:

Other Gravity Sp. z o. o., Żwirki I Wigury 17, 38-400 Krosno / www.othergravity.com

1.1 CE Certificate.

Apparatus described in this manual has been subjected to a certification process in the notified body, Polish Register of Shipping S.A., and meets the requirements of Directive 89/686/EEC and the standard EN 14143: 2013 Respiratory equipment.

The CE mark indicates conformity with the requirements, and the number 1463 next to the CE mark is an identification code of the Polish Register of Shipping S.A.

2. Introduction

Thank you for purchasing breathing apparatus T-REB® We believe that our device will allow you to perform unforgettable dives and will open new possibilities for underwater exploration. We believe that you will be able to enjoy the parameters of our equipment, developed with the participation of divers and produced using advanced technology.

We thank you for your choice and wish you many safe dives.

Before initial use of the apparatus manufactured by OTHER GRAVITY Sp. z o.o., please read in detail and understand all the information presented in this instruction manual. Getting acquainted, understanding and compliance with its content is a prerequisite for safe and long-term use of the apparatus shown in this instruction manual.

It is recommended to keep this manual for the lifetime of the product. OTHER GRAVITY Sp. z o.o.'s apparatus can only be used in a way that is presented in this instruction manual.

OTHER GRAVITY Sp. z o.o.'s apparatus is a precision mechanism. Due to the important role it plays during the dive, it requires care on the part of the owner / user. For the efficiency and lifetime of the apparatus to be as good as possible, please comply with the recommendations contained in this instruction manual.

The manufacturer hopes that the functional properties of the APPARATUS manufactured by OTHER GRAVITY Sp. z o.o. will give you a lot of satisfaction and make diving more enjoyable.

OTHER GRAVITY Sp. z o.o. shall not be liable for damages resulting from failure to comply with the provisions contained in this instruction manual.

The design of the device was being developed from 2013 and resulted in many hours of dives on the prototype device in various hydrological conditions. The effects of diving on the T-REB® test equipment, as well as the opinions and voices of experienced divers, encouraged us to produce a breathing apparatus that allows its use in the sidemount system (SM), and at the same time allows the apparatus to be easy to use and transport.

Developing the project, we were guided by the following objectives:

•The accuracy and robustness of workmanship thanks to high-end materials such as Delrin and aluminum.

•Integration in a single enclosure of the oxygen supply, counterlungs, radial CO2 scrubber and a system for measuring and controlling oxygen partial pressure.

•The simplicity of design guarantees it is easy to put on the equipment in all conditions.

•Excellent fusion of breathing apparatus with a diver limiting hydrodynamic resistances underwater and on its surface.

•The ability to remove the device underwater and its deposition without the need for ascent.

•The possibility of using of the device with the use of simple and reliable electronics managing partial pressure of oxygen in the breathing loop and informing the diver about the basic parameters of diving with rebreathing apparatus.

•The use of visual alarm system in the event of production of hypoxic or hyperoxic breathing gas in the breathing loop of the apparatus.

•Presentation of reliable test results of respiratory parameters of the device.

3. T-REB® – description of the apparatus

Architecture/scheme of the breathing apparatus T-REB is shown on page 41

3.1 T-REB® – construction and functionality

•Body of the apparatus is made of high-quality, hard, sea water corrosion-resistant aluminum, additionally coated with a layer of ceramic surface with a Teflon surface coating. The remaining structural components were made from high quality Delrin and stainless steel 316L. Counterlungs have a capacity of 4.5 liters, a 3D construction and are covered with polyurethane on the inside, which prevents colonization of the environment by microorganisms.

•The apparatus consists of breathing hoses with ma dive surface valve (DSV), containing the loop directional valves. Apparatus in the upper part of the body contains two counterlungs (exhalation side with an over pressure valve - OPV), a manual diluent valve (MDV) for supply of the diluent with a male-female quick connector, 2l cylinder with first stage regulator for compressed oxygen, an automatic oxygen supply system with solenoid valve and manual oxygen valve (MOV) for supply of the oxygen, with the possibility of connecting an external oxygen source. The upper head with connections to the breathing hoses has an attachment for a bungee loop of sidemount systems on the right side of the diver. The oxygen sensors head with eCOiS® (electronically controlled oxygen injection system) system can be attached to the lower head with oxygen solenoid Valve. Entire upper body is also a closure for the bottom canister that contains the radial flow CO2 scrubber, to which the "snap bolt" carabiner is present for attachment to sidemount systems..

•You can monitor the composition of the gas in the breathing loop on the controller mounted on the forearm. Monitoring of the parameters of the oxygen partial pressure in the breathing gas of the loop is done via the eCOiS® control module. Oxygen is added to the loop automatically via the solenoid valve or manually by operating of MOV.
Additionally, there is a wire transmitting the analog signal of the three oxygen sensors placed within the head. The cable is provided with a universal Fischer connector (7 pin)

•Communication between electronic devices of the eCOiS® system is done digitally with use of the CAN BUS implemented hardware.

3.2 Technical data:

Dimensions	H x W = 750 x 175; Weight netto 17 kg, brutto 19,5 kg
Container with the scrubber	Type: Radial Soda lime: approx. 2.5 kg (Sofnolime 797, 1.0 mm-2.5 mm) Usage time: 180 min Operating parameters: 40 l / min. of air, 1.6l / min. of CO2, 4°C
Scrubber	Sofnolime 797, 1.0 mm-2.5 mm Molecular Products
Oxygen cylinder	2 liters, steel (200 bar)
Diluent cylinder	External supply, minimum 5l, 200 bar
Consumption of gases	Oxygen: Under normal conditions, the oxygen consumption by the diver is 0.7l / min which allows for the theoretical oxygen consumption for 570 min. Taking into account the 30% margin of safety, the oxygen will be sufficient for 400 minutes. 2lx200bar=400l – 30%=280l/0.7l/min=400min Diluent: diluent consumption depends on the technical profile of the dive
Batteries / accumulators	4x 700 mAh LiIon
Capacity of the counterlungs	2x2.25 liters
The permissible depth of the dive	40m with air 100m with trimix **NOTE:** It is strongly recommended not to exceed END = 30 **WARNING:** Diving deeper than 100m is possible, but involves additional risk
Purity of the gases	Air: DIN EN 12021:2014-08 Oxygen: >99.5% (medical oxygen) Helium: >99.996 (Helium 4.0)
1st stage	DIN M26x2, operational pressure 6 ± 1 bar
Oxygen sensors	NaNS01 Oxygen Sensor
Oxygen alerts	Low ppO2: ≤0.4 bar High ppO2: ≥1.6 bar
Temperature ranges	Diving: from +4°C to 34°C Brief exposure to air: from -10°C to + 50°C Storage: +5°C to +28°C
Safety purge valve	10 bar

3.3 Temperature conditions of diving

Diving with the use of breathing apparatus T_REB® can only be performed in the temperature of the surrounding water from +4 to +34 degrees Celsius. Dives beyond this temperature range can lead to transient disturbances of the process of diving.

3.4 The physical effort during the dive

Breathing apparatus T-REB® is designed as a device for respiration during recreational and technical dives in the water without making a physical effort other than the change of depth and calm, horizontal movement. Breathing apparatus T-REB® can be used in conditions of increased physical activity, however, one should take into account all the risks that are its consequence. In particular, increased oxygen consumption, increased excretion of CO2, the extension of the reaction zone of the scrubber, increasing the breathing resistance and the possible CO2 retention in the lungs and its effect on decompression. With this in mind you should always have an adequate margin of safety resulting from the knowledge of the capabilities of your own body. It should be remembered that the risk of dangerous course of the dive with increased physical effort increases with depth.

3.5 Visibility

On the surface and during the dive, the diver has the ability to monitor the indications on the display by placing it on the forearm or wrist on the side on which the apparatus is mounted. This means that at any moment it is possible to monitor the basic parameters of the dive. In extreme cases of the lack of visibility, the breathing gas and setpoints parameters may remain unread. Therefore it is recommended to the dive in conditions of not less than 30cm. No possibility of reading the indications of the instrument constitutes an enormous operational risk for the dive.

3.6 Oxygen under high pressure

Breathing apparatus T-REB® is designed as a breathing device in which existing breathing mixture is supplemented with the oxygen stored in a high pressure vessel. The device is adapted to such conditions and is in compliance with oxygen purity. Take extra care when filling the bottles with oxygen and keep all components in oxygen purity. Repair and maintenance of parts exposed to high pressure oxygen values can be performed only by the relevantly authorized services. Failure to comply with these instructions may result in fire or explosion, which can lead to a bodily injury or death.

3.7 The expected concentrations of respiratory gases

The eCOiS® electronic system of the breathing apparatus T-REB® is designed as a device for breathing in which existing breathing mixtures is supplied with the oxygen up to the partial pressure between 0.4 and 1.6 bar.

3.8 The high partial pressure of oxygen

The breathing apparatus T-REB® is designed as a device for breathing in which existing breathing mixtures is supplied with the oxygen up to the partial pressure between 0.4 and 1.6 bar.

3.9 The expected concentration of gas in the respiratory mixture of the loop

As mentioned, the partial pressure of oxygen in eCCR of T-REB® is between 0.4 and 1.6 bar (high and low). In this respect, it is also possible to set the setpoint value. Defined and set oxygen partial pressure will result in varying its concentration depending on the depth.
The following table shows the values of selected parameters to a depth of 100m.

Depth	Pressure	Setpoint	PPO2 (bar)	O2 (%)	PPN2 (bar)	N2 (%)
0	1.0	0.7	0.7	70	0.3	30
3	1.3	1.3	1.3	100	0	0
6	1.6	1.3	1.3	81	0.3	19
10	2.0	1.3	1.3	65	0.7	35
20	3.0	1.3	1.3	43	1.7	57
30	4.0	1.3	1.3	32	2.7	68
40	5.0	1.3	1.3	26	3.7	74
50	6.0	1.3	1.3	21	4.7	79
60	7.0	1.3	1.3	18	5.7	82
70	8.0	1.3	1.3	16	6.7	84
80	9.0	1.3	1.3	14	7.7	86
90	10.0	1.3	1.3	13	8.7	87
100	11.0	1.3	1.3	12	9,7	88

As can be seen the concentration of nitrogen will be increased along with the depth. In order to maintain END = 30m at the greater depths, it is necessary to use breathing mixtures containing helium. Such dives require additional training and refined skills.

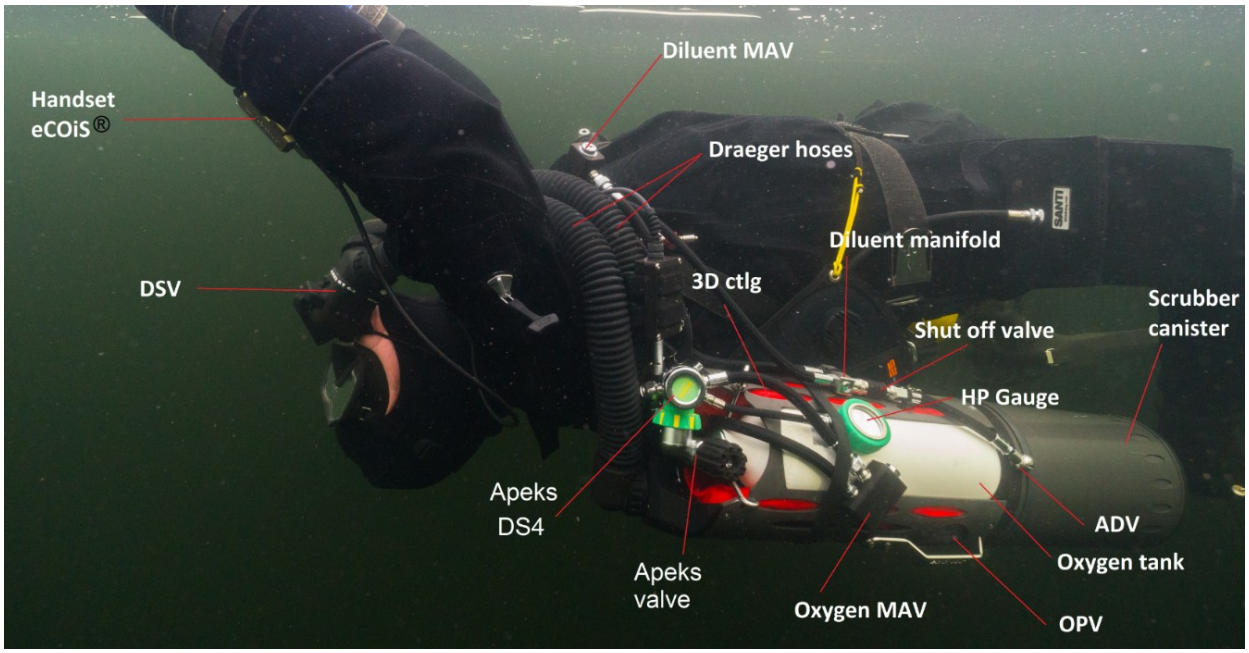
3.10. The use of high concentrations of oxygen in the respiratory mixtures

The human nervous system is susceptible no oxygen's toxicity that is caused by a combination of pressure and exposure time. Prolonged exposure to pressures above 0.5 bar results in oxygen toxicity of the lungs. Exposure to the elevated partial pressure of the oxygen can be monitored by means of the so-called oxygen toxicity units (OTU). One unit is equivalent to breathing pure oxygen for one minute at a pressure of 1 bar. You should not exceed the value of 300 OTU per day.

There can also occur oxygen toxicity, which directly affects our nervous system, leading to the loss of consciousness and uncontrolled seizures. While diving with the breathing apparatus T-REB®, you should avoid exposure to high partial pressures of the oxygen.

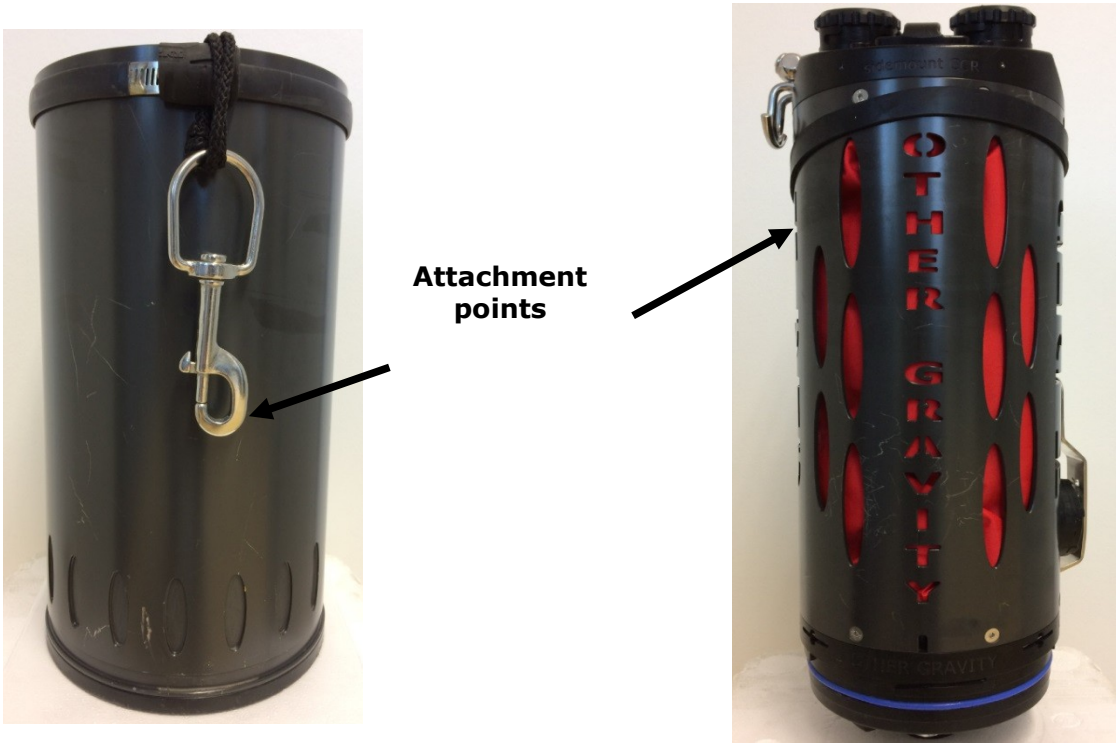
4.0 Construction of the apparatus

In this chapter we will discuss the essential components of the apparatus. Our intention is to acquaint the user with the possibility of assembly, disassembly of the elements of the apparatus.



4.1 Body.

The body of the apparatus consists of two cylindrical parts, upper and lower. The lower part has a bottom, and a clamp with a "snap bolt" type carabiner attached to it by a cable for attaching to any diving harness. In its form, it is a container for the supply with the scrubber, as well as the basis for the entire device. It is connected to the upper body by a secured bayonet connection. The top part is an openwork cylinder and constitutes a cover for the counterlungs and the oxygen cylinder. From the top and the bottom, the cylinder is limited by the functional heads made of POM-C.

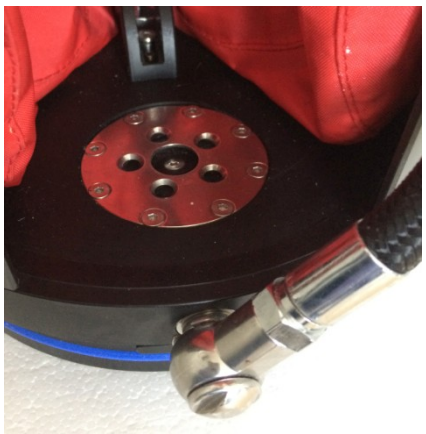


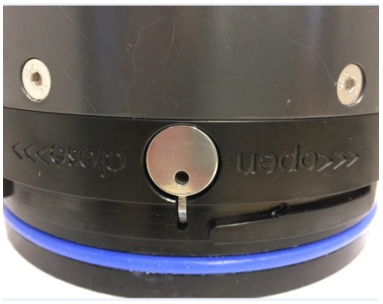
4.2 Heads of the upper body

The functionality of the apparatus is primarily affected by structural components of the heads limiting the light of the main body.

The upper head has connectors for the breathing hose with bayonet mounts that prevent the reverse connection of hoses. In addition, there is an opening in the head, through which the oxygen cylinder is mounted to the body between the counterlungs. The head contains an output of the communication cable connecting the display with the electronics, which control the solenoid valve of the oxygen. The body of the head also contains a connection for the LP hose, which supplies diluent to the inhalation part of the apparatus. On this head, there is also a mounting system for "bungee" of the side system.

The lower head has a bayonet connection to the lower body and has an integrated anty-collapse system to automatically add diluent (ADV; automated diluent valve) and the oxygen solenoid valve. In its bottom part, the head constitutes a socket for the electronic system of





the apparatus, which simultaneously act as a passage for the gas without carbon dioxide following from the scrubber.

Both the upper and lower head have counterlungs bayonet connections with the possibility of dismantling.

4.3 Oxygen cylinder and the automatic oxygen supply for the breathing apparatus

Breathing apparatus T-REB is equipped with a single 2 l oxygen cylinder placed inside the upper body between the counterlungs. The oxygen supply is performed by the first stage of the diving automatic breathing supply with the M26x2 connector, through two hoses that supply the electronically controlled solenoid and MOV (manual oxygen valve) that allows for manually dispensing oxygen to the system. The oxygen pressure in the system does not exceed 7 bar. The I st stage regulator has a relief valve enabling opening at a pressure of 10 bar to prevent rupture of LP hoses.

4.3.1 Breathing gas supply system for the breathing apparatus

Breathing apparatus T-REB is equipped with a breathing gas supply system having an oxygen content from 1% to 50%. The system is built from a quick connector, a manifold, a shut-off valve of the gas supply to the ADV system, and the MDV (manual diluent valve). The system has a relief valve enabling opening at a pressure of 12 bar to prevent rupture of LP hoses.

4.4 Breathing counterlungs.

Breathing apparatus T-REB is equipped with two counterlungs with a total capacity of 4.5 liters. Counterlungs are made of ballistic nylon and the interior is covered with an integrated layer of polyurethane with properties that protect this environment against the development of microorganisms. Counterlungs are attached to the heads by a bayonet locking system. Inside the counterlungs, there are polyethylene spirals, which prevent them from completely collapsing in case of the pressure difference at the ends. The exhalation counterlung is provided with a water trap, from which it is possible to remove the fluid through a relief SiTech valve, additionally protected by a steel spur. Counterlungs have a 3D design which greatly reduces breathing resistance of the system.

4.5 CO2 scrubber.

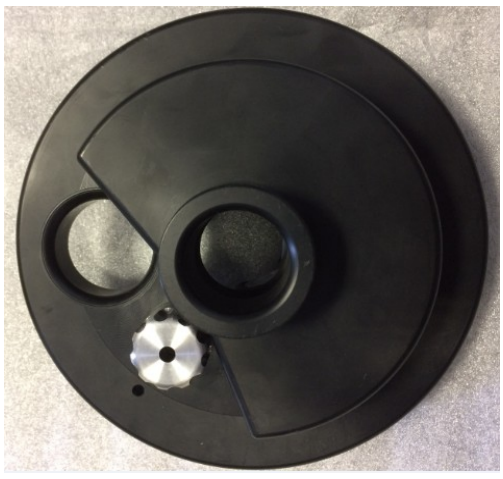
CO2 scrubber in apparatus T-REB is poured into a container designed to allow radial flow of the gas. The container holds up to 2.5 kilograms of Sofnolime 797 lime with grain size of 1.0mm - 2.5mm. This is an amount sufficient for 180 minutes of dive. Container shall be filled with the above quantity of lime and evenly tapped for optimal arrangement of crystals against each other. The container is filled at a time when it is possible to mount the bayonet cover. The amount of lime, with the aforementioned parameters, poured into the container should be strictly adhered to.

4.6 DSV and breathing hoses

Breathing apparatus T-REB has a mouthpiece, which contains an integrated shut-off valve between the inhalation loop and the DSV environment. The valve has two extreme positions. Open and closed. Breathing in the loop should only occur at the extreme opening of the valve. The mouthpiece can be removed from the mouth only at the extreme closure of the valve. This rule must be strictly observed. In the water or under its surface, with the closed valve of the mouthpiece, breathing loop may be taken only after emptying the mouthpiece from the water through a strong exhalation and then turning the valve to the extreme open position. Another procedure may result in flooding the system with water.
The mouthpiece contains integrated directional valves of the loop, which provide a directed gas flow. Before every dive, you should check their condition and correct installation.
The mouthpiece has breathing hoses connected using bayonet connectors, which constitutes the physical connection to the apparatus

4.7 Sensors compartment and enclosure for electronics and power supply of the apparatus

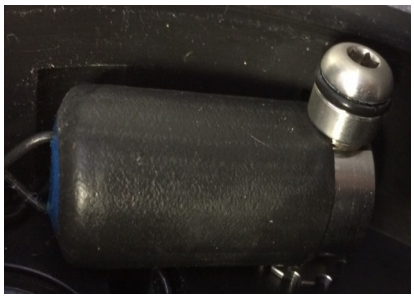
Breathing apparatus T-REB comes with a compact, easily removable socket for three NaNS01 Oxygen Sensors. This socket, together with sensors, can be stably integrated with the enclosure for electronics and the power supply of the apparatus. The sensors are connected to an electronic inspection system using cables with gold-plated SMB connectors. Electrical system is fully built-up and sealed together with an integrated lithium ion battery. Charging is made via the connector on the cable.



Body of the system's electronics is firmly mounted on the lower head of the breathing apparatus, from the side of the scrubber, and the digital communication with the display and the electrical communication with the solenoid valve is done by gold-plated spring contacts not placed in a dedicated slot.
Both the electronic components and the battery are completely separated from the system and the sealing used protects the system against humidity and changes in ambient pressure. Charging the battery with a total capacity of 2800 mAh is done by connecting the head to a standard USB power adapter using the supplied cable. Charging time of a fully discharged system is approx. 3 hours. Electronics compartment is sealed and cannot be opened otherwise than by the service of Other Gravity Sp. z o. o.

4.8 Solenoid valve.

The solenoid valve is characterized by very low power consumption and high refinement. For safety reasons, it is in a de-energized state, the position is always closed and uncontrolled increase in the oxygen pressure in the system is unable to open it. The valve is not to be disassembled and in the event of a malfunction is to be replaced only by the service of Other Gravity Sp. z o. o.



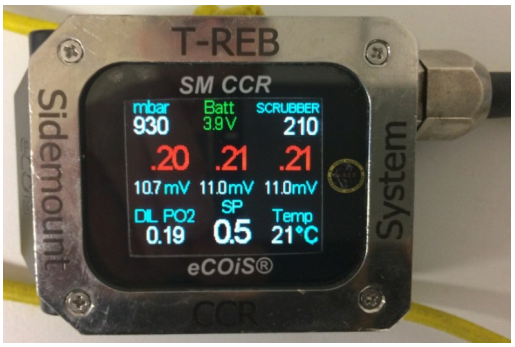
4.9 Oxygen sensors

Three oxygen sensors required for correct operation of the eCOiS® system of the breathing apparatus T-REB are mounted on a separate adapter and do not require tools for installation.
Adapter with sensors mounted in the head allows them to be connected with the cables in such a way that the sensors get positions 1, 2 and 3 on the controller, clockwise.

5.0 Controllers of eCOiS® system.

Self contained breathing apparatus T-REB® is equipped with a system to control the partial pressure of oxygen in the loop and, in addition, with a cable that allows to read the sensor readings on the dedicated decompression instruments (e.g.: manufactured by Shearwater)
The first one manages the basic parameters of the apparatus operation, which consists of monitoring the partial pressure of oxygen in the breathing loop. This controller does not turn off automatically after turning it on and constitutes eCOiS® system. It consists of two parts, the interface in the form of a display - the drivers and electronic supervision and power supply unit. Communication between components is done digitally. In the breathing apparatus T-REB®, eCOiS® allows the control of depth, manages the time of consumption of the CO2 scrubber, allows calibration of sensors for the selected gas with a specified the oxygen content, programming and use of multiple gas mixtures, setting six values of the partial pressure of oxygen to choose from during the dive. On the surface and during the dive, the eCOiS® system oversees the set partial pressure of oxygen, it informs about the indications of three sensors, about the PPO2 value of the oxygen in the currently selected diluent at every stage of the dive, and about the dive depth and time. In the case of exceeding the limit values of PPO2 (below 0.4 and above 1.6) in the breathing loop, the eCOiS® system activates a visual alert.
The second controller is the decompression computer selected by the diver, to which the signal is transmitted in analog form (mV).

Upper button



Lower button

5.1. Preparing the eCOiS® system for operation.

Preparing the eCOiS® system involves connecting the enclosure of the electronics to the upper body of the breathing apparatus T-REB®. As a result of this operation, the controller is supplied with power and the Fischer Connector is supplied with voltage from the oxygen sensors.

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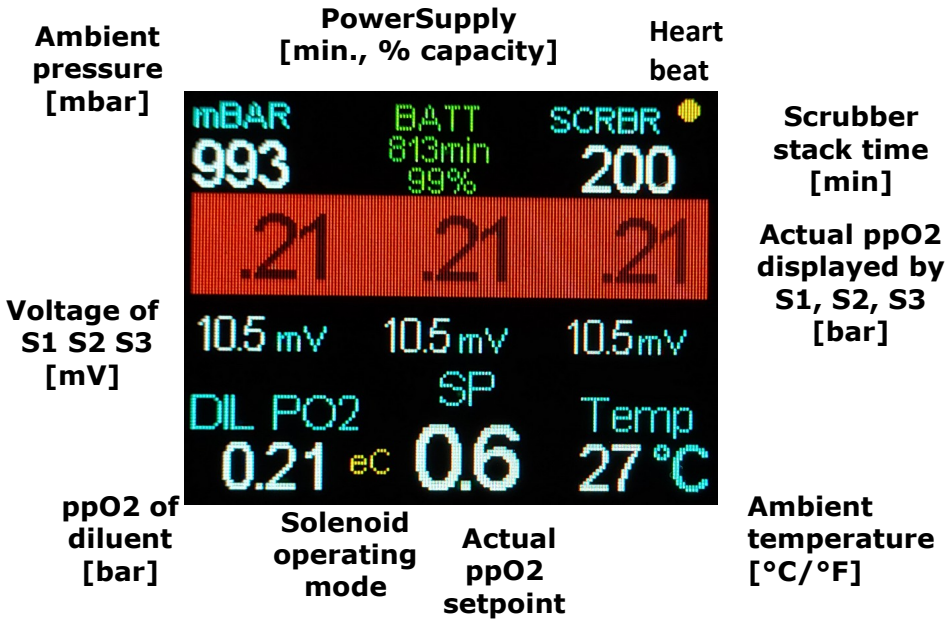
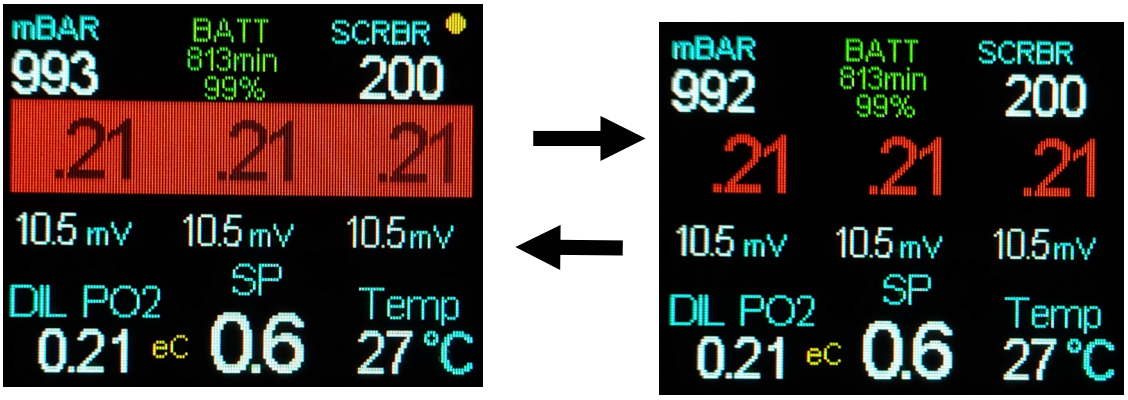
Powered controller allows the activation of the system by using the upper and lower control buttons,. To do this, press the upper and the lower button simultaneously for 5 seconds. A welcome screen appears with company logo and information about installed firmware versions for handset and sensor head.

At this moment, the eCOiS® system will start up in surface mode. The display will show such operating parameters as heart beat ambient pressure expressed in millibars, power supply voltage expressed in operating time remaining and percentage of capacity left, the time remaining to the end of operation of the CO_2 absorbent, partial pressure of oxygen in the system, along with the value of the voltage on the oxygen sensors no. 1, 2 and 3, counted from the left side, the value of the partial pressure of the diluent at the current ambient pressure, the setpoint value set and the temperature measured in handset and solenoid operating mode.



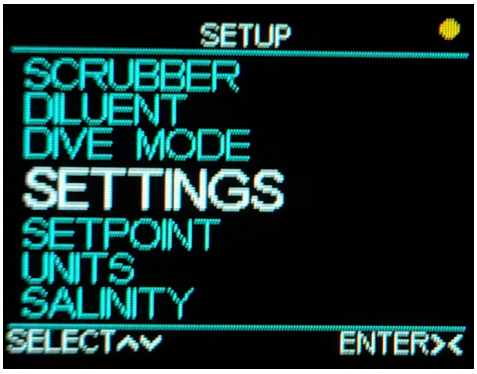
The controller can be switched off only in the surface mode, by simultaneously pressing the lower and the upper button for at least 3 seconds.

From this moment the eCOiS® system is activated, the visual blinking alert system is activated if the partial pressure of oxygen drops below 0.4 bar or the value increases above 1.6 bar.



5.2. Surface operation mode of the controller

After starting the eCOiS® controller, it is possible to activate setpoint parameters (SETUP) by briefly pressing both buttons.



The SETUP Menu consists of nine items that you can select by scrolling with the upper or the lower button presses (SELECT, ^v). Approval of the selection is made by simultaneously pressing buttons (ENTER> <). This way of scrolling / changing the parameter (^v) and its selection / approval (> <) is the rule for the eCOiS® controller.

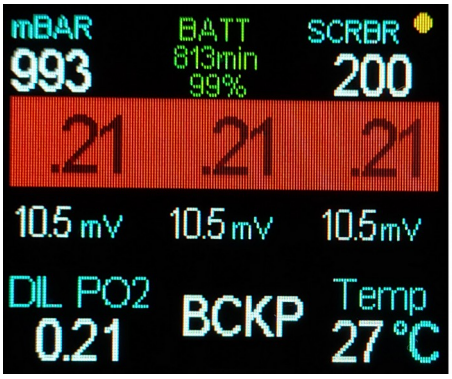
5.2.1. Selecting the operating mode of the oxygen solenoid valve (SOLENOID).

The eCOiS® system in the SOLENOID mode allows three settings for the algorithm managing the oxygen dosing in the breathing loop - eCOiS, Classic and BCKP.

Each time the control device is switched on, the supervision of the partial pressure in the breathing loop of the apparatus is taken over by the specially developed in the laboratories of Other Gravity Sp. z o. o. eCOiS algorithm. It is recommended to use it in all conditions in which the control system and depth indications operate.
In case of failure of the depth sensor, the system should be switched to CLASSIC mode. The eCOiS algorithm is not available when the manual mode is active - DIVE MANUAL (description below). In addition, the eCOiS® system gives the diver the ability to turn off the oxygen solenoid valve for the purpose of diving with the T-REB as a bailout / backup device or for dives scenarios in which the diver uses T-REB as a deposit. The BCKP ON operating mode leaves all functions of the eCOiS® system active except for the control of the setpoint of partial pressure oxygen SP (setpoint).

Accidental activation of the BCKP mode is burdened with unacceptable risk of oxygen PPO2 drop in the breathing loop, therefore in order to activate it, both buttons should be pressed simultaneously three times.

When the BCKP mode is enabled, it is not possible to enter the SETUP menu in the surface function of the eCOiS® system.
The symbol of the BCKP mode is displayed instead of the value of the SP setting both on the surface and under the water.



Accidental return from the BCKP mode is burdened with unacceptable risk of unwanted or uncontrolled inflow of oxygen to the breathing loop, therefore in order to activate it, both buttons should be pressed simultaneously three times.

5.2.2. Selection of the T-REB breathing apparatus dive mode (DIVE MODE)

The T-REB breathing apparatus can be used in two DIVE AUTO and DIVE MANUAL operating modes. The DIVE AUTO mode is the mode of choice and does not need to be adjusted after switching on the eCOiS® system.

The DIVE AUTO mode allows automatic recognition of the immersion moment, taking into account the data from the pressure sensor placed in the handset.
The eCOiS® system goes into dive mode after changing the ambient pressure by 50 mbar in less than 30 seconds. From now on, it becomes impossible to turn off the system until the end of the dive. In this mode, the SETUP functions are no longer available. The displayed data also changes. Instead of the pressure in mbar, the depth display appears in meter or feet. Instead of the scrubber stack time, the dive time is visible, which according to the EN13319 standard will be calculated from the depth of 1.6 m (~ 5 ft) and is given in minutes.

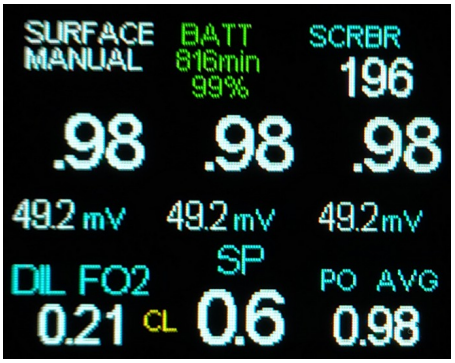
Depth [m/ft]

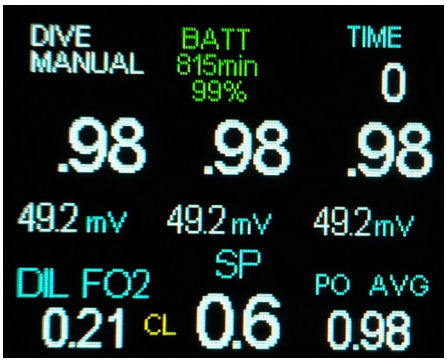
Dive time [min]

The exit from the dive mode takes place after 5 minutes from reaching the depth less than 1.6 m determined by the EN13319 standard. Then all functions of the SETUP menu will be available.

The DIVE MANUAL mode activates system functions that do not require pressure and temperature data.

Mode





FO2 of diluent [bar]

Actual average ppO2 [bar]

The DIVE mode must be selected manually by pressing the upper button twice. Otherwise, the system will not measure the time of the dive.
To end the DIVE mode press the upper button twice. You will return to SURFACE mode.
In the DIVE MANUAL mode it is not possible to switch the eCOiS off. You must leave this mode by choosing DIVE AUTO and then switch the system off.

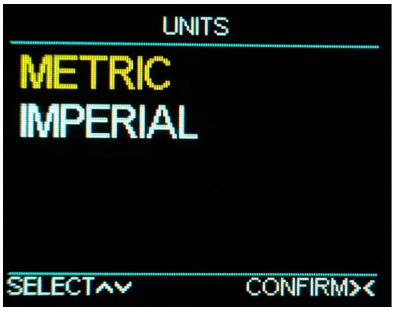
5.2.3. The choice of setpoint values for the partial pressure in the loop (SETPOINT)

SETPOINT menu offers the possibility to set two parameters. SETPOINT LOW in the range of 0.5 to 0.9 oxygen partial pressure (PPO_2) and SETPOINT HIGH in the range of 1.0 to 1.5 oxygen partial pressure (PPO_2).

After selecting the SETPOINTS, we may leave the menu by approving the EXIT item.

5.2.4. The choice of units (UNITS)

The controller can inform us about the environment parameters using units such as feet and temperature in Fahrenheit degrees (IMPERIAL, ft, °F) or meters and Celsius degrees (METRIC, m, °C)



The choice of units, CONFIRM, will exit the menu and return to the SETUP.

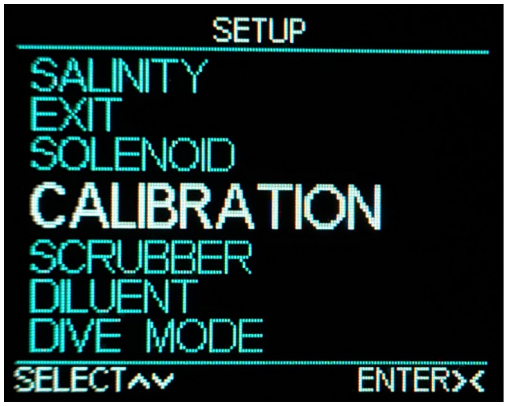
5.2.5. Selecting the salinity of water according to EN13319 (SALINITY)

The controller can inform us about the depth during the dive according to the type of water in which we are immersed. The calculation of depth depending on the salinity of the water is done in accordance with the EN13319 standard.

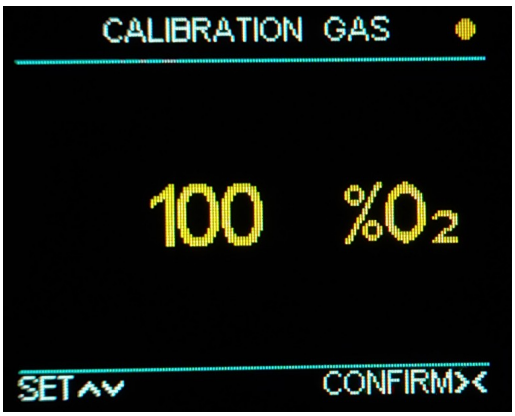
Selecting the current type of water, fresh (FRESH) or salt (SALT), by using CONFIRM function, will exit the menu and return to the SETUP.

5.2.6. Calibration of the oxygen sensors (CALIBRATION)

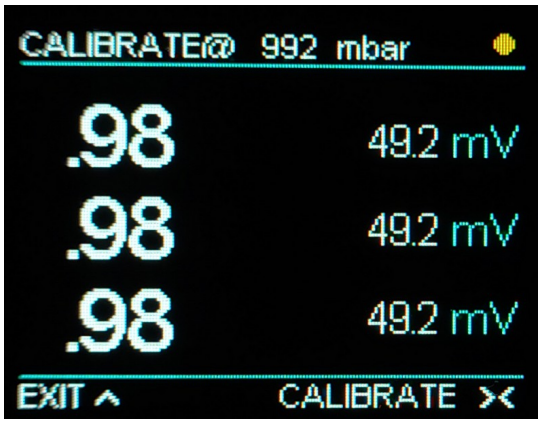
In order to calibrate the oxygen sensors integrated into the eCOiS® system, you must first select the parameters of the calibration gas on the display. The eCOiS® system allows you to calibrate against air (21%), as well as gases having an oxygen content of 90 to 100%.
The choice of calibration gas and its approval gives us an insight into the oxygen saturation process expressed by the value of mV for each sensor at the current atmospheric pressure. The CALIBRATION menu allows you to calibrate the sensors in two modes. AUTO - data on ambient pressure are taken from the pressure sensor and MANUAL - data on the ambient pressure must be entered manually.



To calibrate the oxygen sensors integrated in the eCOiS® system, first select the calibration gas parameters on the display. The eCOiS® system allows calibrating against air (21%) and gases with oxygen content from 90 to 100%. Alternatively, in the MANUAL mode actual ambient pressure has be entered.

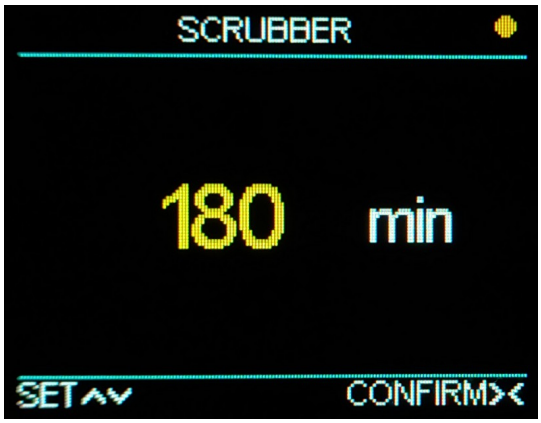


After stabilizing the voltage value at the given parameters, we can approve the calibration process by selecting CALIBRATE, which will automatically exit to the SETUP mode.
At this stage it is possible to leave the CALIBRATE mode by pressing the lower EXIT button



5.2.7. Setting the remaining operation time of the CO2 scrubber (SCRUBBER)

During the dive, the consumption of CO2 scrubber is calculated. Using the controller, you can select the time of operation from 30 min to 600min (for the largest scrubbers possible to be used in the device). For the scrubber containing soda lime in the amount of 2.5 kg, the setpoint should be 180 min.



The choice of the operation time, using the CONFIRM function, will exit the menu and return to the SETUP.

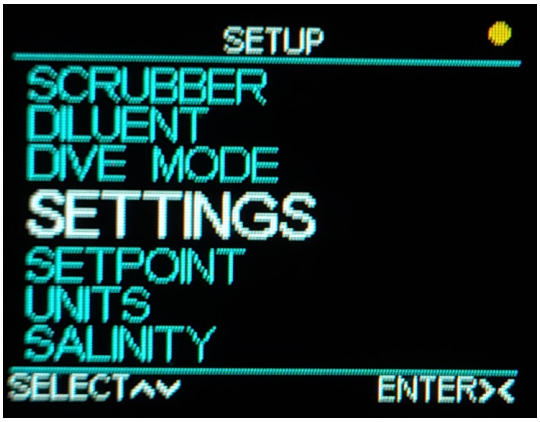
5.2.8. The choice of the oxygen content in the breathing loop gas (DILUENT)

Breathing apparatus T-REB allows for supply of the breathing loop with gas mixtures with an oxygen content of 1% to 50%. The selection of the current value is made in the DILUENT menu.

Approval of the selection of the percentage of oxygen in the respiratory mixture (CONFIRM) will return to SETUP.

5.2.9. Selecting the display mode (SETTINGS)

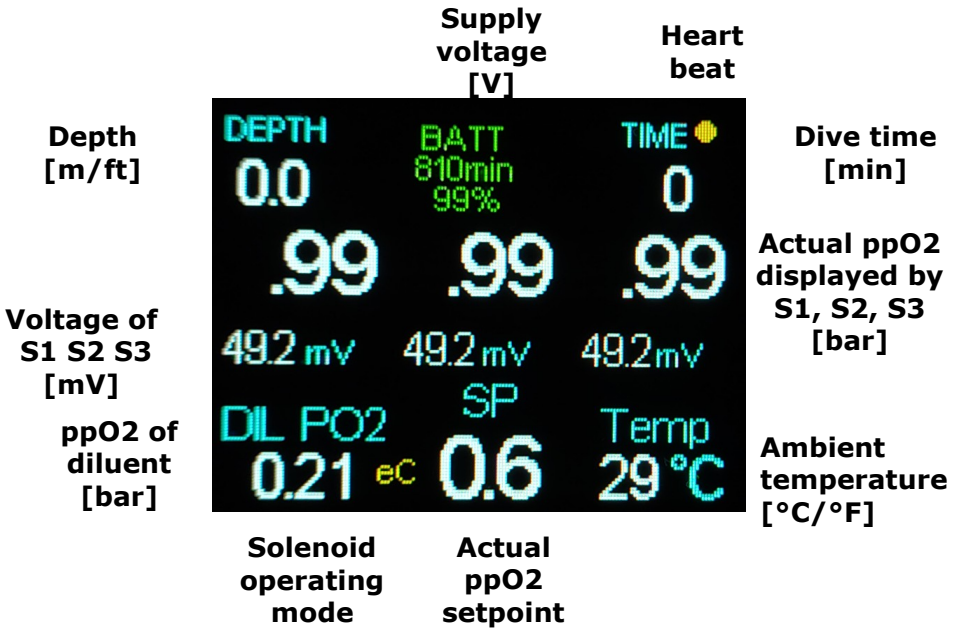
Display brightness can be adjusted in the DISPLAY menu within the range of BRIGHTNESS options by selecting the CAVE (5%), 25%, 50%, 75% or 100% value. In addition, in the case of mounting the display on the second arm, we can use the FLIP option.



5.3. Controller operation in the eCCR dive mode.

During the dynamic change of pressure by the value of +50 mbar, the eCOiS® system goes into the dive mode. This means that the display shows the value of Depth expressed in meters or feet and Time expressed in minutes. After 10 minutes of lack of change in depth, the system returns to the surface operation mode.

The system recognizes that diving starts at a depth of 1.6 m (+160 mbar pressure against the initial value). From this point, the dive time and the consumption of CO2 scrubber is calculated. Turning the controller off in the dive mode is impossible.



During the dive mode using the settings (SETUP) is limited to a few functions described below.

Pressing briefly two controller buttons simultaneously will activate the SETUP menu for setting SETPOINT, DILUENT, DISPLAY and SOLENOID.

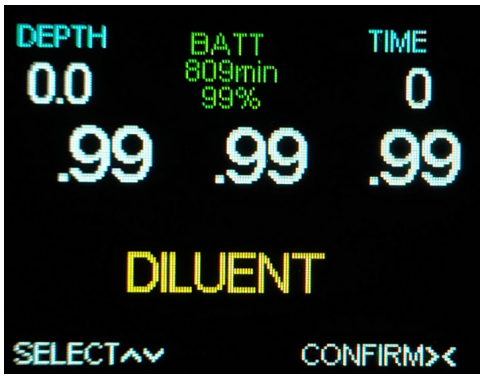
5.3.1. Changing the setpoint of the partial pressure of oxygen (SETPOINT).

Pressing briefly two controller buttons simultaneously will activate the SETUP menu for setting SETPOINT, DILUENT, DISPLAY and SOLENOID. Menu scrolling is possible using individual buttons, the selection of the SETPOINT option is activated by pressing them simultaneously.

In the SETPOINT menu we are able to select the for SETPOINT LOW and SETPOINT HIGH, which have been defined in the surface operation mode. Manually changing the set point in the range of 0.4 to 1.6 is possible in manual mode SP M (setpoint manual).
Approval of the settings will result in return to dive mode.

5.3.2. Setting up the fraction of oxygen in the breathing gas (DILUENT).

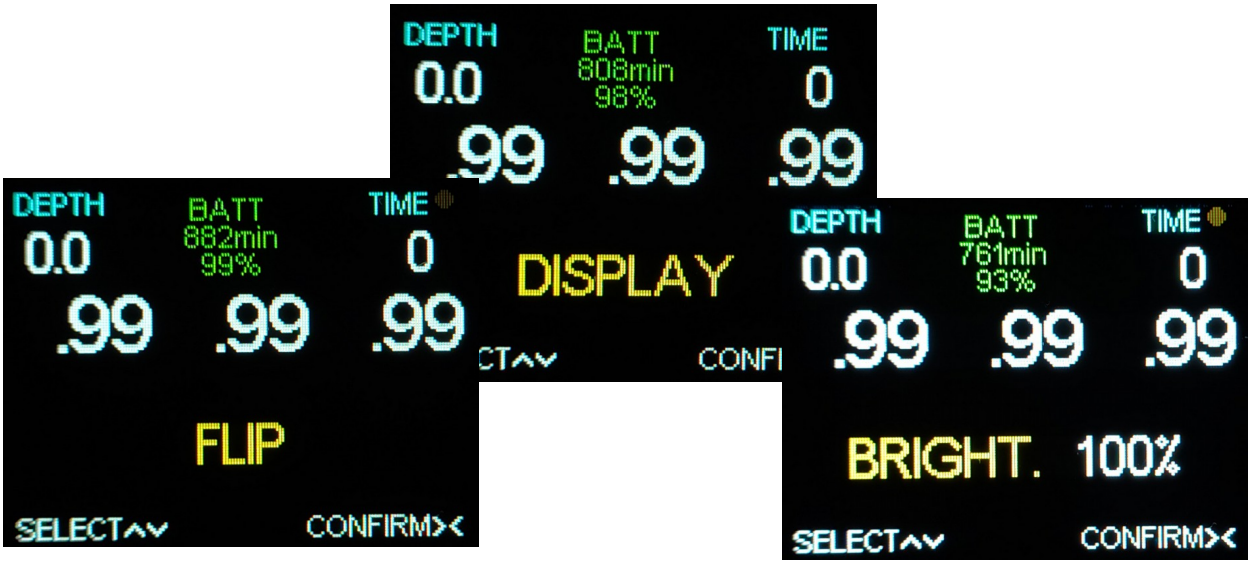
Pressing briefly two controller buttons simultaneously will activate the SETUP menu for setting SETPOINT, DILUENT, and DISPLAY. Menu scrolling is possible using individual buttons, the selection of the DILUENT option is activated by pressing them simultaneously.
The oxygen content in the breathing gas is permissible in the same range as in the surface



operation mode (1% - 50%). Oxygen fraction confirmation will result in the return to the dive mode of the display. The partial pressure of oxygen in diluent will be calculated and displayed for the current depth.

5.3.3. Selecting the display mode (DISPLAY)

Pressing briefly two controller buttons simultaneously will activate the SETUP menu for setting SETPOINT, DILUENT, and DISPLAY. Menu scrolling is possible using individual buttons, the selection of the DISPLAY option is activated by pressing them simultaneously.

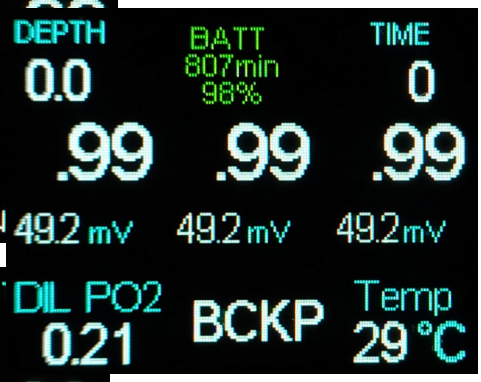


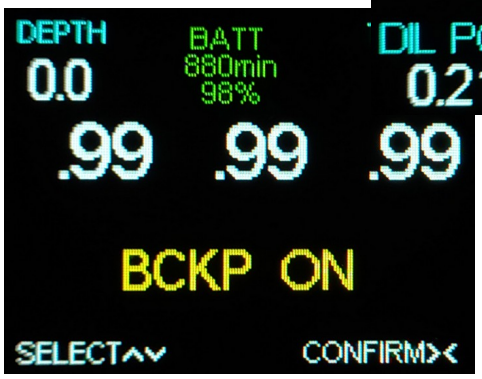
Display brightness can be adjusted in the DISPLAY menu within the range of BRIGHTNESS options by selecting the CAVE (5%), 25%, 50%, 75% or 100% value. In addition, in the case of mounting the display on the second arm, we can use the FLIP screen option.
Selection of brightness or change of the FLIP option will result in return to dive mode.

5.3.4. Solenoid operation mode (SOLENOID)

In dive mode three solenoid modes are available. First and default is the eCOiS® mode. It should be used always when pressure sensor is working properly. In case of Pressure sensor failure (usually the displayed depth will be 300m and will no vary) we recommend the use of CLASSIC mode which excludes data coming from depth in oxygen portion calculation. Both modes are selected by simultaneous pressing of two buttons.

For special purposes, a BACKUP mode is available. To activate and deactivate this mode two buttons has to be pressed three times. Instead of SP on screen, BCKP ON will be displayed indicating that solenoid is switched off. In this mode all other functions of the eCOiS system are unavailable. The system will only indicate the actual status of batteries, ppO2 and milivolts on sesors, depth, ppO2 in diluent at depth and temperature.





Accidental activation of the BCKP mode is burdened with unacceptable risk of oxygen PPO2 drop in the breathing loop, therefore in order to activate it, both buttons should be pressed simultaneously three times.

Accidental return from the BCKP mode is burdened with unacceptable risk of unwanted or uncontrolled inflow of oxygen to the breathing loop, therefore in order to activate it, both buttons should be pressed simultaneously three times.

6. Preparation for usage, putting on and adjusting the apparatus

Safe use of the apparatus is possible only by ensuring appropriate level of care for the equipment. The apparatus should be stored, transported and used under conditions which prevent physical damage to any of its components.

T-REB was intended for usage with sidemount diving systems

6.1 Inspection of the apparatus before the dive.

1. Before the dive be sure that the batteries of the eCOiS system are entirely charged.

2.You should be absolutely sure that the container with the CO2 scrubber contains fresh soda lime, ensuring the implementation of the dive for the planned time.

3. Analyze the contents of the selected diving oxygen cylinder and the contents of the adopted diluent.

4. Prepare and check the open circuit gas resources prepared for the dive.

5. Connect the oxygen cylinder to the apparatus.

6. Put the container with soda lime into the lower canister of the apparatus.

7. Assemble the unit and make sure that the bayonet connector is fully closed.

8. Verify that the oxygen cylinder is fixed firmly and the regulator is installed properly.

9. Check the operational direction of the directional valves of the loop.

10. Connect the breathing hoses to the body of the apparatus.

11. Open the oxygen and diluent valves, and check the gas pressure on the control gauges.

12. Measure the intermediate pressure of the oxygen and diluent. Oxygen may exceed 7.0 bar, diluent must have the pressure of 9.0-10.0 bar.

13. Connect the diluent to the apparatus with quick connector.

14. Check the operation of the MOV and MDV inflation valves, as well as ADV of the anty-collapse system.

15. Disconnect the diluent from the apparatus and leave the MDV under pressure.

16. Check the operation of the DSV valve.

17. Perform a leak test with closed OPV relief valve by inflating the apparatus with the exhaled air. Keep the overpressure in the apparatus for 5 minutes.

18. Check the operation of OPV. When loosening, gas should escape from the apparatus. Tighten the valve back.

19. For 5 minutes perform the leak test in negative pressure. Remember that ADV should be cut off from gas supply (disconnected quick connector). Using the mouthpiece suck all the gas in the loop until the full collapse of the counterlungs and close the DSV. With the re-opening of DSV, you should hear a clear hiss of the gas sucked in from the environment.

20. Turn on the eCOiS® system controller.

21. Breathe from your apparatus until you reach the selected PPO2 setpoint.

22. Close the DSV.

23. Turn off the controller.

24. Turn close the oxygen valve.

6.2 Inspection of the apparatus directly before the dive

1.Open the oxygen cylinder valve.

2.Manually add oxygen until gas begins to escape through the OPV valve.

3. Put the apparatus on in a lateral position.

4. Turn on the eCOiS® system controller.

5. Check the PPO2 setpoint.

6. Set up and connect the diluent cylinder.

6.3 Inspection of the apparatus immediately after entering the water.

1. Breathe from the apparatus, dive to a depth of 6m and check the display indications.

2. Check the indications of the decompression controller if it is used.

3. Check the water-tightness of all systems.

4.4. Perform a "bubble check". No gas should escape from the unit.

7. Handling during the dive.

The most important rule during the dive is to control the PPO2 in the breathing loop. The apparatus T-REB contains two independent controllers. While diving, you should keep an eye on any signs of internal unrest and investigate their source. Apparatus T-REB allows for comfortable diving in many positions and breathing resistance is one of the smallest in this type of devices. Whenever possible, you should consciously and manually keep the PPO2 slightly above the set value.

8. Handling after completing the dive, maintenance and storage

8.1 Handling after completing the dive

1. Close the DSV.
2. Disconnect the diluent from the apparatus.
3. Turn off the eCOiS® system controller.
4. Close the the gas cylinder valves.
5. Disconnect the breathing hoses from DSV, from the upper head.
6. Remove the condensate from the hoses.
7. Remove the condensate from counterlungs by upending the apparatus.
8. Separate the canister with the scrubber and remove the soda lime container.
9. Separate the controller with sensors. Inspect and clean the contacts if necessary.
10. Leave the container with the scrubber and controller with sensors to dry.
11. Take care of hygiene of all elements of the apparatus.

8.2 Storage

- APPARATUS should be stored in a dry, well-ventilated place, away from heat sources, not exposed to direct impact of sunlight or chemicals,
- APPARATUS should be protected from the fumes of gasoline, oil, alcohol and other chemicals,
- components of the apparatus should lay free, especially the hoses should be loosely packed, without bends and twists,

- both during storage and during operation, the apparatus must be protected against mechanical damage, especially against impact,
- you should avoid crushing, which deforms breathing hoses and mouthpiece, and other flexible parts of the apparatus.
- parts of the apparatus subject to the wear and tear process must be replaced every year, regardless of the frequency of use.

8.3 Maintenance

- after diving, the apparatus should be rinsed in clean, fresh water,
- parts of the apparatus can be washed with warm water
- Maintenance of parts of the apparatus should be performed with an oxygen-compatible lubricant,
- during repairs and maintenance, only the original spare parts should be used,
- APPARATUS must be subject to annual technical inspections carried out by an authorized service
- after a prolonged period of intensive exploitation (APPARATUS may need more frequent service, depending on how often and in what environment it is used), it is recommended to perform and inspection and maintenance of the systems of the apparatus, combined with control of basic operating parameters.

8.4 Charging of batteries

The eCOiS® system has to be switched off with help of handset buttons. For charging, the electronic sensor head of the unit has to be removed and the cable which is plugged into the heads receptacle has to be disconnected. This activates a deep sleep mode in which the batteries consumption is limited to minimum.

The same cable has to be used for charging batteries with the help of supplied cable which is compatible with all USB power supplier. To optimize the charging the power supplier should have at least 5V and 1500 mA. Charging process is indicated by glowing blue diode which will switch off when charging is complete.

IMPORTANT

It is essential to commission any and all periodic inspections, repairs and any work affecting the performance of this device to the manufacturer or a service authorized by the manufacturer. It is unacceptable for disassembly and assembly of subassemblies and components of the apparatus to be carried out by persons unauthorized to perform such activities.

9. Warranty

When submitting warranty claims, you should always show proof of purchase issued by the authorized dealer and the warranty card that contains a record of annual inspections.

OTHER GRAVITY Sp. z o.o. warrants to the original purchaser that the product will be free from defects in scope of materials and workmanship, provided that the user complies with the recommendations for use, maintenance and service, subject to the following limitations.

The warranty shall be invalid in the case of misuse, neglect, modification, or unauthorized service of the product.

The scope of the warranty is limited to repair or replacement of the product, depending on the decision made by OTHER GRAVITY Sp. z o.o.

IMPORTANT

Self-performed repairs will result in loss of warranty and can lead to loss of life or health.

WARRANTY CARD

of breathing apparatus T-REB® manufactured by OTHER GRAVITY Sp. z o.o.

OTHER GRAVITY Sp. z o.o. provides 1 year warranty to the original owner for the correct operation of the apparatus.

In order for this warranty card to be valid, you must meet the following conditions:

- purchase must be made at an authorized shop of OTHER GRAVITY Sp. z o.o.,
- the owner of the apparatus is a person registered in the warranty card,
- service of the apparatus must be performed at least once a year,
- service operations must be performed with appropriate service sets authorized by OTHER GRAVITY Sp. z o.o.. service,
- The recommendations on the use, operation and maintenance of the apparatus must be complied with.

IMPORTANT

Loss of warranty shall occur as a result of any repair and adjustment performed by persons unauthorized to service the equipment manufactured by OTHER GRAVITY Sp. z o.o., and also as a result of improper use of the product and mechanical damage.

Performance of inspections or services by unauthorized persons will void your warranty.

Full name of the owner.....

Address .....

Model .....

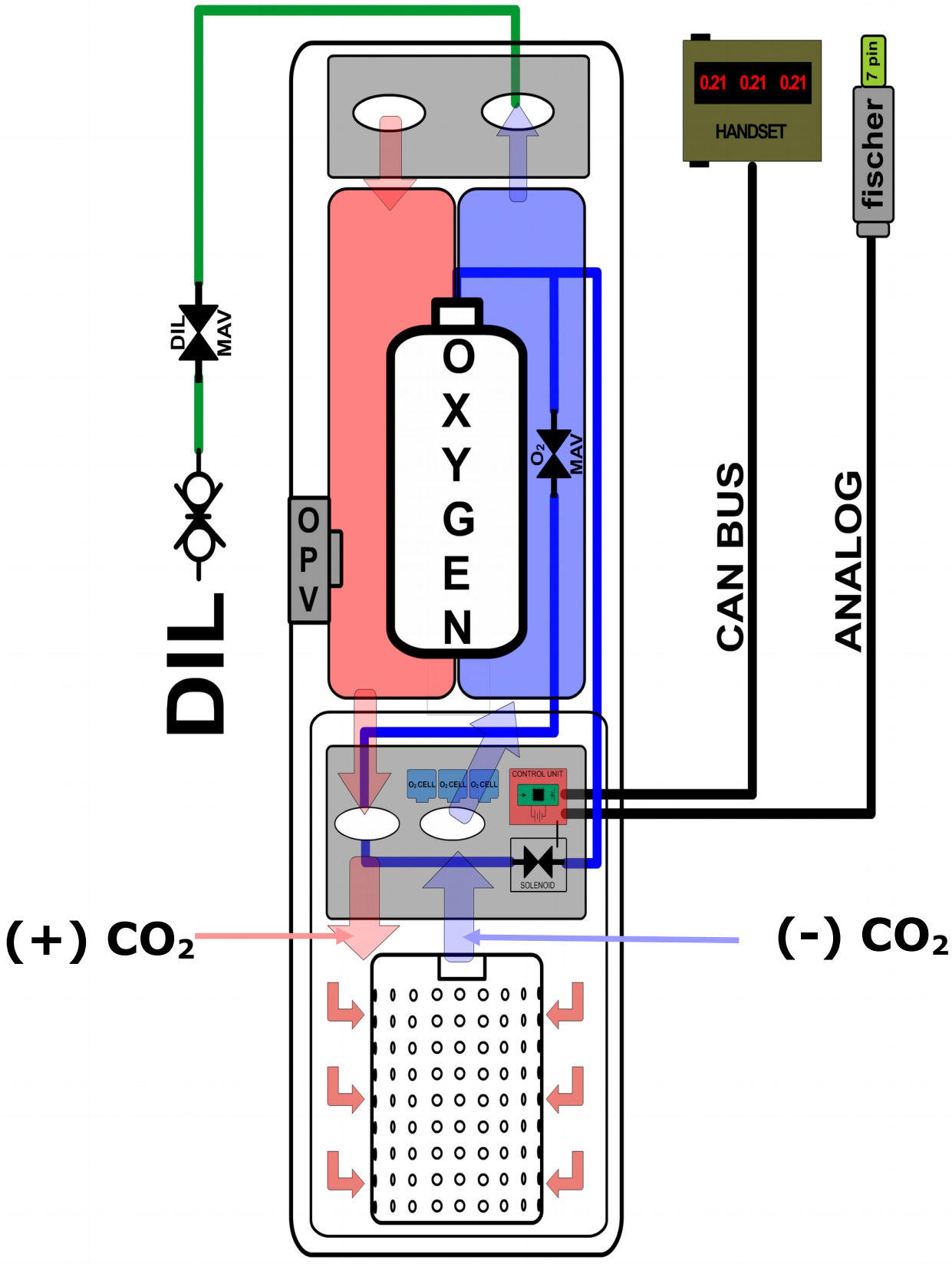
....

Date of sale Stamp and signature of the dealer

INSPECTION SHEET

Review date	Technical state assessment	Surname of the service engineer	Signature and stamp

T-REB – Architecture



10. Notes

Manufacturer's details

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