FX CCR

USER INSTRUCTIONS

Edition 2024.1

1 List of contents

Important warning

Important information

1 GENERAL INFORMATION

1.1 Important Information and Warnings

It is extremely important that you read this manual in its entirety and understand the content and practical application to diving the FX CCR prior to use. If you are unsure of any information included in this text, please consult with your FX CCR Instructor or directly with iQsub Technologies.

The FX CCR unit must never be used without obtaining specific training, the FX CCR Diver course provided by an authorized training association.

This manual is intended to be used as reference material to supplement the training provided by a qualified and factory approved instructor, who will instruct you in the proper use and care of your FX CCR unit. It is not intended to replace your qualifying agency's rebreather training materials, nor does it cover all critical aspects of rebreather diving in general.

Remember, a closed-circuit rebreather can fail at any time!
Therefore, the diver must be equipped with an autonomous bailout system that is independent of the CCR equipment and is adequate for the dive, considering worst-case scenarios.
The bailout system must be configured in such a way that, in the event of malfunction, the dive can be terminated without difficulty.

The manufacturer assumes no responsibility for the use of the FX CCR if it has been modified in any way not specified in this manual or in the manufacturer's technical guidelines.

Any modification to the FX CCR unit will immediately increase your risk while diving with the FX CCR.
Any modification to the FX CCR unit will void the warranty and certification.

Failure to observe the service and maintenance intervals will increase your risk while diving with the FX CCR.

Repairs and replacement of parts on the FX CCR must only be carried out by the manufacturer or by a service centre officially approved by the manufacturer. Spare parts, repairs and servicing of the FX CCR are only available to users who can prove that they are certified to use the FX CCR.

The FX CCR unit must only be used with cylinders that have a valid certificate in accordance with the requirements of the country in which the unit is used.

You MUST READ AND ACCEPT these warnings in order to dive with the FX CCR unit.

Countries outside the European Union may have additional requirements for the use of closed-circuit rebreathers.

Before using the FX CCR unit, it is necessary to check the actual mandatory requirements in the country in which you intend to use the device.

1.2 Manufacturer

The FX CCR rebreather is designed and manufactured in the Czech Republic by:

iQsub Technologies s.r.o.
U Struzky 297
73514 Orlova
Czech Republic

www.iqsub.com
info@iqsub.com

1.3 Certification

The FX CCR presented in this manual has been certified by at the notified body DEKRA Testing and Certification GmbH, Adlerstraße 29, Essen, Germany and meets the requirements of Regulation (EU) 2016/425. The essential health and safety requirements are met taking into account DIN EN 14143:2013-10.

The CE mark indicates compliance with the requirements of the PPE regulation (EU) 2016/425 and the number 0158 next to the CE mark determines the identification code of DEKRA Testing and Certification GmbH.

2 INTRODUCTION

The FX CCR is a front mounted rebreather designed to provide reliable performance in demanding underwater environments. The unit was developed using years of experience in CCR development and testing with respect to the needs of recreational and technical divers.

The FX CCR combines a well proven rebreather chassis with the most innovative electronics package to form a fault tolerant rebreather. The most important features of the FX CCR are reliability, flexibility, durability and user-friendly design with tool-less assembly and maintenance.

The FX CCR is intended for use solely by persons trained and qualified to assemble and use the FX CCR and are capable of fully understanding the instructions contained in this instruction manual.

The FX CCR is intended for use for recreational and technical diving.

All subsequent updates will be available on iQsub.com and factory approved instructors.

2.1 Limitations on use

2.1.1 Depth limits

The maximum operating depth for FX CCR users in accordance with the EN 14143:2013 is **100m**.

Additional maximum operating depth limitations depend on diluent used:

Diluent	Max. depth
Air	40 m
Trimix	100 m

2.1.2 Temperature conditions

The FX CCR can be used within the water temperatures range above **4°C / 39°F** and less than **34°C / 93°F**. Operation at temperatures outside of this range may lead to unreliable function or even injury of the diver. The minimal temperature is defined by CO_2 scrubber duration tests, which is executed at **4°C / 39°F.**

2.1.3 CO_2 scrubber duration limit

The maximum safe operating period of sorbent is 140 min, determined by a test in accordance with EN 14143:2013, during which 1.6 liters per minute of CO_2 were added to the breathing loop with ventilation of 40 liters per minute, in water of temperature 4°C, while the exhaled gas was of temperature 32±4 °C with limit at $ppCO_2$ 5mBar.

The sorbent maximum operating duration differs depending on the type of sorbent, ambient temperature, depth and exertion rate of the diver.

2.2 Assessment of risks

2.2.1 Work rates

The FX CCR is intended for use on dives involving low to moderate work rates (normal activities in recreational and technical diving). It is also capable of sustaining a diver operating at higher work rates, however the diver needs to calculate a significant reduction in scrubber duration, due to related CO2 production. Also, with a higher work rate, the diver must take into consideration increased oxygen consumption.

Additionally the diver needs to take into account, that a higher work rate may have an impact on decompression as well as oxygen toxicity thresholds. Certain additional safety margins should be added. Each body is different and reacts differently gas stresses. Consequently, it is not possible to specify 100% accurate gas loading and decompression information.

2.2.2 Vertical head-up or head-down position

A vertical head-down or head-up position during a dive is an unusual position for a diver and is not normally used unless absolutely necessary.
In a vertical head-down position, inhalation can be difficult and it is recommended to return to a normal horizontal position as soon as possible.
In a vertical head-up position, exhalation may be difficult and it is recommended to return to a normal horizontal position. If this is temporarily not possible, the diver should switch to an open circuit until returns to a normal horizontal position.

2.2.3 Expected inspired gas concentrations

The oxygen setpoint range of the FX CCR is from 0.5 to 1.5 bar.
The setpoint range creates breathing gas mixture representing an inspired oxygen partial pressure between 0.5 bar and 1.5 bar.

The default Low setpoints is 0.7 and the High setpoint is 1.3 and they are selectable and changeable by user within the listed setpoint range. The oxygen fraction of the mixture depends upon depth and the set point.

The following table shows the oxygen and nitrogen fraction with diluent "Air", for the setpoints 0.7 and 1.3 and depth 0 to 50 meters. The nitrogen fraction varies depending upon the selected diluent for a dive.

Depth	Abs. Pressure	Setpoint	ppO_2	O_2 (%)	ppN_2	N_2
m	bar		bar	%	bar	%
0	1.0	0.7	0.70	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

Diving to depths exceeding the maximal recreational depth of 40 meters requires additional training and significantly increases all the risks and may only be carried out by well trained and qualified divers.

To reach the maximum operating depth of 100 meters a Trimix diluent 10/70 is strongly required (10% Oxygen; 70% Helium; 20% Nitrogen).

2.2.4 Visibility

During a dive it is essential that the diver is able to read all the information from the setpoint controller display and HUD. Therefore the FX CCR should only be used when the visibility in water exceeds approximately 30 centimeters. Using the FX CCR in visibility conditions that make impossible viewing of the setpoint controller display and HUD poses increased risks of operation.

2.2.5 Use of high oxygen content gases

CNS = Central Nervous System Oxygen Toxicity is a combination of oxygen pressure and time of exposure. The training for the FX CCR rebreather covers CNS oxygen toxicity and the NOAA exposure limits.
Prolonged exposure to oxygen in excess of 0.5 bar can lead to pulmonary toxicity, affecting the whole body. Pulmonary toxicity is tracked using Oxygen Toxicity Units, known as OTUs. One OTU is earned by breathing 100% oxygen at one bar for one minute. The most conservative limit sets a maximum of 300 OTUs per day for multi day diving activities.
During several days of diving it is necessary to calculate OTUs consistently with the principles of NOAA or other recognized organizations (for instance IANTD, TDI).

2.2.6 Potential long term health effects

At the time of publishing, there are no long term studies available for using a rebreather. It is the responsibility of the diver to inform himself of the consequences of CNS, OTU's and the effect of decompression, and emersion in water.

2.3 Scope of functionality and features

2.3.1 Working Principle of CCR

The basic working principle of the closed circuit rebreather consists of recycling the breathing mixture. Carbon dioxide produced by a diver is removed from the exhaled gas. After replenishing the consumed oxygen, this is again refreshed for the next inhalation by a diver. The composition of the breathing mixture changes continuously during the dive.

2.3.2 Main body

The main body consists of the robust

- CCR Canister with the radial scrubber,
- CCR Head with the control electronics, solenoid and three O2 sensors placed in the easily removable sensor holder,
- FX Case protecting the Canister, Head and Counterlungs and holds the mounting carabiners
- L-pieces that connect the breathing hoses to the Counterlungs, the LP hoses for oxygen and diluent, and carry the ADV (Automatic Diluent Valve).

The unit is standardly equipped with on-board oxygen cylinders 2L/300bar mounted at the bottom of the case with Velcro straps

The diluent manual adding valve allows direct connectivity of off-board gases via quick disconnect connectors QC6 (UNF 9/16”-18).

The Solenoid, Oxygen electronics board and Head-Up display are power supplied with two separate and easy replaceable Li-Ion batteries 18500, located in the Battery Case connected by cable with waterproof connector to the CCR Head and placed in the FX Case.

2.3.3 Radial Scrubber

The radial FX scrubber with self-packing feature has capacity 2,2 kg of soda lime.
The scrubber operating time is max. 4 hours.

2.3.4 Breathing loop

The FX CCR unit is equipped with the 3D shaped Counterlungs placed inside the FX Case and connected to the FX Head and the Canister with Click-Lock Bayonet Couplers allowing easy and quick removal of the Counterlungs for rinsing and drying and easy reassembly.

The Automatic Diluent Valve (ADV) is integrated into the ADV L-piece and is operated by negative pressure in the breathing loop. The ADV has an adjustment knob for setting the inspiratory resistance.
The breathing loop is equipped with manual add valves for manual addition of oxygen and diluent by the diver.
BOV Shrimp - the bail-out valve is a standard part of the loop.
The entire breathing loop is fitted with click-lock bayonet couplings at each connection point.

2.3.5 Set-point Controller and Display devices

The FX CCR is equipped with the following features as standard:

- Reliable Shearwater Petrel3 Controller equipped with color OLED display, Trimix deco, log-book, digital compass, vibration alarm and the option to display high pressure HP readings via Shearwater pressure transmitters installed on the 1st stage regulators.

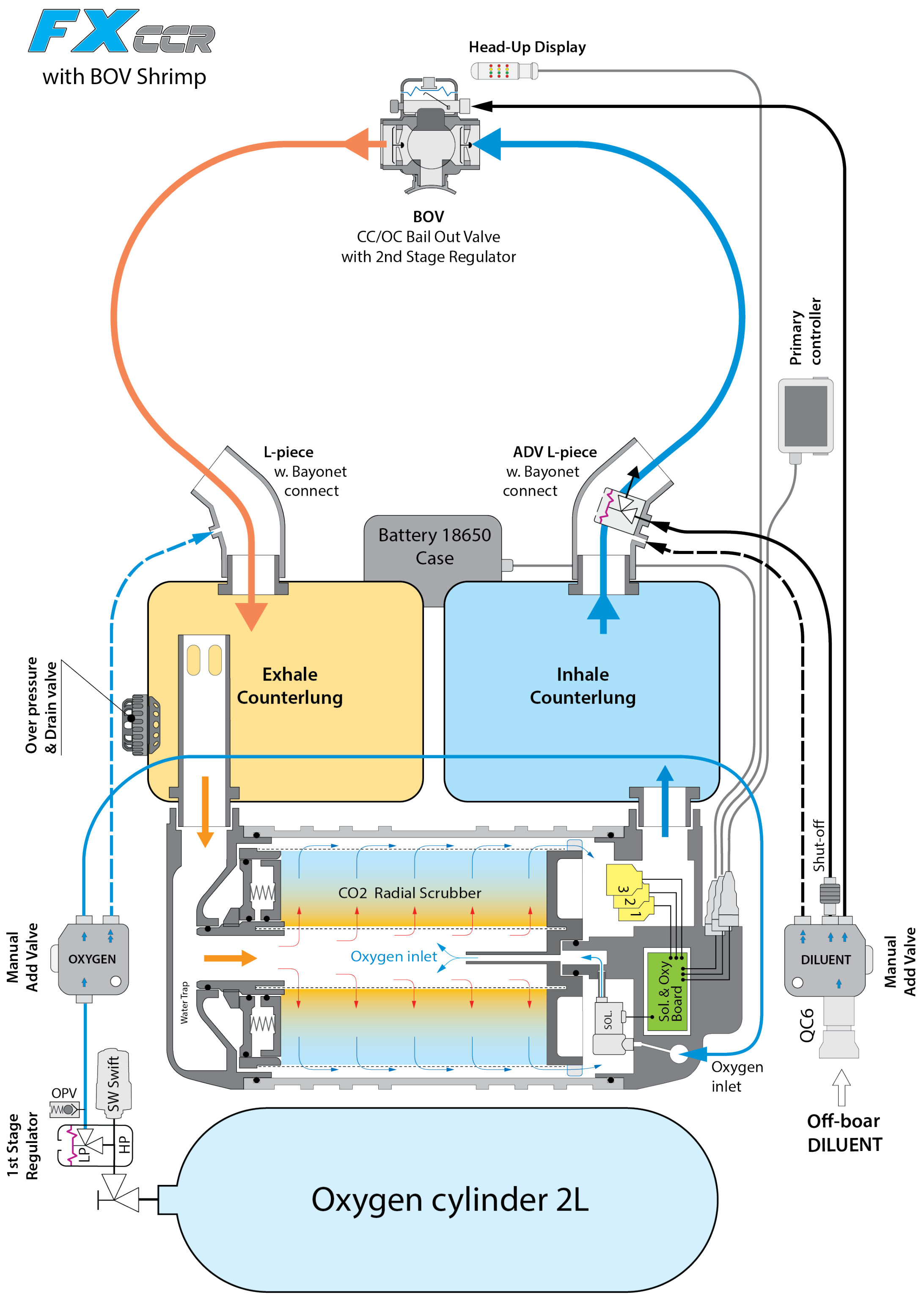
- compact Shearwater Head-Up Display (the HUD) with independent PPO_2 monitoring on three O_2 sensors.

The Shearwater Petrel3 Controller can be optionally replaced by the Shearwater DiveCAN NERD2 Controller (near to eye display controller) or Shearwater HUD can be optionally replaced by the Shearwater DiveCAN NERD2 Monitor (near to eye display monitor)

2.4 Technical specifications

Dimensions	H x W x D	45 x 35 x 16,5 cm
Weight	11kg 13kg 14 kg 16 kg	Travel weight - complete unit with CF tank, no soda lime and gases Travel weight - complete unit with steel tank, no soda lime and gases Complete unit ready for dive with filled oxygen CF tank and soda lime Complete unit ready for dive with filled oxygen CF tank and soda lime
Temperature limits	Diving: Transport: Storage:	water temperature above 4 °C and less than 34 °C in accordance with requirements of EN14143:2013 +4°C to +40°C / 39°F to 104°F +5°C to +25°C / 41°F to 77°F
Atmospheric pressure range		800 – 1050mbar
Maximum application depth	Max. 40 m Max. 100 m Warning:	with Air as diluent with Trimix 12/65 (or higher) as diluent Dives exceeding a depth of 100m bring significantly increased risks and therefore are prohibited
CO2 Scrubber	Type: Soda lime: Running time: Test parameter:	Radial 2,2 kg / 4,85 lb (Sofnolime 797) or equivalent soda lime 160 min Ventilation 40l/min, 1.6l/min CO2, 4°C water temperature Diluent for 40 m - Air Diluent for 100 m - Trimix 12/65
Soda lime	Sofnolime® 797	1-2,5mm, non indicating or white to violet indicating manufactured by Molecular Products Limited, U.K.
3D Counterlungs	Volume:	Full volume 2x 3,7 liter; useable capacity 2x 3,2 liter
Oxygen Tank	Steel cylinder 2 Liter / 300bar with monovalve 300bar, M26x2	
	Carbon-fiber cylinder 2 Liter / 300bar with monovalve 300bar, M26x2	
Diluent Tank	Off-board cylinder min. S40 in side-mount or back-mount configuration	
Gas endurance of the unit On-board Gases (300bar)	OXYGEN:	2 liter x 300bar = 600 liters, minus 180 liters reserve (30%) => 420 liters useable The on-board oxygen supply will last up to 280 minutes at consumption 1.5 liter O_2 per minute.
Off-board Gas (200 bar) cylinder min. S40	Diluent	5,8 liter x 200bar = 1160 liter minus 232 liters reserve (20%) => 928 liters useable Diluent endurance depends on the max. depth and changes of the depth during the dive.
Required purity of the gases	Air: Oxygen: Helium:	EN 12021 ≥99.5% (medicinal oxygen) ≥99.99 (Hel 4.0)
1st stage Regulator - Oxygen	Connection:	M26x2 , medium pressure: 9.5 +/- 0,5 bar
1st stage Regulator - Diluent	Connection:	DIN 5/8", medium pressure: 9.5 +/- 0,5 bar connected to the unit via QC6 connector
Oxygen control	Readings from three oxygen sensors with Voting logic	
Oxygen sensors	3 galvanic rebreather oxygen sensor, type NaNS01 SMB, M16x1, Output 9-13 mV	
Oxygen Setpoint range	2 changeable setpoints, settable from 0,5 to 1,5 bar O_2	
Oxygen Alarms	Low oxygen High oxygen	0,4 bar or less 1,6 bar or above
Batteries in separate housing	2 independent batteries 3,7V Li-Ion, size 18650, replaceable by user	
Battery in Primary Handset	1 battery AA size 1.5V Alkaline, replaceable by user	
Safety devices	Over pressure valve on Oxygen manifold (15 - 18 bar)	
	Over pressure valve on Exhale Counterlung (40mbar)	

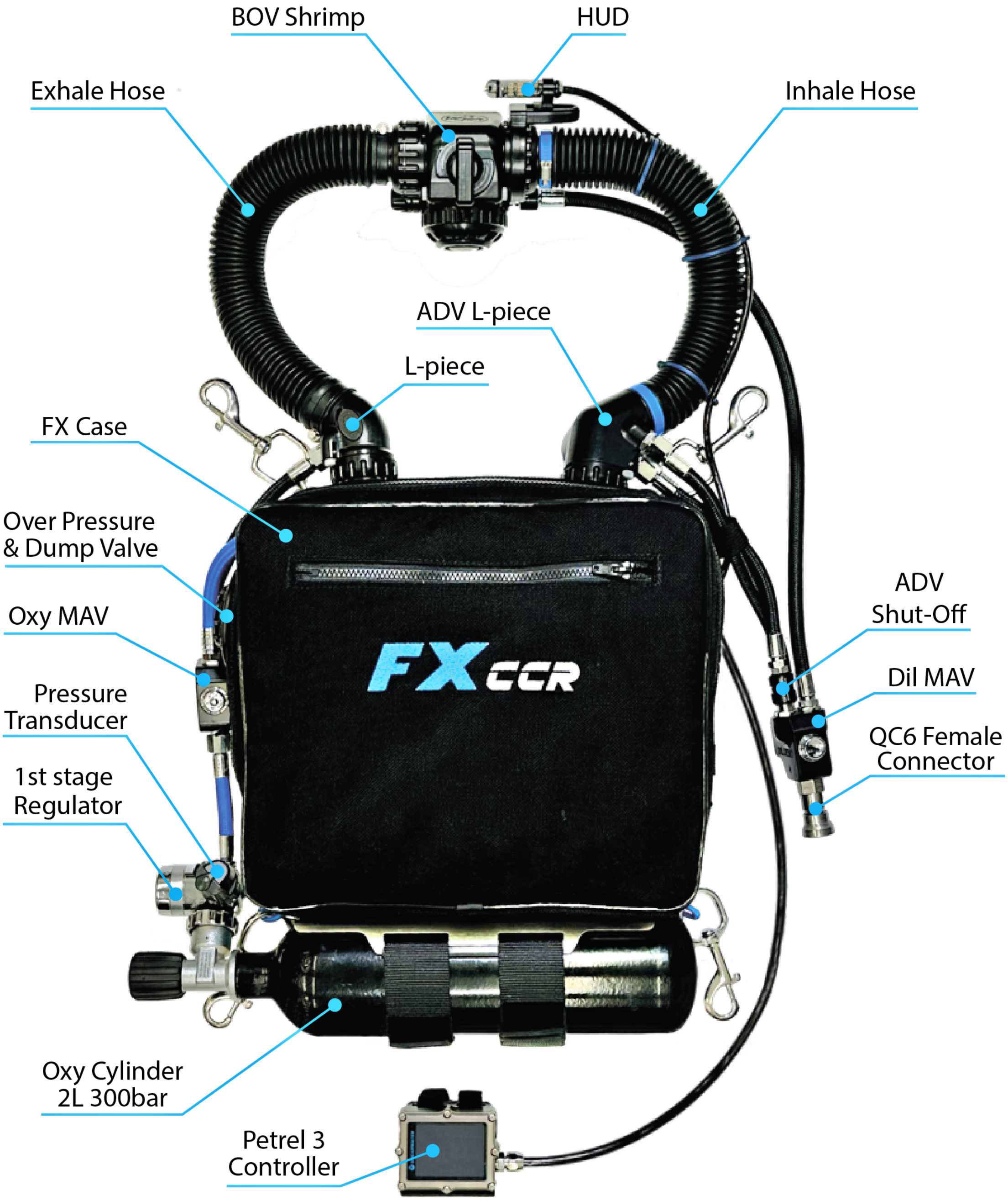
2.5 Diagram of FX CCR with BOV Shrimp



3 TECHNICAL DESIGN

This chapter describes the basic design and the assembly of the FX CCR and acts as a guideline for better understanding the unit and for reassembly, if it is necessary to disassemble it for maintenance or for any other reason (transport, maintenance, storage etc.)
The whole unit is fully assembled and tested before shipping.

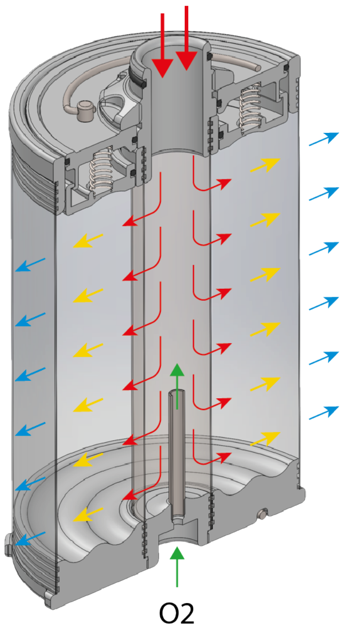
3.1 FX CCR overview



3.2 Scrubber Canister

The Scrubber Canister is made from durable Delrin tubing and has grooves for O-rings and locking strings. The Canister has the fitted Canister Lid which is equipped with the water trap disk, sealed with an o-ring. The water trap disk is a pull-out if it's needed for cleaning.
The Lid is secured in the Canister by the string which is inserted through the hole in the Canister into the corresponding groove.
The Lid is fitted with bayonet connector BN4 for quick and easy connection of the exhaust counterlung.
To remove the Lid from the canister, pull the locking string out from the Canister, insert one or two fingers into the bayonet connector BN4 on the Lid and pull the Lid slightly out of the Canister.

3.3 Radial Scrubber



The FX CCR is equipped with the radial scrubber placed in the Scrubber Canister.
The breathing gas passes through the center tube to the outer tube of the scrubber, then it flows along the outer tube to the FX head.
The FX scrubber has capacity of 2,2 kg / 4,9 lb of soda lime with typical operating time of up to 4 hours.

The FX CCR scrubber consist of the outer and inner tubes made of stainless steel, which are very finely perforated for perfect retention of soda lime granules while low resistance of the breathing gas flow. The robust scrubber bottom holds the both tubes together and is equipped with a folding handle for easy removal of the scrubber from the canister. The Top ring reinforces and protects the outer tube. The scrubber bottom is equipped with a number of protrusions on the periphery that enable breathing gas to flow between the canister wall and the scrubber to the FX head. In the middle of the bottom is a short stainless steel tube that feeds oxygen from the solenoid into the scrubber to homogenize the gas before it enters the O2 sensors.

The scrubber is closed by the upper lid secured by nut with trapezoidal thread.
The scrubber lid has a spring loaded plate in order to ensure sustained compression of the soda lime (self-packing feature) to protect against gas channeling (bypass of the soda lime). The lid is fitted with a folding handle for easy removal from the scrubber.

The supported soda lime is Sofnolime 797, 1-2,5mm, non indicating or white to violet indicating, manufactured by Molecular Products Limited, U.K.
It is also allowed to use other soda lime of equivalent parameters to Sofnolime 797.

The safe operating period of the scrubber is 140min in accordance with EN 14143:2013, when the extreme conditions are applied:
1.6 L/min of CO_2 is injected to the breathing loop, with diving profile of 40 m depth,
at 40 L/min ventilation, in water temperature 4°C,
while exhaled gas temperature is 32±4 °C,
until the limit level $ppCO_2$ of 5 mBar is achieved.
This corresponds to consumption 1.78 l/min of Oxygen.

The typical operating period of the scrubber at mild to moderate work is up to 240 min.

3.4 FX Head

The CCR head is the heart of the FX CCR, which contains the control electronics, the solenoid valve for controlled dosing of oxygen, the removable sensor holder carrying three oxygen sensors, watertight connectors for connection of the external battery case, primary controller and Head-Up Display as well as the BN3 connector with unique Click-Lock bayonet for quick and easy connecting of the inhale counterlung.

The Control electronics (Shearwater SOLO board) is built in the hermetically sealed compartment inside the FX head. The SOLO board uses ppO2 readings from three O2 sensors to autonomously maintain the ppO2 in the breathing loop in accordance with the current chosen setpoint.

Modular design compartmentalizes critical functions for redundancy. The Solenoid and Oxygen electronics (on the SOLO board) can measure and inject oxygen independently of the Primary Controller handset even in case that the handset or its cable is unplugged or damaged, while the SOLO board continues to control loop PPO2 until the diver is surfacing. The control electronics uses the DiveCAN®, a digital communication standard developed by Shearwater Research Inc. specifically for rebreathers for robust error-checked

communications, when a message is either received correctly or it isn't received at all. The DiveCAN® is upgradable and expandable.
The SOLO board has the Primary Controller Bus and the Secondary Monitoring Bus.
PPO2 reading output from all three oxygen sensors are electronically separated one from another as well as the PPO2 reading outputs to the Primary Controller Bus and the Secondary Monitoring Bus are electronically separated one from another.

The Secondary Monitoring Bus is independent on the Primary Controller Bus and provides backup PPO2 monitoring in the event of a failure on the Primary Controller.

A fault or short circuit on any sensor or one connected device does not affect the remaining ppO2 readings on the working device.

The head is equipped with three watertight connectors made of AISI 316 and rated up to 300m depth. These connectors allow for flexible, easy, and safe connection of the Primary Controller handset, Head-Up Display, or NERD2, as well as the external battery case.

The head is equipped with 3 watertight connectors made of AISI 316 and rated up to 300m depth for easy and safe connecting the Primary Controller handset and Head-Up Display or NERD2 and also facilitate easy disconnection of the devices for travel, upgrades, and repair.

The watertight connectors are color coded this way:
GREEN - DiveCAN Controller Bus.
BLUE - DiveCAN Monitor Bus.
RED - Battery Case

The Primary Controller Handset or optionally NERD2 Controller must be connected to the GREEN labelled connector.
The DiveCAN Head-Up Display or optionally NERD2 Monitor must be connected to the BLUE labelled connector.
The Battery Case must be connected to the RED labelled connector.

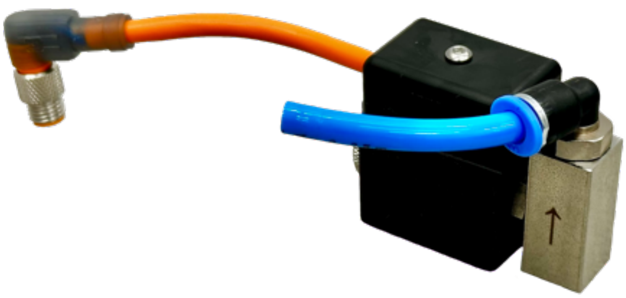
Three Oxygen sensors are placed in the easily removable sensor holder making it easy to dry, check or replace the sensors.

The sensors are connected to the head electronics via 3 coaxial cables with the

robust
6-pin connector with gold plated banana pins.
The sensor holder is held in position by the pin with an o-ring.
To remove the sensor holder, grab the holder with two fingers and pull it out.
To place the sensor holder back, insert the holder into the guide grooves in the FX head and and push it all the way in.

The FX Head is inserted into the Canister, sealed with an O-ring and secured in the Canister by the string that passes through the hole in the Canister and into the corresponding groove.
To remove the FX head from the canister, pull the locking string from the Canister, insert one or two fingers into the bayonet connector BN3 on the FX head and pull the head slightly out of the Canister.

The low power Solenoid valve has a Stainless steel AISI 316 body and operates up to 17 bar (above the ambient pressure) and no low-pressure adjustment on the 1st stage regulator is needed.



The solenoid is connected to the fitting, which is inserted through the head and secured in place with the 8 mm retaining ring.

The control electronics and the Secondary Bus are supplied by two independent, easily replaceable, rechargeable Li-Ion 18500 batteries.
The batteries are located in the separate Battery Case, which is connected to the FX head via a waterproof connector marked **RED**.

Battery #1 supplies the Solenoid,
Battery #2 supplies the Head-Up Display.

The batteries are easily accessible via the battery threaded caps sealed with an O-ring.

The battery Caps must be tightened using only your fingers (no tools), but each time to the stop. This will ensure the correct and reliable electrical connection of the battery.
Failure to fully tighten the cap to the stop may result in a brief loss of power due to movement in the thread caused by pressure changes at depths of approximately 15 to 20 meters.

3.5 FX Counterlungs

The FX CCR is equipped with 3D shaped Counterlungs designed as gas-tight bags of a cube shape, made of soft Cordura with PU coating.

The Counterlungs are equipped with the unique and secure Click-Lock Bayonet Couplers.

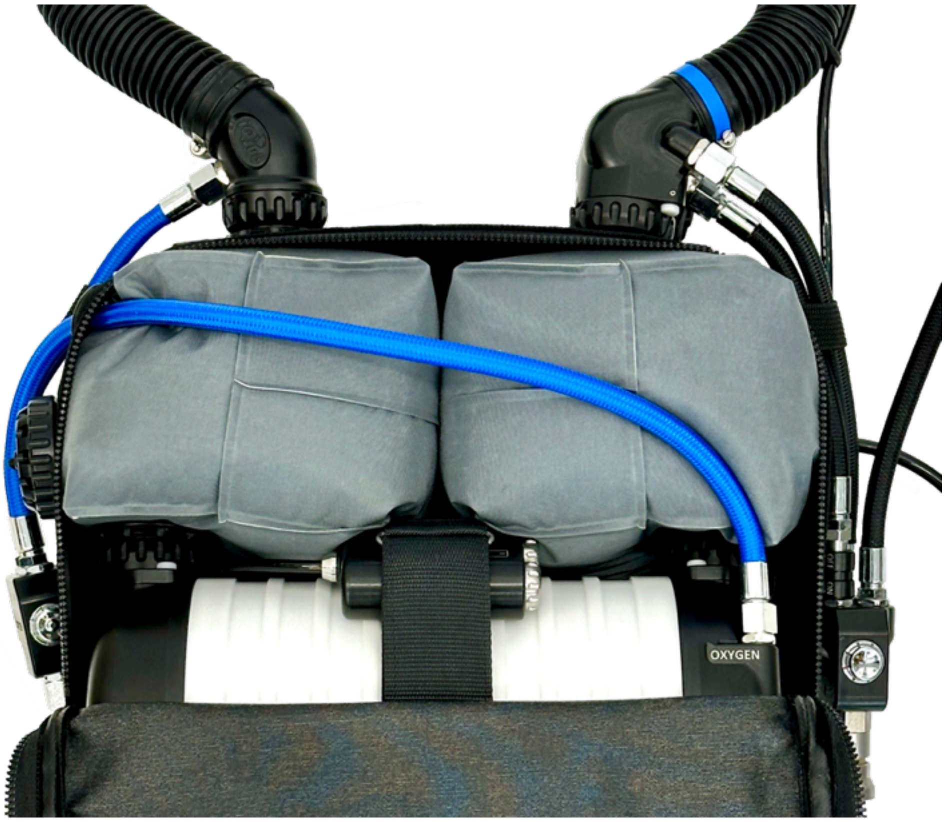
The exhale Counterlung has an internal snorkel that prevents eventual water from going directly to the scrubber.

The Counterlungs are connected to the Canister and FX Head via the click-Lock Bayonet Couplers with different keying on each bayonet connector, making it impossible to connect the counterlungs incorrectly.

The exhalation Counterlung is equipped with an adjustable Over Pressure / Dump Valve (OPV) to allow any water to be drained. The OPV can be manually operated by pulling the knob on the cord.

At the top of the Case, the Counterlungs are attached to the grommets with two snap locks and connected to the L-pieces with click-lock bayonet couplers with different keying on each bayonet connector, making it impossible to connect the L-pieces incorrectly.

To release the counterlung couplers, just press the white locking button on the appropriate connector on the Canister or Head, turn the nut counterclockwise and pull the coupler out of the connector.



To reassemble, insert the coupler into the connector and push it all the way in, turn the nut clockwise until the locking button clicks into the nut and verify that the nut is locked.

The Counterlungs can be easily removed for cleaning, disinfection, drying or storing.
To disassemble Counterlungs and OPVs from the case grommets, press one of the snap locks on the top coupler or OPV while pushing the coupler or OPV inward into the housing. To reassemble, insert the snap locks into the corresponding grooves in the grommet and snap into place.

To dry counterlungs after rinsing, use the bayonet-lock drying holder included with each unit.

3.6 FX Case

The FX Case is made of Cordura 2000 and primarily protects the Counterlungs, Canister and the FX Head and carries the oxygen cylinder at the bottom and a breathing loop at the top.

The FX Case holds the entire unit together and is equipped with carabiners to attach the unit to the diver's body.

The Case features a zipper that runs from the left side across the top to the left side, allowing the case to be opened for easy access to the Counterlungs and Canister with the FX Head.

The Case has integrated two integrated snap-in grommets on the top for attaching the counterlung connectors.

On the right side, it has one integrated snap-in grommet for attaching the Overpressure Valve and one small grommet for passing the oxygen LP hose to the solenoid.

The inside bottom of the Case is equipped with the Canister Holder with a Velcro strap for attaching the Canister and the Battery container.

The outer bottom of the Case is equipped with the Cylinder Holder for attaching the Oxygen cylinder. The Cylinder Holder has a 5mm bungee on each side with a carabiner for side attachment of the unit to the D-rings on the diver's belt.

The Case has an integrated internal zipped pocket on the front and a soft grip handle sewn on the back for easy one-handed carrying.

The Case has double D-rings on the top right and left side connected by a shackle that holds the top carabiner for attaching the unit to the BCD shoulder strap D-rings.

There are 25mm webbing loops sewn into the sides of the case to guide and secure LP hoses to the L-pieces.

3.7 ADV L-piece

The L-pieces connect breathing hoses with the counterlungs.

The ADV L-piece has an integrated ADV (Automatic Diluent Valve) and an inlet for diluent manual addition.

The integrated ADV is designed in a similar way like a 2nd stage regulator. It is activated by a negative pressure in the breathing loop and automatically adds diluent to the breathing loop when needed (in the event of decreasing the volume of the breathing loop).

The ADV is fed by the LP hose leading from the Diluent Manual Adding Valve, while the LP hose is connected via the Shut-off Valve that can shuts off diluent gas when needed. The Shut-off valve is operated by sliding the black switching ring up or down. It is useful if the diver wants to have the adding of diluent under full control or in case of malfunction of the ADV.

The hose connection fitting for ADV is labeled „ADV", and the hose connection fitting for manual diluents adding is labeled "Manual Adding". The both fitting have UNF 3/8" thread for connecting standard regulator LP hoses connected to the Diluent Manual Adding Valve.

The ADV L-piece is attached to the inhale Counterlung with the bayonet connector BN3. The inhale breathing hose is banded to the L-piece by the blue clamp.

The ADV diaphragm, which opens the ADV valve is an element that may be sensitive to damage. The condition of the diaphragm must be verified prior each dive by the negative pressure test and by a visual inspection.

3.8 Exhale L-piece

The exhale L-piece has an inlet for oxygen manual addition.

The hose connection fitting for oxygen manual adding is labeled "Oxygen". The fitting have UNF 3/8" thread for connecting standard regulator LP hose connected to the Oxygen Manual Adding Valve.

The exhale L-piece is attached to the exhale Counterlung with the bayonet connector BN4. The exhale breathing hose is banded to the L-piece by the black clamp.

3.9 Oxygen Manual Adding Valve

For adding gases to the breathing loop, the FX CCR is equipped with manual adding valves (MAVs).

The Oxygen Manual Adding Valve (Oxygen MAV) is intended for manual addition of oxygen to the breathing loop.

The Oxygen MAV has one outlet controlled by the manual push-button and one pass-through outlet. The manual trigger outlet is used for manual addition of oxygen to the breathing loop and is connected by an LP hose to the oxygen injection port on the exhalation L-piece. The pass-through outlet is connected by an LP hose to the oxygen inlet port located at the FX Head to supply the solenoid.

The Oxygen MAV inlet is connected by the 10cm long LP hose to the 1st stage regulator on the

3.10 Diluent Manual Adding Valve

The **Diluent Manual Adding Valve** (Diluent MAV) is equipped with two pass-through outlets and one outlet controlled by the manual push-button.

The button controlled outlet is used to manually add diluent to the breathing loop and is connected to the diluent injection port on the ADV L-piece. One pass-through outlet is connected via the Shut-off valve and an LP hose to the ADV integrated in the ADV L-piece. The second pass-through outlet is connected to a 62cm long LP Regulator hose leading to the 2nd stage of the BOV Shrimp (the Bail-Out Valve).

The **Shut-off valve** shuts off diluent leading to the ADV.
It is easily operated by sliding up or down the black switching ring.
The Shut-off valve is useful if the diver wants to have the adding of diluent into the loop under his full control or in the event of malfunction of the ADV.

The Diluent MAV inlet is connected to the off-board diluent cylinder by the QC6 female quick connector located on the underside of the Diluent MAV.

The Diluent MAV is attached to the unit just by the LP hoses which are fastened in the webbing loop on the left side of the FX case.

3.11 Breathing Hoses

The corrugated breathing hoses are made of silicon rubber, which is resistant to weathering, salt water, UV radiation and grease.

The silicone corrugated breathing hoses are very flexible and soft, adapt well to changes in position and are thus very comfortable to use. The length of the inhale hose is 330 mm and the length of the exhale hose is 345 mm.

The breathing hoses are fitted at both ends with the unique and easy to use Click-Lock Bayonet coupling for secure connection of the hoses to the L-pieces and to the BOV Shrimp (Bail-Out Valve).

Cable hooks are clipped onto the inhale breathing hose to hold the HUD cable that leads to the holder on the BOV.

The click-Lock Bayonet coupling makes it impossible to connect the breathing hoses incorrectly due to different keying on each bayonet connector on the loop.

The breathing hoses are the mechanically weakest part of the unit, therefore focus your attention on protecting them at all times.
The breathing hoses can be damaged by excessive stress and it is necessary to protect them from perforation, cuts, excessive stretching and wear.

Avoid any deformation of the hoses when storing or transporting the unit. Never use the breathing hoses for gripping, holding or fixing the FX CCR !!!

3.12 BOV Shrimp - the Bail-Out Valve

The Bail-Out Valve (BOV) is a Diver Surface Valve with a 2nd stage regulator incorporated into the mouthpiece with the ability of supplying the diver with open circuit breathing gas.

A diver can be switched to the closed circuit or if needed to the second stage regulator and breathe an open circuit bail-out gas. This allow the diver to have a source of breathing gas at all times. The BOV 2nd stage regulator is connected to the diluent cylinder via the LP hose connected to the diluent manifold or to an off-board bailout tank.

The BOV's CC/OC switching valve allows to switch between the close circuit (the CC mode) and the open circuit (OC mode) and is easy operated by rotating the knob on the front of the BOV.

When the BOV is switched to the CC mode - the knob is rotated to its horizontal position, the breathing loop is open via the mouthpiece, this allows the diver to breathe on the rebreather closed circuit.

When the BOV is switched to the OC mode - the knob is rotated to its vertical position, the open circuit via the 2nd stage regulator is operable while the rebreather breathing loop is fully closed. In this position no water can enter the breathing loop when the BOV is out of the diver's mouth and submerged.

In case that the BOV in CC mode is out of the diver's mouth and submerged, water can easy enter the breathing loop and flood the counterlung and even the whole rebreather. Therefore anytime before removing the BOV from the mouth, the diver must switch the BOV to OC mode.

The knob must be turned always to its extreme positions (vertical or horizontal) and must never be turned in any intermediate position, this would cause malfunction due to semi opening of the CC and the OC mode together.

One-way directional valves (mushroom valves)
provide and ensure the correct breathing gas circulation in the breathing loop in the correct direction from left to right, from the inhalation counterlung to the exhalation counterlung, then through the CO2 scrubber and subsequently to the oxygen sensors and back to the inhalation counterlung and over again.

They are among the most important parts of the BOV and the entire XCCR. They ensure gas flow in the correct direction from left to right and ensure the proper flow of the breathing gas through the entire rebreather. One-way directional valves ensure the exhaled breathing gas cannot return to the inhalation counterlung and cannot be repeatedly inhaled by the diver without removal of carbon dioxide and replenishment with oxygen.

When inhaling, the breathing gas comes from the inhaling counterlung on the left through the corrugated hose to the BOV, where it flows through the inhalation valve on the left side to the mouthpiece and into the diver's lungs.

When exhaling, the breathing gas flows through the mouthpiece and the exhalation one-way valve on the right side through the corrugated hose to the exhaling counterlungs on the right.

The one-way directional valves are one of the most critical parts of the rebreather, where it is difficult to detect a malfunction on them during a dive. Therefore before every dive and before connecting the breathing corrugated hoses it is very important and necessary to check that the both one-way directional valves are in good condition and work correctly! If any of the valves would found as not sufficiently flexible or even partially stiff or damaged in any way, any diving must be immediately canceled until the both valves are replaced with new ones and are functioning properly.

Ignoring this warning can lead to injury and possibly even death of the diver.

The mouthpiece
is the connecting piece between the rebreather and the diver. The mouthpiece is robust and anatomically shaped to ensure easy gas flow and secure retention of the BOV in the diver's mouth during long dives.
Before starting a dive, the diver must check that the mouthpiece is in good condition and securely attached to the BOV.

The 2nd stage regulator
is operable in the OC mode and allows the diver to breathe an open circuit bail-out gas.
The 2nd stage regulator has an adjusting knob on the right allowing to adjust optimal breathing resistance and prevention against free flow.

The breathing corrugated hoses
are connected to the bayonet connectors on the BOV using couplers with bayonet nuts. The bayonet nuts are locked by the white buttons on the BOV.
It is impossible to connect the breathing hoses incorrectly by using different bayonet connectors on the BOV. The 4-lug bayonet is located on the inhalation side on the diver's left and the 3-lug bayonet is located on the exhalation side on the diver's right.

The BOV comes standard with the 2-axis adjustable HUD Holder or with the 3-axis adjustable holder for NERD2.

3.13 Oxygen Cylinder

The FX CCR unit is equipped with a 2L / 300 bar steel cylinder with a diameter of 100 mm and with an M25x2 valve tread . The cylinder is marked „OXYGEN".

The oxygen cylinder S-valve has an M26×2 / 300 bar outlet connection.

The oxygen cylinder is placed in the Cylinder Holder on the bottom of the Case and secured with two Velcro straps.

The FX CCR uses the Apeks US4 Nitrox or Apeks DS4 Nitrox 1st stage regulator with M26x2 connection thread. The 1st stage regulator must to be set to the original LP pressure setting of 9,5bar +/-0,5bar.

Alternatively, a 2L / 300 bar carbon fiber cylinder with a diameter of 111 mm with the valve tread M18x1.5.

3.14 Diluent Cylinder

The FX CCR unit uses an off-board source of diluent from a side-mounted stage cylinder or alternatively from a back-mounted cylinder.

The LP supply hose coming from the 1st stage regulator of the diluent cylinder must be fitted with a QC6 male quick connector, which must be connected to the QC6 female quick connector on the diluent MAV (manual adding valve).

3.15 Buoyancy Control Device - BCD

The FX unit must be attached to a certified BCD (buoyancy control device), which is equipped with D-rings at the top of the shoulder straps and also D-rings on both sides of the belt.

The FX unit must be attached to the BCD by clipping the upper carabiners to the top D-ring on the shoulder strap and the lower side carabiners to the D-ring located on the belt.

It is recommended to use a side-mount BCD with a minimum nominal buoyancy of 130N, equipped with a standard manual inflation valve, which is supplied with gas via an LP hose connected to the 1st stage regulator connected to an off-board cylinder. The inflation valve should be in the correct position so that it is easy to locate and use during the dive.

The side-mount BCD should be equipped with a double bungee with a carabiner on the each side to secure the off-board stage cylinders with diluent and bail-out gases.

Alternatively, the FX CCR unit can also be attached to a standard BCD with a minimum nominal buoyancy of 150N, which is equipped with D-rings at the top of the shoulder straps and also D-rings on both sides of the belt.

The BCD must be secured by the the shoulder straps, belt and crotch strap and sit firmly on the diver's body.

The BCD is not a life support device !!!
It is not a life jacket or a rescue device !!!
It is not designed to keep the diver's face above the surface if the diver loses control or becomes unconscious.

4 Oxygen Control Electronics

The Solenoid & Oxygen electronics, the SOLO board, controls the Solenoid and maintains ppO2 in the loop. The SOLO board is located in the hermetic compartment inside the head, not accessible by the user.

The SOLO board is power supplied from two independent batteries.
Only replaceable Li-Ion 3,7V, 18500 size batteries should be used in the FX Battery Case.
The **Battery #1** supplies the Solenoid, while the **Battery #2** supplies the Head-Up Display and ppO2 reading output for an optional secondary monitoring computer (NERD2).

The fully charged battery should has a voltage of 4.1V - 4.2V.
The voltage of the discharged battery is about 3.6V.

The SOLO board has very low power consumption and providing long term battery life.

The SOLO Board functions & features
- monitoring the current ppO_2
- firing the solenoid and maintaining ppO_2
- Head-Up Display control and calibration
- batteries status monitoring
- ppO2 reading for a secondary computer

The SOLO board uses ppO_2 readings from three O2 sensors to maintain the ppO2 in the breathing loop in accordance with the currently chosen setpoint.

PPO2 reading output from all the three oxygen sensors are electronically separated one from another as well the PPO2 reading outputs to the Primary Controller and Head-Up Display are electronically separated one from another.
In the event of a failure or short circuit on any sensor or a connected device, it does not affect the values of the remaining ppO2 readings.

In the event of a failure or short circuit on the cable connected to a secondary device, it does not affect the ppO2 readings on the SOLO board as well as on outputs to the Primary Controller or the HUD.

In the event that communications between the Primary controller and the FX-Head are lost for any reason or a short circuit on the cable connected to the Primary, the SOLO board in the FX-Head will continue working while revert to a **0.7** setpoint.

The SOLO board uses DiveCAN bus for communicating with connected electronics devices (see chapter 4.1).

4.1 DiveCAN Communication Bus

The DiveCAN® is a digital communication standard developed specifically for rebreathers by Shearwater Research Inc.

The DiveCAN® standard was designed to improve rebreather electronics. It offers the following advantages over an analog wiring:

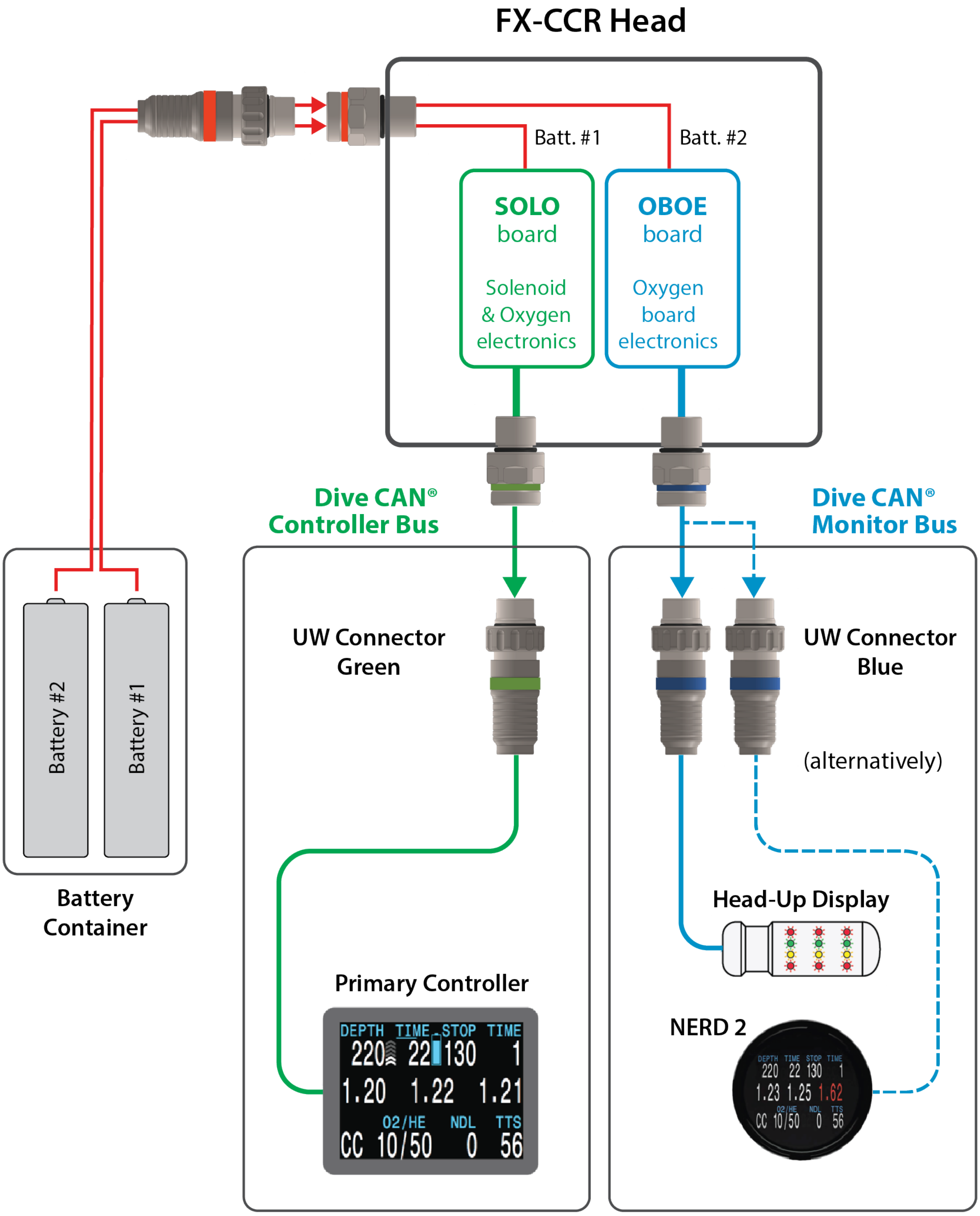
- Robust error-checked communications. A message is either received correctly or it isn't. Compare this with analog wiring where corrosion or poor connections can result in incorrect data being used.
- Upgradable and expandable.
- Components (Primary Controller, HUD, secondary monitor, etc.) can be easily removed for travel, repair, backup, and upgrades.
- Modular design compartmentalizes critical functions for redundancy. For example, the Solenoid and Oxygen electronics (the SOLO board) can measure and inject oxygen independently of the handset. If the handset is unplugged or damaged, the SOLO board can continue to control loop PPO2.

A minimum configuration has:
One **Control Bus** with the Primary controller connected to the SOLO board
and one **Monitor Bus** with the Head-Up Display connected to the SOLO board.

The Monitor Bus is independent and provides backup PPO2 monitoring in the event of a failure of the primary control bus.

DiveCAN® devices are connected to the FX-head using specially designed watertight connectors. This allows easy disconnection of devices for travel, upgrades and repair.

DiveCAN® Bus diagram



DiveCAN® connections allow rebreather components to communicate.

4.2 Primary Controller Handset

The Primary Controller Handset is the Shearwater DiveCAN Petrel3 Controller, specifically designed for the XCCR, FLEX2 CCR and FX CCR.

The Primary Controller Handset is connected to the control electronics in the CCR head via a robust, durable and very flexible cable equipped with the X-connector, made of AISI 316L rated up to 300m depth and marked with a **GREEN** ring.

Primary Controller Feature List

- Two PPO2 set-points, which can be set between 0.5 and 1.5
- Automatic PPO2 set-point switching (configurable)
- Depth, time, 3x ppO2 and deco data display
- Strong Vibration alert system
- Up to 4 pressure transmitters for gas pressure monitoring
- Bühlmann decompression model with gradient factors conservatism - Optional VPM-B decompression model
- 5 CC and 5 OC gases
- Gases can be changed and added during a dive
- CNS tracking
- Any combination of oxygen, nitrogen, and helium (Air, Nitrox, Trimix) - Open and closed circuit, switchable during a dive
- No lockout from violating deco stops
- Metric and Imperial units
- Automatic turn off on the surface (after 15 minutes)
- Tilt compensated digital compass
- Dive Planner
- 1000 hour dive log memory
- Log downloads and firmware upgrades using Bluetooth
- Flexible user replaceable "AA" battery of almost types

Specifications

Specification	DiveCAN® Rebreather Model
Operating Modes	Closed Circuit (CC) Open Circuit (OC, for bailout)
Decompression Model	Bühlmann ZHL-16C with GF VPM-B and VPM-B/GFS (optional)
Pressure (depth) sensor	Piezo-resistive
Range	0 Bar to 14 Bar
Accuracy	+/-20 mBar (at surface) +/-100 mBar (at 14bar)
Crush Depth Limit	30 Bar (~290msw)
Surface Pressure Range	500 mBar to 1080 mBar
Depth of dive start	1,6 m of sea water
Depth of dive end	0,9 m of sea water
Operating Temperature Range	+4°C to +32°C
Long-Term Storage Temperature Range	+5 °C to +25°C
Battery	AA Size, 0,9V to 4,3V
Recommended Battery Type	AA 1,5V Lithium (eg Energizer Ultimate Lithium)
Battery Operating Life (Display Medium Brightness)	35 Hours with AA 1,5V Alkaline battery 55 Hours with AA 1,5V Lithium battery
External Connector	Hardwired cable to 8-pin DiveCAN® connector
Weight	0,4kg
Size (W X L X H)	84mm x 74mm x 38mm

Turning the Controller On

To turn the Primary Controller On:
Press both the MENU (left) and the SELECT (right) buttons at the same time.

The Buttons

Two piezo-electric buttons are used to change settings and view menus Except for turning the Primary Controller Handset On, all operations are simple single button presses

MENU button (Left)

From main screen:	brings up the menu
In a menu:	moves to the next menu item
Edit a setting:	changes the setting's value

SELECT button (Right)

From main screen:	steps through info screen
In a menu:	performs command or starts editing
Edit a setting:	saves the setting's value

BOTH button (Left & Right)

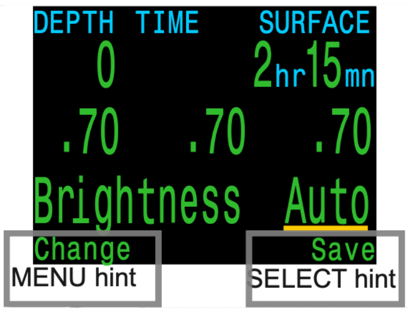
When the handset is off: pressing MENU and SELECT at the same time will turn the Primary handset on.

No other operation requires pressing both buttons at the same time.

Button Hints

When in a menu, button hints label each button
For example, the hints to the right tell us:

use MENU to **change** the brightness value
use SELECT to **save** the current value



Turning the Controller Off

The "Turn Off" item puts the computer to sleep While sleeping, the screen is blank, but the tissue contents are maintained for repetitive diving The "Turn Off" menu item will not appear during a dive It will also not appear after a dive until the End Dive Delay time has expired to allow for a continuation dive.

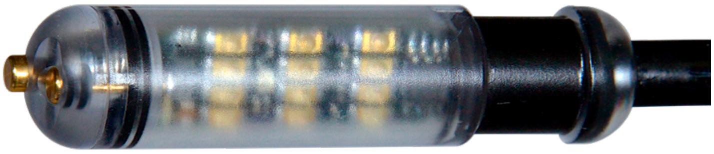
To turn the Primary Controller OFF:

- Press the MENU (left) button, "Turn Off" menu appears on the screen.
- Then confirm it by pressing the SELECT (right) button.
  Then the Primary Controller should turn off.

For detailed operating instructions for the FX CCR Primary Controller see:

4.3 Head-Up Display

The Head-Up Display is the compact Shearwater DiveCAN Head-Up Display (the HUD) with PPO2 monitoring on three O2 sensors.



The main feature of the Head-Up Display (the HUD) is to show the current status of ppO2 in the breathing loop as well as ppO2 alarms to the diver.
The HUD has two wet contacts for automatic turning on when entering water.
The rear longer wet contact acts as a mechanical push button.
The HUD is power supplied by the battery #2 in the CCR Head.
The HUD is placed in a two way adjustable holder located on the BOV Shrimp.

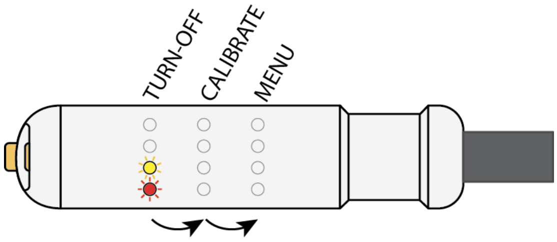
The HUD is connected to the control electronics in the CCR head via a robust, durable and very flexible cable with the X-connector, made of AISI 316L rated up to 300m depth and marked with a **BLUE** ring.

Turning On: Press the push button once.

Basic Commands:

1. Press the button until desired column blinks
2. Hold for 3 seconds.
3. LEDs blink twice to confirm.
4. Command executes.

Basic Commands



Each press advances one column

TURN-OFF: Turn-off to save power. The HUD will auto shutdown if not wet for 30 minutes.

CALIBRATE: Execute this command to perform PPO2 calibration. Calibrates to a PPO2 of 1.0 absolute atmospheres (ata) or bar. i.e. assumes 100% O2 at sea-level.

Unplug the HUD and use alternate DiveCAN handset (e.g. the Primary controller or an optional PPO2 monitor) for high-altitude calibration.

MENU: Execute this command to enter the Advanced Options menu.

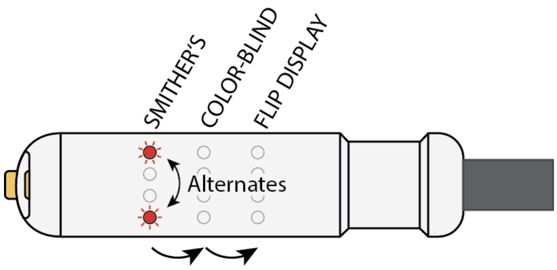
Advanced Options menu:

Enter Advanced Options by executing MENU command (see above).
Press to select, hold 3 seconds to confirm.

SMITHER'S: Default Smither's PPO2 code blink pattern.

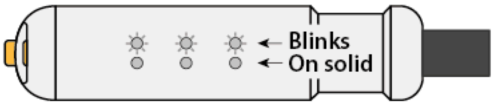
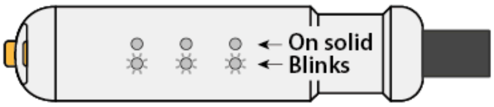
COLOR-BLIND: Optional blink pattern that does not require color to determine PPO2

Advanced Options

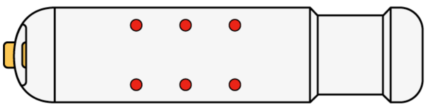
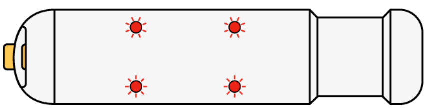
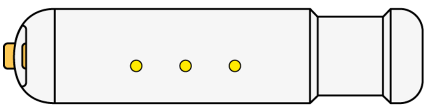


Each press advances one column

PPO2 Display

PPO2 (ata)	Modified Smither's (default)	Color Blind Option
Above 1,6	 Top-Red blinks each 0,1 above 1,6	 Top row blinks each 0,1 above 1,6
1,1 to 1,6	 Green blinks each 0,1 above 1,0	 Middle-top blinks each 0,1 above 1,0
1,0	 Green & Yellow blink once	 Both middle rows on solid
0,4 to 0,9	 Yellow blinks each 0,1 below 1,0	 Bottom-middle blinks each 0,1 below 1,0
Below 0,4	 Bottom-Red blinks each 0,1 below 0,4	 Bottom row blinks each 0,1 below 0,4

Error Display

Error Display	Display Description	Error Description
	Top and bottom Red LEDs on solid	Sensor has failed PPO2 calibration. One or more columns may display this error.
	Four corners blinking	No communication with O2 sensor electronics.
	After turn on, the yellow row stays on for 30 seconds	Battery is low and should be changed

Troubleshooting:

Bizarre displays or commands and PPO2 backwards?
Flip HUD and do "Flip Display" command.

The button not working?
Ensure wet contacts are dry, as the button is disabled when diving (because wet).

The HUD is not able to turn on?
Check the battery #2 status and whether correct connection of the UW connector on the head.

When not in use - always dry the wet contacts and turn-off the HUD to conserve battery power.

4.4 NERD 2

The FX CCR can optionally be equipped with the **NERD 2** - the compact near to eye Shearwater DiveCAN Computer in place of the HUD.
NERD 2 acts as a secondary computer with PPO2 monitoring on three O2 sensors and Trimix decompression. It is power supplied by its own Integrated rechargeable battery for up to 15 h operation time. It has wet contacts for automatic turning on when entering water.
The NERD 2 is placed in a three way adjustable holder located at the BOV Shrimp.

The NERD 2 is connected to the FX-head control electronics via a robust, durable and very flexible cable with the X-connector, made of AISI 316L rated up to 300m depth and marked with a **BLUE** ring.

NERD 2 Feature List

- Depth, time, 3x ppO2 and deco data display
- Bühlmann decompression model with gradient factors conservatism - Optional VPM-B decompression model
- 5 CC and 5 OC gases
- Gases can be changed and added during a dive
- CNS tracking
- No lockout from violating deco stops
- Any combination of oxygen, nitrogen, and helium (Air, Nitrox, Trimix) - Open and closed circuit, switchable during a dive
- Metric and Imperial units
- Automatic turn off on the surface (after 15 minutes)
- Tilt compensated digital compass
- Dive Planner
- 1000 hour dive log memory

5 PROCEDURES, Usage and Checks

5.1 Preparation before the dive

5.1.1 Replacement of CO_2 sorbent

Completely remove the previous sorbent from the scrubber. If necessary, clean the perforated tubes of any remaining sorbent or dust.

Place the scrubber on a dry and clean surface, preferably on a cloth pad to avoid scratching the scrubber bottom. Unscrew the lock nut on the scrubber lid and pull the lid handle to open the scrubber.
To prevent sorbent from entering the centre tube, use the cap from the sorbent canister and place it on the throat of the centre tube.
Pour the sorbent into the scrubber between the outer and inner tubes.

Fill the scrubber until approx. half full with the sorbent. Knock lightly all around the outer tube of the scrubber in order to level out the sorbent and compact it.
Fill the scrubber again to the marker line - close to the bottom edge of the top ring. Repeat light taps around the outside of the scrubber to level and compact the sorbent. If the final sorbent level is below the marker line, add the appropriate amount of sorbent. If the final sorbent level is above the marker line, remove the appropriate amount of sorbent to reach the correct level.
Then insert the scrubber lid, push the lid down and tighten the nut to lock the lid.
The scrubber is correctly filled when the sorbent level remains at the marker line on the top ring after shaking, rolling and light tapping.
To check this, open the lid again and the top lid should spring back up spontaneously, indicating that the springs are well compressed and the self-packing feature is working correctly.

When the scrubber is properly filled, turn it upside down and tap it lightly to remove any dust that may have entered the central tube.

Before inserting the scrubber into the FX CCR canister, ensure that the water trap area in the canister lid is clean and dry. Then insert the filled scrubber into the FX CCR canister with the throat towards the water trap.

IMPORTANT:
Any sorbent that has already been used must never be used for another dive!
Always handle the sorbent in accordance with the safety and operational instructions of the sorbent manufacturer.

5.1.2 Assembling the head onto the canister

Before mounting the FX-head:

- take the sensor bracket and visually check that all oxygen sensors are correctly installed and connected to the coax cables via SMB connectors.
- Then insert the sensor holder into the guide grooves in the FX head and push in the stop. Take care not to pinch the coaxial cables.
- apply a light coat of oxygen compatible lubricant to the sealing surface of the FX head where the sealing O-ring is located.

Mounting the FX-head on the FX-canister:
Put the head on the canister and rotate it so that the BN3 bayonet connector on the head is flush with the BN4 bayonet connector on the Canister Lid. Then push the FX-head into the Canister. Insert the locking string through the oval hole in the Canister into the appropriate groove and slide the full length of the string in until the black button is close to the hole.

Placing the FX-canister assembly with the head into the FX-Case:
Insert the canister into the case so that it sits on the Canister Holder at the bottom of the case and the FX-head is on the right when looking into the open case. Rotate the Canister so that the bayonet connectors are facing the top grommets on the case and secure it with the Velcro strap.

5.1.3 Connecting the counterlungs and the breathing loop

Mounting the Counterlungs:
First insert the exhalation counterlung into the FX-Case, insert the upper coupler into the grommet on the top of the case so that the snap locks are guided in the respective grooves, and the snap locks click on the top edge of the grommet.

Then insert the OPV into the grommet on the side of the case so that the snap locks are guided in the respective grooves, and the snap locks click on the top edge of the grommet.

Then insert the lower Coupler to the bayonet connector BN4 on the Canister Lid and secure the bayonet nut by turning it clockwise until the white locking button clicks into place.

Insert the inhalation counterlung into the FX-Case, insert the upper coupler into the grommet on the top of the case so that the snap locks are guided in the respective grooves, and the snap locks click on the top edge of the grommet.

Then insert the lower Coupler to the bayonet connector BN4 on the Canister Lid and secure the bayonet nut by turning it clockwise until the white locking button clicks into place.

Mounting the Breathing Hoses:
Connect the ADV L-piece with the breathing hose (blue marked hose clamps) to the inhale Counterlung coupler on the top of the case and turn the bayonet nut clockwise until the white lock button clicks into place.

Connect the exhale L-piece with the breathing hose (back marked hose clamps) to the exhale Counterlung coupler on the top of the case and turn the bayonet nut clockwise until the white lock button clicks into place.

Mounting the BOV Shrimp:
Take the BOV Shrimp and first connect the 2nd stage regulator port to the LP regulator hose (62cm long) coming from the Diluent MAV.

Then connect the inhalation hose (blue marked hose clamps) to the left hose connector with the 3-bit bayonet lock and turn the bayonet nut clockwise until the white lock button clicks into place.

Connect the exhalation hose (black marked hose clamps) to the right hose connector with the 4-bit bayonet lock and turn the bayonet nut clockwise until the white lock button clicks into place.

5.1.4 Filling the gas cylinders

Filling the tanks is subject to specific safety regulations and must be carried out by a qualified personnel, especially in the case of filling and handling oxygen.
If you are not such a person, leave the filling oxygen and blending of mixtures to a fully qualified person.

5.1.5 Battery charging

To charge the 18500 Li-ion batteries, they must be removed from the battery container.
Check that the batteries are not deformed, corroded or otherwise damaged, otherwise replace them immediately.
Do not discharge the batteries before charging.
Place the batteries in an external charger supplied with the FX CCR unit and connect the charger to a micro USB cable with 5V power supply adaptor. Follow the charger manufacturer's instructions. When the charging is complete, remove the batteries from the charger and place them into the battery case with the positive terminal facing forward. The correct polarity of the contacts (+/-) is indicated by the symbol on the battery case.
Check that the battery caps, especially the sealing O-rings, are clean and lightly greased. If this is not the case, remove the O-ring, clean the o-ring and the corresponding groove, grease the O-ring lightly with an oxygen-compatible lubricant (silicone lubricant is not recommended) and replace it back into the groove.
Keep the thread and the sealing surfaces in the battery case clean.

Screw the caps into the battery case with your fingers only without using any tool, as far as they go (touching the metal ring) to ensure proper electrical connection.

Failure to tighten the battery cap fully (to the metal ring in the head) may result in a brief interruption of power due to movement of the thread caused by pressure changes at depths of approximately 15 to 20 metres.
The batteries should be checked and recharged before each dive, especially before the first dive after a period of inactivity.

Remove both batteries from the battery canister before prolonged storage or transport. The Solenoid & Oxygen electronics (the SOLO board) has minimal power consumption when switched off, but can drain the battery significantly over a long period of time.

Particularly during transport, it can be switched on by improper handling or manipulation, which may cause the unit to switch on and discharge the batteries or even empty the oxygen tank (due to the active solenoid) before diving.

5.1.6 Calibration of oxygen sensors

The oxygen sensor must be calibrated using the Calibration Kit supplied with the unit, which consists of two parts, the the one-way valve and blind cap.

1. Disconnect the Counterlungs from the bayonet connectors on the CCR head and canister Lid and turn the canister with the connectors slightly towards you. Check that the oxygen supply hose to the solenoid is plugged in.
2. Insert the one-way valve into the bayonet connector on the FX head (on the right hand side of the Canister).
3. Insert the blind cap into the bayonet connector on the canister Lid (on the left side of the Canister).
4. Open the valve on the oxygen cylinder.
5. Turn on the Petrel 3 controller and set the setpoint to 1.3bar and switch the screen to display millivolt readings on the sensors.
6. Verify that the solenoid dosing oxygen to the head.
7. Within a while the values of ppO2 and millivolts increase on all sensors on the Petrel 3.
8. Wait for the ppO2 to stabilize and and millivolts are above 40 mV.
9. Then perform calibration of the Petrel 3 Controller and HUD or NERD 2.

If the calibration process fails, repeat the entire procedure. If an oxygen sensor fails repeatedly, it must be replaced immediately and permanently before the dive.

If the FX Calibration Kit is not available, perform the calibration as follows:

1. Keep the unit fully assembled.
2. Open the BOV to CC mode to ensure proper flow in the loop and to avoid overpressure during calibration.
3. Open the valve on the oxygen cylinder.
4. Turn on the Petrel 3 controller and set the setpoint to 1.3bar and switch the screen to display millivolt readings on the sensors.
5. Verify that the solenoid dosing oxygen to the head.
6. Within a while the values of ppO2 and millivolts increase on all sensors on the Petrel 3.
7. Wait for the ppO2 and millivolts to stabilize and above 40 mV.
8. Then calibrate the connected Petrel 3 and HUD, or NERD 2 if used.

With this method of calibration there is a greater consumption of oxygen necessary to fill the entire loop.

5.1.7 One-way directional valves check

The one-way directional valves are one of the most critical parts of the rebreather and it is difficult to detect a malfunction on them during a dive. Therefore before each dive and before connecting the breathing hoses, it is very important and necessary to check that the both one-way directional valves are in good condition and working properly! If either valve is found to be insufficiently flexible or even partially stiff, or damaged in any way, all diving must be stopped immediately until both valves are replaced with new ones and are functioning properly.

Disconnect the BOV Shrimp from the breathing hoses, set it to CC mode and place the mouthpiece in the mouth.

Cover the left hose connector on the BOV (the inhale side) and try to inhale from the mouthpiece, no gas can enter the BOV but exhalation should be possible.
Cover the right hose connector on the BOV (the exhale side) and try to make overpressure in the mouthpiece, no gas can leave the BOV but inhalation should be possible.

Then perform the leak test. Switch the BOV to OC mode and try to suck hard through the mouthpiece for a few seconds. In this situation no gas can enter the BOV. During the test, close the diluent tank or disconnect the 2nd stage regulator hose and seal the inlet port with a finger.

5.1.8 The whole FX CCR unit inspection

Carefully check that the FX CCR unit is complete, that all the FX CCR components and their parts are correctly assembled and that no part has been replaced by another that is not part of the original unit.

If any part is found to be defective or damaged, even partially, do not use the FX CCR until the defect has been completely repaired.

5.1.9 Bail-out system

The diver must have an appropriate bail-out system that allows a safe return to the surface from the deepest / furthest point of the dive with the longest decompression time, while maintaining a safety margin.

It is a good practice to carry an adequate number of stage cylinders with appropriate travel and decompression gases and to have a bail-out plan for each dive. The preparation and set-up of the bail-out stage cylinders is similar to open circuit diving.

5.1.10 Attaching the FX CCR unit to the diver

After completing the pre-dive check, place the unit on a flat and stable surface.
Standing on both feet, place the BCD straps on the shoulders. Place the crotch strap in the correct position, pass the belt buckle through the eye of the crotch strap, tighten the belt slightly and lock the buckle. Check that all the straps and belt fit snugly against the diver's body and are properly tightened.

Before attaching the unit to the diver's body, it is necessary to check that the harness fits the diver's physical dimensions of and is comfortable. The unit and the BCD harness must not restrict the diver's breathing.

Attach the top left and right carabiners to the D-rings located at the top of the shoulder straps.

Then clip the bottom left and right carabiners to the D-rings on the belt.

The unit can also be attached to the diver in shallow water, which makes it easier. Fully inflate the breathing loop by mouth through the BOV and close it (OC mode) or inflate from the Diluent MAV. Place the unit on the surface. Stand next to the floating unit and attach all carabiners as described above.

Attach the Primary Controller Handsets to your left wrists. The HUD must be placed in the adjustable holder attached to the BOV.

Place the BCD inflator valve in the correct and easily accessible position. Check that the BCD inflator valve is connected to the 1st stage regulator, which is connected to an off-board cylinder.

Connect the supply hose coming from the 1st stage regulator on the diluent stage cylinder to the Diluent MAV using the QC6 quick-connector and open the diluent cylinder valve.

Donning and fitting of the FX CCR unit:

The correct position of the unit is when the top edge of the unite is about 20cm below the diver's chin.

Ensure that the unit fits snugly and comfortably on the diver's body, and that no part of the unit or harness is trapped or obstructed anywhere or interferes with the diver's movement.

5.2 Checklist - Prior the dive

Prior every dive on the FX CCR unit it is essential that the diver executes all the checks according to this checklist:

	Check procedures - Prior the dive
Step	Procedure description
1	Check the CO2 scrubber that is filled with new soda lime that has never been used before.
2	Check that the CO2 scrubber is inserted in the canister
3	Check the sensor holder is inserted into the head
4	Analyze the content and the sufficient pressure of the oxygen cylinder and check the oxygen tank is fastened properly.
5	Analyze the content and the sufficient pressure of the connected diluent cylinder and check the diluent cylinder is attached properly.
6	Take a Bailout system adequate for the dive, while assume the worst case scenarios.
7	Open the valves on the both oxygen and diluent cylinders.
8	Check the medium pressure of both 1st stage regulators. The medium pressure of oxygen and diluent pressure must be within the range 9,5 +/-0,5 bar and stable. It is prohibited to dive the unit, if the medium pressure is out of the range.
9	Calibrate the O_2 sensors
10	Check that the head is firmly attached and locked with the locking string.
11	Check that the canister lid is firmly attached and locked with the locking string.
12	Check all the LP hoses are connected and lightly tightened so they don't loosen themselves
13	Check that the both one-way directional valves in the BOV are in good condition and work properly!
14	Check the manual adding valves that are working properly.
15	Check the ADV that is working properly.
16	Check the sidemount BCD inflating valve that it works properly.
17	Check the BOV to ensure that the CC/OC switch and the 2nd stage regulator are working properly.
18	Check the overpressure / drain valve on the counterlungs that is working properly.
19	Perform the negative pressure test: Close the cylinder valves and perform suction through the mouthpiece to create underpressure in the breathing loop. Close the BOV and wait a few minutes to see if the breathing loop remains underpressurized.
20	Conduct the positive pressure test: Fill the breathing loop completely with air through the mouthpiece until the overpressure valve on the counterlung releases the overpressure. Close the mouthpiece and wait a few minutes to see if the breathing loop remains pressurized.
21	Open the both tank valves.
22	Switch on the primary handset and check the status of the batteries and that the solenoid is working properly.
23	Turn on the HUD (or NERD2) and make sure that it is working properly.
24	Open the BOV - switch it to CC mode and breathe for 2-3 minutes from the unit in order to check that the CO_2 scrubber works properly.
25	Close the BOV - switch it to OC mode
26	Turn off the primary handset and HUD, and close both tank valves.

5.3 Checklist - Just before the dive

Prior entering the water, the diver has to execute all the checks according to this checklist:

	Check procedures - Just before the dive
Step	Procedure description
1	Check the diluent cylinder that is connected properly.
2	Open the valves on the oxygen and diluent cylinder and check the system, that no gas leak anywhere.
3	Check the manual adding valves that are working properly.
4	Check the ADV that is working properly. Perform suction through the mouthpiece to create negative pressure to activate the ADV.
5	Check the BCD inflating valve that it works properly.
6	Check the BOV to ensure that the CC/OC switch and the 2nd stage regulator are working properly.
7	Perform the negative pressure test
8	Perform the positive pressure test
9	Turn on the primary controller handset and check the Low setpoint, status of the batteries, and that the solenoid is working properly.
10	Turn on the HUD (or NERD2) that is working properly.
11	Breathe for 2-3 minutes from the unit in order to check that the CO_2 scrubber works properly.

5.4 Checklist - When entering the water

Do not enter the water without having performed the Prior the dive check and the Just before the dive check !
Immediately upon entering the water, the diver must perform all the checks listed in this checklist:

	Check procedures - When entering the water
Step	Description
1	Check that breathing is comfortable and without increased breathing resistance.
2	Check that the unit is properly attached to the diver's body at all 4 attachment points.
3	Check the Primary Controller display and verify the ppO_2 is above 0,5 bar and that the Low Set Point is set.
4	Verify that the HUD (or NERD2) is working and displaying ppO_2 correctly.
5	Perform a bubble check in the shallow water between the surface and max. 3m depth. Never start a deeper descent without carrying out the bubble check.

5.5 When diving

When diving the FX CCR unit, the diver have to read the HUD signals and check the current values on the primary handset. The diver has to check the current ppO_2 reading on every cell, the current status of batteries, any alarms displayed on the screen, current depth and time, the status of the CO_2 stack timer and the pressure in the cylinders.

The current ppO_2 in the breathing loop is the most important information the diver needs to know at any moment !!!

The optimal position of the diver in the water for minimal breathing effort is at an angle of 0 to 20 degrees, which means that the diver's head is in line with, or just slightly higher, than the legs. Breathing should be deep and continuous at all times.

If the diver must swim in a vertical head-up or head-down body position, the diver should switch to OC mode for the necessary time until the diver returns to the normal 0° - 20° swim position.
This is a necessary precaution against excessive overpressure or underpressure in the breathing loop caused by the non-standard position of the Counterlungs relative to the mouth.

The volume of the breathing loop should be as low as necessary for comfortable breathing. Too high volume will affect breathing effort and buoyancy. Low volume is optimal until spontaneous activation of the ADV is required.

In case, that the ppO_2 deviation from the setpoint is close to the safe limits (minimum 0,5 bar or maximum 1.6 bar), the diver must intervene to manually maintain the ppO_2 in the breathing loop within the safe limits:

In case of high ppO_2 - flush the loop with diluent in appropriate volume via the manual adding valve.

In case of low ppO_2 - use manual dosing of oxygen via the manual adding valve while adding oxygen in several steps with a delay of 10 seconds between doses (due to the delay in O_2 cell readings and circulation in the breathing loop).

This situation can occur during a dive if the diver ascends or descends too quickly or if the solenoid fails.

5.6 Checklist - After the dive

This procedure describes all steps that should be performed on the FX CCR unit after the dive.:

	After the dive Procedures
Step	Procedure description
1	Never close the cylinder valves until the FX CCR unit is taken out of the water.
2	Take the unit out of the water.
3	Turn off the primary controller handset.
4	Turn off the Head-Up Display (or NERD2, if installed) and dry its wet contacts.
5	Close the valves on the oxygen and diluent cylinders and disconnect the off-board diluent cylinder.
6	Disconnect the L-pieces with breathing hoses from the unit and disconnect the BOV.
7	Rinse the breathing hoses and L-pieces with fresh water, hang them in a vertical position and allow to dry.
8	Rinse the BOV with fresh water, then set the valve knob to an intermediate position between CC and OC and allow the BOV to dry.
9	Fully open the perimeter zipper on the FX case, disconnect the counterlungs from the bayonet connectors on the head and lid, unlock and slide out the top fittings and OPV from the grommets on the case and remove the counterluns out.
10	Rinse the Counterlungs with fresh water and hang them using the drying holder (supplied with the unit) and leave them to dry.
11	Remove the FX head from the Canister and pull out the sensor holder to dry the sensors.
12	Take off the scrubber and leave it out to dry.
13	Wipe the FX canister to dry.

Steps 6 to 13 are only necessary if no further dive will be done in the same day.

5.7 Quick cleaning of the unit

The quick-cleaning procedure should be performed after every dive.

	Quick cleaning Procedures
Step	Procedure description
1	Rinse the fully assembled and closed FX CCR unit with fresh water.
2	Disconnect the L-pieces with breathing hoses from the unit and disconnect the BOV.
3	Rinse the breathing hoses and L-pieces with fresh water, hang them in a vertical position and allow to dry.
4	Rinse the BOV with fresh water, then set the valve knob to an intermediate position between CC and OC and allow the BOV to dry.
5	Fully open the perimeter zipper on the FX case, disconnect the counterlungs from the bayonet connectors on the head and lid, unlock and slide out the top fittings and OPV from the grommets on the case and remove the counterluns out.
6	Rinse the Counterlungs with fresh water and hang them using the drying holder (supplied with the unit) and leave them to dry.
7	Remove the FX head from the Canister and pull out the sensor holder to dry the sensors.
8	Take off the scrubber and leave it out to dry.
9	Wipe the FX canister to dry.
10	Allow the entire unit to dry completely.

REMOVE the sensor holder and disconnect it from the Head each time before every cleaning! The sensor holder contains electronic parts that can be damaged.

REMOVE the Scrubber from the unit each time before every cleaning! Soda lime and water form a caustic solution that can damage electrical and metal parts of the unit.

5.7 Complete cleaning of the unit

The complete cleaning procedure should be performed at the end of the diving day.

	Procedure - Complete cleaning
Step	Procedure description
1	Rinse the fully assembled and closed FX CCR unit with fresh water.
2	Disconnect the L-pieces with breathing hoses from the unit and disconnect the BOV.
3	Prepare the recommended disinfectant solution **EW 80 clean** and **EW 80 des** in accordance with its manufacturer specifications.
4	Immerse the breathing hoses with L-pieces and the BOV into the disinfectant solution for a couple of minutes (in accordance with the manufacturer specifications).
5	Rinse the breathing hoses with L-pieces and the BOV thoroughly with fresh water and allow to dry.
6	Fully open the perimeter zipper on the FX case, disconnect the counterlungs from the bayonet connectors on the head and lid, unlock and slide out the top fittings and OPV from the grommets on the case and remove the counterluns out.
6	Pour an appropriate small amount of disinfectant into the counterlungs, fill them with water and allow the solution to act for a few minutes (according to with the manufacturer's instructions).
7	Empty the counterlungs, rinse them thoroughly with fresh water (min. 2x) and hang them using the drying holder (supplied with the unit) and leave them to dry.
8	Remove the CCR head, remove the sensor holder and pull out the sensor cartridge to dry.
9	Take off the scrubber, remove the soda lime and clean the scrubber of any soda lime residue.
10	Clean scrubber O-rings and their grooves, and lightly lubricate the O-rings with an oxygen-compatible lubricant.
11	Wipe the CCR canister.
12	Leave every part of the FX CCR unit to dry.

REMOVE the sensor holder from the Head each time before every cleaning! The sensors contains electronic parts that can be damaged.

REMOVE the Scrubber from the unit each time before every cleaning! Soda lime and water form a caustic solution that can damage electrical and metal parts of the unit.

5.9 Storage

The FX CCR unit must be stored in a dry and well ventilated area out of the sun (UV radiation).

Prior to storage, each part of the breathing loop must be thoroughly cleaned and disinfected according to Chapter 5.8 Complete Cleaning of the unit, and must be completely dried.

The scrubber must be emptied, cleaned, dried, and should be placed in the FX canister.

The FX CCR unit must be fully assembled to prevent any organisms from entering the breathing loop.

The BOV should be partially open with the valve knob in an intermediate position between CC and OC to avoid the stress on the one-way valves due to changes in ambient pressure.

The unit should be stored in a horizontal position.

For extended storage (one year or more), it's recommended to keep the gas pressure in the both gas tanks in the range of 30 to 50 bar.

6 MAINTENANCE and SERVICING

6.1 Maintenance

The FX CCR unit should be treated with thorough care. In general, the maintenance includes periodic inspection of the unit's condition, regular cleaning and greasing of all O-rings and sealing surfaces, and monitoring and adherence to maintenance intervals.

All the rubber and plastic parts age and this process is accelerated by exposure to direct sunlight and/or prolonged exposure to salt. The parts listed in the table should be replaced at the standard maintenance interval or at the latest after the end of their service life as indicated in the table:

Service lifetime	Part
5 years	BCD wing
5 years	All rubber parts - Breathing hoses, O-rings
5 years	Diluent high and low pressure hoses
3 years	Oxygen high and low pressure hoses
3 years	Counterlungs
2 years	Diaphragm assembly in the BOV 2nd stage regulator
2 years	Diaphragm in the ADV
1 year	Oxygen sensors; BOV's one-way valves

The date of manufacture of the unit determines the maintenance intervals.

The service life of the oxygen sensors is one year of use or 18 months maximum from the date of manufacture printed on the sensors.

6.2 Maintenance and Service inspection intervals

The FX CCR unit must be maintained and serviced at the intervals and under the conditions shown in the tables below:

The user may replace oxygen sensors, o-rings in the breathing loop, breathing hoses, diaphragms in the BOV and ADV, one-way valves in the BOV, shut-off valve, scrubber, fasteners and counterlung assemblies.

The user must use only original FX CCR replacement parts. Use of any other part will void the warranty and create a serious risk of malfunction that could result in personal injury or death.
Replaced parts must be returned to the manufacturer.

The periodical maintenance, service inspections and repairs to the electronics, solenoid, 1st stage regulators, BOV, ADV and the BCD wing may only be performed by the manufacturer or by a service center approved by the manufacturer.

The periodic maintenance intervals are based on normal use.
In case of more intensive use or if the unit is used in training courses, the periodic maintenance intervals must be adjusted accordingly.

Defective and or unreliable parts must be replaced immediately, regardless of the periodic maintenance and service inspection intervals.

Regular service inspection

The FX CCR requires a periodic service inspection always every 12 months or after 100 hours of underwater use.
If the unit is used in salt water or polluted water, the service interval should be reasonably shorter.

Service inspections may only be performed solely by the manufacturer or an authorized service center officially approved by the manufacturer.

6.3 12-months Maintenance and Service interval

Part	Maintenance or Service performance
Oxygen sensors	Replace the O2 sensors when the period of use is 12 months or 18 months from date of manufacture.
Oxygen 1st stage regulator	Revision or setting of the low pressure to 9,5 +/- 0,5 bar, inspection of the valve seat, diaphragm, o-rings. Performing of the oxygen service.
Diluent 1st stage regulator	Revision or setting of the low pressure to 9,5 +/- 0,5 bar, inspection of the valve seat, diaphragm, o-rings.
LP & HP oxygen hoses	Inspection and oxygen service on all the oxygen hoses.
LP & HP diluent hoses	Inspection on all the diluent hoses.
Breathing loop	Replacement of o-rings on all the breathing hose connections and on the head.
BOV	Replacement of the one-way directional valves, cleaning and greasing the CC/OC valve. Revision of the 2nd stage regulator and breathing parameters.
Scrubber	Inspection on the scrubber tubes and connections. Replacement of all the o-rings.
High pressure gauge	Inspection of the HP values displayed on the pressure gauges.
CCR Head	Replace the two o-rings 156x3 on the head.
BOV	Replace the 2nd stage regulator diaphragm and exhalation valve.
Oxygen tank	Let do an official pressure test and oxygen service, this has to be in compliance with the specific regulations applicable in the country of use. Replace gas marking stickers.
Diluent tank	Let do an official pressure test, this has to be in compliance with the specific regulations applicable in the country of use. Replace gas marking stickers.
ADV	Replace the blue diaphragm.

6.4 36-months Maintenance and Service interval

Part	Maintenance or Service performance
FX CCR Unit	Return the entire unit to the manufacturer or an authorized service center for a complete inspection, maintenance, and service.

7 Warranty

The company iQsub Technologies s.r.o. provides the first owner with a 12-month warranty on the proper operation of the unit.

The company iQsub Technologies s.r.o. guarantees that the product is free from defects in material and workmanship, provided that the recommendations for use, maintenance and service are followed within the following limits.

The warranty does not apply in case of misuse, neglect, modification or unauthorized service of the product.

The warranty is limited to repair or replacement of parts or the entire product, depending on the decision of iQsub Technologies s.r.o.

Self-repair will result in loss of warranty and may result in personal injury or death !!!

8 Impressum

This user instructions manual was created and produced by iQsub Technologies s.r.o. in 2024. The original version is in English language. All other language mutations of this manual are based on the original English version.

All information in this document is believed to be accurate and sufficient for the safe operation of the FX CCR unit.

The contents of this User Instructions are based on knowledge available at the time of publication.
iQsub Technologies s.r.o. reserves the right to make changes at any time.
New updates will be available from the manufacturer or on its official web page iQsub.com.

Since it is not possible to guarantee the complete accuracy and suitability of this document, any liability arising from this document is excluded.

Mentioned companies or product names are trademarks belonging to the respective companies.

iQsub® is a trademark of iQsub Technologies s.r.o. registered since 2000.

SHEARWATER is a trademark of Shearwater Research Inc.

DiveCAN® is a trademark of Shearwater Research Inc. for digital communication standard developed for rebreathers.

Appendix 1

Operation of SHEARWATER PETREL 3 DiveCAN Controller

List of Content

1. Introduction

The Shearwater Petrel 3 is an advanced technical diving computer for open and closed circuit divers.
Although we strive to make the Petrel 3 easy enough to use without reading the manual, please take some time to read this manual to get the best performance from your new computer Diving involves risk and education is your best tool for managing this risk.

Features

- High-contrast 26" AMOLED display
- Rugged computer construction with titanium bezel
- DiveCAN communications for robust connections to rebreathers
- A menu system that adapts to diving status
- Powerful vibration alerts
- Programmable depth sampling rates
- Depth sensor calibrated to 130 msw
- Depth sensor function past 300 msw
- Crush pressure rating of 290 msw
- 5 CC & 5 BO gases
- Any combination of Oxygen, Nitrogen and Helium (Air, Nitrox,Trimix)
- Gases can be added and changed during a dive
- Automatic PPO2 set-point switching (configurable)
- Two PPO2 set-points, each of which can be set between 5 and 15
- Bühlmann ZHL-16C with gradient factors standard
- Optional VPM-B decompression model
- No lockout for violating deco stops
- CNS Tracking
- Gas Density Tracking
- Full decompression planner built in
- Simultaneous wireless pressure monitoring of up to 4 cylinders
- Tilt compensated digital compass with multiple display options
- Bluetooth Dive log uploading to Shearwater Cloud
- Bluetooth Firmware Updates

2. Basic Operation

2.1. Turning On

To turn the Petrel on, press both the MENU (left) and the SELECT (right) buttons at the same time.

Auto-On

The Petrel will automatically turn-on when submerged underwater. For rebreather controller models, this is based on the presence of water.

The Petrel 3's buttons act as wet contacts. All other versions of the Petrel are only activated by pressure, not the presence of water.

2.2. Buttons

Two titanium piezo-electric buttons are used to change settings and view menus.
All Petrel 3 operations are simple single button presses.

Don't worry about remembering all the button rules below Button hints make using the Petrel 3 easy.

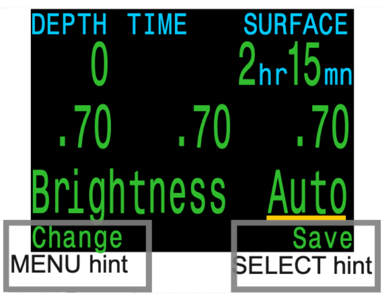
MENU (Left) button	
From main screen	Brings up menu
In a menu	Moves to the next menu item
Editing a setting	Changes the setting's value
SELECT (Left) button	
From main screen	Steps through info screens
In a menu	Performs command or starts editing
Editing a setting	Saves the setting's value

BOTH BUTTONS

When Petrel 3 is off pressing MENU and SELECT at the same time will turn the Petrel 3 on.
No other operation requires pressing both buttons at the same time.

BUTTON HINTS

When in a menu, button hints label each button.
For example, the hints to the right tell us:
Use MENU to **change** the brightness value.
Use SELECT to **save** the current value.



3. The Main Screen

The main screen shows the most important information needed for technical diving.

Color Coding

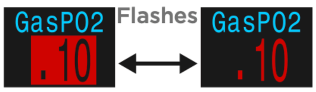
Color coding of text draws attention to problems or unsafe situations.

White text indicates normal conditions.

YELLOW is used for warnings that are not immediately dangerous but should be addressed.
Sample warning: A better gas is available.

Sample warning - a better gas is available

FLASHING RED is used for critical alerts that could be life threatening if not immediately addressed.



Sample critical alert - continuing to breathe this gas could be fatal

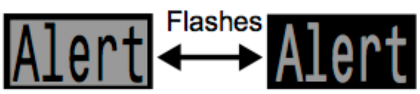
Color Blind Users

The warning or critical alert states can be determined without the use of color.

Warnings display on a solid inverted background.
Warning - doesn't flash

Warning - doesn't flash

Critical alerts flash between inverted and normal text.
Critical alert - flashes.



Critical alert - flashes

3.1 The Top Row

The top row shows depth and time information

Depth

Imperial: In feet (no decimal places)
Metric: In meters (displays with 1 decimal place up to 99,9m)
Note: If the depth shows a Flashing Red zero, then the depth sensor needs service.

in feet

in meters

Ascent Bar Graph

Shows how fast you are currently ascending:
Imperial: 1 arrow per 10 feet per minute (fpm) of ascent rate
Metric: 1 arrow per 3 meters per minute (mpm) of ascent rate

Green when 1 to 3 arrows,
Yellow when 4 to 5 arrows,
Flashes Red when 6 arrows or more

Note: Deco calculations assume 33fpm (10mpm) ascent rate

Dive Time

The length of the current dive in minutes.
The seconds display as a bar drawn below the word "Time".
It takes 15 seconds to underline each character in the word.
Does not display the seconds bar when not diving.

Battery Icon

Yellow when the battery needs to be changed
Red when the battery must be replaced immediately.

The default behavior is that battery icon is shown on the surface but disappears when diving.
If low or critical then the battery icon will appear while diving.

BLUE
Battery OK
YELLOW
Battery low.
RED
Replace immediately!

Stop Depth and Time

Stop – The next stop depth in the current units (feet or meters). This is the shallowest depth to which you can ascend.

Stop 27 meters for 2 min

Time – The time in minutes to hold the stop.

Will Flash Red if you ascend shallower than the current stop.

Decompression Stop Violated

By default the Petrel 3 uses a 10ft (3m) last stop depth.
At this setting, you may perform the last stop deeper if you choose.
The only difference is that the predicted time-to-surface will be shorter than the actual TTS since off-gassing is occurring slower than expected.

There is also an option to set the last stop to 20ft (6m) if you wish.

Surface Interval
When on the surface, the STOP DEPTH and TIME are replaced by a surface interval display.

2 hour and 15 minute surface interval

Shows the hours and minutes since the end of your last dive
Above 4 days, the surface interval is displayed in days.

The surface interval is reset when the decompression tissues are cleared See the section on Tissues Cleared.

Deco Clear Counter
When deco clears the STOP DEPTH and TIME are replaced by a counter that begins counting up from 0

Deco Clear Counter

3.2 The Center Row

The center row of a DiveCAN controller always displays the PPO2 as measured by the three external O2 sensors.

All centre row positions show PPO2 information

PPO2 units are absolute atmospheres (1ata = 1013mbar).

PPO2 Flashes Red when less than 0.40 or greater than 1.6. These limits can be adjusted in the Adv. Config 2 menu.

PPO2 Unsafe

When a sensor is voted out, it displays in Yellow Voting is performed to determine which sensors are most likely to be correct if the readings disagree A sensor that is within 20% of either of the other sensors passes the voting and is included in the system average PPO2 (used to control O2 injection and calculate decompression).

Sensor 3 voted out

When the O2 sensors require calibration, the PPO2 value will display as FAIL Instructions can be found in the Calibration section.

Requires Calibration

Voting Failed

If no consensus can be found between the three O2 sensors, then voting has failed This displays as PPO2 values alternating with "VOTING FAILED"

When voting fails, the solenoid will not inject O2 to maintain the PPO2 setpoint .
If this occurs, follow the training guidelines from your rebreather manufacturer or training agency.

When voting fails the decompression calculations use the PPO2 from the lowest sensor (most conservative value), down to a minimum PPO2 of 0,16.

3.3 The Bottom Row

The bottom row displays the current mode, gas and decompression information.

Circuit Mode

The current breathing configuration. One of:
CC = Closed circuit
BO = Open circuit bailout (bailout so displays in Yellow)

Current Gas (O2/He)

The current gas shown as a percentage of Oxygen and Helium. The remainder of the gas is assumed to be Nitrogen.

In closed circuit mode, this gas is the diluent.
In open circuit mode this is the breathing gas.

Displays in Yellow when there is better deco gas available than the current gas.

Air:
21% O2
79% N2

Trimix:
10% O2
50% He
79% N2

A better deco gas is available

No Decompression Limit (NDL)

The time remaining, in minutes, at the current depth until decompression stops will be necessary.
Displays in Yellow when the NDL is less than 5 minutes.

Once NDL reaches 0 (i.e. deco stops needed), the NDL display is just wasting space. To address this, a few different values can be set to replace the NDL (see Dive Setup ➔ NDL Display)
The options are:
• Ceiling
• @+5
• Delta+5
• GF99
• SurGF

Each of these values is discussed further in the next section

Time-to-Surface (TTS)

The time-to-surface in minutes. This is the current time to ascend to the surface including the ascent plus all required deco stops.

All decompression information including Deco Stops, NDL, and Time to surface are predictions that assume:

- Ascent rate of 10mpm / 33fpm
- Decompression stops will be followed
- All programmed gases will be used as appropriate

The bottom row is also used to show additional information.

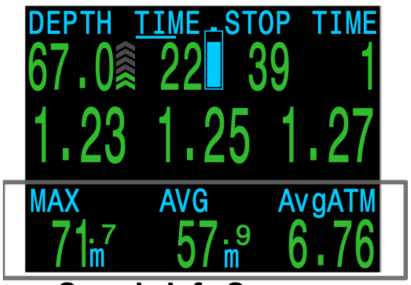
By using only the bottom row for this additional information, the critical information contained on the Top and Center Rows is always available during a dive.

The additional information that can be displayed on the bottom row includes:

Info Screens: Shows additional dive information
Press SELECT (right button) to step through info screens

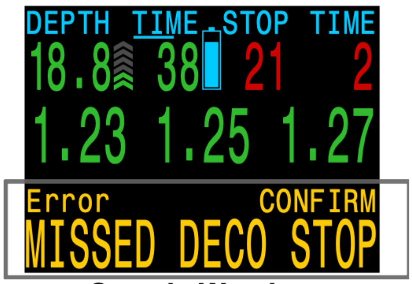
Menus: Allows changing settings
Press MENU (left button) to enter menus

Warnings: Provide important alerts
Press SELECT (right button) to clear a warning



Sample Info Screen

Sample Menu

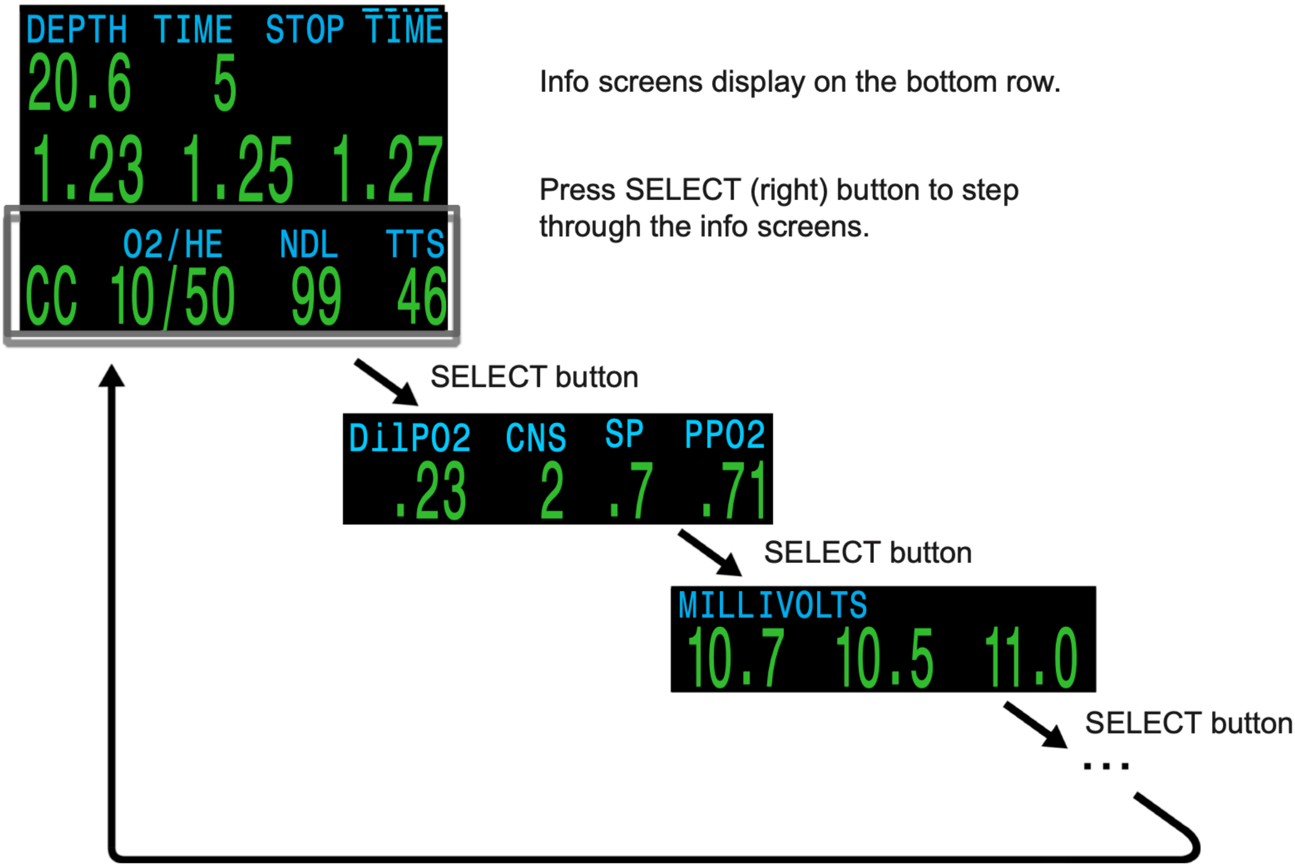


Sample Warning

The bottom row is used to display additional information.

4. Info Screens

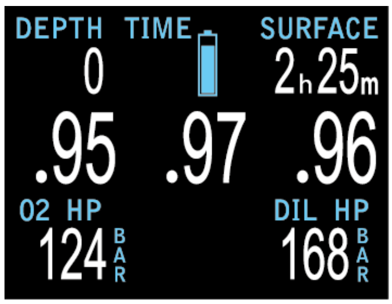
Info screens provide additional information that does not fit on the main screen.



Starting from the main screen, the SELECT (right) button steps through the info screens .

Compass is displayed on the second info screen.

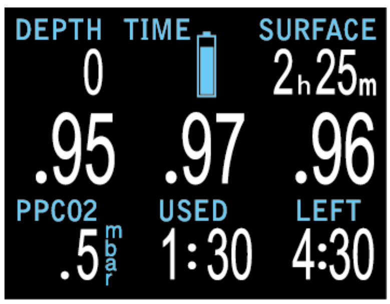
High Pressure readings from the on-board oxygen and diluent cylinders are displayed on the third info screen.



ppCO2 and **Stack-Timer** are displayed on the fourth info screen.

More info on Stack-Timer Setup see capture 11.12.4 Advanced Config 4

More info on ppCO2 Setup see capture 11.8.



When all info screens have been viewed, pressing SELECT again will return to the main screen.

Info screens also automatically time-out after 10 seconds, returning to the home screen. This prevents active gas information from being hidden for an extended period.

Note that the Compass, Tissues and AI Info screens do not automatically time out when active.

Pressing the MENU (left) button will return to the home screen at any time.

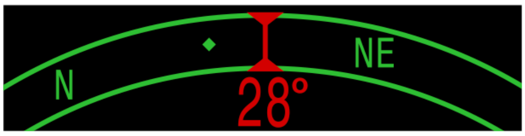
The next section gives descriptions of the data elements shown on the info screens.

Last Dive Info Screen (surface only)
The maximum depth and dive time from the last dive.

Air integration
Only available if AI feature is turned on The contents of the AI info line will automatically adapt to the current setup.

More information on AI features, limitations, and displays can be found in the Air Integration (AI) section.

Compass



Marked headings appear in green while reciprocal headings are shown in red Green arrows point in the direction of your mark when off course by 5° or more.
Compass info row will not time out and is only available when compass feature is turned on.

See the Compass section for more information.

Millivolts

Shows the raw millivolt outputs of external PPO2 cells This is important information used to understand the O2 cell output behavior over time.

Average Depth

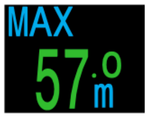
Displays the average depth of the current dive, updated once per second. When not diving, shows the average depth of the last dive.

Average Depth in Atmospheres (AvgATM)

The average depth of the current dive, measured in absolute atmospheres (ie a value of 10 at sea level) When not diving, shows the average depth of the last dive.

Maximum Depth

The maximum depth of the current dive
When not diving, displays the maximum depth of the last dive.



CNS Toxicity Percentage

Central Nervous System oxygen toxicity loading percentage Flashes Red when 100 or greater.

The CNS percentage is calculated continuously, even when on the surface and turned off When deco tissues are reset, the CNS will also be reset.

The CNS value (short for Central Nervous System Oxygen Toxicity) is a measure of your exposure to elevated partial pressures of oxygen (PPO2) as a percentage of a maximum allowable exposure As PPO2 goes up, the maximum allowable exposure time goes down The table we use is from the NOAA Diving Manual (Fourth Edition) The computer linearly interpolates between these points and extrapolates beyond them when necessary Above a PPO2 of 165 ata, the CNS rate increases at a fixed rate of 1% every 4 seconds

During a dive the CNS never decreases When back at the surface, a half- life of elimination of 90 minutes is used So for example, if at the end of the dive the CNS was 80%, then 90 minutes later it will be 40% In 90 more minutes it will be 20%, etc Typically after about 6 half-life times (9 hours), everything is back close to equilibrium (0%)

Temperature

Reports the temperature in degrees Celsius or Fahrenheit

Diluent PPO2
The PPO2 of the currently selected diluent. Not measured directly, but calculated as the fraction of O2 in the diluent multiplied by the current depth's pressure.

Displays in Flashing Red when the PPO2 of the diluent is less than 0,19 or greater than 1,65
,When performing a manual diluent flush, you can check this value to see what the expected PPO2 will be at the current depth. Also, can use to verify it is safe to flush with the diluent.

Setpoint (SP)
The currently requested PPO2 setpoint.

Average PPO2
The purpose of this value is to show what PPO2 is actually being used for setpoint maintenance and decompression calculations.

The Petrel votes on the three measured PPO2 values to decide what is the most likely true PPO2 This value shows the result of the voting.

When you have bailed out to OC, the center row continues to display the external measured PPO2 Use this info display to see the OC PPO2.

In CC mode, displays in Flashing Red when less than 0,40 or greater than 1,6.

In OC mode, displays in Flashing Red when less than 0,19 or greater than 1,65.

Fraction Inspired O2 (FiO2)
The fraction of the breathing gas composed of O2. This value is independent of pressure.

CEIL
The current decompression ceiling in the current units (feet or meters) not rounded to the next deeper stop increment (ie not a multiple of 10ft or 3m)
Flashes Red if you ascend shallower than the current ceiling

GF99
The current gradient factor as a percentage (ie super-saturation percent gradient).

0% means the leading tissue super-saturation is equal to ambient pressure Displays "On Gas" when tissue tension is less than the inspired inert gas pressure.

100% means the leading tissue super-saturation is equal to the original M-Value limit in the Bühlmann ZHL-16C model.

GF99 is displayed in Yellow when the current gradient factor modified M-Value (GF High) is exceeded.

GF99 is displayed in Red when 100% (un-modified M-Value) is exceeded.

SurfGF
The surfacing gradient factor expected if the diver instantaneously surfaced.

SurfGF colour is based on the current GF (GF99). If the current GF is greater than GF High, SurfGF will be displayed in Yellow. If the current gradient factor is greater than 100%, SurfGF will be displayed in Red.

@+5/TTS
"At plus 5" is the TTS if remaining at the current depth for 5 more minutes. This can be used as a measure of how fast you are on-gassing or off- gassing.

Since this value is most useful when compared to the current TTS, the current TTS is displayed beside the @+5 value.

Δ+5
The predicted change in TTS if you were to stay at the current depth for 5 more minutes.

A positive "Delta plus 5" indicates that you are on-gassing the leading tissue while a negative number indicates that you are off-gassing the leading tissue.

Dive End Time (DET)
This is similar to TTS but is expressed as a time of day.

The time of day at which you can expect to surface if you depart immediately, ascend at 10mpm or 33fpm, change gases when prompted, and perform all decompression stops as directed.

Gradient Factor
The deco conservatism value when the deco model is set to GF.
The low and high gradient factors control the conservatism of the Bühlmann GF algorithm. See "Clearing up the Confusion About Deep Stops" by Erik Baker.

VPM-B (and VPM-BG)
The deco conservatism value when the deco model is set to VPM-B.
For VPM-B, higher values are more conservative.

If the deco model is VPM-B/GFS, also displays the gradient factor for surfacing. For the gradient factor, higher values are less conservative.

Battery
The Petrel's internal battery voltage. Displays in Yellow when the battery is low and needs replacement. Displays in Flashing Red when the battery is critically low and must be replaced as soon as possible.
Also shows battery type

External Battery (EXT V)
The voltage of the external battery used to fire the solenoid.
Flashing Red when the battery is critically low and must be replaced as soon as possible.
Only sampled when solenoid is fired, so if solenoid has not yet fired, value is unknown and displays as a Yellow '?'.

Pressure
The pressure in millibars. Two values are shown, the surface (surf) pressure and the current (now) pressure.
The current pressure is only shown on the surface.

Note that typical pressure at sea level is 1013 millibar, although it may vary with the weather (barometric pressure). For example, surface pressure may be as low as 980 millibar in a low pressure system, or as high as 1040 millibar in a high pressure system.

For this reason, the PPO2 displayed on the surface may not exactly match the FO2 (fraction of O2), although the displayed PPO2 is still correct.

The surface pressure is set based on the lowest pressure the dive computer sees in the 10 minutes prior to the start of a dive. Therefore, altitude is automatically accounted for and no special altitude setting is required.

The surface pressure is set when the Petrel is turned on. If the Altitude setting is set to SeaLvl, then surface pressure is always 1013 millibars.

Date and Time
In the format dd-mon-yy
12 or 24 hour clock time.

Serial Number & Version
Each Petrel has a unique serial number.

The version number indicates the available features.
The last two numbers are the firmware version (V12 in this image).

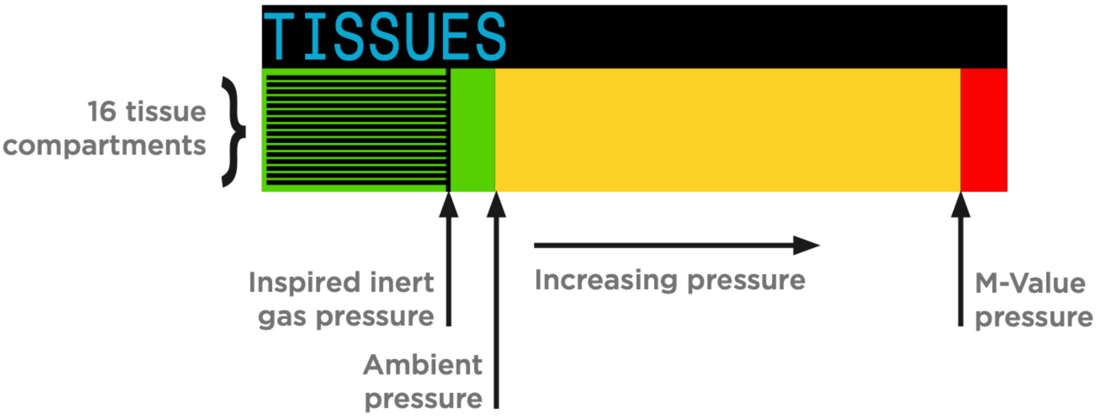
TISSUES BAR GRAPH

The tissues bar graph shows the tissue compartment inert gas tissue tensions based on the Bühlmann ZHL-16C model. Note that VPM-B also tracks tensions in the same way.

The fastest tissue compartment is shown on the top, and the slowest on the bottom. Each bar is the combined sum of the nitrogen and helium inert gas tensions. Pressure increases to the right .

The vertical black line shows the inert gas inspired pressure. The boundary between the green and yellow zones is the ambient pressure. The boundary between the yellow and red zone is the ZHL-16C M-Value pressure.

Note that the scale for each tissue compartment above the green zone is different. The reason the bars are scaled in this way is so that the tissues tensions can be visualized in terms of risk (ie how close they are as a percentage to Bühlmann's original super- saturation limits).
Also, this scale changes with depth, since the M-Value line also changes with depth.



Sample Tissues Graphs

On surface (sat. with air)
Note: Gas is 79% N_2 (21% O_2, or Air)

After descent

On-gassing

Deep stop

Last deco stop
Note: Gas is now 50% O_2 and 50% N_2

5. Notifications

This section describes the different types of notifications the computer may present the diver.

Limitations Of Alarms

All alarm systems share common weaknesses.

They can alarm when no error condition exists (false positive).
Or they can fail to alarm when a real error condition occurs (false negative).

Respond to alarms if you see them, but NEVER depend on them Your judgment, education, and experience are your best defenses. Have a plan for failures, build experience slowly, and dive within your experience.

5.1 Types of Notifications

There are two types of notifications displayed by this dive computer.
Primary notifications and persistent notifications.

Primary Notifications

Each primary notification displays as a message in Yellow across the bottom row until dismissed.

The notification is dismissed by pressing either button.

Sample Primary notification - High PPO2 Warning

For example, this "HIGH PPO2" message will appear if the average PPO2 goes above the high PPO2 limit for more than 30 seconds.

The highest priority notification is listed first. If multiple errors occur simultaneously, the notification with the highest priority will be displayed.
Clear the first notification by pressing a button to see the next one.

If vibration alerts are on, the unit will vibrate when the alert first occurs and every 10 seconds until it is acknowledged.

Persistent Notifications
Persistent notifications complement primary notifications, displaying while a dangerous condition is present until the condition is resolved.

Persistent notifications cannot be cleared while the condition that caused them persists.

Sample "Low PPO2" Persistent Notification

Example: when PPO2 is in an unsafe range,

● Center row text that shows a "Low PPO2" or "High PPO2" message.

● PPO2 and gas values are highlighted and flash.

These persistent notifications will clear automatically once a safe PPO2 is restored.

Sample "High PPO2" Persistent Notification

5.2 Vibration Alerts

In addition to visual notifications, the Petrel 3 has vibration alerts to help quickly notify the diver of warnings, errors and dive events.

> **Vibration is Battery Dependant**
>
> Vibration Alerts are only available when using a 15V Lithium or 37V Rechargeable Li-ion battery

If turned on, attention vibration alerts occur when a safety stop starts, pauses, or is completed. Vibration alerts also occur any time a primary notification is triggered and every 10 seconds until it is acknowledged.

There are some persistent conditions, such as low PPO2 that will cause vibration to continue until the condition is resolved.

The vibration alert can be toggled on or off in System Setup > Alerts Setup , or in the Dive Setup menu.

A Test Vibration tool is also available in the Dive Setup menu and should be used regularly before diving to ensure the vibrator is functioning properly.

Caution

Although vibration alerts are very useful, never rely on them for your safety. Electromechanical devices can and will eventually fail.

Always be proactively aware of your depth, no-decompression limit, gas supply, and other critical dive data. You are ultimately responsible for your own safety.

5.3. List of primary notifications

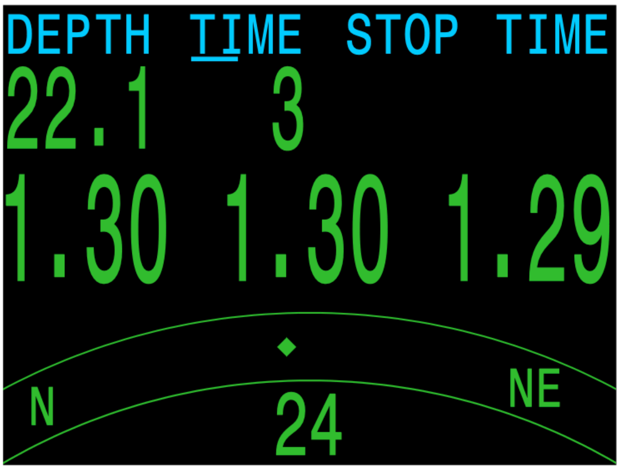
The following table lists primary notifications you may see, their meaning, and steps to take to solve any problems.

If multiple warnings are triggered simultaneously, the notification with the highest priority will be displayed. Clear that notification by pressing any button to see the next notification.

Display	Meaning	Action to take
Warning Confirm LOW PPO2	The PPO2 is below the limit set in the PPO2 limits menu.	**Change your breathing gas to one safe for the current depth.**
Warning Confirm HIGH PPO2	The PPO2 is above the limit set in the PPO2 limits menu.	**Change your breathing gas to one safe for the current depth.**
Warning Confirm MISSED DECO STOP	A required decompression stop was violated.	**Descend deeper than the currently displayed stop depth. Monitor for symptoms of DCS. Use extra conservatism for future repetitive dives.**
Warning Confirm FAST ASCENT	The ascent was sustained as faster than 10m/min (33ft/min)	**Use a slow ascent rate. Monitor for symptoms of DCS. Use extra conservatism for future repetitive dives.**
Warning Confirm LOW BATTERY INT	The internal battery is low.	**Replace the battery.**
Warning Confirm TISSUES CLEARED	The decompression tissue inert gas loading has been set to default levels.	**Plan repetitive dives accordingly.**
Warning Confirm VERY HIGH CNS	Central Nervous System (CNS) toxicity clock exceeded 150%	**Switch to a gas with a lower PPO2 or ascend shallower (decompression ceiling allowing)**

Display	Meaning	Action to take
Warning Confirm HIGH CNS	Central Nervous System (CNS) toxicity clock exceeded 90%	**Switch to a gas with a lower PPO2 or ascend shallower (decompression ceiling allowing)**
Alert Confirm Low NDL Alert	NDL is less than low NDL alert value. (Only if alert active)	**Ascend soon to avoid decompression obligation.**
Alert Confirm Depth Alert	Depth is deeper than depth alert value. (Only if alert active)	**Ascend above depth limit.**
Alert Confirm Time Alert	Dive time has surpassed time alert value. (Only if alert active)	**End dive safely.**
No Comms 210 BAR ⇄ Alternates ⇄ T1 ---- BAR	No communications for 30 to 90 seconds.	**See the Transmitter Connection Issues section for more information.**
No Comms ---- BAR ⇄ Alternates ⇄ T1 ---- BAR + Warning Confirm AI LOST COMMS	No communications for 90+ seconds.	**See the Transmitter Connection Issues section for more information.**
Low Bat 3042 PSI ⇄ Alternates ⇄ T1 3042 PSI + Warning Confirm AI LOW BATTERY	Low transmitter battery.	**Replace the transmitter battery.**
T1 260 BAR	Tank pressure exceeds rated pressure by more than 10%	**Properly set the rated pressure in the AI Setup menu.**
T1 24 PSI + Warning Confirm T1 CRITICAL PRES	Tank pressure has fallen below the critical pressure.	**Be aware that gas is running low. Begin to end your dive and perform a controlled ascent to the surface.**
Error Confirm WATCHDOG RESET	The computer has reset to recover from an unexpected software condition.	**If this occurs more than once over a long period, please report to Shearwater Research Inc.**
Error Confirm UPGRADE RESET	This reset shows up after a software update. This is the normal event that shows the computer has been rebooted after the software update.	N/A
Error Confirm UPGRADE FAIL	Firmware update failed, possibly due to a communications error or corrupted file.	**Try the firmware upgrade again. Contact Shearwater if problem persists.**

6. Compass



The Petrel 2 contains a tilt-compensated digital compass.

Compass features:

- 1° resolution
- ±5° accuracy
- Smooth, high-speed refresh rate
- User set heading marker with reciprocal
- True North (declination) adjustment
- Tilt compensation: ±45°

Viewing the Compass

When enabled, the compass is viewed by pressing the SELECT (right) button once Press SELECT again to continue on to view the regular info screens.

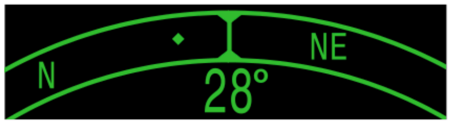
Unlike the regular info screens, the compass never times out back to the main screen Pressing the MENU (left) button brings up the Mark Heading option.

Pressing MENU again returns to the main screen

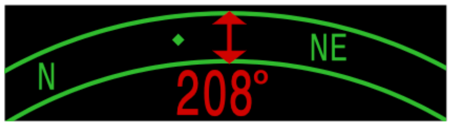
Marking a Heading

To mark a heading, when viewing the compass press the MENU (left) button. This brings up the "Exit Mark" menu. Press the SELECT (right) button to mark the heading.

The marked heading is shown with a green arrow. When within ±5° of the heading, the degrees display turns green.



The reciprocal heading (180° from marked heading) is shown with a red arrow. When within ±5° of the reciprocal heading, the degrees display turns red.



When more than 5° off the marked heading, a green arrow shows the direction back to the marked heading Also, the offset degrees to the heading are displayed (16° in
the example image). This offset is useful when navigating patterns. For example, a box pattern requires turns at 90° intervals, while a triangle pattern requires 120° turns.

Compass Limitations

Calibration - The digital compass needs occasional calibration. This can be done in the **System Setup ➔ Compass** menu

Battery Changes - When the battery is changed, the compass requires calibration.

Interference - Since a compass operates by reading the Earth's magnetic field, the compass heading is affected by anything that distorts that field or creates its own. Steel objects and electric motors or cabling (eg from dive lights) should be kept at a distance. Being close to or inside a shipwreck may also affect the compass.

Magnetic declination (also called magnetic variation) is the difference between magnetic and True North. This can be compensated in the Compass Setup menu using the True North setting. The magnetic declination varies around the world, so will need to be readjusted when traveling.

Magnetic inclination (or magnetic dip) is how much the Earth's magnetic field points up or down. The compass automatically compensates for this angle. However, near the poles, the inclination angle can exceed 80° (ie the magnetic field points almost directly up or down), in which case the specified accuracy may not be met.

7. Air Integration

The Petrel 3 is equipped with 4-transmitter air integration capability.

This section covers operation of the AI feature.

AI Features

- Simultaneous wireless pressure monitoring of up to 4 tanks.
- Units in psi or bar.
- Logging of pressure.
- Reserve and critical gas pressure warnings.

Shearwater Swift Wireless Transmitter

7.1 What is AI ?

AI stands for Air Integration. On the Petrel 3, this refers to a system that uses wireless transmitters to measure the gas pressure in a SCUBA tank and transmit this information to the Petrel 3 dive computer for display and logging.

Data is transmitted using low-frequency (38kHz) radio frequency communications. A receiver in the Petrel 3 accepts this data and formats it for display.

The communication is one-way. The transmitter sends data to the Petrel 3, but the dive computer does not send any data to the transmitter.

Important EN 250 Certification Notes

The European EN 250 standard specifies minimum requirements for self-contained open-circuit compressed air underwater breathing apparatus and their sub-assemblies to ensure a minimum level of safe operation of the apparatus down to a maximum depth of 50 m.

Testing and validation of the Petrel 3 wireless air integration system for the EN 250 standard was only performed with the Shearwater Swift transmitter. Therefore, the Swift transmitter is the only officially compatible wireless pressure measurement accessory certified for use with the Petrel 3.

Under EN 250, the Petrel 3's air integration system is certified for use with air only to a maximum depth of 50 meters. Products marked EN 250 are intended for air use only. Products marked EN 13949 are intended for use with gases containing more than 22% oxygen and must not be used for air .

7.2. Basic AI Setup

This section will get you started with the basics of AI on the Petrel 3. Advanced setup and detailed descriptions will be covered in later sections.

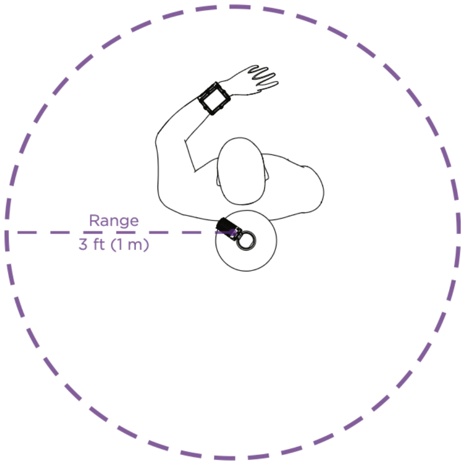
Install the Transmitter

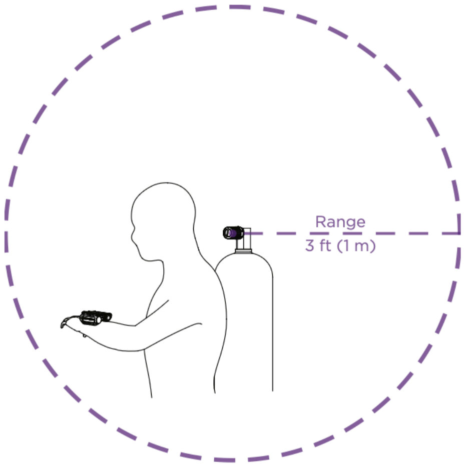
Before using the AI system, you will need to install one or more transmitters on a scuba tank first stage regulator.

The transmitter must be installed on a first stage port labeled "HP" (high pressure). Use a first stage regulator with at least two HP ports, so that a backup analog submersible pressure gauge (SPG) can be used.

Position the transmitter such that it is on the same side of your body as you wear your Petrel 3 handset. Range is limited to approximately 1 m (3 ft)

A high-pressure hose may be used to relocate the transmitter for better reception or convenience Use hoses rated for a working pressure of 300 bar (4500 psi) or higher.





Install transmitter on 1st stage HP port
Install transmitter on the same side of your body as the handset. Range is approximately 3 feet (1 m).

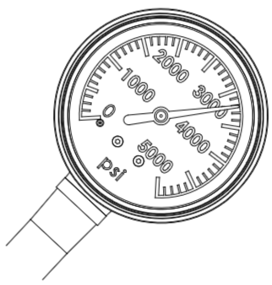
Some transmitters require a wrench (11/16" or 17mm) to tighten or loosen

Avoid hand tightening or loosening unless otherwise specified by the transmitter manufacturer, as this may damage the transmitter .

The Shearwater Swift transmitter can be installed without tools.

Use a backup analog SPG

Always use a backup analog submersible pressure gauge as a redundant source of gas pressure information



Turn on the Transmitter

Turn on the transmitter by opening the tank valve. The transmitter will automatically wake up when it detects pressure.
Pressure data is transmitted approximately every 5 seconds.

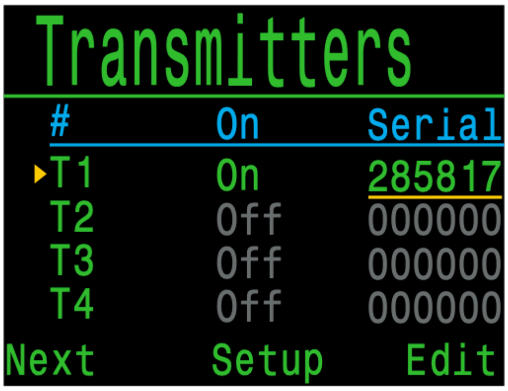
Enable AI on the Petrel 3

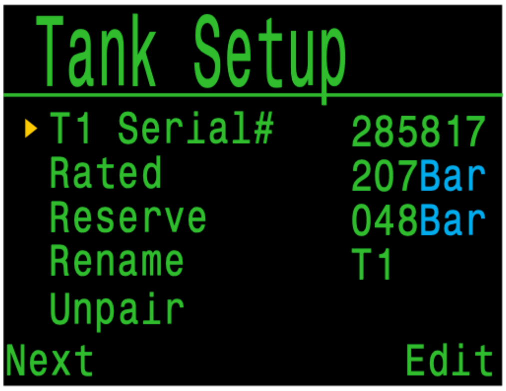
On the Petrel 3, navigate to the System Setup > AI Setup
Change the AI Mode setting to On.
When AI Mode is set to Off, the AI sub-system is completely powered down and does not consume any power. When on, the AI system increases power consumption by approximately 10%.
Note that AI is never on when the Petrel 3 is turned off.

Pair the Transmitter

Each transmitter has a unique serial number etched on its body All communications are coded with this number so that the source of each pressure reading can be identified.

Pair the transmitter by going to the Tx Setup menu option, and selecting T1. Turn on T1, then enter the 6-digit transmitter serial number into the T1 Serial # setting.. You only need to set this once, as it will be permanently saved in the settings memory.





Check that your tank valve is open

Always take a few breaths from your regulator or purge your regulator's second stage while monitoring your tank pressure for a full 10-15 seconds prior to entering the water to ensure your tank valve is turned on.

If the first stage regulator is charged but the tank valve has been closed, the breathing gas available to the diver will decrease rapidly and within a few breaths the diver will face an "out of air" situation. Unlike an analog gauge, the air pressure reported on the Petrel 3 will only update every 5 seconds, so the pressure reported by the Petrel 3 must be monitored for longer than that (we suggest 10-15 seconds) to ensure the tank valve is open.

Including a regulator purge test followed by 10-15 seconds of air pressure monitoring before entering the water as part of your pre-dive safety check is a good way to mitigate this risk.

7.3. AI Displays

This section describes the display field types that are used to display AI information.

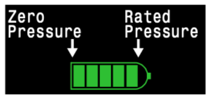
Tank Pressure Display

The pressure displays are the most fundamental AI displays, showing pressure in the current units (psi or bar).

At the top of each pressure display, a bar graph represents the pressure graphically. This bar graph is scaled from zero pressure up to the rated pressure setting. This is NOT a battery level indicator.

bar display

psi display



Tank pressure bar graph

Low Pressure warnings:

Reserve Pressure

Critical Pressure

Reserve Pressure thresholds can be managed in the AI Setup Menu.

No Communication Warnings:

No communication for 30 to 90 seconds

No communication for more than 90 seconds

Low Transmitter Battery Warnings:

Transmitter battery should be replaced soon

Transmitter battery should be replaced immediately

Renaming Transmitters

Transmitter titles can be customized in the transmitter setup menu. This makes it easier to keep track of which transmitter is reporting which cylinder pressure.

Each transmitter title has 2 characters that apply to all AI displays. The following options are available.

First Character: T, S, B, O, or D
Second Character: 1, 2, 3, or 4

Example of tanks labeled for bailout and deco

Renaming is for display purposes only. There is no relationship between a transmitter title and gas fraction for decompression calculation purposes.

7.4. Using Multiple Transmitters

When using multiple transmitters, best reception reliability will be attained by using transmitters with different transmission intervals or by using transmitters with active collision avoidance such as the Shearwater Swift Transmitter.

When two transmitters of the same transmission interval are used, the potential exists for their communication timing to become synchronized. When this occurs, data dropouts may result and could last up to 20 minutes or more.

Legacy Shearwater transmitters of different colors have different transmit timing. This reduces communication collisions that could potentially cause a loss of connection.

When using more than two transmitters, Shearwater recommends using the Swift transmitter which actively 'listens' for other transmitters in the vicinity and dynamically alters transmit timing to avoid interference.

There is no defined upper limit to the number of Swift transmitters that can be run concurrently. For more details, see the Swift Operating Instructions Manual.

Using Multiple Transmitters With The Same Transmission Interval May Result in Lost Comms

When using more than one transmitter, use transmitters with adaptive collision avoidance or legacy transmitters of different colors to prevent interference (see above).

7.5. Transmitter Connection Issues

If you are seeing "No Comms" errors, follow these steps:

If the "No Comms" is persistent:

- Check that the proper serial number is entered into the AI Setup Transmitter Setup menu
- Ensure the Transmitter battery is not dead
- Ensure the transmitter is turned on, by connecting it to a first stage and turning on the tank valve. Applying high pressure > 35 bar (50 psi) is the only way to turn on the transmitter.

  The indicator light on a Swift transmitter will flash to indicate it is transmitting.

  All compatible transmitters will power off after 2 minutes of no pressure.
- Bring the handset within range (1m / 3ft) of the transmitter Having the transmitter too close (less than 5 cm / 2 inches) can also cause communication loss.

If the "No Comms" is intermittent:

- Search for sources of radio frequency (RF) interference, such as HID lights, scooters, suit heaters, or photo flashes. Try eliminating such sources to see if this solves the connection problem.
- Check the distance from transmitter to handset If range related dropouts are occurring during diving, locating the transmitter on short length of high pressure hose is possible to decrease the transmitter to handset distance.
- If more than one legacy or compatible third party transmitter is in range of the computer, ensure that they have different transmit timings (grey vs yellow coloured transmitters), to minimize interference. This is not usually a source of problems with Shearwater Swift transmitters.

8. Example Dives

8.1. Basic Setup

Before using the computer there are several things that need to be configured. This is not an exhaustive list of the pre-requisites for diving the system, but a suggestion of key tasks.

- **Calibrate the oxygen sensors if needed.** If calibration is not needed, then we recommend verifying the PPO2 at multiple points For example, in air, flushed with oxygen, and ideally also a PPO2 greater than 10.
- In the System Setup menu set the units to metric or imperial, also set the date and time.
- **Enter the gases.** This includes the diluents (CC gases) and bailout gases (OC gases).
- The system will use the gases that are available in the order of oxygen content during the Time To Surface (TTS) prediction. The system will use the next available gas that has a PPO2 of less than 10 for closed circuit diving.
- If the computer is in open circuit or is switched to open circuit during a dive, the system will calculate the TTS based on the configured open circuit gases that are available. It will use the next available gas that has a PPO2 of less than 16 for open circuit diving.

NOTE: These gases are used automatically only for TTS predictions. The gas used to calculate the current tissue load and the current ceiling is always the gas actually selected by the diver.

8.2. Simple Example Dive

The following is a simple rebreather dive that includes decompression stops.

In this example:
Diluent: Air
Max Depth: 125 feet for 42 minutes

Dive Phase	Description	Petrel Display
On the Surface	The mode is set to CC and the diluent is set to air (21/00). Typically a PPO2 setpoint of 0.7 will be used at the surface. Never use the 0.19 PPO2 setpoint when breathing on the loop. It is for setup only!	
Descending	Once the descent has started the Petrel will change to dive mode. In dive mode dive time starts counting and the surface interval display changes to stop depth and time.	
Setpoint Switch	Press MENU to access the switch PPO2 setpoint menu. Then press SELECT to make the change. You can do this manually or have it switch automatically once you reach a certain depth.	
Reached Bottom	You've reached the bottom and can enjoy the fishies/wrecks/cave/mermaids. Remember to always monitor your PPO2. The NDL is showing that we have 11 minutes at this depth until decompression stops will be needed. The TTS of 4 minutes is the time to ascend directly to the surface at 33 ft/min.	

Continued on next page

<table>
<tr><th>Dive Phase</th><th>Description</th><th>Petrel Display</th></tr>
<tr><td>Deco Needed</td><td>Once the NDL hits 0, deco stops will be needed, which display in the top-right corner.

Also, note that the NDL location is now displaying additional info, in this case @+5.

TTS has increased to include deco stop time.</td><td>
</td></tr>
<tr><td>Ascending</td><td>It is safe to ascend to 40ft. 2 minutes must be spent at this deco stop.

While ascending, the bar graph to the right of the depth shows the ascent rate.

Each bar indicates 10 ft per minute (3m/min) of ascent rate.</td><td>
</td></tr>
<tr><td>On Deco</td><td>Stay at each stop depth until it clears.</td><td>
</td></tr>
<tr><td>Missed Deco Stop</td><td>If you ascend shallower than the stop depth, the display will alarm.

Acknowledge and clear the warning by pressing the SELECT button.

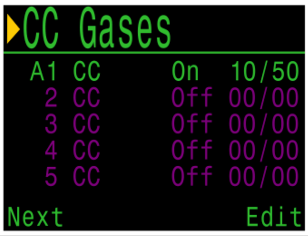
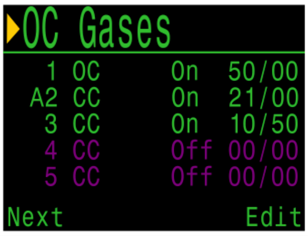
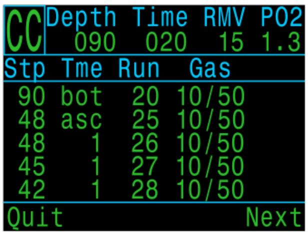
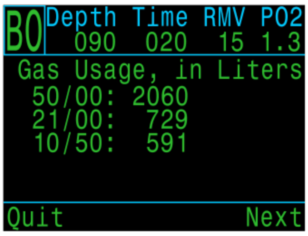
Re-descend deeper than the stop depth to clear the flashing red text.</td><td>
</td></tr>
<tr><td>Deco Clear</td><td>Once all the deco stops have cleared, you can ascend to the surface to end the dive.

End of example.</td><td>
</td></tr>
</table>

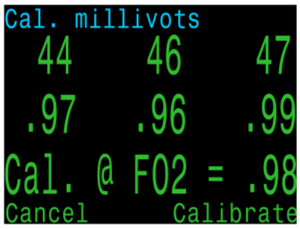
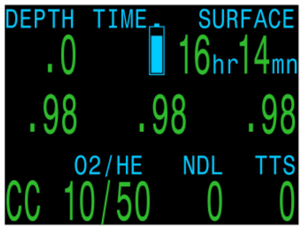
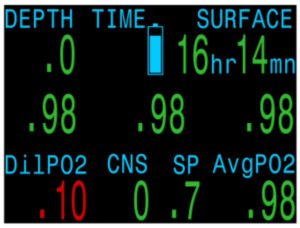
8.3. Complex Example Dive

The following is a more complex rebreather dive that includes dive-planning and multi-gas OC bailout.

Diluent:	Trimix (10/50)	Bailout gases: 10/50, 21/00, and 50/00
Max Depth:	90 meters for 20 minutes	Metric units (meters) are used

Dive Phase	Description	Petrel Display
Setup CC Gases	Best practices include checking your gas lists before each dive. This screen is available in the System Setup menu. For this dive the only CC diluent is trimix 10/50 (10% O2, 50% He, 40% N2).	
Setup OC Bailout Gases	For the OC bailout gas list, several gases are needed. We will verify that we are carrying enough of each gas when we plan the dive.	
Verify Settings	It is also prudent to ensure all other settings are correct before starting the dive. Although gases and some settings can be changed underwater, it is best to have them right from the start.	
Plan Dive & Bailout	Use the dive planner to check the total runtime, decompression schedule and bailout gas quantity needed. For CC dives, both the closed-circuit (CC) and bailout (BO) plans are displayed. The bailout plan also includes how much gas is needed. The on-board deco planner is limited in functionality, so for complex dives we recommend planning using desktop or smartphone dive planning software.	 

Complex CC Dive Example (continued)

Dive Phase	Description	Petrel Display
PPO2 Calibration	If the PPO2 sensors need calibration, follow the instructions from your rebreather manufacturer. On the PPO2 calibration screen, the top row displays the millivolt (mV) reading from each sensor. The middle row is the current PPO2 (from the last calibration). The bottom row shows the fraction of oxygen setting. After calibration completes a results screen will be displayed. Note that the PPO2 might not match the FO2 exactly, due to the ambient pressure not being exactly 1 ata.	
Ready to Dive	The dive is now ready to begin.	
Note on Hypoxic Diluents	Hypoxic diluents such as the 10/50 in this example require special training since they can be deadly near the surface. Pressing SELECT brings up the first info screen which shows the diluent PPO2. The **red** indicates it is unsafe to breathe directly. You can view this info at any time to verify that the diluent is safe or to check what the expected PPO2 will be when flushing with diluent at depth.	

Complex CC Dive Example (continued)

<table>
<tr><th>Dive Phase</th><th>Description</th><th>Petrel Display</th></tr>
<tr><td>Decreasing NDL</td><td>As we descend, the NDL decreases.
The TTS shows it will take 5 minutes to ascend to the surface at 10m/min (33ft/min).</td><td>
</td></tr>
<tr><td>Bottom Time</td><td>We have now completed the bottom time.
The TTS indicates we have about 1.5 hours (92 minutes) of decompression to do.
The first stop will be at 48m for 1 minute.</td><td>
</td></tr>
<tr><td>Ascending to First Stop</td><td>Here we are ascending at 3m/min (each bar beside the depth is 3m/min). This is slower than the expected 10m/min ascent rate.
This slow ascent has caused the TTS to rise, as most tissues are still on-gassing.</td><td>
</td></tr>
<tr><td>First Deco Stop</td><td>The slow ascent has caused the first stop to clear before we reached it. This often happens with slow ascents.
Note that the GF99 value now indicates that the leading tissues are now off-gassing. However, at this deep depth most tissue compartments are still on-gassing.</td><td>
</td></tr>
<tr><td>A problem has developed</td><td>The yellow cell reading is disagreeing with the other two.
A flush with diluent has shown that the lone low cell is actually correct.
It is decided to bailout to open circuit.</td><td>
</td></tr>
</table>

Complex CC Dive Example (continued)

Dive Phase	Description	Petrel Display
Bailout	After physically switching the BOV or mouthpiece, the computer needs to be set to BO mode for proper deco calculations. Two presses on MENU brings up the "SWITCH CC -> BO" menu. Pressing SELECT makes the change. Note that the loop PPO2 continues to display. This is important in case the diver later needs to go back onto the loop. Also note that "BO" is displayed in **yellow** to indicate the bailout condition. The best BO gas was automatically selected, and the deco schedule has been adjusted based on the BO gases.	 
Switch Gas	We are now at 21m, having completed a few more deco stops. The gas is now displaying in **yellow**, indicating a better gas is available. Pressing MENU twice brings up the "SELECT GAS" menu, and pressing SELECT enters it. With the "new style" gas select menu, the best gas will already be the initial selection, just press SELECT to make it the active gas. If using the "old style" gas select menu, see the gas select section for instructions.	 
Deco Clear	Follow the deco stops until they have all cleared. Now it is time to ascend and end the dive. End of example.	

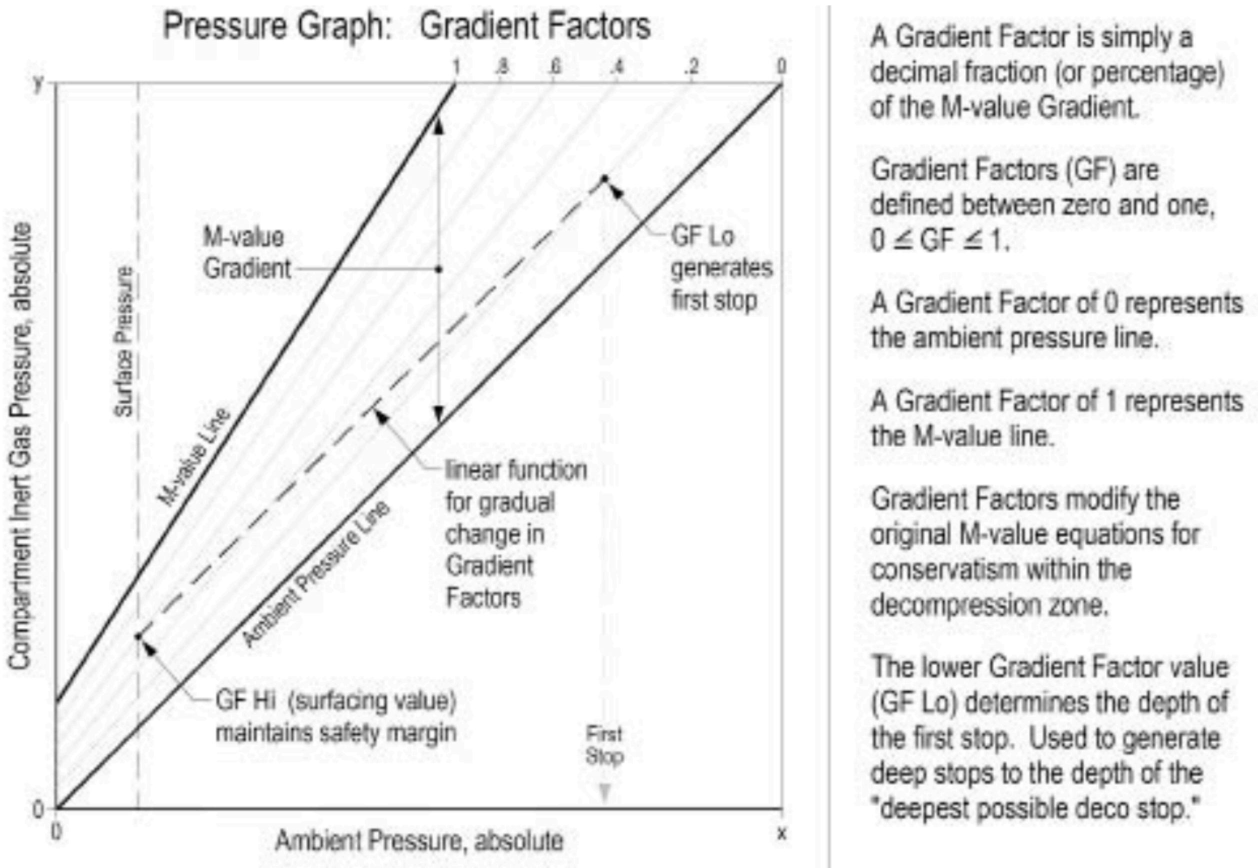
9. Decompression and Gradient Factors

The basic decompression algorithm used for the computer is Bühlmann ZHL- 16C It has been modified by the use of Gradient Factors that were developed by Erik Baker. We have used his ideas to create our own code to implement it. We would like to give credit to Erik for his work in education about decompression algorithms, but he is in no way responsible for the code we have written.

The computer implements Gradient Factors by using levels of conservatism. The levels of conservatism are pairs of number like 30/70. For a more detailed explanation of their meaning, please refer to Erik Baker's excellent articles: **Clearing Up The Confusion About "Deep Stops"** and Understanding **M-values**. The articles are readily available on the web. You might also want to search for "Gradient Factors" on the web.

The default of the system is 30/70. The system provides several settings that are more aggressive than the default .

Don't use the system until you understand how it works.



Graph from Erik Baker's "Clearing Up The Confusion About Deep Stops"

9.1. Decompression information accuracy

Decompression information displayed by this computer, including NDL, stop depth, stop time, and TTS are predictions. These values are continuously recalculated and will change with changing conditions. The accuracy of this information is dependent on several assumptions made by the decompression algorithm. It is important to understand these assumptions to ensure accurate decompression information.

It is assumed that the diver's ascent rate is 10m/min. Ascending significantly faster or slower than this will impact decompression obligations. It is also assumed that the diver is carrying and plans to use every gas that is currently turned on. Leaving gasses that are not expected to be used turned on will result in inaccurate time to surface, decompression stop and decompression time information being displayed.

On ascent, it is assumed that the diver will perform decompression stops using the gas with the highest PPO2 below the OC Deco PPO2 value (default 161) If there is a better gas available, the current gas will be displayed in yellow, indicating that a gas change is expected. The decompression prediction displayed always assumes that the best gas will be used. Even if the switch to a better gas has not been completed yet, decompression predictions will be displayed as if the switch is about to occur in the next 5 seconds.

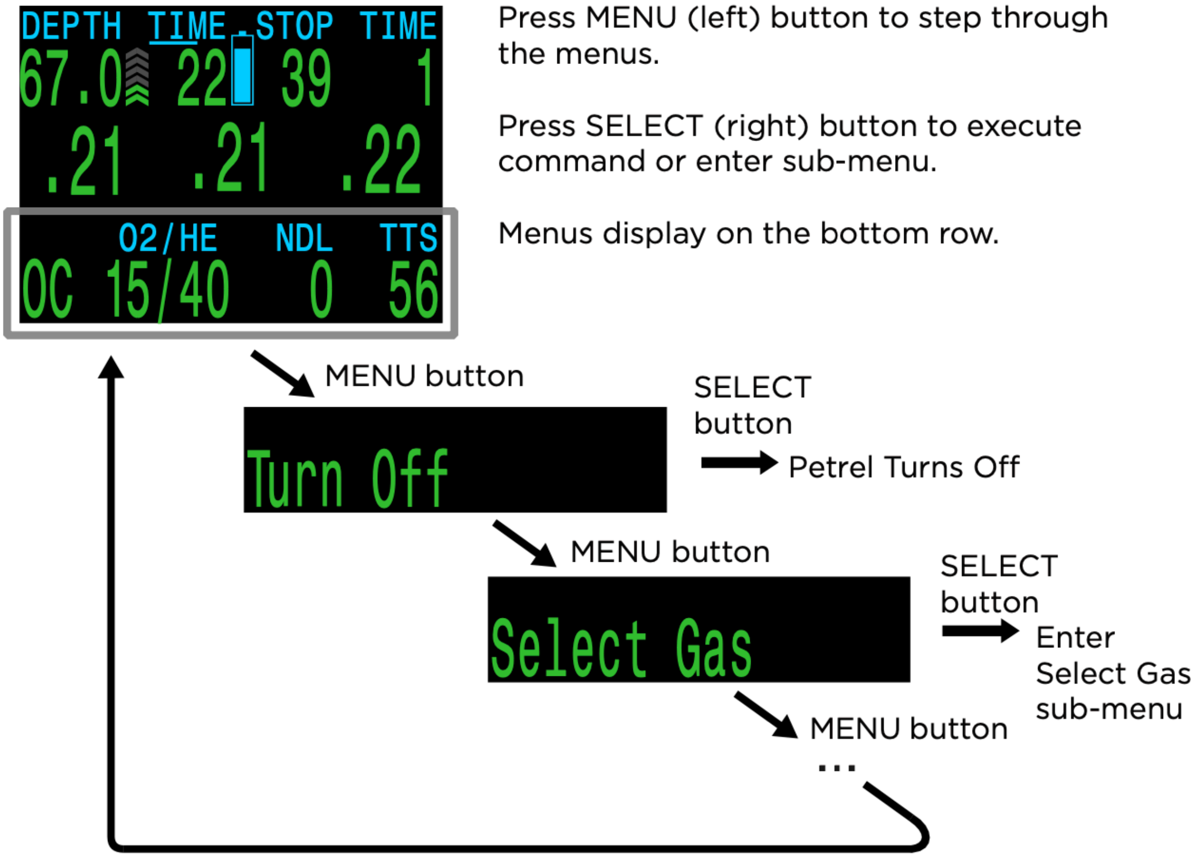
Divers can encounter longer than expected decompression stops as well as inaccurate time to surface predictions if they fail to switch to a better gas when prompted by the computer.

Example: A diver on a decompression dive to 40m/131ft for 40 minutes with GF settings of 45/85 has two gasses programmed into their computer and turned on: 21/00 & 99/00. The diver's decompression schedule will be calculated based on breathing 21% oxygen for the decent, bottom and ascent phases of the dive until the diver ascends to 6m/20ft. At 6m/20ft the PPO2 of the 99/00 mix is 1606 (less than 161), so it is the best decompression gas available.

Decompression information for the remaining stops will be calculated and displayed assuming the diver is going to switch to this better gas. This dive profile indicates these stops would be 8 minutes at 6m/20ft and 12 minutes at 3m/10ft. If the diver never makes the switch to 99/00, the computer will not allow them to surface until adequate off-gassing has occurred, but it will continue to assume the diver is about to make the gas switch and the decompression times given will be grossly inaccurate. The 6m/20ft stop will take 19 minutes to clear and the 3m/10ft stop will take 38 minutes to clear. That is a total time to surface difference of 37 minutes.

In a lost gas scenario or in the event a diver forgets to turn off a gas they are not carrying before a dive, gasses can be turned off during the dive in the Dive Setup -> Define Gas menu.

10. Menus



Menus perform actions and allow settings to be changed.

Starting from the main screen, pressing the MENU (left) button steps through the menus. When all menus have been viewed, pressing MENU again will return to the main screen.

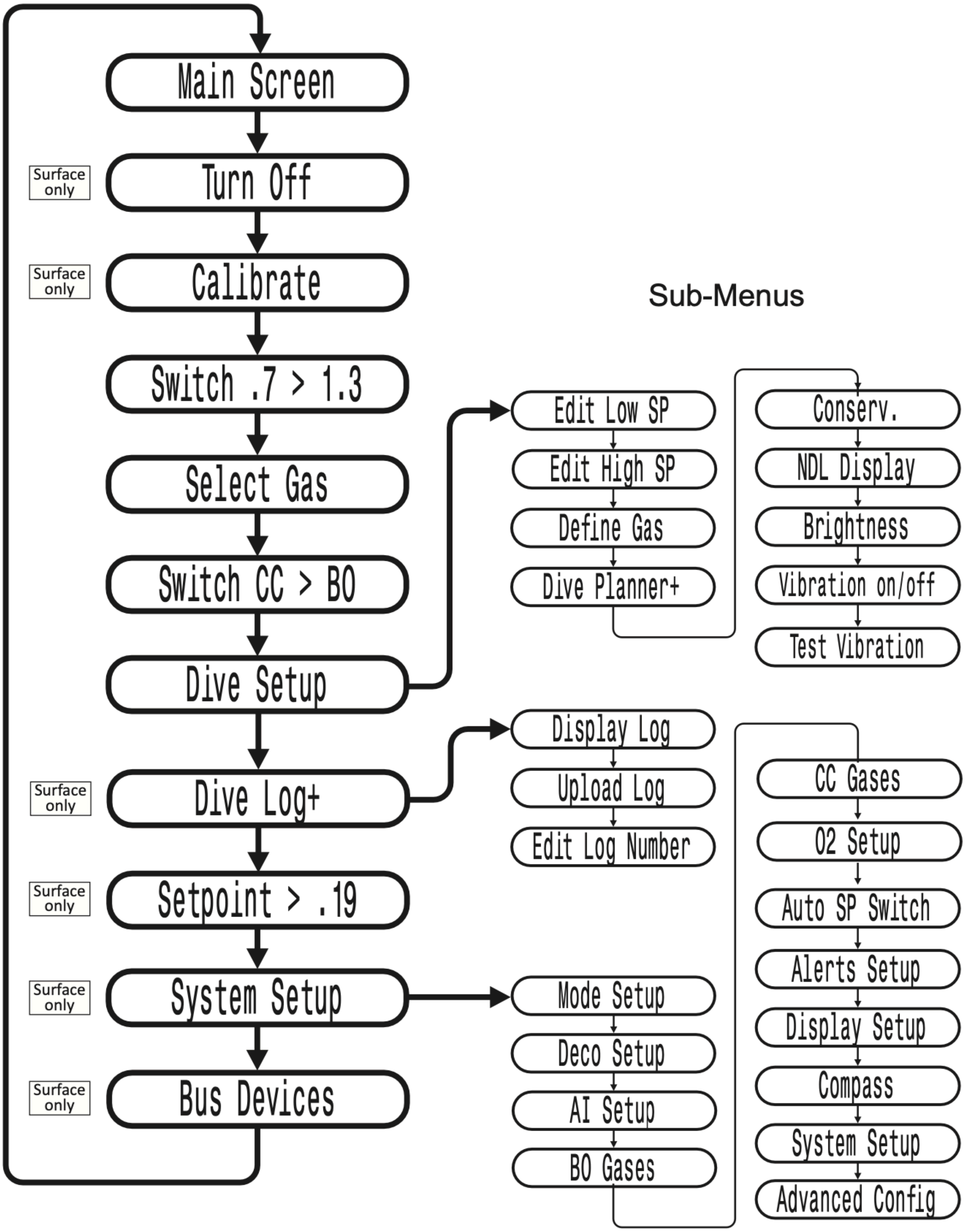
Pressing the SELECT (right) button when a menu is displayed, either performs that action or enters a sub-menu.

If no buttons are pushed for 1 minute, the menu system will time-out, returning to the main screen. Anything that had been previously saved will be retained. Anything that was in the middle of editing will be discarded.

Adaptive Menus

Only menus necessary for the current mode are shown. This keeps operation simple, prevents mistakes, and reduces button presses

10.1. Menu Structure



10.2. Menu Reference

10.2.1. Turn Off

The "Turn Off" item puts the computer to sleep. While sleeping, the screen is blank, but the tissue contents are maintained for repetitive diving. The "Turn Off" menu item will not appear during a dive It will also not appear after a dive until the End Dive Delay time has expired to allow for a continuation dive.

10.2.2. Calibration

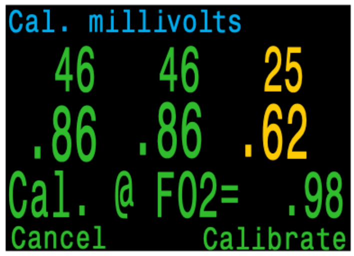
The Calibrate menu will only appear when in CC mode and on the surface This menu calibrates the mV output from the oxygen sensors to PPO2

Upon selecting the calibration menu, the screen will show:

- Top row: Millivolt (mV) readings from the 3 O2 sensors
- Middle row: PPO2 values (using the previous calibration)
- Bottom row: The calibration gas fraction of O2 (FO2)

If you need to change the calibration gas FO2, do this in the System Setup ➔ O2 Setup menu.

After flooding the breathing loop with the calibration gas (typically pure oxygen), press the SELECT button to perform the calibration.



Good sensors should be in the range of 35 - 65 mV at sea level in 100% oxygen. A sensor will fail calibration if not in the range of 30mV to 70 mV. This allowable range scales automatically with changes to FO2 and barometric pressure. If outside the allowable range, a millivolt reading is shown in yellow.

Once the calibration completes, a report will be shown. This shows which sensors passed calibration, and the value of the expected PPO2 based on barometric pressure and the FO2.

Back at the main screen, the displays should now all read the expected PPO2. For example, if FO2 is 0,98 and barometric pressure is 1013 mbar (1 ata), then PPO2 will be 0,98. If any display shows FAIL, the calibration has failed because the mV reading is out of range
The "Calibrate" menu item will not display during a dive.

10.2.3. Calibration Problems

One sensor displays FAIL after calibration

This could indicate a bad sensor It has failed because the mV output was not in range. The sensor could be old or damaged, and should be inspected Damage and corrosion to wires or connectors is also a common problem. Fix the problem and recalibrate before diving.

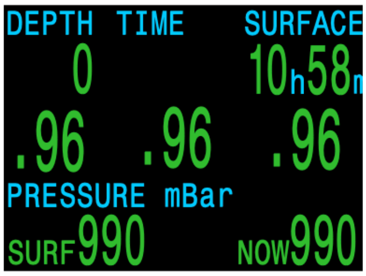
All sensors display FAIL after calibration

This could be caused by an accidentally unplugged cable or a damaged cable or connector. Also, accidentally performing the calibration in air or without a proper oxygen flush could cause this problem. A failed calibration can only be fixed by performing a successful calibration.

PPO2 does not show 0.98 after calibration

If the Altitude setting in the Display Setup menu is set to Auto, then the PPO2 after calibration may not be exactly equal to the F02.

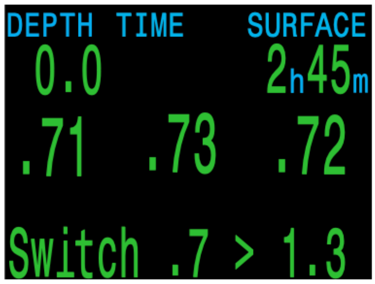
This is because weather causes minor changes in barometric pressure. For example, say a low-pressure weather system has reduced the normal (1013mbar) barometric pressure to 990mbar. The PPO2 in absolute atmospheres is then 0,98 * (990/1013) = 0,96.



The 0,96 PPO2 result is, in this case, correct. At high altitudes, the difference between FO2 and PPO2 will be even larger. To see the current pressure, start at the main screen and press the SELECT button a few times (displays as Pressure mbar NOW).

If you are at sea level, and want the calibrated PPO2 to exactly match the FO2, then change the Altitude setting to SeaLvl. Only do this when actually at sea level, and also be aware that using this SeaLvl setting is actually introducing error into the PPO2 measurements.

10.2.4. Switch Setpoint

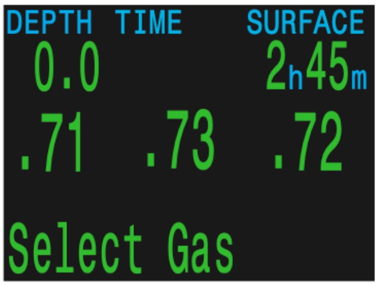


During a dive the "Switch Setpoint" menu item will be the first item displayed, since the "Turn Off" and "Calibrate" displays are disabled when diving.

Pressing SELECT when this menu is displayed changes the PPO2 setpoint from the low setpoint to the high setpoint or vice-versa. To redefine the PPO2 value of a setpoint, use the Dive Setup menu.

This menu item performs a manual switching of PPO2 setpoint. Automatic setpoint switching can be setup in the System Setup > Auto SP Switch menu. When auto setpoint switches are enabled, this menu item is still available to provide manual control.

10.2.5. Select Gas



Select Gas main menu

Gas 1, Active Gas, 21% O2

Gas 2, Turned on, 50% O2

Gas 3, Turned Off, 18% O2, 50% He

This menu item allows you to pick a gas from the gases you have created. The selected gas will be used either as the breathing gas in open circuit mode, or the diluent in closed circuit mode.

Gases are always sorted from most to least oxygen content.

Use the MENU button to increment to the desired diluent/gas, then press the SELECT button to select that diluent/gas.

If you increment past the number of gases available, the display will fall back out of the "Select Gas" display without changing the selected gas.

An 'A' will appear next to the currently active gas.

A gas that is off will be shown in magenta, but can still be selected It will be turned on automatically if it is selected Off gases are not used in decompression calculations.

10.2.6. Radio Station Gases

For computer models that support open circuit and closed circuit operation, the system maintains two sets of gases - one for open circuit and one for closed circuit.

The way they operate is very similar to the way car radios work with AM and FM stations.

When you are listening to an FM station and you push a station selection button, it will take you to another FM station. If you add a new station, it will be an FM station.

Similarly, if you are in the AM mode, adding or deleting a station would add or delete an AM station.

With radio station gases, when you are in open circuit, adding, deleting or selecting a gas will refer to an open circuit gas. Just like the FM stations are selected when your radio is in FM mode, the closed circuit gases are available in the closed circuit mode. When you switch to open circuit, the gases available will be open circuit gases.

Gases will not turn off automatically

Selecting a new gas will turn that gas on if it is off, but gases will never turn off automatically.

It is important to turn off all gases you are not carrying and or do not plan to use on the dive in the Define Gas menu to ensure you receive accurate decompression information.

10.2.7. Select Gas Menu Styles

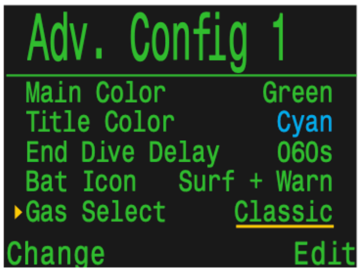
Two styles of Select Gas menus are available, Classic and New.

Change between the two styles in the Adv Config 1 menu.

Classic Style Select Gas

The classic Select Gas style is as described on the previous page.

- One gas is shown at a time.
- Press MENU to step through gases, and SELECT to select the shown gas.
- Gases are sorted from highest O2% to lowest O2%.
- Stepping past the last gas will exit the menu without changing the active gas.
- Upon entering the Select Gas menu, the first gas shown is always the highest O2% gas.



Gas select menu style changed in Adv. Config 1

Classic style gas select menu

New Style Select Gas

The new style makes visualizing the gas list easier. It also reduces button presses for deco gas switches.

- Shows all gases on the screen at once.
- Press MENU to step through gases, and SELECT to select the pointed to gas.
- A gas must be selected to exit the menu (scrolling past last gas wraps back to first gas).
- The active gas is shown with a green background.
- Turned off gases are shown in magenta (purple).
- Gases are sorted from highest O2% to lowest O2%.
- When diving and there is a deco stop, the first gas pointed to will be the most appropriate gas (highest PPO2 less than 161) This reduces button presses in most cases.
- On the surface or when no deco stops are needed, the first gas pointed to will be the active gas.

New style gas select menu layout. 5 gases currently programmed and on

50% O2 turned off. Select to change to 50% and turn gas on

21% O2 is currently active gas, Select to exit menu making no changes.

10.2.8. Switch to CC/BO

Depending on the current computer setting, this selection will show as either "Switch CC > BO" or "Switch BO > CC" .

Pressing SELECT will select the displayed mode for decompression calculations. When switching to Bailout while diving, the most appropriate open circuit gas will become the breathing gas for calculations.

At this point, the diver may want to switch to a different gas, but since the diver may have other things to deal with, the computer will make a "best guess" of which gas the diver would choose.

External PPO2 sensors readings will continue to be displayed so the user can monitor their loop PPO2 in case they need to return to the loop.

10.2.9. External PPO2 Monitoring

This system is connected to three sensors inside the rebreather. The PPO2 input from these sensors is used to determine the system average PPO2 which is used to govern solenoid injections and for decompression calculations and CNS tracking.

A voting algorithm is used to decide which of the three sensors are likely to be correct. If a sensor matches either of the other two sensors within ±20%, it passes voting. The system average PPO2 is the average of all sensors that have passed voting.

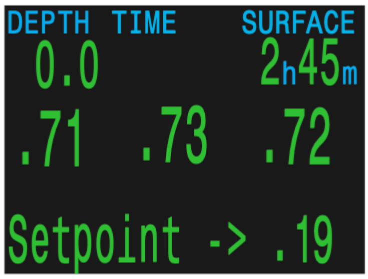
For instance, in the example above, sensor 1 has failed voting. The PPO2 is displayed in yellow to show that it has failed voting. The system average PPO2 is the average PPO2 of sensor 2 and 3.

If all sensors fail voting, then the display will alternate VOTING FAILED with the PPO2 measurements (which will all be yellow to indicate that voting has failed). When voting has failed, while still in closed circuit mode, the lowest PPO2 reading will be used for deco calculations (ie the most conservative value) .

10.2.10. Setpoint -> .19

Pressing SELECT when this menu is displayed changes the PPO2 setpoint to 0,19. This menu is only available when on the surface.

This feature is provided as a convenience to prevent the solenoid from firing when setting up the rebreather on your workbench. There is very little room for error with a 0,19 setpoint, so it should never be used when breathing on the loop.



Set Setpoint to 0.19

If a dive begins on the 0,19 setpoint, the setpoint is automatically switched up to the low setpoint.

Save your life! NEVER breath on the loop when setpoint is 0.19

There is very little room for error with a 0,19 PPO2 setpoint. A small drop in PPO2 could lead to hypoxia, which is a leading cause of rebreather fatalities and can be just as deadly on the surface as underwater.

The 0,19 setpoint is only for use during setup and transportation.

10.3.Dive Setup

All of the Dive Setup menus are available both on the surface and when diving.

The values in Dive Setup can also be accessed in the Systems Setup menu, but the System Setup menu is not available when diving.

Pressing the right (SELECT) button will enter the Dive Setup sub-menu.

Menu appearance in BO mode

10.3.1. Edit Low Setpoint

This item allows you to edit the low setpoint value Initially it will display the currently selected value.

Press the right (Edit) button to open the edit display. Press the left (Change) button to increment the setpoint. ,

Values from 0,4 to 1,5 are allowed Incrementing past 15 returns the value to 0,4 Press the right (Save) button to lock in new low setpoint .

Edit Low Setpoint option shows current setpoint

Press the Change button to increment the setpoint

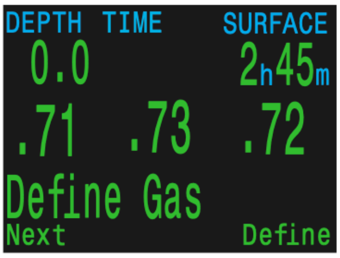
10.3.2. Edit High Setpoint

Works in exactly the same way as the Edit Low Setpoint function above.

Edit High Setpoint menu

10.3.3. Define Gas

The define gas function allows you to set up 5 gases in Closed Circuit and 5 gases in Open Circuit. You must be in Bail Out mode to edit open circuit gases, and you must be in Closed Circuit to edit closed circuit diluents. For each gas, you can select the percentage of oxygen and helium in the gas. The remainder is assumed to be nitrogen.



Define Gas Menu

Pushing the right (Define) button presents the function to define gas number 1.

Press Next to increment to next gas

The left (Next) button increments to the next gas.

Press the right (Edit) button to edit a gas.

Press Edit to modify this gas

The first option is to toggle the gas on or off as indicated by the underline. Use the left (Change) button to toggle the gas on.

Press Change to toggle gas on

Continuing along, the gas contents are edited one digit at a time. The underline shows the digit being edited.

Each push of the left (Change) button increments the digit being edited When the digit reaches 9, it will roll over to 0.

Press Next to move on to edit gas contents

Pushing the right button (Next) will lock in the current digit, and move on to the next digit.

A helpful indicator of what is being edited is included in the center at the bottom.

Press Change to increment underlined digit

Pushing the right (Save) button on the last digit will finish editing that gas, and bring you back to the gas number. You can continue to increment through the gases pressing the left (Next) button.

The "He%" indicator shows we are editing the fraction of helium

The "A" denotes the active gas. You cannot turn off the active gas in the Define Gas menu. If you try, it will generate an error. You can edit it, but cannot set both the O2 and HE to 00.

Setting any gas to 00/00 will automatically turn it off.

Press Save after editing the last digit

The computer will display all 5 gas entries available to allow you to enter new gases.

Pressing MENU one more time when the fifth gas is displayed will return you to the "Define Gas" menu item.

The "A" denotes the currently active gas

10.3.4. New Style Define Gas

Similar to the New Style Select Gas menu, the New Style Define Gas menu shows all gases on the screen at once at the expense of font size.

If the Gas Select style is set to New, the computer will also display the New Style Define Gas Menu.

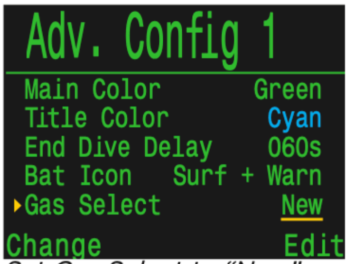
When the Define Gas menu is opened, all of the gases will be displayed. Turned on gases will be in green, turned off gases will be magenta, and the currently active gas will be highlighted.

Press the left (Next) button until the arrow points to the gas you would like to edit, then press the right (Edit) button.

Similar to the Classic Style Define Gas menu, the attribute being toggled is displayed at the bottom of the display.

Gases can be toggled on or off, and the gas fractions of oxygen and helium can be changed one digit at a time.

When you are finished editing move the arrow to the Exit option and press the right (Exit) button to leave the define gas menu.



Set Gas Select to "New" in Adv.1 to use New Style Define Gas menu

Press Next to increment to next gas

Press Change to toggle the gas on

Press Change to increment gas fraction one digit at a time

Press Save when finished editing the last digit

Select the Exit item to leave the Define Gas Menu when finished

Turn off gases you are not carrying

Only turn on the gases you are actually carrying and plan to use on the dive. Failure to abide by this warning may result in inaccurate decompression information being displayed.

With radio station gases, the computer has a full picture of the OC and CC gases you are carrying and can make informed predictions about decompression times. There is no need to turn gases off and on when you switch from CC to OC, because the computer already knows what the gas sets are. You should only have the CC and OC gases you are actually carrying turned on.

If you often use other gases, you can enter the gas and turn it off. You can turn gases on and off during a dive and you can also add or remove a gas during the dive if needed.

10.3.5. Deco Planner

Introduction

Calculates decompression profiles for simple dives.
Calculates gas consumption based on RMV.
Can be used both on the surface and during a dive.

Deco Planner Menu

Setup

The planner uses the current gases programmed in the current dive mode, as well as the current conservatism (GF low/high) settings. VPM-B dive planning is available on units with the optional VPM-B unlock.

Deco Planner Limitations

The Petrel 3's Deco Planner is intended for simple dives.

Multi-level dives are not supported.

The Deco Planner does not provide thorough validation of the profile. For example, it does not check for nitrogen narcosis limitations, gas usage limitations, or CNS percentage violations.

The user is responsible for ensuring a safe profile is followed.

Important!

The Petrel 3's Deco Planner makes the following assumptions:

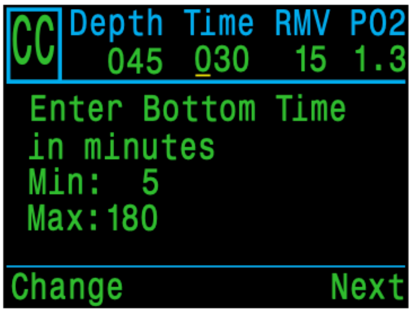
- Descent rate is 18m/min (60ft/min) and the ascent rate is 10m/min (33ft/min).
- The gas in use at any time will be the gas with the highest PPO2 within the PPO2 limits.
- The planner will use the configured last stop depth.
- The RMV is the same during the bottom phase of the dive as it is while traveling and during deco.

When used at the Surface

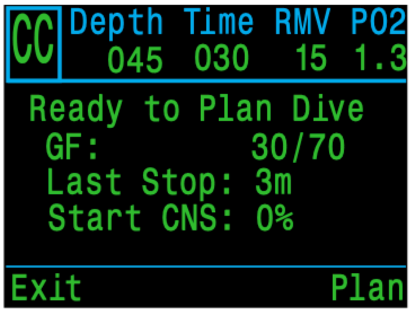
Enter the dive bottom depth, bottom time, respiratory minute volume (RMV) and PPO2.

Note: Residual tissue loading (and CNS%) from recent dives will be used in calculating the profile.

When the correct values are entered, confirm decompression settings and starting CNS, then select "Plan".



Enter dive details



Press Plan when ready

When used during a dive

Computes the decompression profile assuming the ascent will begin immediately There are no settings to enter (RMV is last used value).

Result Screens

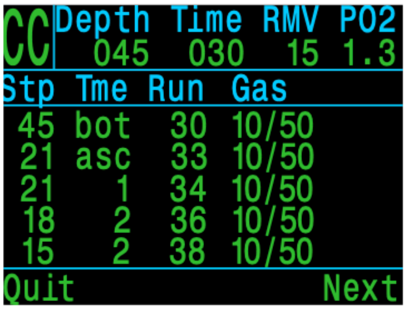
The results are given in tables showing:

Stp:	Stop Depth	In meters or feet
Tme	Stop Time	In minutes
Run	Run Time	In minutes
Gas	Gas Used	%O2 / &He
Qty	Quantity Used	In liters or Cuft

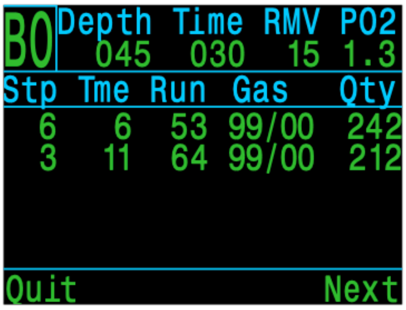
The first few rows will show the bottom time (bot) and the ascent time (asc) to the first stop. Multiple initial ascent legs may be shown if gas switches are needed.

If there are too many stops to display, the results will be split onto several screens.

A bailout plan based on the programmed bailout gases will automatically be generated after the closed circuit deco summary.

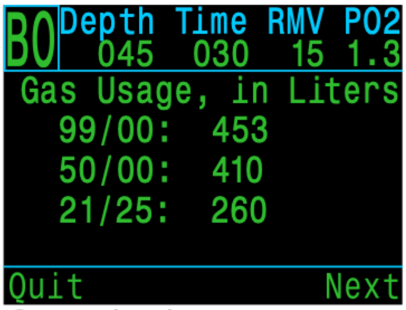


Closed circuit deco plan page 1

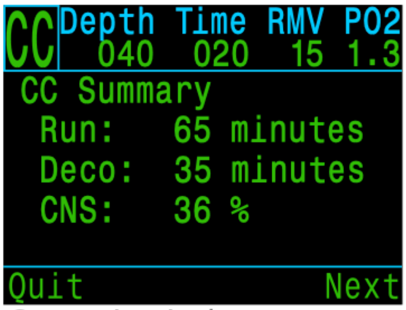


Bailout deco plan page 2

After the last page of the deco schedule, bailout gas usage and deco summary screens show the expected quantity of each gas used for the dive, the total dive time, the time spent on deco and final CNS%.

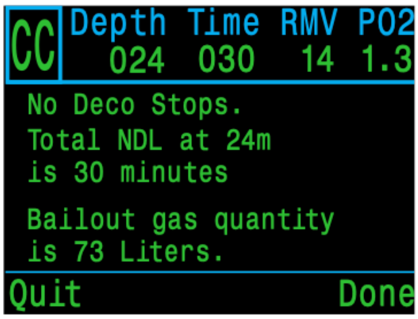


Open circuit gas usage summary



Open circuit deco summary

If no decompression is required, no table will be shown Instead, the total No- Decompression-Limit (NDL) time in minutes, at the given bottom depth will be reported. Also, the gas quantity required to surface (bailout in CC) will be reported.



No decompression required

10.3.6. Conservatism

The conservatism settings (GF High and GF Low) can be edited in the Dive Setup menu.

While diving, only the GF High value can be edited. This allows changing the surfacing conservatism during a dive. For example, if you worked much harder on the bottom segment than expected, you may wish to add conservatism by reducing the GF High setting.

10.3.7. NDL Replacement Display

While in decompression, NDL is 0. This makes the NDL area wasted space until decompression is cleared.

The NDL Display option allows you to replace the NDL with different information once decompression is required and the NDL has gone to 0.

The NDL display option can be changed during the dive through the dive setup menu.

There are 6 options for NDL Display:

1. NDL
2. CEIL
3. GF99
4. SurfGF
5. @+5
6. Δ+5

10.3.8. Brightness

The display brightness has four fixed brightness settings plus an Auto mode.

The fixed options are:

Cave: Longest battery life.
Low: Second longest battery life.
Med: Best mix of battery life and readability.
High: Easiest readability, especially in bright sunlight.

Auto will use the light sensor to determine the brightness of the display. The more ambient light there is, the brighter the display will get. At depth, or in dark water, very little brightness is needed to see the display.

The Auto setting works well in most situations.

The brightness of the display is the major determinant of battery life Up to 80% of the power consumption is to power the display When a low battery alert occurs, the display brightness is automatically reduced to extend battery life.

10.3.9. Vibration On/Off

Shows current state of vibration function Press the right (Edit) button to toggle the vibration function on or off.

10.3.10.Test Vibration

Press the right (Ok) button to quickly test the vibration function to ensure it's working correctly.

Regularly test vibration alerts with the Test Vibration tool to ensure they are working and you can hear/feel them through your exposure suit.

10.4 Dive Log

Use the Dive Log menu to review logs stored on the Petrel 3. Up to 1000 hours of detailed logs can be stored at the default sampling rate of 10 seconds.

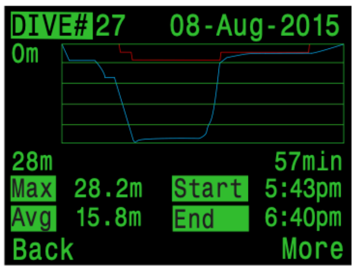
The Dive Log menu is only available when on the surface.

10.4.1. Display Log

Use this menu to display a list of logged dives and view details. Select a dive to view from the Dive log list.

The profile of the dive is plotted in blue, with decompression stops plotted in red. The following information is displayed by scrolling through the dive log screens:

Maximum and Average depth
Dive number
Date (dd-mon-yyyy)
Start - Time of day dive started
End - Time of day dive ended
Length of dive in minutes
Minimum, maximum, and average temperature
Dive mode (Air, Nitrox, etc)
Surface interval preceding the dive
Recorded Surface Pressure at the beginning of the dive
Gradient factor settings used
Start and end CNS
Start and end pressure for up to 4 AI transmitters



10.4.2. Edit Log

Scrolling past all screens of an individual log brings up the Edit Log page where Dive number, Date, and Time can be changed, or the dive log can be deleted.

10.4.3. Next Log

The dive log number can be edited. This is useful if you want the dive computer log numbers to match your lifetime dive count.

This number will be applied to the next dive.

10.4.4. Restore Mode

Restore mode can be toggled on and off. When toggled on, it shows deleted logs, grayed out in the "Display Log" sub-menu. These dives can be restored to the Dive Log.

The Delete All Logs option is also changed to Restore All Logs when Restore mode is enabled.

10.4.5. Delete All Logs

Deletes All of the Logs.

Deleted Logs can be restored by toggling Restore Mode to on.

10.4.6. Start Bluetooth

Bluetooth is used for both firmware uploading and dive log downloading.

Use this option to initialize Bluetooth on your dive computer.

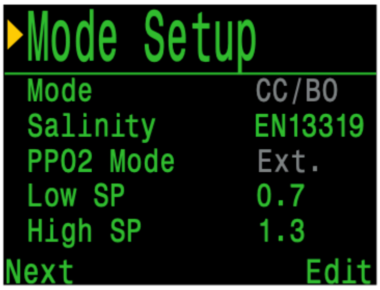
11. System Setup Reference

System Setup contains configuration settings together in a convenient format for updating the configuration before a dive.

System setup cannot be accessed during a dive.

All of the settings available in Dive Setup are available in System Setup which can be accessed during a dive. However, not all settings in System Setup can be edited in Dive Setup.

11.1. Mode Setup



The first sub-menu of System Setup is Mode Setup.

Mode

Rebreather controllers are locked in Closed Circuit mode with external sensor monitoring.

Salinity

Water type (salinity) affects how the measured pressure is converted to depth.

Settings:

- Fresh
- EN13319 (default)
- Salt

Density of freshwater and saltwater differ by about 3%. Saltwater, being denser, will display a shallower depth for the same measured pressure versus the Fresh setting.

The EN13319 value is between Fresh and Salt. It is from the European CE standard for dive computers, and is the Petrel 3's default value.

Note that this setting only affects the depth displayed on the computer and has no impact on decompression calculations which rely on absolute pressure.

PPO2 Mode

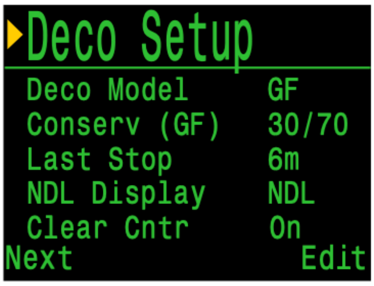
On the Petrel 3 DiveCAN Controller Models this value is always "ext" (Externally measured PPO2).

Low and High Setpoints

Each setpoint can be set from 0,5 to 1,5.
The setpoints can also be edited, even during a dive, in the Dive Setup menu.

11.2 Deco Setup

Deco Model



By default this will show "Buhlmann ZHL16C GF" indicating that the Bühlmann ZHL-16C with gradient factors model is being used.

An optional VPM-B decompression algorithm unlock is available at an additional cost If applied, the deco model item allows the user to change between the available algorithms.

Conservatism

In technical dive modes conservatism can be adjusted in either the GF or VPM model.

For a more detailed explanation of their meaning for the GF algorithm, please refer to Erik Baker's excellent articles: Clearing Up The Confusion About "Deep Stops" and Understanding M-values. The articles are readily available on the web.

VPM-B has conservatism settings from 0 to +5, with higher numbers being more conservative.

Last Stop

Allows you to choose where to do your last mandatory decompression stop. The choices are 3m/10ft and 6m/20ft.

NDL Display

These options were previously covered in the Dive Setup section.

Clear Cntr

This option allows you to toggle the deco clear counter on or off.

When turned on, the counter will count up from zero in the deco area starting when decompression obligations are cleared.

11.3 AI Setup

All AI settings must be configured on the surface before a dive, since the System Setup menu is not accessible during a dive.

AI Mode

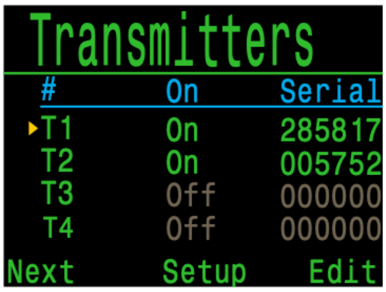
AI Mode is used to easily enable or disable AI.

AI Mode Setting	Description
Off	AI sub-system is completely powered down and consumes no power.
On	AI is enabled. When on, AI increases power consumption by about 10%.

Units

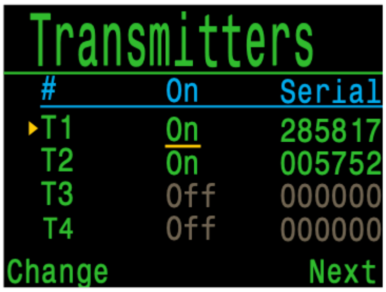
Choices are bar or psi.

11.3.1 TX Setup



The Transmitter setup (TX Setup) menu is used to set up transmitters. Currently active transmitters are shown next to TX Setup in the top level AI menu.

Up to 4 transmitters can be configured in this menu. Select a transmitter to modify its attributes.



Transmitter On/ Off

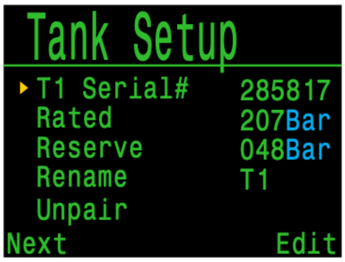
Turn off transmitters that are not currently in use to save battery power.

Set AI Mode to OFF when AI not in use

Leaving AI enabled when not in use will negatively impact battery life when the computer is turned on When a paired transmitter is not communicating, the Petrel 3 goes into a higher power scan state. This increases power consumption to about 25% higher than with AI off. Once communications are established, power drops to about 10% higher than with AI off.

Note, AI is never active when the computer is off. There is no need to turn AI off when the computer is turned off.

11.3.2. Tank Setup



Navigate over to and select a transmitter's serial number in the transmitter setup menu to enter the tank set up menu for that transmitter.

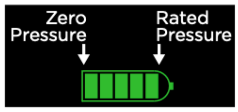
Serial Number Setup

Every transmitter has a unique 6-digit serial number. This number is etched onto the side of the transmitter.

Enter the serial number to pair the transmitter to T1. This number only needs to be entered once Like all settings, it is stored in permanent memory.

Rated Pressure

Enter the rated pressure of the tank on which the transmitter is installed.
The valid range is 69 to 300 bar (1000 to 4350 psi).
The only use of this setting is to scale the full-scale range of the gas pressure bar graph that appears over the numerical tank pressure number.



Reserve Pressure

Enter the reserve pressure.

The valid range is 28 to 137 bar (400 to 2000 psi).
The default reserve pressure value is 50 bar (725 psi).

The reserve pressure setting is used for low pressure warnings.

A "**Reserve Pressure**" warning will be generated when the tank pressure falls below this setting.

A "**Critical Pressure**" warning will be generated when the tank pressure falls below the larger of 21 bar (300 psi) or half the reserve pressure.

For example, if reserve pressure is set to 48 bar, the critical warning will occur at 24 bar (48/2). If the reserve pressure is set to 27 bar, the critical warning will occur at 21 bar.

Rename

Allows the changing of the transmitters title as it appears on menus and screens throughout the dive computer. Two characters can be customized per tank. The options are:

First Character: T,S,B,O, or D.

Second Character: 1,2,3, or 4.

Unpair

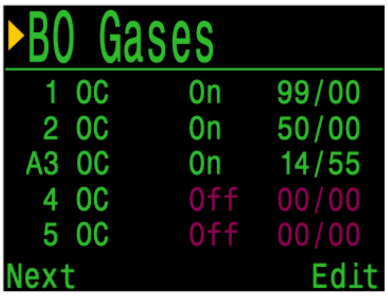
The unpair option is simply a shortcut to reset the serial number to 000000.

When not using T1 or T2, for lowest power consumption, disable receiving completely by setting the AI Mode setting to Off.

GTR Mode

Gas time remaining and Sac are not available on rebreather controllers .

11.4 BO Gases

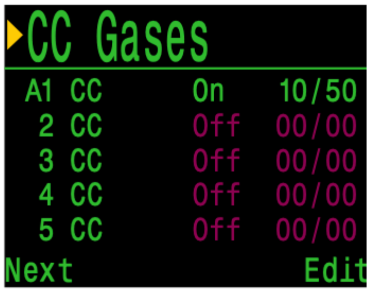


This menu allows the user to edit the open circuit bailout gas list. The options contained here are the same as those in the "Define Gases" subsection of the "Dive Setup" section. This menu page conveniently displays all five gases simultaneously

Each gas can be turned on or off and set to any concentration of O2 and helium. The remaining percentage is assumed to be nitrogen.

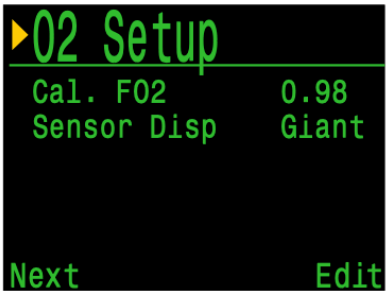
The active gas is shown with a leading 'A'. All gases that are turned off are drawn in magenta (purple) .

11.5 CC Gases



This menu allows the user to edit the closed circuit diluent gas list. The options contained here are the same as those in the OC Gas list setup menu.

11.6 O2 Setup



Cal. FO2

This setting allows you to set the fraction of oxygen (FO2) of the calibration gas

The calibration gas FO2 can be set from 0,70 to 1,00. The default value of 0,98 is for pure oxygen, but assumes about 2% water vapor due to the diver's breathing on the loop during the flushing process.

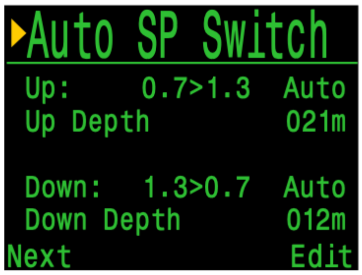
NOTE: This setting value is the fraction of oxygen, not the partial pressure of oxygen. When the calibration is performed, the Petrel measures the ambient barometric pressure to determine the PPO2. If you are at sea-level, and do not want small variations in barometric pressure changing the calibrated PPO2 result, there is an option to set the Altitude to a SeaLvl.

Sensor Disp

Sets the sensor display mode on the center row of the main screen. The available settings are:

- Large: the PPO2 text is the normal large font.
- Giant: the PPO2 text is larger.

11.7 Auto Setpoint Switch



This page sets up automatic setpoint switching. The dive computer can be set up to auto switch the setpoint up only, down only, both, or neither.

First, you set whether the "Up" switch occurs automatically or manually. If "Up" is set to "Auto", then you can set the depth at which the auto switch occurs.

The menu options are the same for the down setpoint switch.

When a switch is set to "Auto", you can always manually override the setting at any time during the dive..

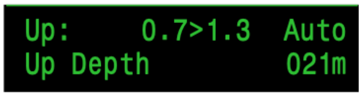
The automatic switches only occur when crossing the specified depth Say for example, the switch up depth is set to 15m. You start the dive on the low setpoint, then as you descend past 15m, the setpoint automatically switches up to high. If at 24m you then manually switch back to the low setpoint, the setpoint will remain low. If you ascend shallower than 15m then re-descend deeper than 15m again, the automatic setpoint switch will occur again.

The Petrel 3 enforces a 6m (20ft) gap between switch up and switch down depths to prevent rapid automatic switching between setpoints for small depth changes. The values 0,7 and 1,3 are shown as examples only. Other values for the low and high setpoint can be adjusted in the Dive Setup or Mode Setup menu.

Auto setpoint switch example:

The settings displayed to the right would cause the computer to behave as follows.

The low to high auto setpoint switch is enabled at a depth of 21 meters.



The dive starts at the 0,7 setpoint. As you descend past 21m, the setpoint switches"up" to 1,3.

You finish your bottom time, then begin ascending.

The high to low auto setpoint switch is enabled at a depth of 12 meters.

When you ascend above 12, the setpoint switches "down" to 0,7.

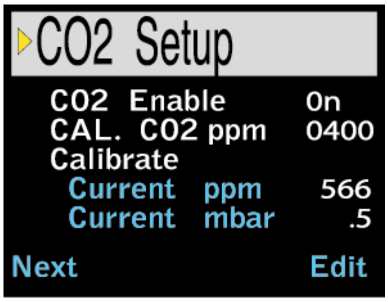
11.8 CO2 Monitioring Setup

The CO2 monitoring displays current ppCO2 (in mbar) in the breathing loop right behind the scrubber.
The ppCO2 value is viewed by pressing the right button a few times from the main screen.

Setting up the CO2 monitoring

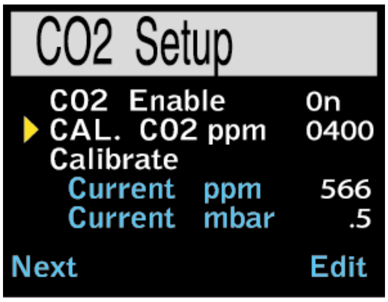
Setup is done in the System Setup menu.
Scroll through the menu until you come to the CO2 Setup.

Settings:
- CO2 Enable (On or Off)
- CAL. CO2 ppm (CO2 ppm of the used calibrating gas)



In CAL. CO2 ppm set the actual CO2 ppm of the currently used calibrating gas according to which ppm was set.

Note:
ppm is the unit "parts per million",
for air as the calibrating gas use 400 ppm (0,04% CO2).

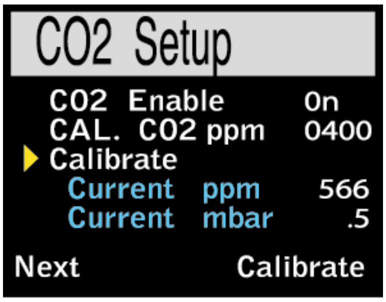


Calibration of the CO2 monitoring

Select "Calibrate" and confirm with right button.

Keep sensor in a known CO2 gas until reading is stable, then Confirm with right button.

"Waiting for calibration to complete" is shown on the screen until the calibration is executed.



Then the screen shows a CO2 Calibration Report:

SUCCESS - the calibration was executed successfully.

FAILED - the calibration was unsuccessful and must be repeated until successful.

11.9. Alerts Setup

This page is used to set up custom dive alerts for Maximum Depth, Time, and Low NDL. Notifications will be triggered when these values are exceeded.

You can also toggle the vibration function from this page.

11.10. Display Setup

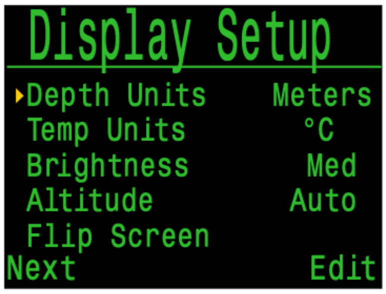
Depth and Temperature

Depth: Feet or Meters

Temperature: °F or °C

Brightness

See brightness options in section 10.8.3.



Altitude

The altitude setting on the Petrel 3 is set to Auto by default In this mode the computer will automatically compensate for pressure changes when diving at altitude If all your diving is at sea level, then setting this to 'SeaLvl' will assume that surface pressure is always 1013 mbar (1 atmosphere).

> **Diving At Altitude**
> When diving at altitude you must set this option to 'Auto' or incorrect decompression calculations could result.

Further, when diving at altitude, you **must** turn the computer on at the surface. If the auto-on safety feature is allowed to turn the computer on after a dive has started then the computer assumes the surface pressure is 1013 mbar. If at altitude this could result in incorrect decompression calculations.

Flip Screen

Displays the contents of the screen upside down. This is useful if you wish to wear your controller on the right arm.

Determination of Surface Pressure

Accurate depth measurements and decompression calculations require knowing the ambient atmospheric pressure at the surface. Regardless of the turn on method, the surface pressure is determined the same way. While in the off state the surface pressure is measured and saved every 15 seconds. A 10 minute history of these pressure samples is kept. Immediately after turn on this history is examined and the minimum pressure is used as the surface pressure. The surface pressure is then remembered, and not updated again until the next turn on.

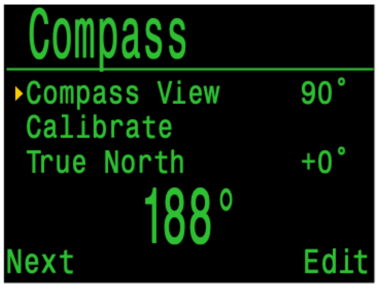
11.11 Compass

Compass View

The Compass View setting can be set to the following options:

Off: The compass is disabled.

60°, 90°, or 120°: Sets the range of the compass dial that is visible on the main screen. The actual amount of arc that there is room for on the screen is 60°, so this may feel the most natural. The 90° or 120° settings allow a wider range to be seen at once The default is 90°.



True North (declination)

Enter the declination of current position to correct compass to true north.

This setting can be set from -99° to +99°.

If matching an uncompensated compass, or navigation is based on relative directions, then this setting can be left at 0°.

Calibrate

Calibration of the compass may be needed if the accuracy drifts over time or if a permanent magnet or ferromagnetic metal (eg iron or nickel) object is mounted very close to the Petrel 3. To be calibrated out, such an object must be mounted with the Petrel 3 such that it moves along with the Petrel 3.

Compare the Petrel 3 with a known good compass or fixed references to determine if calibration is needed If comparing against fixed references, remember to consider the local deviation between Magnetic North and True North (declination). Calibration is typically not needed when traveling to different locations. The adjustment needed then is the True North (declination).

When calibrating, rotate the Petrel 3 smoothly through as many 3D twists and turns as possible in 15 seconds.

Calibrate the Compass Each Battery Change

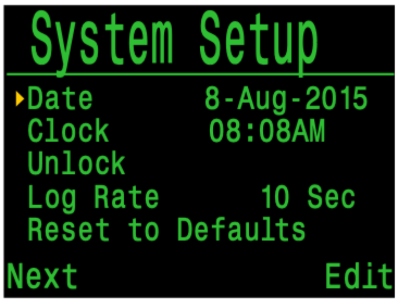
Each battery has its own magnetic signature, mostly due to its steel case. Therefore, recalibrating the compass when changing batteries is recommended.

Compass Calibration Tips

The following tips will help ensure a good calibration:

- Stay away from metal (especially steel or iron)objects. For example, wrist watches, metal desks, boat decks, desktop computers, etc. These can all interfere with the Earth's magnetic field.
- Rotate to as many 3D positions as possible Upside down, sideways, on edge, etc.
- Compare with an analog compass to check calibration.

11.12 System Setup



Date
Allows the user to set the current date .

Clock
Allows the user to set the current time.
The format can be set to AM, PM or 24 hour time.

Unlock
Only to be used at the direction of Shearwater technical support.

Log Rate
Sets how often dive samples are added to the computer's log. More samples will give a higher resolution dive log at the expense of log memory. Default is 10 seconds Maximum resolution is 2 seconds.

Reset to Defaults
The final 'System Setup' option is 'Reset to Defaults'. This will reset all user changed options to factory settings and/or clear the tissues on the dive computer. 'Reset to Defaults' cannot be reversed.

Note: This will not delete dive logs, or reset dive log numbers.

11.13 Advanced Config

Advanced configuration contains items that will be used infrequently and can be ignored by most users. They provide more detailed configurations.

The first screen allows you to enter the advanced configuratior area, or to set the advanced configurations settings to their default.

Reset Adv. Config

This will reset all advanced config values to their default settings.

Note: This will not affect other computer settings, delete dive logs, or reset dive log numbers.

System Info

The System Info section lists the computer's serial number as well as other technical information you may be asked to provide to tech support for troubleshooting purposes.

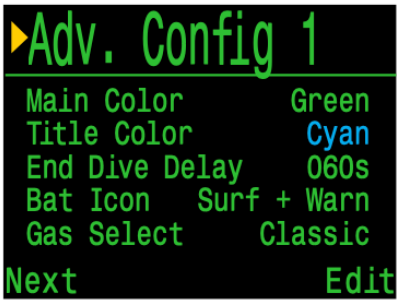
Battery Info

This section gives additional information on the type of battery being used and battery performance.

Regulatory Info

This section is where a user can find the specific model number of their computer as well as additional regulatory information.

11.13.1 Advanced Config 1



Main Colour

Main colours can be changed for user preference.
Default is green. The other option is red.

Consider the impact on colour coded warnings if changing the colour to red.

Title Colour

The title colors can be changed for added contrast or visual appeal. Default is Cyan, with gray, white, green, red, pink, and blue also available.

End Dive Delay

Sets the time in seconds to wait after surfacing before ending the current dive.

This value can be set from 20 seconds to 600 seconds (10 minutes).
Default is 60s.

This value can be set to a longer time if you want brief surface intervals connected together into one dive. Alternatively, a shorter time can be used to exit dive mode more quickly upon surfacing.

Battery Icon

The behavior of the battery icon can be changed here. Options are:

- Surf+Warn: The battery icon always displays when on the surface. During dive it displays only if there is a low battery warning.
- Always: The battery icon always displays.
- Warn Only: The battery icon only appears when there is a low battery warning.

Gas Select

The feature is described in the Select Gas Menu Style Options section.

11.13.2. Advanced Config 2

PPO2 Limits

This section allows changing of PPO2 limits.

> **WARNING**
> Do not change these values unless you fully understand the effect.

All values are in absolute atmospheres [ATA] of pressure.
(1 ATA = 1013 bar).

OC Low PPO2

PPO2 of all gases display in flashing red when less than this value (Default 0,18).

OC MOD PPO2

This is the maximum allowable PPO2 during the bottom phase of the dive - **M**aximum **O**perating **D**epth (Default 1,4).

OC Deco PPO2

All decompression predictions (Deco schedule and TTS) assume that the gas used for decompression at a given depth will be the gas with the highest PPO2 that is less than or equal to this value (Default 1,61).

Suggested gas switches (when the current gas is displayed in yellow) are determined by this value. If you change this value, please be sure you understand its effect.

For example, if lowered to 1,50, then a switch to oxygen (99/00) will not be assumed at 6m/20ft.

CC Min PPO2

PPO2 displays in flashing red when less than this value (Default 0,40).

CC Max PPO2

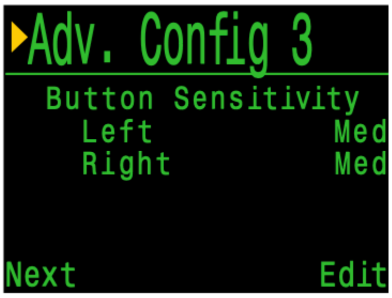
PPO2 displays in flashing red when greater than this value (Default 1,60)..

Note: In both CC and BO modes, "Low PPO2" or "High PPO2" alerts are displayed when the limits are violated for more than 30 seconds.

11.13.3 Advanced Config 3

Button Sensitivity

This menu allows some fine tuning of button sensitivity. This can be useful to adjust downward if you often experience accidental button presses.



11.13.4 Advanced Config 4

Stack Timer

A stack timer is available for tracking the amount of time spent diving with a CO2 absorbent canister.

It can be toggled on and off in the Advanced Config. 4 menu. The total time can be set anywhere between and 1h and 9h 59m. The stack timer can be set to count down either when diving, or when the computer is ON. A warning will alert the diver when the stack timer has 1h remaining and an alarm will be displayed when the stack timer has 30 minutes remaining.

The current stack timer count used and remaining will be available as an info screen when the stack timer is enabled. The stack timer can also be reset from the main level menu. The stack timer cannot be reset during a dive.

12. Firmware Update and Log Download

It is important to keep the firmware on your rebreather controller up to date In addition to new features and improvements, firmware updates address important bug fixes.

There are two ways to update the firmware on your Petrel 3:
1) With Shearwater Cloud Desktop
2) With Shearwater Cloud Mobile

Upgrading the firmware resets decompression tissue loading. Plan repetitive dives accordingly.

During the update process, the screen may flicker or go blank for a few seconds.

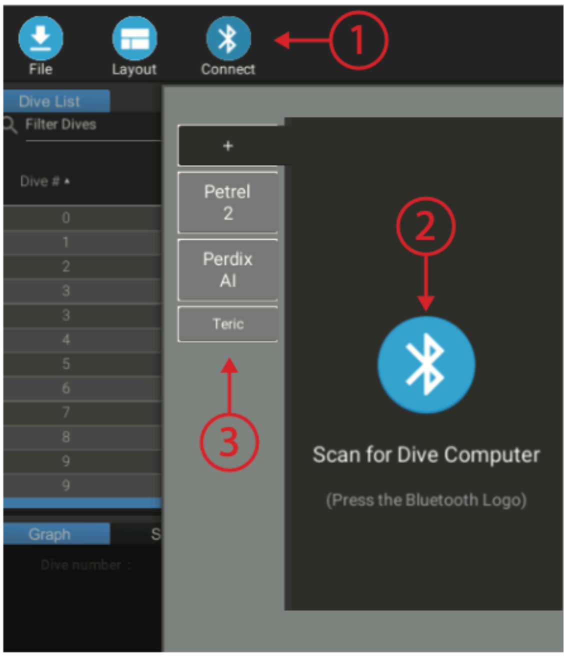
12.1. Shearwater Cloud Desktop

Ensure you have the most recent version of Shearwater Cloud Desktop.
Shearwatercom/cloud

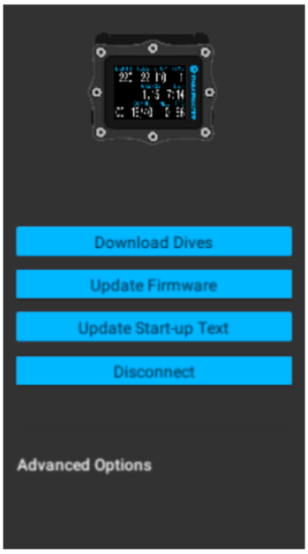
Connect to Shearwater Cloud Desktop

On your Petrel 3, start Bluetooth by selecting the Bluetooth menu item from the main menu.

In Shearwater Cloud Desktop:
1. Click the connect icon to open the connect tab.
2. Scan for Dive Computer.
3. Once you've connected the computer once, use the Petrel 3 tab to connect faster next time.



Shearwater Cloud Desktop Connect Tab



Shearwater Cloud Desktop Connect Tab

Once the Petrel 3 is connected, the connect tab will show a picture of the dive computer.

Download Dives

Select "Download Dives" from the connect tab.

A list of dives will be generated You can un-select any dive logs you don't want to download, then press OK.

Shearwater Cloud Desktop will transfer the dives to your computer.

From the connect tab, you can give the Petrel 3 a name If you have multiple Shearwater dive computers, you will be able to easily tell which dive was downloaded from which dive computer.

Select the dives you wish to download and press OK

Update Firmware

Select "Update Firmware" from the connect tab.

Shearwater Cloud Desktop will automatically select the latest available firmware.

When prompted, select your language and confirm the update.

The Petrel 3 screen will give percentile updates of receiving the firmware, and then the Personal Computer will read "Firmware successfully sent to the computer" on completion.

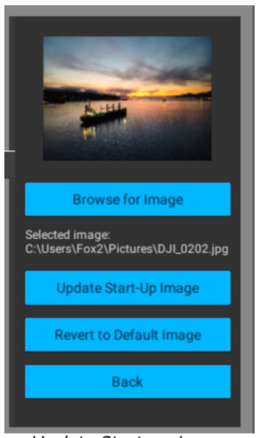
> Firmware updates can take up to 15 minutes.

Update Start-up Text

Start-Up text appears at the top of the start up splash screen when the Petrel 3 is turned on It's a great place to put your name and phone number so your computer can be more easily returned if mis-placed.

Update Start-up Image.

Here you can also change the startup image that appears when the Petrel 3 turns on to help better differentiate your dive computer



Update Start-up Image

12.2 Shearwater Cloud Mobile

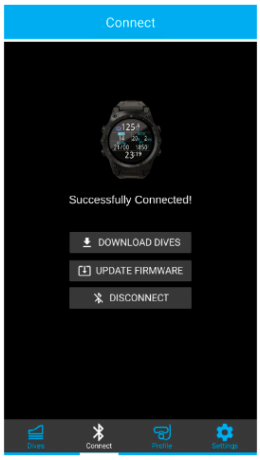
> Ensure you have the most recent version of Shearwater Cloud Mobile.
> Downloand it from Google Play or the Apple App Store.

Connect to Shearwater Cloud Mobile

On your Petrel 3, start Bluetooth by selecting the Bluetooth menu item from the main menu.

On Shearwater cloud mobile:

1. Press the connect icon at the bottom of the screen
2. Select your Petrel 3 from the list of Bluetooth devices

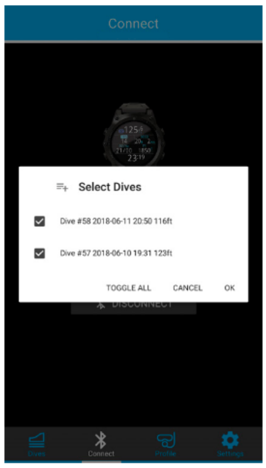


Download Dives

Select "Download Dives"

A list of dives will be generated and you can un-select any dive logs you don't want to download, then press OK.

Shearwater Cloud will transfer the dives to your smart phone.



Update Firmware

Once the Petrel 3 is connected to Shearwater cloud mobile, select "Update Firmware" from the connect tab.

Shearwater Cloud mobile will automatically select the latest available firmware. When prompted, select your language and confirm the update.

The Petrel 3 screen will give percentile updates of receiving the firmware, and then the mobile app will read "Firmware successfully sent to the computer" on completion.

> Firmware updates can take up to 15 minutes.

13. Changing the Battery

A large coin or washer is required to change the battery.

Remove the battery cap

Insert the coin or washer into the battery cap slot. Unscrew by turning counter clockwise until the battery cap is free. Be sure to store the battery cap in a clean dry space.

Exchange the battery

Remove the existing battery by tilting the Petrel 3 and letting the old battery slide out. Insert a new battery positive contact first. A small diagram on the bottom of the Petrel 3 shows the proper orientation.

Reinstalling the battery cap

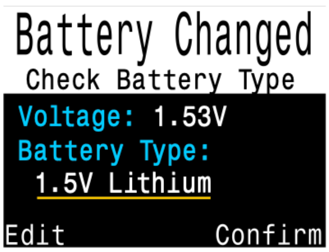
It is **very important that the battery cap O-rings are clear of dust or debris.**
Carefully inspect the O-rings for any debris or damage and gently clean. It is recommended that the battery cap's O-ring is lubricated on a regular basis with an O-ring lubricant compatible with Buna-N (Nitrile) O-rings. Lubricating helps ensure that the O-ring seats properly and does not twist or bunch.

Insert the battery cap into the Petrel 3 and compress the battery contact spring. While the springs are compressed rotate the battery cap clockwise to engage the threads. Be sure not to cross thread the battery cap's threads. Tighten the battery cap until snug and the Petrel 3 powers on. Do not over tighten the battery cap.

NOTE: Battery cap O-rings are Type 112 Buna-N 70 durometer.

13.1. Battery Type Selection

After changing the battery, select the battery type used.



The Petrel 3 attempts to guess what type of battery is being used If the battery type is incorrect, it should be manually edited.

The Petrel 3 can accept most AA sized (14500 size) batteries that output a voltage between 0,9 V and 4,3V. However, some batteries are better than others.

- Not all batteries support vibration.
- Battery types that support the fuel gauge feature will give more warning before the computer dies.
- Some battery types perform better in cold water.

Shearwater recommends using Energizer Ultimate Lithium batteries for best performance.

Supported battery types:

Battery Type	Approx. Battery Life	Vibration Support	Fuel Gauge	Cold water Performance
1.5V Lithium **Recommended**	60 hours	Yes	Yes	Very Good
1.5V Alkaline	45 hours	No	Yes	Ok
1.2V NiMh Rechargeable	30 hours	No	No	Poor
3.6V Saft LS14500	130 hours	No	No	Poor
3.7V Li-Ion Rechargeable	35 hours	Yes	Yes	Good

Battery life is based on medium brightness.

Alkaline batteries are especially prone to leaking.
This is a leading cause of dive computer failure.

Alkaline batteries are not recommended.

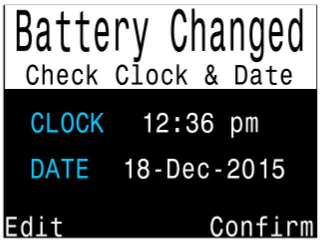
13.2 Behaviour on Battery Change

Settings

All settings are retained permanently. No loss of settings occurs when changing the battery.

Clock

The clock (time and date) is saved to permanent memory every 16 seconds when the dive computer is on, and every 5 minutes when off. When the battery is removed, the clock stops running. Once the battery is replaced, the clock is restored to the last saved value (so it is best to remove the battery while the dive computer is on for lowest error).



After replacing the battery a screen appears for quick adjustments to the time

Quick battery changes will not require any adjustment, but the time should be corrected if the battery is removed for more than a few minutes.

Expected clock drift is about 4 minutes per month. If there is higher drift, it is likely due to clock stoppage during battery changes, and is easily corrected at the time of a battery change.

The clock is also updated every time the dive computer is connected to Shearwater Cloud Desktop or Shearwater Cloud Mobile.

13.2.1. Decompression Tissue Loading

The battery may be safely changed between repetitive dives.

Like the clock, the decompression tissue loading is saved every 16 seconds to permanent memory when on, and every 5 minutes when off.

When the battery is removed the tissues remain stored in the permanent memory and are restored once the battery is replaced, allowing for battery changes between repetitive dives. However, the dive computer does not know for how long the battery was removed, so no surface interval adjustment is applied for the time that the battery is removed.

For quick battery changes, the un-powered time interval is not significant. However, if the battery is removed shortly after a dive and then remains out for a long period, residual tissue loading will remain when the battery is replaced.

If at the time of battery replacement any tissue is below saturated with air at the current pressure, then that tissue is brought up to being saturated with air. This might happen after a decompression dive that used 100% O2, where the faster tissues are often completely depleted of inert gas loading. Bringing such tissues back up to saturated with air after a battery change is the most conservative approach.

When deco tissues are reset:

- Inert gas tissue loadings are set to saturated with air at current atmospheric pressure
- CNS Oxygen Toxicity set to 0%
- Surface Interval time set to 0
- All VPM-B values set to default levels

14. Storage and Maintenance

The Petrel 3 dive computer should be stored dry and clean.

Do not allow salt deposits to build up on the dive computer. Rinse the computer with fresh water to remove salt and other contaminants.

Do not wash under high pressure jets of water as it may cause damage to the depth sensor.

Do not use detergents or other cleaning chemicals as they may damage the dive computer. Allow to dry naturally before storing.

Store the dive computer out of direct sunlight in a cool, dry and dust free environment. Avoid exposure to direct ultra-violet radiation and radiant heat.

Do not store batteries in the Petrel 3 for long periods (several months). Batteries can leak, so don't risk your expensive computer on a simple task like removing batteries. Dead batteries are at a higher risk of leaking. Leaking batteries is a leading cause of dive computer failure and is not covered under warranty.

15. Servicing

There are no user serviceable parts inside the Petrel 3. Do not tighten or remove any faceplate screws.

Clean with water ONLY. Any solvents may damage the Petrel 3 dive computer.

Service of the Shearwater Petrel 3 may only be done at Shearwater Research, or by any of our authorized service centers

Contact Info@shearwatercom for service requests.

Shearwater recommends service of all dive computers every 2 years by an authorized service center.

Evidence of tampering will void your warranty.

16. Glossary

CC - Closed circuit Scuba diving using a rebreather where exhaled gas is recirculated with carbon dioxide removed.

GTR - Gas Time Remaining. The time, in minutes, that can be spent at the current depth and SAC rate until a direct ascent to the surface would result in surfacing with the reserve tank pressure.

NDL - No Decompression Limit. The time, in minutes, that can be spent at the current depth until mandatory decompression stops will be required.

O2 - Oxygen gas.

OC - Open circuit Scuba diving where gas is exhaled into the water (i.e. most diving).

PO2 - Partial Pressure of Oxygen, sometimes PPO2.

RMV - Respiratory Minute Volume. Gas usage rate measured as the volume of gas consumed, adjusted as if at a pressure of one atmosphere. Units of Cuft/minute or L/ minute.

SAC - Surface Air Consumption Gas usage rate measured as the rate of tank pressure change, adjusted as if at a pressure of one atmosphere (ie surface pressure) Units of psi/minute or bar/ minute.

17. Specification

Specification	**Petrel 3 Model Dive Can Controller**
Operating Modes	Closed Circuit (CC) Open Circuit Bailout (BO)
Display	Full color 2.6” AMOLED
Pressure (depth) sensor	Piezo-resistive
Accuracy	+/-20 mbar (at surface) +/-100 mbar (at 14bar)
Calibrated Depth Sensor Range (Maximum Rated Depth)	0 bar to 14 bar (130 msw, 426 fsw)
Crush Depth Limit	30 bar (~290msw) Note: this exceeds the calibrated depth sensor range.
Surface Pressure Range	500 mbar to 1040 mbar
Depth of dive start	1.6 m of sea water
Depth of dive end	0.9 m of sea water
Operating Temperature Range	+4ºC to +32ºC
Short-Term (hours) Temperature Range	-10ºC to +50ºC
Long-Term Storage Temperature Range	+5ºC to +20ºC
Battery	User Replaceable AA Size, 0.9V to 4.3V
Battery Operating Life (Display Medium Brightness)	45 Hours (AA 1.5V Alkaline) 60 Hours (1.5V Lithium) 130 Hours (SAFT LS14500)
Communications	Bluetooth Low Energy (4.0)
Compass Resolution	1°
Compass Accuracy	±5°
Compass Tilt Compensation	Yes, over ±45° pitch and roll
Dive Log Capacity	Approximately 1000 hours
Battery cap o-ring	Dual o-rings. Size: AS568-112 Material: Nitrile Durometer: 70A
Wrist Attachment	2 x 3/4" Elastic Straps with Buckles
Weight	DiveCAN Cable Gland (DCG) Model - 345g
Size (W X L X H)	83mm X 75.5mm X 39mm

18. List of Petrel 3 Models

The following is a list of Petrel 3 models to which this manual is applicable The model / part number and Petrel 3 variant can be found on the Regulatory Information screen of the System Setup Menu (System Setup > Advanced Config > Regulatory Info)

All models to which this manual applies are DiveCAN cable gland variant, controller models (DCG /DCC).

Model/Part Number
11304
11305
11306
11307
11308
11310
11312
11313
11316

The Petrel 3 comes in 4 variants:

1 Stand Alone (SA) - The stand alone variant has no connection to a rebreather.

2 Fischer Connector (FC) - The Fischer connector is a bulkhead connector that is commonly used on manual rebreathers. This Petrel 3 variant interprets signals from galvanic oxygen cells over the Fischer connection.

3 Analog Cable Gland (ACG) - The analog cable gland is a newer alternative to the Fischer connector variant. This variant has a permanently attached cable that can be connected to a compatible rebreather to interpret signals from galvanic oxygen cells.

4 DiveCAN Cable Gland (DCG) - The DiveCAN cable gland variant is built for use exclusively with DiveCAN supported rebreather systems. This manual is only applicable to DiveCAN cable gland Petrel 3 controllers (DCC), all of which listed in the table above For DiveCAN monitors (DCM) operating instructions, please see the Petrel 3 Tecnical Modes operating instructions manual.

19. Regulatory Information

A) USA-Federal Communications Commission (FCC)
THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES OPERATION IS SUBJECT TO THE FOLLOWING TWO CONDITIONS:
(1) THIS DEVICE MAY NOT CAUSE HARMFUL INTERFERENCE, AND
(2) THIS DEVICE MUST ACCEPT ANY INTERFERENCE RECEIVED, INCLUDING INTERFERENCE THAT MAY CAUSE UNDESIRED OPERATION.
Changes to or modification of this equipment are not authorized, doing so may void the user's authority to operate this equipment.
Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
—Reorient or relocate the receiving antenna.
—Increase the separation between the equipment and receiver.
—Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
—Consult the dealer or an experienced radio/TV technician for help.

Caution: Exposure to Radio Frequency Radiation.
This device must not be co-located or operating in conjunction with any other antenna or transmitter.
Petrel 3 Dive Computer Contains TX FCC ID: 2AA9B04

B) Canada - Industry Canada (IC)
This device complies with RSS 210 of Industry Canada.
Operation is subject to the following two conditions:
(1) this device may not cause interference, and
(2) this device must accept any interference, including interference that may cause undesired operation of this device.

L'utilisation de ce dispositif est autorisée seulement aux conditions suivantes :
(1) il ne doit pas produire d'interference, et
(2) l'utilisateur du dispositif doit étre prêt à accepter toute interference radioélectrique reçu, même si celle-ci est susceptible de compromettre le fonctionnement du dispositif.

Caution: Exposure to Radio Frequency Radiation.
The installer of this radio equipment must ensure that the antenna is located or pointed such that it does not emit RF field in excess of Health Canada limits for the general population; consult Safety Code 6, obtainable from Health Canada's website.
Petrel 3 Dive Computer Contains TX IC: I2208A-04

C) EU and UK Conformance Statements
• EU Type examination conducted by: SGS Fimko Oy Ltd, Takomotie 8, FI-00380 Helsinki, Finland Notified Body No 0598.
• UK Type examination conducted by: SGS United Kingdom Ltd, Rossmore Business Park, Ellesmere Port, South Wirral, Cheshire, CH65 3EN, United Kingdom Approved Body No 0120.
• This device is in conforms with REGULATION (EU) 2016/425 on personal protective equipment.
• High pressure gas sensing components are in conformity with EN 250:2014 – respiratory equipment -open circuit self-contained compressed air diving apparatus – requirements, testing and marking – clause 6111 Pressure Indicator Pressure indication is designed to protect a trained diver from the risk of drowning.
• EN 250:2014 is the standard describing certain minimum performance requirements for SCUBA regulators to be used with air only sold in EU EN 250:2014 testing is performed to a maximum depth of 50 M (165 FSW). A component of self- contained breathing apparatus as defined by EN 250:2014 is: Pressure Indicator, for use with air only Products marked EN250 are intended for air use only. Products marked EN 13949 are intended for use with gases containing more than 22% oxygen and must not be used for air.
• Depth and time measurements conform with EN 13359:2000 - Diving Accessories - depth gauges and combined depth and time monitoring devices.
• Electronic instruments are in compliance with:
- ETSI EN 301 489-1, v223: 2019 Electromagnetic compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements.
- ETSI 301 489-17 V324:2020 ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 17: Specific conditions for Broadband Data Transmission Systems.

- EN 55035:2017/A11:2020 Electromagnetic compatibility of multimedia equipment. Immunity requirements.
- CISRP32/EN 55032, 2015 A11:2020 Electromagnetic compatibility of multimedia equipment. Emission requirements.
- DIRECTIVE 2011/65/EU Restriction of the use of certain hazardous substances in electrical and electronic equipment (ROHS).

• Declarations of Conformity are available at: https://wwwshearwatercom/iso-9001-2015-certified/.

EU Authorised Representative: 24hour-AR,
Van Nelleweg 1
3044 BC Rotterdam
The Netherlands

UK Authorised Representative: 24hour-AR
15 Beaufort Court
Admirals Way
Canary Wharf London
E14 9XL

WARNING:
Transmitters marked EN 250 are certified for use with air only. Transmitters marked EN 13949 are certified for use with Nitrox only.

20. Contact

www.shearwater.com/contact

Headquarters
100-10200 Shellbridge Way,
Richmond, BC
V6X 2W7
Tel: +16046699958
info@shearwatercom

End of Manual