FATHOM
DIVE SYSTEMS

Gemini CCR User Manual

Version 1.1

Contents

Introduction

Welcome to the FATHOM Gemini CCR, a closed circuit rebreather designed for the most demanding diving environments. The FATHOM Gemini CCR combines high quality materials, precision machining, and simple intuitive operation. The FATHOM Gemini CCR is the measure of exploration.

This manual is not intended to replace formal training with a factory authorized FATHOM Gemini CCR instructor, nor does it cover all relevant topics for CCR diving. It is designed to supplement your training and act as a reference for future use. Inside, you will find detailed information about the components, assembly, breakdown, cleaning, and maintenance of your FATHOM Gemini CCR. It is extremely important that you read this manual in its entirety and understand the information contained as well as its practical application prior to diving your rebreather.

Warning, Caution, and Notice Statements

Periodically you will see special warning, caution, and notice statements that highlight information that requires special attention. These notices are highlighted using the following format:

NOTICE statements are used to notify the user of information regarding installation, operation, maintenance, performance, general tips that are important, or statements describing a procedure or situation that might cause damage to the device but is unrelated to physical injury.

CAUTION statements indicate a hazardous situation which, if not avoided, could result in minor or moderate injury.

WARNING statements describe potentially hazardous situations which, if not avoided, could result in serious injury or death. Avoid these situations under any circumstances.

Closed Circuit Rebreather

A closed circuit rebreather (CCR) is a type of self-contained underwater breathing apparatus (SCUBA) that recycles a diver's exhaled gas by removing carbon dioxide (CO_2) and replacing metabolized oxygen. The essential components of a rebreather include a flexible breathing bag known as a counterlung, a means of removing CO_2, a means of replacing metabolized oxygen, and a means of adding diluent gas.

CCRs are broadly categorized as either electronic (eCCR) or mechanical (mCCR), which refers to how they add oxygen. Within the mCCR category is a subcategory of CCRs that utilize a needle valve to control oxygen addition. Another broad categorization is how the CCR is worn on the diver. The CCR can be backmounted, sidemounted, chestmounted, or a hybrid. The FATHOM Gemini CCR is a split scrubber design hybrid mCCR.

CCRs have advantages and disadvantages when compared to open-circuit diving. The advantages include significant gas efficiency, which results in practical advantages such as increased duration, reduced logistical requirements, and cost savings. Other advantages include increased warmth, silence, and lack of bubbles.

The disadvantages of CCRs include complexity, insidious failure modes such as hypoxia, which can overcome a diver with little to no warning, and upfront costs. The key is to weigh the advantages against the disadvantages to determine whether CCR diving is warranted. This determination is diver specific and depends on the type, location, and depth of dives being planned. CCRs provide a significant safety advantage for dives exceeding 60 msw/200 fsw.

Inherent Risks

There are several inherent risks to rebreather diving that divers need to be aware of in order to prevent injury or death. These risks, known as the three H's are hypoxia, hyperoxia, and hypercapnia.

Hypoxia is the result of insufficient oxygen in the diver's breathing gas which starves the diver's tissues of oxygen causing confusion, reduced motor function, unconsciousness and ultimately death. This can occur due to a system failure or user error. In the case of a Fathom CCR, failure to open the oxygen cylinder or needle valve, or a complete loss of oxygen supply, could lead to hypoxia if not noticed and corrected by the diver.

Hyperoxia occurs when a diver is exposed to oxygen in high concentrations for prolonged periods and can result in central nervous system (CNS), pulmonary, or ocular oxygen toxicity. This occurs when oxygen exposure limits are exceeded due to either excess oxygen being added to the rebreather by either a malfunction or a human error in dive planning or execution. CNS oxygen toxicity is the most immediate concern since it can cause a seizure, which is typically not a survivable event underwater. The limitations for oxygen exposure are clearly outlined in your provided training materials.

Hypercapnia is an excess of carbon dioxide (CO_2) in the diver's bloodstream causing increased breathing rate, anxiety, confusion, perceptual narrowing, headache and eventually unconsciousness. There are several rebreather components which are critical for removal of CO_2 from the breathing loop. Incorrect assembly of the rebreather and exceeding the limits of the CO_2 scrubber are the primary causes of hypercapnia, but incorrect gas choices and exertion can also lead to CO_2 accumulation.

Methods of prevention, recognition and correction are covered thoroughly in your training materials as well as in class by your instructor. Special attention should always be given when assembling your rebreather and completing predive checks, as well as continuous systems checks throughout the dive, to ensure the rebreather is functioning correctly. It is also imperative that you continue to practice skills necessary for managing failure modes often so you can manage issues safely when they arise.

Components

This section discusses the individual components of the FATHOM Gemini CCR with detailed descriptions of each component's function and use. The individual components are divided into the following sections: breathing loop, scrubbers, oxygen addition, diluent addition, head, displays, and gas cylinders.

The FATHOM Gemini CCR offers several configurations as well as periodic updates. As such, it is possible that not all components listed in this manual are installed on your unit or may appear slightly different than yours. The images and descriptions found in this section are for reference only and may not accurately represent all FATHOM Gemini CCRs produced.

Breathing Loop

The FATHOM Gemini CCR's breathing loop consists of a dive-surface valve (DSV), loop hoses, and a counterlung. These components direct the flow of gas around the loop, allowing the scrubber material to absorb carbon dioxide and the sensors to measure and report the oxygen content to the monitoring devices.

Counterlungs

The counterlungs are the variable volume portion of the breathing loop, which expand and contract as the diver inhales and exhales. Counterlungs are broadly classified by their location on the diver, i.e., front mounted or back mounted counterlungs. The location of the counterlungs in relation to the lung centroid has significant influence on the work of breathing.

The FATHOM Gemini CCR has a single back mounted counterlung, which provides excellent work of breathing in all positions while keeping the diver's frontal area free of clutter and minimizing their profile. The counterlung has a low-profile exhaust valve, which acts as an over pressure valve (OPV) and allows the diver to manually vent gas or dewater the unit.

DSV

The dive-surface valve (DSV) is the interface between the diver and the CCR. The DSV consists of a mouthpiece, an on/off valve, and two one-way valves that direct the flow of gas. The FATHOM DSV utilizes a barrel valve for simple one-handed operation to open (dive) or close (surface) the loop. When the DSV is in the closed (surface) position, with the handle down, the loop is closed off from the environment. The FATHOM DSV has one-way mushroom valves built into the inhale and exhale ports which direct the flow of gas from the diver's right to left, or counterclockwise. The DSV uses bayonet connectors, which allows the mushroom valves to be visually inspected prior to each dive.

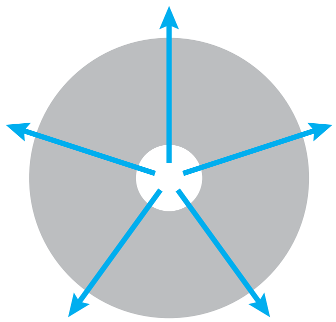
BOV

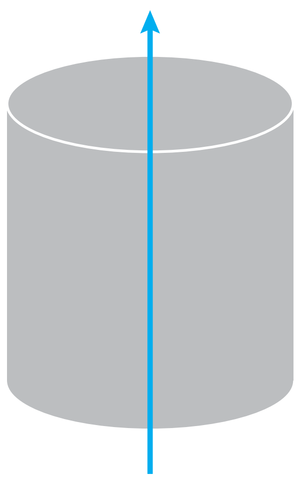
The bail-out valve (BOV) has many of the same features as the DSV with the addition of a second stage regulator, which provides the diver with open circuit gas when the valve is in the surface (closed) position. This simple feature means that as long as gas is plugged in to the diluent MAV, the mouthpiece is always a source of gas for the diver. The BOV also provides a secondary means of adding gas to the loop if needed.

CAUTION Mushroom valves must be tested prior to every dive to ensure proper function.

Loop Hoses

The FATHOM Gemini CCR utilizes flexible stretch hoses, which allow divers to turn their head more easily. The loop hoses connect to the DSV or BOV with bayonet fittings to enable quick visual inspection and service of the mushroom valves, while the head connections are threaded for added security.





Scrubber

Carbon Dioxide (CO_2) is a byproduct of the metabolic process. One of the primary functions of a rebreather is to remove the diver's exhaled CO_2 from the loop. The scrubber basket, which houses the CO_2 absorbent, sits in the scrubber canister and mates with the CCR head.

Radial vs Axial

There are two primary scrubber designs: radial and axial, both of which typically have a cylindrical shape. As its name implies, a radial scrubber flows gas along a radius of the circular cross-section, either from the curved sides of the cylinder into a central tube or vice versa. This means that the breathing gas only has to travel a short distance through the scrubber material over a large surface area, which maximizes dwell time and improves efficiency. Increasing the length of the scrubber does not increase the distance the breathing gas must pass through the media, meaning no increase in work of breathing. Because of the shorter bed length, extra care must be taken when packing a radial scrubber to avoid channeling and breakthrough.

Conversely, an axial scrubber moves the breathing gas axially from one end of the cylindrical scrubber to the other. This decreases the surface area of the sorb bed, but increases the distance the breathing gas must travel through, increasing breathing resistance. Because of this, an axial scrubber is limited in its size (and duration) as work of breathing increases dramatically as scrubber bed length is increased.

Scrubber Capacity

The FATHOM Gemini CCR utilizes twin axial scrubbers. The removable scrubber baskets, which combined hold 2.3 kg/5 lb of 812 sorb, are convienient for packing and assist in reducing heat loss to increase scrubber efficiency.

Scrubber Canister

The scrubber is housed in a Black Amalgon canister, which is nearly indestructible and insulates the scrubber four hundred times better than aluminum. Constructed of fiber-reinforced thermoset epoxy matrix, Black Amalgon features an ultra-smooth inner surface. It is a lightweight, high-strength, corrosion-resistant composite alternative to aluminum. Both the head and bottom are CNC machined Delrin and secured to the canister with a strong and simple latchless line-lock design that streamlines the profile and eliminates snags or broken latches. With both the head and bottom in place, the scrubber canister measures 13 in/33 cm tall and 5 in/13 cm diameter. The canister bottom has a recessed water trap that funnels moisture or condensation to the counterlung.

Head

The head is the central component of a rebreather which houses the oxygen sensors, sends information to the PO_2 monitoring devices, and connects the loop hoses to the scrubber canister. The FATHOM Gemini CCR's head was designed with simplicity, minimal static loop volume, and the smallest possible footprint as primary objectives. It is machined out of a single piece of Delrin with removable hose connections and cell holders, allowing for replacement in the event of damage during transport.

Pro-tip: Use positive pressure from the MAV to remove the head prior to complete disassembly.

There are no batteries or exposed wiring inside the head, only a fully potted splitter/isolation board that allows for two separate cell monitoring devices, such as a handset and HUD. Only the gold-plated male SMB connectors protrude from the potting. Once the sensors are removed, the head can be fully submerged in your rinse bin for cleaning.

Oxygen Sensors

Oxygen sensors tell us the oxygen content in a gas. Those designed for use in rebreathers are typically electro-galvanic fuel cells which generate an electrical charge when exposed to oxygen. The voltage output is proportional to the partial pressure of oxygen to which the sensor is exposed and is measured in millivolts (mV). They have a finite lifespan, and in-water failure can result in the diver being unaware of the contents of the gas they are breathing leading to hypoxia or hyperoxia.

The most common failure modes for oxygen sensors are current limiting and non-linearity, both of which are more common as sensors age but can also happen spontaneously. It is critical that close attention is paid to sensor health during setup and throughout each dive.

The FATHOM Gemini CCR head contains three Analytical Industries PSR-11-39-FDS oxygen sensors which all face downwards while the diver is in a prone swimming position. This reduces the potential for moisture collecting on the sensor faces, which can create inaccurate PO2 readings.

Current limiting

Current limiting describes a situation where the oxygen sensor cannot read above a given value. All oxygen sensors are current limited; however, it is important that the current limiting is well above the useable range for diving.

Current limiting can be extremely dangerous if two or more sensors become limited at the same time. If multiple sensors were to be limited to a PO_2 of 1.1 bar, they may calibrate accurately at 1.0 bar, but will be limited to 1.1 bar as the diver injects increasingly higher levels of oxygen into the loop trying to reach a PO_2 of 1.2 bar, while the actual PO_2 in the loop could be far greater and result in hyperoxia. This scenario is most common when divers use sensors beyond their expiration date or for more than 12 months.

To check the cells for current limiting, the diver can perform an oxygen flush on a dive at or around 6 msw/20 fsw ensuring the sensors can read up to PO_2 1.6 bar. This can be done at the start of the dive where conditions permit or at the end of the dive at deco, however; both scenarios can be problematic. Performing this check at the beginning of a dive can be difficult if not dangerous in a dynamic open-water environment. However, doing it at the end of a dive during deco or a safety stop requires the diver to blindly trust the sensors on the dive. A better method is to check the cells for current limiting with a cell-checker which is a pressure pot that can pressurize the sensors in oxygen to at least 2.0 bar.

Non-Linearity

Non-linearity and current limiting are related and often symtoms of the same problem. All current limited sensors are non-linear but not all non-liner sensors are current limited in the usable range. While current limiting is relatively easy to check for, non-linearity can be insidious because the sensor output tapers off in a curve as the actual PO_2 increases. This can be dangerous because the sensors appear to be reading correctly within the appropriate range, but it is taking more oxygen to drive the output up than it should and the PO_2 of the loop can become hyperoxic without the diver's knowledge. Again, this scenario is most common if the diver is using sensors beyond their expiration date or after more than 12 months of use.

To check linearity, divers must pay close attention during the calibration phase of the setup and cross check the sensors voltage output in air vs oxygen to ensure the relationship is linear. For example, if a sensor's output in air at sea level (PO_2 0.21) is 10 mV, we can calculate that we expect it's output in oxygen (PO_2 1.0) to be by simply dividing 10 mV by 0.21 resulting in 47.6 mV. We can also use a cell checker to verify linearity up to 2 ata to ensure all sensors are linear within the expected operating range. This process is part of the Fathom CCR Periodic Checklist and should be completed at least every three months or whenever the diver hasn't been in the water for more than a month.

WARNING It is extremely important that sensor health is monitored closely. Just because the electronics pass calibration during setup does NOT mean the sensors are performing properly.

Gas Injection

Both oxygen and diluent are injected directly into the exhale head, allowing ample time for homogenization as the gas passes through the scrubber prior to reaching the oxygen sensors.

Oxygen Addition

The heart of any rebreather is its oxygen addition system. CCRs are broadly categorized as either electronic or mechanical, which refers to how they add oxygen. eCCRs utilize an electronically controlled solenoid that adds small bursts of oxygen to the loop as needed while most mCCRs use a fixed-orifice, aka a leaky valve, that constantly bleeds a small amount of oxygen into the loop to meet the diver's metabolic needs. FATHOM CCRs are unique in that they utilize a needle valve, which allows for precise regulation of oxygen flow and can be adjusted underwater to match the diver's changing metabolic rates.

Adjustable CMF

The downside of a traditional fixed-orifice mCCR is that the oxygen flow must be set to your resting metabolic rate, and then requires the diver to manually add oxygen during the dive to meet their current metabolic needs. Unfortunately, this requires the most attention when the diver is working hard and possibly task loaded. While not quite as much work as diving an eCCR manually, this can certainly add to task loading.

The FATHOM needle valve, which is incorporated into the Gemini's dual MAV, allows the diver to precisely adjust the flow of oxygen into the breathing loop. The needle valve has all the advantages of a fixed-orifice constant mass flow (CMF) system with few, if any, of the drawbacks. The key difference between a needle valve and a traditional fixed-orifice is that the needle valve allows the oxygen flow to be adjusted in the water during the dive.

However, unlike needle valve systems of the past, FATHOM CCRs employ a needle valve with a non depth-compensated, or absolute pressure, first stage, creating an adjustable, on-the-fly CMF system. This system consists of two main components: the absolute pressure oxygen regulator, which provides CMF, and the needle valve, which provides in-water adjustability. These components work together to give the diver the best of both worlds. The needle valve allows the diver to precisely set the oxygen flow to meet their current metabolic needs and the CMF eliminates the need to constantly adjust the needle valve with depth changes.

Once the needle valve is dialed into the diver's metabolic needs, it only needs to be adjusted when those needs change, such as swimming versus hanging on deco. While this may sound challenging, brand new CCR divers frequently comment on how intuitive and easy to use it is.

1 (145 psi/14.7 psi/ata-2 ata) x 33 fsw/ata = 260 fsw (Note: always subtract 2 ata when calculating the maximum operational depth of a CMF system.)

The other frequently noted drawback of a mCCR with a CMF regulator is a depth limitation that is reached when the first-stage intermediate pressure is equal to the ambient pressure. For example, a CMF system with a 10 bar/145 psi intermediate pressure (IP) has a practical depth limit of 80 msw/260 fsw.[1]

FATHOM CCRs address the depth limit by modifying the oxygen first-stage with a stronger spring that allows for higher intermediate pressures. The first-stage intermediate pressure is factory set to 14 bar/205 psi for a practical depth limit of 120 msw/400 fsw. If a deeper maximum depth is needed, the intermediate pressure can be increased in the field to 20 bar/290 psi for a practical depth limit of 180 msw/600 fsw. Deeper than that, a standard depth-compensated first-stage can be used. Low pressure hoses rated for 28 bar/400 psi are used to safely handle the increased pressures, which is actually easier on the first-stage high pressure seat due to the lower pressure differential. The oxygen first stage is also fitted with a 25 bar/360 psi adjustable pressure relief valve (APRV) to protect the low pressure hoses from rupture in the event of a high pressure seat failure.

Smaller orifices and higher intermediate pressures can be used in a traditional fixed-orifice mCCR for deeper depths, but the risk of a blockage from debris is significant, and the options are limited by orifice availability. Conversely, the needle valve minimizes the risk of a blockage from debris, since it can be opened up to allow small particles to pass.

A fixed-orifice requires that the first stage intermediate pressure be adjusted to achieve a flow rate that corresponds to the diver's metabolic needs, typically around 0.6 to 0.8 L/min. The needle valve, however; allows the first-stage intermediate pressure to be set to any pressure since the needle valve handles the flow adjustments.

The Gemini dual MAV, which contains the needle-valve, is ported directly into the exhaust side of the head so oxygen must travel through the scrubber and mix with loop gas before reaching the diver.

Oxygen First Stage IP Adjustment

The higher the intermediate pressure, the more stress placed on components such as low pressure hoses, overpressure valves, etc. Be sure to select an IP that comports with the depth range of dives you intend to make regularly. When deciding on an IP, use the maximum depth you will realistically achieve in atmospheres, making sure to add two atmospheres as a safety measure. This is the minimum IP in bar (if your IP gauge is in psi, you will need to convert ata to psi) to dive to that maximum depth. For example, let's look at a maximum depth of 120 msw/396 fsw:

Metric: *120 msw / 10 msw/bar = 12 bar*
12 bar + 2 bar = 14 bar
14 bar = Min IP

Imperial: *396 fsw / 33 fsw/atm = 12 atm*
12 atm + 2 atm = 14 atm
14 atm x 14.7 psi/atm = 206 psi
206 psi = Min IP

We can also calculate the maximum operating depth of a specific IP by doing the reverse. For example, a standard first stage has an IP set around 10 bar/145 psi:

Metric: *(10 bar - 2 bar) x 10 msw/bar = 80 msw*

Imperial: *147 psi / 14.7 psi/atm = 10 atm*
10 atm - 2 atm = 8 atm
8 atm x 33 fsw/atm = 264 fsw

Adjustment: Adjusting the IP on your FATHOM CCR is fairly straight forward. Equipment you will need includes a spanner wrench to remove the environmental endcap, a 6 mm allen wrench, and an IP gauge.

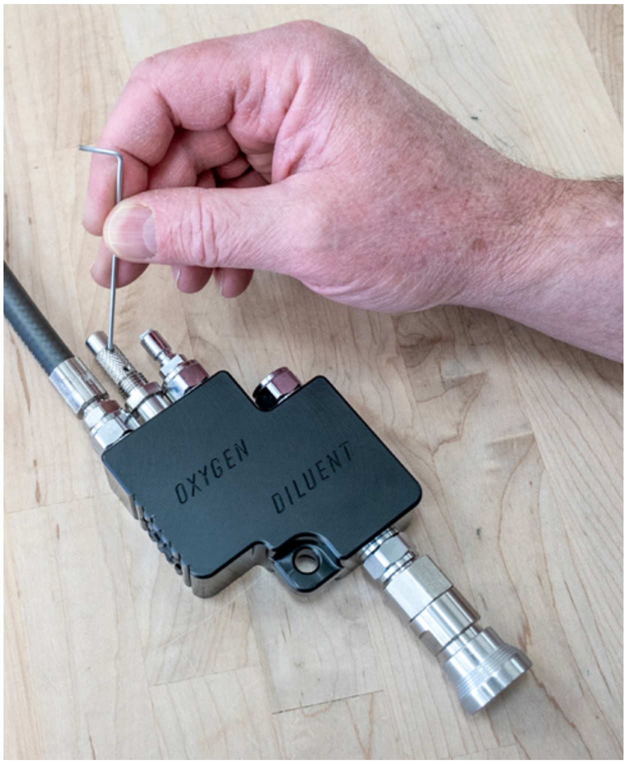
1. Remove the retaining ring with a spanner wrench and remove the Delrin blanking plug under it.
2. With the first stage attached to a cylinder with the valve turned off and the IP gauge plugged into the LP inflation hose from the first stage, slowly turn on the cylinder and check the current IP.
3. Insert the allen key into the spring adjuster and turn clockwise to increase the IP or counterclockwise to lower it. Make adjustments in small increments, about 1/8th of a turn per adjustment until the desired IP is reached.

CAUTION The oxygen first stage comes set to 14 bar/205 psi from the factory. It is adjustable up to 20 bar/290 psi. Exceeding 20 bar/290 psi can cause damage to equipment and catastrophic failure.

Submersible Pressure Gauge (SPG)

The oxygen first stage is equipped with a miniSPG so oxygen pressure can be verified immediately prior to diving. A standard SPG on a high pressure hose which can be viewed during the dive is acceptable, but adds several unnecessary failure points and adds very little useful information. Keep in mind that a 2L of oxygen will last upwards of seven hours. If divers want to monitor their oxygen supply during the dive they are encouraged to use a wireless transmitter. The Shearwater Petrel 3 handset can monitor up to four transmitters.

WARNING The adjustable pressure relief valves (APRV) on both the oxygen and inflation regulators must never be removed during use. A leaking APRV may indicate a high pressure seat failure in the first stage or it may just need to be adjusted. Either issue should be addressed prior to use.



Needle Valve Adjustment

Over time, the needle valve may need to be adjusted to allow it to continue to operate within the desired range. This is a simple process which requires only a 1/16" allen key and the included flow meter, which is used to measure the flow rate of oxygen through the needle valve. The flow meter measures the flow in liters per minute (lpm). The needle valve is not designed for shut-off service and should be set with a slight flow between 0 and 0.1 lpm. Setting the needle to shut-off flow completely can damage the needle valve.

CAUTION Avoid closing the needle valve with force to prevent damage to the needle. The handle stop is secured by a set screw, which can be overcome by excessive force.

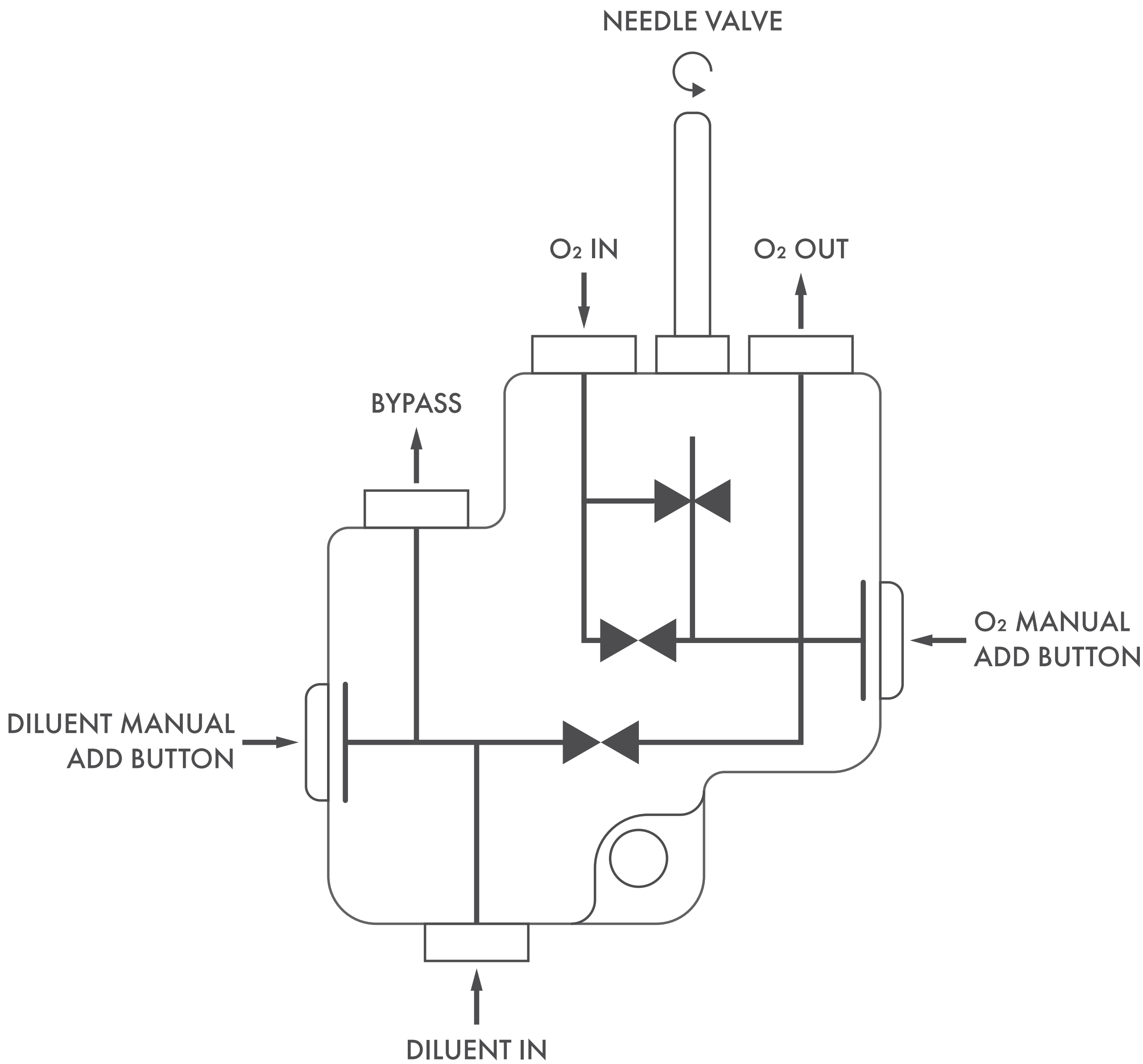
1. Connect the oxygen feed hose to the flow meter, ensuring the flow meter is standing upright on a level surface.
2. Connect the oxygen first stage to a cylinder and turn on the gas.
3. Set the needle valve to the "closed" position and note flow rate. The flow should be between 0 and 0.1 lpm.
4. If the flow is out of range, slightly loosen the handle set screw so that the handle can slide up and down on the stem.
5. Use the handle to adjust the needle valve until a flow rate between 0 and 0.1 lpm is achieved. Push the handle down until it stops and re-tighten the set screw.

Dual MAV

The dual Manual Addition Valve (MAV) is the mechanism which allows the diver to manually add oxygen or diluent into the loop. The needle valve is incorporated into the dual MAV. The dual MAV uses industry standard BC inflator cartridges that can be easily rebuilt or replaced. The oxygen button uses 90 durometer Viton o-rings due to the increased IP pressure and oxygen service.

Diluent Addition

Offboard diluent gas is plumbed in through a female QC-6 connector on the bottom of the dual MAV. The dual MAV also has a bypass port, which can be used to plumb gas to a BOV. The buttons are recessed to avoid accidental gas addition.



Displays

Displays allow the diver to monitor the oxygen content in the breathing loop. The FATHOM Gemini CCR utilzes a primary and secondary display for redundancy. The loss of a single PO_2 monitor without a backup would force a diver to bail out to open circuit. As such, all FATHOM CCRs have redundant PO_2 monitoring.

Handset

The handset is the primary means of monitoring the oxygen content in the breathing loop. Often, the handset can monitor various other functions including: depth, time, decompression status, compass, and gas pressures through wireless air integration (AI).

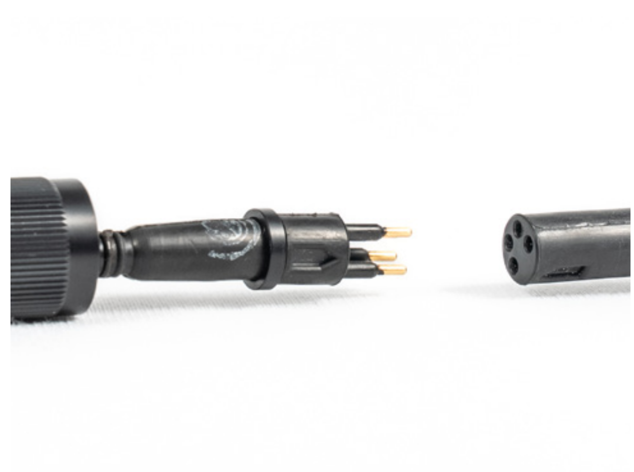
The FATHOM Gemini CCR utilizes the Shearwater Petrel 3 Analog Cable Gland (ACG) model in Closed Circuit/Bail Out (CC/BO) or PO_2 mode as the primary display.

The optional Shearwater NERD 2 Analog Cable Gland (ACG) model in Closed Circuit/Bail Out (CC/BO) or PO_2 mode can be used in place of the Shearwater Petrel 3 and has nearly identical information displayed in the diver's field of vision.

Both the Petrel 3 and NERD 2 utilize a 4-pin AK connector/cable. The AK cable is a wet-pluggable design and has a locking sleeve to prevent separation during a dive.

Please refer to the following Shearwater User Manuals for specific setup and use information.

› Petrel 3 Manual
› NERD 2 Manual



Heads Up Display

The Heads Up Display (HUD) is a visual display that provides the diver with essential PO_2 information. The FATHOM HUD utilizes a modified Smithers Code, which is a system of flashing lights that communicates PO_2 information to the diver. The HUD monitors each of the three sensors and displays the PO_2 on three LEDs. Each of the LEDs corresponds to a sensor. Each LED can flash red, white, blue, green, or amber. The brightness of the LEDs is adjusted automatically based on ambient light.

The HUD flash pattern is:

- A single amber flash is 1.0 bar/ata.
- The number of green flashes is the number of tenths above 1.0, so three green flashes is 1.3 bar/ata.
- The number of blue flashes is the number of tenths below 1.0, so two blue flashes is 0.8 bar/ata.

The HUD display has an accelerometer, which allows it to be turned on, turned off, and calibrated with taps. Five taps turns the HUD on, five taps turns it off, and three taps put it in calibrate mode, which must be accepted with three more taps

When the HUD is first switched on, all three LEDs will flash green at full brightness for one second (to load the battery), then the center LED (cell 2) will indicate the battery voltage, using one green flash for each 0.1 V above 3.0 V, and one red flash for each 0.1 V below (e.g. 3.3 V = 4 green flashes, 2.8 V = 2 red flashes). One amber flash indicates 3.0 V. It is worth replacing the battery when it gets to 2.9 V or below, indicated by red flashes at startup. Battery life will depend somewhat on LED brightness and how often they flash (i.e. how close to a PO2 of 1.0 you are diving). A SAFT LS14250 primary cell should provide 200+ hours of diving. The HUD has an auto-off feature. If the PO2 does not change for an hour the HUD switches itself off.

PO_2	Display
2.0 +	
1.9	
1.8	
1.7	
1.6	
1.5	
1.4	
1.3	
1.2	
1.1	
1.0	
0.9	
0.8	
0.7	
0.6	
0.5	
0.4	
0.3	
0.2	
0.1	
0	

The FATHOM HUD has a visual alarm feature, a distinctive high-visibility warning alternates with the flash pattern if the average PO_2 of enabled cells is below 0.4 PO_2 or above 1.6 PO_2. The visual alarm rapidly flashes alternating red and white LEDs at full brightness to get the diver's attention.

HUD Calibration

Calibration is the process on the rebreather's monitoring devices (handset or HUD) used to align the oxygen sensors' output in millivolts to a known partial pressure of oxygen.

To calibrate the FATHOM HUD, flush the loop with 100% oxygen and tap the HUD display three times. All three LEDs will come on for 5 seconds to indicate calibration mode. If you don't see that, it didn't get the command. Once in calibration mode, tap the HUD display three times again to confirm calibration. Cells that calibrate correctly flash green for 1 second, and if there is a problem with an individual cell, that cell's LED will flash red for 1 second. Each cell calibrates independently of the others. Calibration failure may occur because the cell voltage is out of range (e.g. below 35 mV in 100% oxygen) or the cell voltage is unstable. Calibration data (and other settings) are retained even if power is disconnected (e.g. when changing the battery). After you calibrate, each of the sensors should be flashing one amber. That means the PO_2 is between 0.95 and 1.05. The actual value that's used for calibration is 0.98.

HUD Calibration at Altitude or Lower Fraction of Oxygen (fO_2)

Occasionally divers will encounter a situation where the available oxygen supply fO_2 is < 95% and the HUD will not calibrate properly. Altitude will have the same effect and even a 100% oxygen supply may be below a PO_2 of 0.95 preventing normal calibration. To calibrate in these situations, divers can flush the loop with oxygen, close the loop, and slowly add oxygen to the loop until the handset displays a PO_2 of 0.98. Once a PO_2 of 0.98 is reached, the HUD can be calibrated normally.

Gas Cylinders

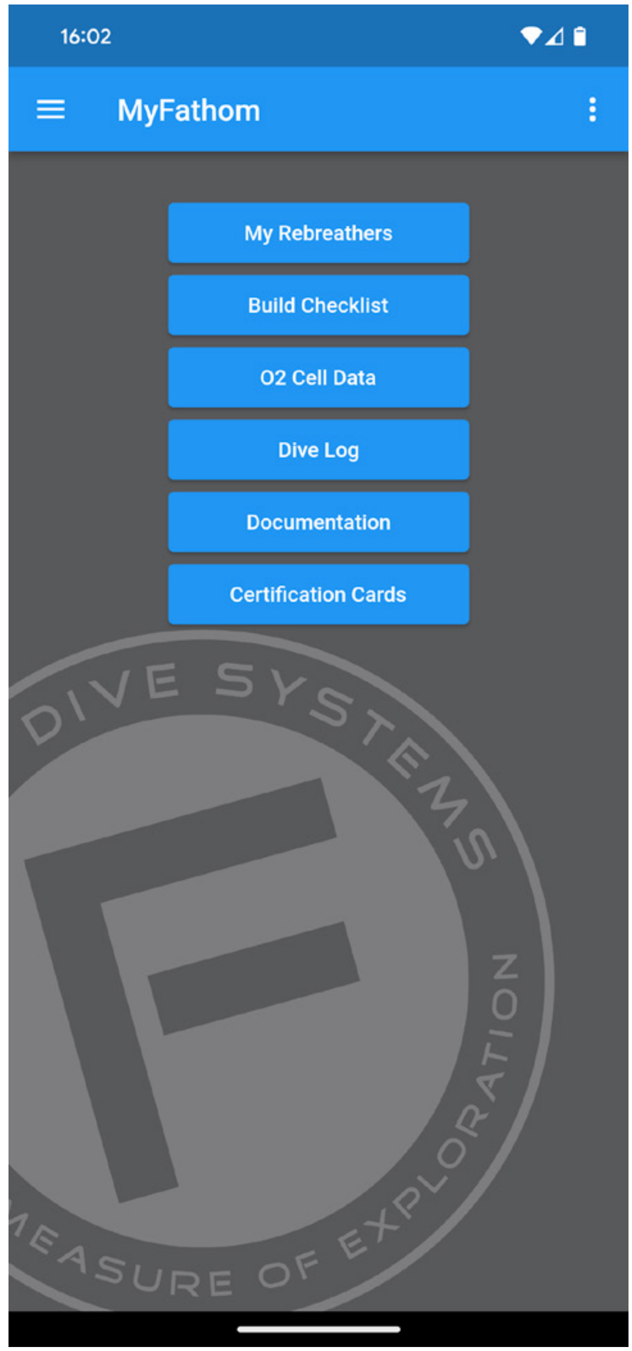
The FATHOM Gemini CCR is designed to allow the diver flexibility in cylinder size and configuration. While there are several options available to divers, we will primarily reference the sidemount configuration.

The sidemount configuration utilizes 2L butt mounted oxygen cylinder with diluent being supplied, by sidemounted bailout cylinders.

Preparing for a Dive

Great care must be taken when preparing your FATHOM Gemini CCR for a dive to ensure proper operation. For this reason, the FATHOM Gemini CCR Build Checklist should be used anytime the unit is being prepared for diving. This section of the manual will explain each step of the assembly process as outlined in the build checklist. As each step of the assembly is completed, fill out the checklist with the information requested. Detailed instruction and practice of assembly will be covered in your training course. Both the Periodic and Build Checklists are available in printed format (see Appendix 1) and in the MyFATHOM app, which is available for both iOS and Android. The interactive checklists on the MyFATHOM app are paperless and always available on your smart phone. In addition, each checklist can be saved and sent to a teammate or instructor for verification.

Ideally you will build and test your unit the night before diving in a protected and clean environment such as a garage or workshop. Do not attempt to build and test your unit on a rocking boat on the way to the dive site.



Periodic Checklist

The FATHOM Gemini CCR has a Periodic Checklist and a Build Checklist. The Periodic Checklist should be used at least every three months or anytime you haven't dived the unit for more than a month. The Periodic Checklist consists of verifying that the oxygen flow is within specifications and that the oxygen sensors are linear and not current limited.

Oxygen Flow

1. Check and record oxygen first stage intermediate pressure (IP). IP should be 205–290 psi/ 14–20 bar depending on planned max depth.
2. Check and record min flow through the oxygen needle MAV. With valve fully closed, flow should be between < 0.1 lpm.

Oxygen Sensors

1. With sensors installed in head and handset connected, check and record air mV for all three sensors in the first column of table. Divide air mV for each sensor by 0.21 and record in second column of table. Multiply result by 2 and record in third column of table.
2. Flush sensors with 100% oxygen and calibrate both handset and HUD.
3. Record oxygen mV @ 1 ATA in fourth column of table.
4. If a pressure pot is available, increase pressure to 2 ATA (14.7 psi/1 bar) and record oxygen mV @ 2 ATA in fifth column of table.
5. Compare columns four and five (actual) to columns two and three (expected) respectively to evaluate cells for linearity and current limiting. If actual mV reading deviates > 10% from expected mV reading, replace sensor.

Build Checklist

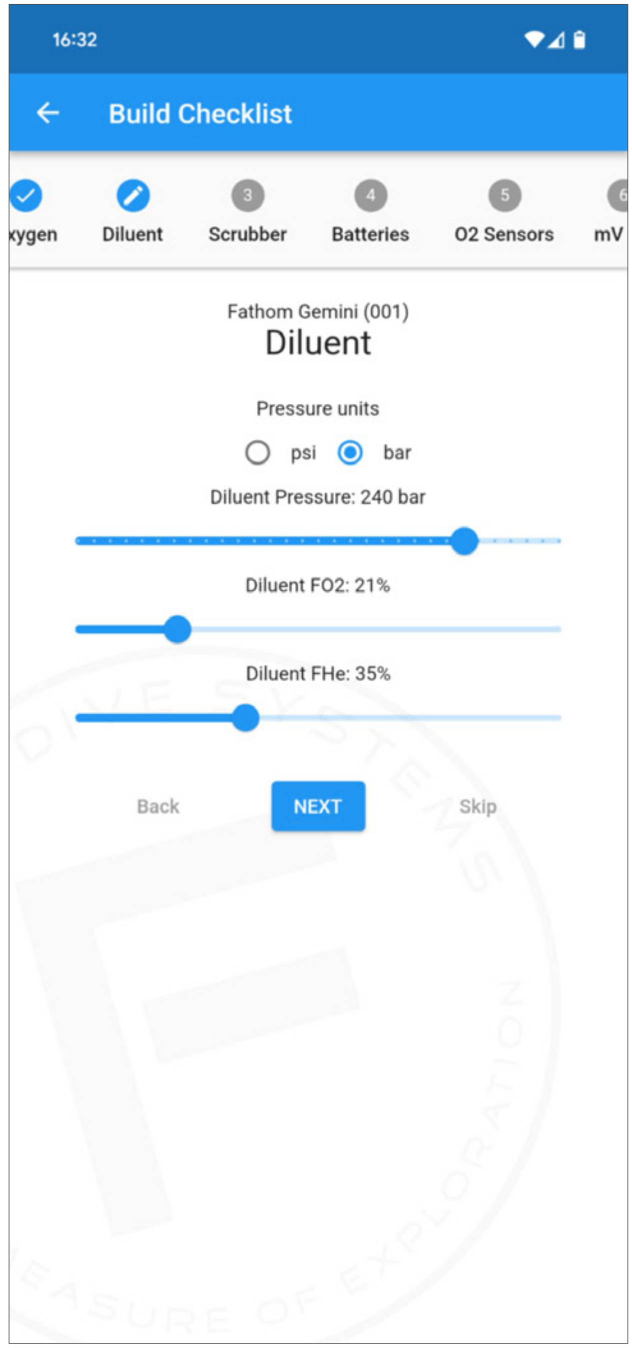
The Build Checklist should be used every time you prepare the unit for diving and consists of inspecting consumables, assembly, pressure tests, and calibration (if needed).

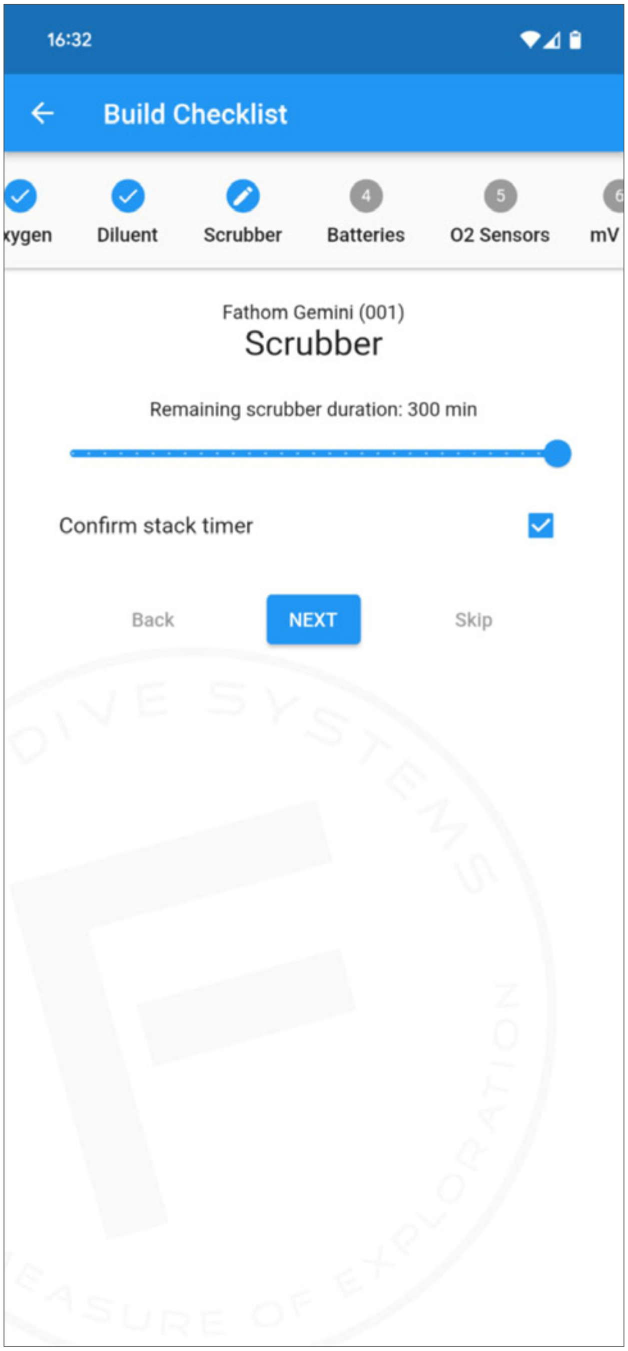
Consumables

The assembly process should begin by inspecting all of the consumables to ensure there is adequate capacity remaining. Consumables, which become depleted during normal use and must eventually be replaced, include: oxygen, diluent, oxygen sensors, batteries, and CO_2 absorbent.

Oxygen and Diluent

1. Check oxygen and diluent fill pressures, refill if necessary.
2. Analyze the contents of each gas, and properly label them including: the oxygen content as analyzed (to the nearest 0.1%), fill pressure, initials of who analyzed the cylinder, and the date it was analyzed. Analysis and labeling should always be done at the time the unit is assembled, if more than a day has passed since analysis, it should be re-done to ensure confidence in the cylinder contents. Fill pressures should also be double checked immediately before each dive.





Remaining Scrubber Duration

If the scrubber was previously filled, check the remaining duration and ensure it is adequate for the planned dive. The Shearwater Petrel 3 has a countdown stack timer that helps track remaining scrubber duration. As a general rule, the scrubber duration is one hour per pound. If needed, refill the scrubber:

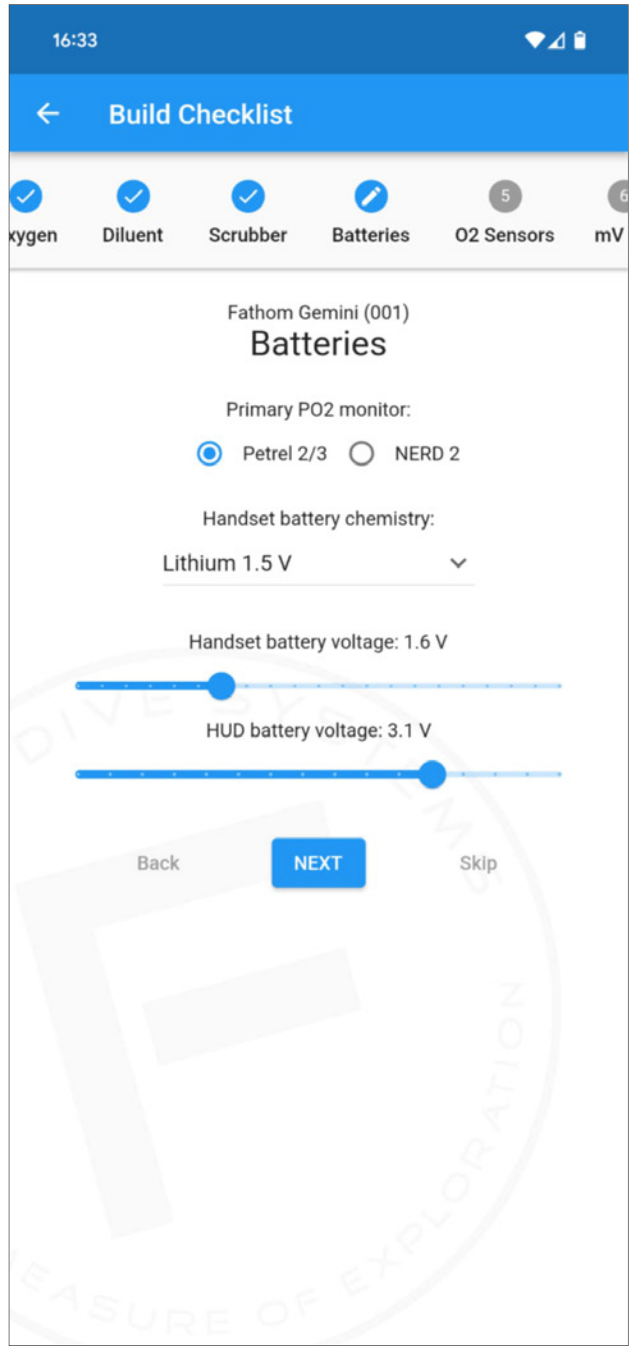
1. Ensure you are in a well ventilated area (outside is preferred), and on a flat and level surface, avoid inhaling sorb dust and limit contact with your skin.
2. Start with a clean and empty scrubber. Inspect all o-rings for damage and proper lubrication. If needed, lightly lubricate the o-rings with oxygen compatible lubricant.
3. Remove the wing nut, spring, screen, and scrim.
4. Place a scrim in the bottom of the scrubber.

5. Fill the scrubber ¼ to ⅓ full with Sofnolime 797 or Intersorb 812 CO_2 absorbent.
6. Tap the sides of the canister gently and evenly with both hands to allow the sorb to settle and fill the air spaces in between the granules.
7. Repeat until the scrubber is filled to just below the top rim.
8. Reinstall the top scrim, screen, spring, and wing nut.
9. The sorb should be packed tight with the screen's spring fully compressed. The spring is designed to create pressure on the top of the sorb bed, so if additional settling takes place en route to the dive site, the screen remains on the top of the sorb bed, avoiding CO_2 bypass.

Check Handset and HUD batteries

1. Check and record the handset battery voltage. Do not rely on the bar graph.
2. Turn on the HUD and record the battery voltage. It is worth replacing the battery when it gets to 2.8V or below, indicated by amber or red flashes at startup.

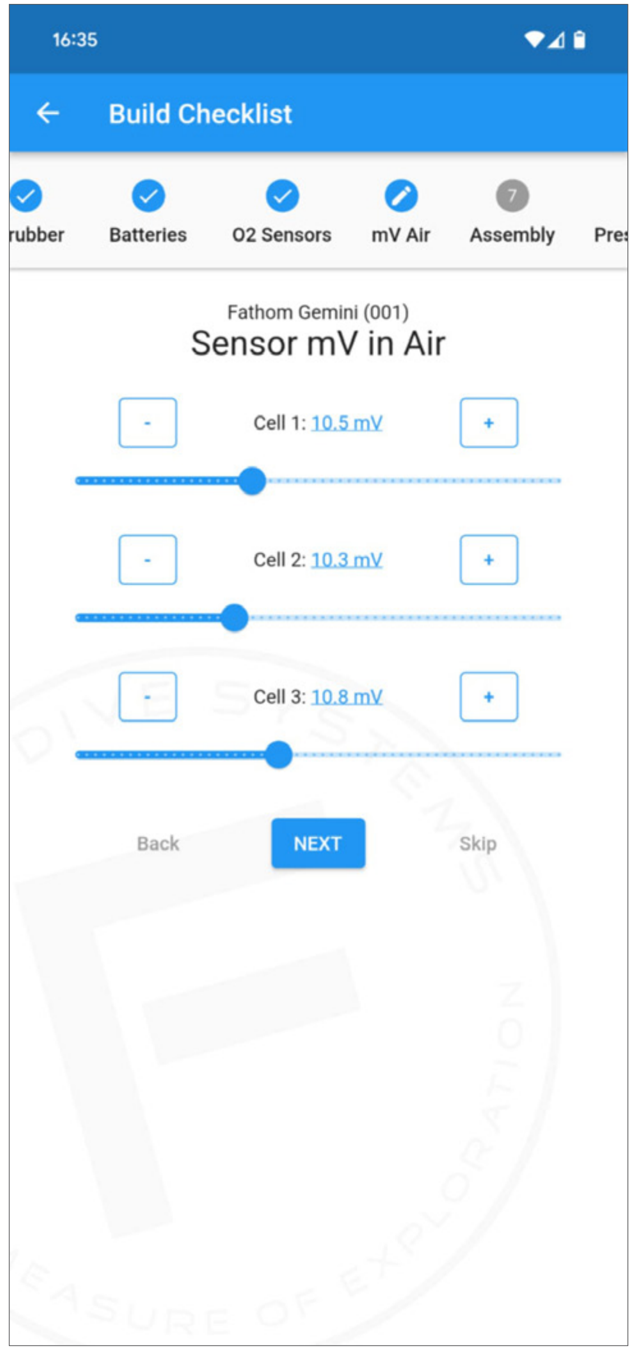
WARNING Lithium batteries have a rapid voltage drop near the end of their lifespan.



Check Oxygen Sensors

> **WARNING** Using expired or failing oxygen sensors is extremely hazardous and is responsible for many rebreather accidents. Never under any circumstances dive an expired or questionable sensor

1. Check and record installation date to ensure the sensor is not beyond 12 months of service OR past its expiration date. If either condition applies to any sensor, it must be replaced prior to use.
2. Record air mV of all three sensors prior to assembly.



Assembly

Insert Scrubber

1. Insert the scrubbers into the canisters, spring and wing nut side down.

Inspect Head and counterlung o-rings

There are 4 o-rings on each side: two on the outside diameter of the head which mates with the canister, and two on the barb that mates with the counterlung. It is important to closely inspect these o-rings for proper lubrication, wear, and debris. If needed, carefully remove, and clean the o-rings with a towel. Lightly lubricate them with oxygen compatible grease prior to reinstalling.

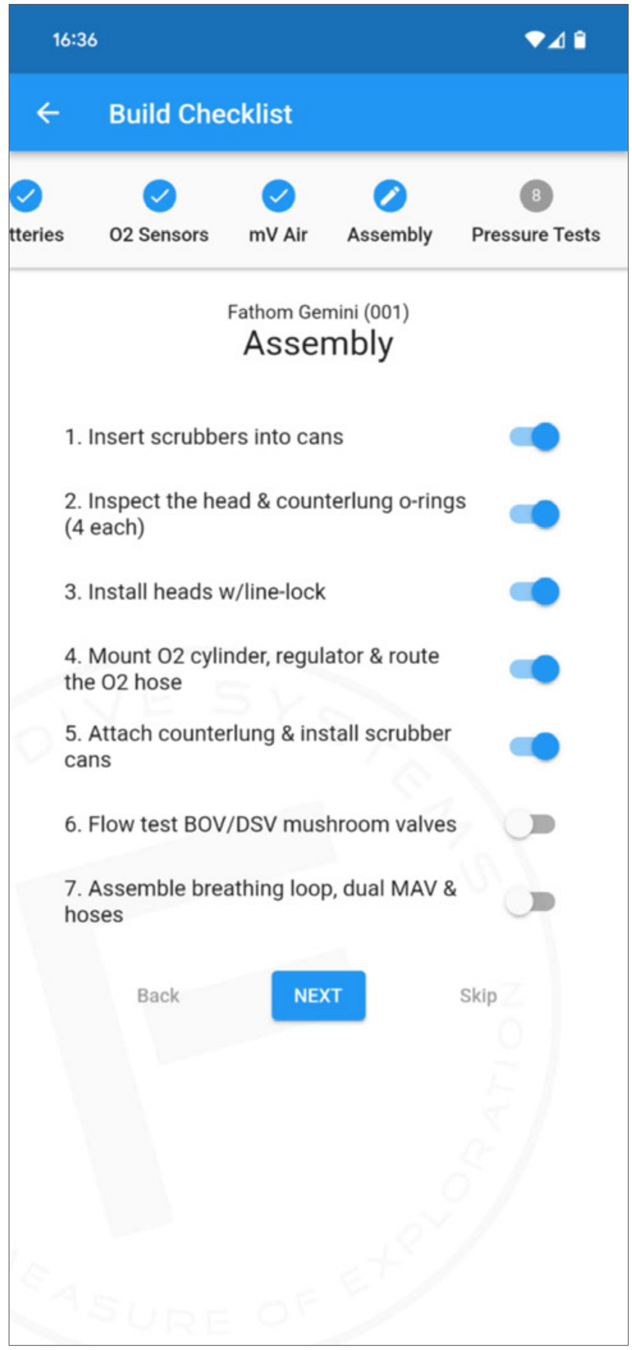
> **NOTICE** Do not use a metal pick to remove o-rings, as they can easily cause damage to the o-ring or score the sealing surface on the rebreather. Use either a plastic pick, or simply pinch the o-ring with your fingers to remove.

Install the Head

1. Line the heads up straight on the unit and press down evenly. You will feel the o-rings seat as each head presses into the canister. If you feel resistance, remove the head and inspect the o-rings for proper lubrication and to ensure they did not roll out of their groove or damage them.
2. Once the heads are seated properly in the canister, insert the line-lock.

Mount oxygen cylinder

1. Mount the 2L oxygen cylinder to the divers crotch strap and attach it to the bottom of the sidemount harness.
2. The valve on the oxygen cylinder should be oriented to the divers right side with the oxygen regulator protected toward the inside.
3. Route the 44" oxygen hose inside the sidemount harness and over the divers left shoulder.



Attach counterlung and scrubber canisters

1. Attach the counterlung and scrubber canisters to the sidemount system. The connection method will vary from system to system but should be secure and support both the counterlung and canisters when the diver is walking to the water.
2. Attach the counterlung barbs to the counterlung. Press and then and tighten the barb nut until secure.

Flow Test BOV or DSV

To ensure that the gas is properly directed through the FATHOM Gemini CCR, special attention needs to be given to the mushroom valves located in the mouthpiece. They must be checked (visually and functionally) prior to assembling the breathing loop.

WARNING A failed mushroom valve can lead to hypercapnia, and there is no pre-dive check that will detect a failure after the loop has been assembled. A failed, or questionable, mushroom valve MUST be replaced prior to use.

Visually inspect both the inhalation and exhalation mushroom valves, looking for wear or warping. If the mushroom valve appears misshapen in any way, it should be replaced prior to use. After a visual inspection, a functional check for proper gas flow must be performed:

1. With the mouthpiece in the "open" position, tightly cover the exhalation (left) mushroom valve with your hand.
2. Gently exhale through the mouthpiece, listening and feeling for bypass on the inhalation (right) side.
3. If you can hear or feel gas escaping from the inhalation valve, the valve has failed and must be replaced. See general care and maintenance section for instructions for replacement.
4. Repeat the process on inhalation side, except inhale gently against the mouthpiece.

Assemble Breathing Loop

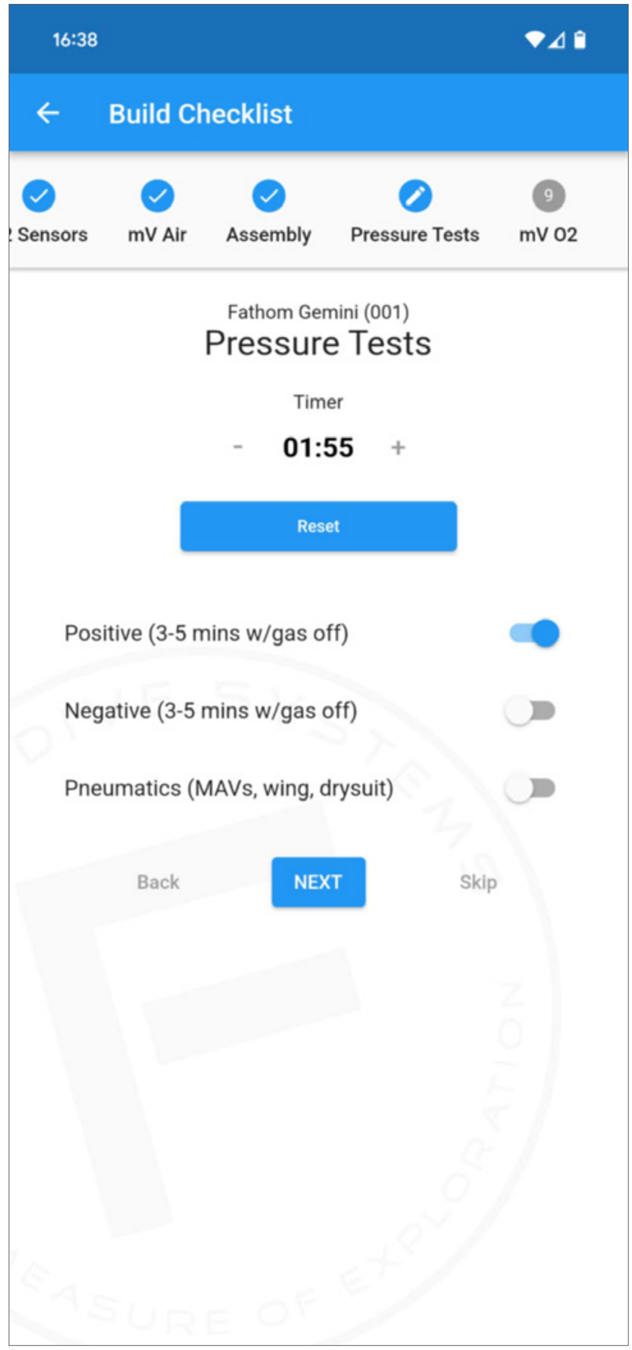
1. Inspect o-rings and lubricate all o-rings seating surfaces.
2. Identify inhalation and exhalation side loop hoses (bayonet fittings which connect to the mouthpiece are keyed differently)
3. Connect loop hoses to inhale and exhale heads, taking care to not cross-thread the fittings
4. Connect loop hoses to mouthpiece.

Install dual MAV

1. Route the hose on the dual MAV through the left shoulder d-ring and connect it to the 110 degree swivel on the exhale head.
2. Bring the 44" hose from the oxygen first stage down through the left shoulder d-ring and connect it to the dual MAV via the bc inflator connection.

Pressure Tests

Prior to diving, the integrity of the breathing loop and high pressure systems must be checked.
If a leak is detected, it must be identified and fixed prior to diving.



Positive Pressure Test

1. Turn all cylinders off and purge all gas out of high pressure components (Oxygen and Diluent MAVs, BOV, etc) to ensure no gas leaks into the loop while conducting the test.
2. Inhale through your nose and exhale into the loop through the mouthpiece repeatedly until the counterlungs are overfilled and close the mouthpiece.
3. Wait three to five minutes and visibly inspect counterlung volume to verify gas has not leaked from the loop.

Negative Pressure Test

1. Turn all cylinders off and purge all gas out of high pressure components (Oxygen and Diluent MAVs, BOV, etc) to ensure no gas leaks into the loop while conducting the test.
2. Open the mouthpiece and inhale through it exhaling out your nose repeatedly until the counterlungs collapse and loop hoses contract.
3. Quickly close the mouthpiece, trapping negative pressure inside the loop.
4. Wait three to five minutes and visibly inspect that the loop hoses have not relaxed, which would indicate a leak in the loop.

Pneumatics Checks

1. Verify all high pressure systems (MAVs, BOV, wing, drysuit) are functioning correctly.

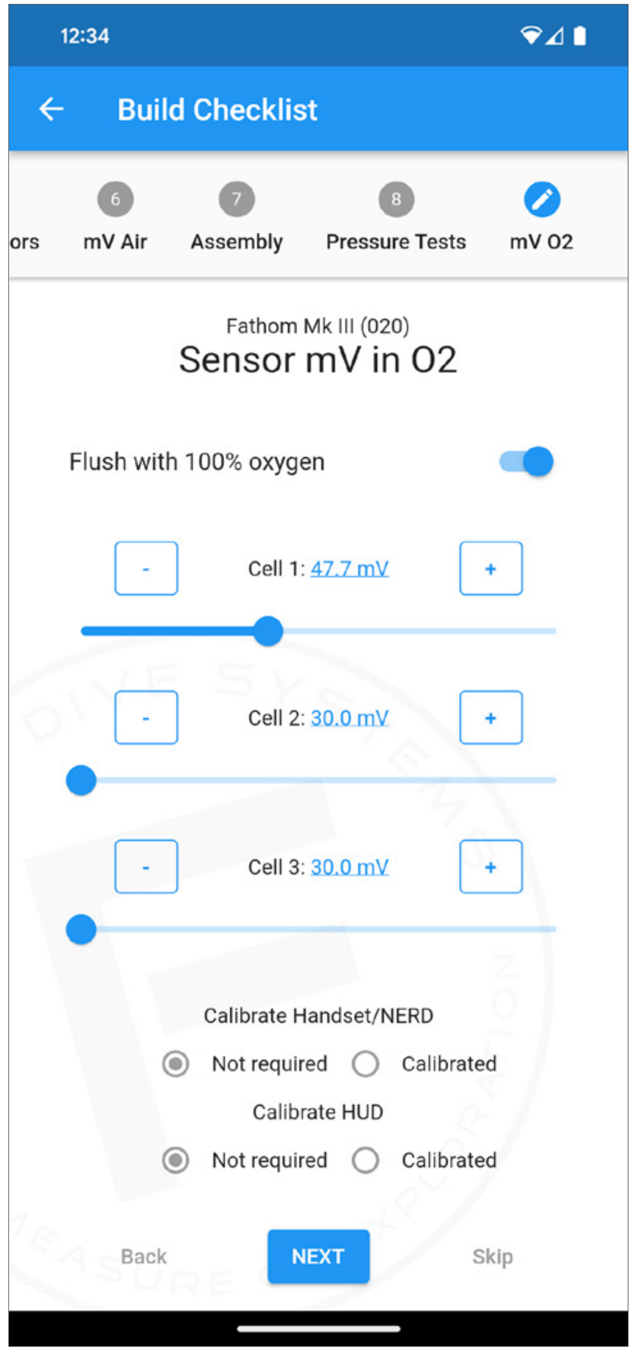
Calibration

While the FATHOM Gemini CCR handset and HUD do not need to be re-calibrated each day, the calibration must be checked to ensure that all sensors are performing correctly. If any sensors' millivolt output has deviated significantly (+/-10%) since the last calibration, or appears to no longer be linear, it should be replaced.

Caution Failure to track sensor health and verify linearity (NOT simply re-calibrating each day), may increase risk of sensor failure mid-dive.

1. Connect an oxygen source to the Diluent MAV via QC-6. The diluent injection occurs in the head, directly over the oxygen sensors
2. Open the mouthpiece.
3. Slowly inject oxygen while watching the handset until PO_2 readings have stabilized. Either verify that all readings are consistent with previous calibration, or if a slight deviation is noticed, recalibrate both handset and HUD (see handset owners manual and FATHOM HUD addendum for specific instructions on calibration).
4. Record millivolt output in oxygen, compare to output in air, verify linearity (air mV/0.21 = expected mV in oxygen).Calibration

While the FATHOM Mk V CCR handset and HUD do not need to be re-calibrated each day, the calibration must be checked to ensure that all sensors are performing correctly. If any sensors' millivolt output has deviated significantly (+/-10%) since the last calibration, or appears to no longer be linear, it should be replaced.



On-Site Checklist

On-site checks should be done at the dive site or on the boat and presumes that some time has passed since the build checklist was completed.

Verify Gas

› Analysis
› Pressures

Pressure Tests

› Positive
› Negative

Pre-dive Checklist

WARNING Pre-dive checks should be completed on the surface, ensuring the unit will sustain life prior to entering the water.

Pre-dive checks should be done immediately before entering the water.

Challenge	Action	Response
Oxygen?	diver activates oxygen MAV	Oxygen on
Diluent?	diver activates diluent MAV	Diluent on
Inflation?	diver activates BC and drysuit inflation	Inflation on
Bailout?	diver breathes from bailout regs	Bailout on
PO_2?	diver verifies PO_2 > 0.7 bar	PO_2 good
Needle valve?	diver sets needle valve and prebreathes for 3–5 minutes.	Needle valve set

WARNING Once pre-dive checks have been completed, DO NOT shut off the oxygen cylinder valve. Doing so has killed many CCR divers.

WARNING Never don a CCR with the oxygen cylinder turned off.

Disassembly and Cleaning

The level of disassembly and cleaning will depend on several factors including whether you plan to dive the next day, whether you need to repack your scrubber, and how many days of diving you've done since the last complete disassembly and cleaning. A complete disassembly and cleaning is recommended if you plan to take one or more days off from diving and at least every time you need to repack your scrubber. Depending on your scrubber size, this could mean as long as three days diving without a complete disassembly and cleaning. Even if you don't do a complete disassembly and cleaning, a few quick cleaning tips are strongly recommended.

Quick Cleaning

1. Remove the line-lock and inhale head from the canister to allow the cells to dry out. Neither the LP hoses or loop hoses need to be disconnected from the head.
2. Remove the line-lock and exhale head from the exhale canister.
3. Pull out the scrubbers to let them dry. Wipe out the canister and any moisture on the head.
4. Disconnect the DSV or BOV from the loop hoses and rinse it with a Steramine solution.
5. Disconnect the exhause loop hose from the exhaust head and pour Steramine solution through the exhaust loop hose.
6. Make the counterlung dump valve the lowest point and dump any water from the counterlung.
7. If Steramine isn't available, use fresh water and rinse several times making sure to dump all the excess water from the counterlung.
8. Leave the head and loop hoses disconnected to dry overnight as long as the unit is protected from the elements, i.e., rain.

Note: do not perform a quick cleaning on a moving boat to avoid damage to the head or salt spray from entering the unit.

Complete Disassembly and Cleaning

The preferred method of cleaning is to fully disassemble the unit and soak the components in a fresh water rinse bin. After a thorough soaking the components are removed, dried with a towel, inspected, and laid out to dry completely.

Loop

Caution The breathing loop and mouthpiece MUST be disinfected regularly. Failure to do so can result in fungal and bacterial growth leading to serious lung infections

DSV/BOV

1. Remove DSV/BOV from breathing hoses and disconnect low pressure hose from BOV (if equipped).
2. Rinse DSV/BOV thoroughly with fresh water in both the open and closed positions to ensure all components have been rinsed.
3. Disinfect the mouthpiece with Steramine.
4. Set aside to dry with the mouthpiece in the open position.

Loop Hoses

1. Remove HUD from HUD holder and unwrap cable from loop hose.
2. Remove loop hoses from heads.
3. Rinse thoroughly with fresh water.
4. Inspect loop hoses and o-rings for damage and clean away any sorb or other residue,
5. Disinfect the loop hoses with Steramine.
6. Drain as much Steramine from the hoses as possible
7. Hang to dry

Counterlung

1. Remove counterlung from the sidemount harness.
2. Rinse thoroughly with fresh water.
3. Disinfect counterlungs with Steramine.
4. Drain as much Steramine from the counterlungs as possible.
5. Hang to dry

Heads

1. Remove the low pressure feed from the exhale head.
2. Remove line-locks and pull the heads out from the canisters.
3. Inspect the head for any salt water intrusion. If evident, remove the oxygen sensors and rinse the head thoroughly with fresh water.
4. Inspect o-rings for damage and clean away any sorb dust or other residue.
5. Dry contacts and re-install oxygen sensors.
6. Set the heads aside to dry.

Canister

1. Remove scrubber baskets from canisters and note the remaining duration of the sorb, or discard sorb if expended.
2. If you are discarding the sorb, clean any residual sorb from the scrubber baskets.
3. Remove scrims and set aside to dry.
4. Rinse any sorb dust or other residue from inside the canister with fresh water.
5. Thoroughly dry the inside of the canister.

Dual MAV

Rinse the exterior of the dual MAV to remove any salt or sand buildup.

Storage

Once the unit has been broken down, cleaned, and thoroughly dried, store in a cool and dry environment until it's time to be assembled for the next dive.

General Care and Maintenance

Other than a bi-annual (every two years) factory service, the FATHOM Gemini CCR requires little additional maintenance. However, certain components should be inspected for wear during unit assembly and disassembly.

Oxygen Sensors

Oxygen sensors must be carefully maintained and performance closely monitored to ensure proper operation.

Storage

Always store sensors in a cool dry place away from extreme temperatures (hot or cold). Avoid transporting sensors in a way that will subject them to shock, as this can easily damage the sensor. Direct sunlight on the head can heat up the sensors and cause them to respond outside their normal range, and if prolonged enough can cause permanent damage.

Monitoring

It is essential to track millivolt readings in both air and oxygen. An expiring sensor will often show a sudden drop millivolt output that will be noticed if you have been keeping track. While this sensor may be within tolerance and calibrate just fine, it is on its way out and should be replaced immediately. You should also check that your cells are performing linearly on a regular basis, and track this performance as well. Cell checkers help with this, as they allow you to check the cell's performance above 1 ATA to identify non-linear behavior at a PO_2 above 1.0.

Replacement

Sensors should be replaced if or when any of the following occurs:

› 12 months after installation.
› Manufacturer's "do not use after" date printed on the sensor is reached.
› Sensor shows signs of deterioration (sudden drop off in millivolt readings, slow response time, non-linear output, etc.).
› Sensor has been physically damaged (dropped, flooded etc.).
› Sensor's millivolts outside the manufacturer's stated minimum (8.5) or maximum (14.0) range.

Be sure to write the installation date on each sensor with a permanent marker. One method is to keep the newest sensor in the #1 sensor position and the oldest in the #3 position. This can be useful information during a dive if one of the sensors starts acting up.

Loop Hoses

Inspect the loop hoses for cracking and general wear and tear, paying special attention to the areas around the fittings and zip ties.

Hose Clamps

Hose clamps can loosen over time, inspect them regularly to ensure they are snug.

DSV

The DSV or BOV requires regular user serviceable maintenance including lubrication and mushroom valve replacement.

Lubrication

The DSV should be lubricated whenever it becomes stiff and is difficult to operate with one hand.
To lubricate the DSV:

1. Remove the inhale side mushroom valve cage with a brass hook.
2. Use a blunt object, like a Sharpie, to push out the exhale side mushroom valve cage.
3. Insert a hex key through the mouthpiece opening and remove the cap head screw that secures the lever.
4. Push out the DSV barrel.
5. Inspect the barrel o-rings and lubricate the barrel with Molykote silicone grease.
6. Lubricate the inside of the DSV body.
7. Reinstall the barrel and secure the lever with the cap head screw.
8. Replace the mushroom valves as needed and reinstall the valve cages taking care to install them in the correct orientation.
9. After reassembly, be sure to perform a flow check on the DSV.

Mushroom Valve Replacement

Mushroom valves should be replaced whenever a valve appears worn or fails the flow direction test. To replace a mushroom valve:

1. Remove breathing hoses from the mouthpiece.
2. Use an a brass hook to carefully pull the mushroom valve cage out of the DSV/BOV.
3. Pull the mushroom valve out of the cage.
4. Inspect, clean and lubricate the mushroom valve cage as necessary.
5. Install a new mushroom valve by carefully pushing the nipple through the hole in the center of the cage and pulling through from the other side.
6. Re-install the mushroom valve cages and verify flow direction by conducting flow direction tests.

BOV Second Stage Service

The second stage components should be serviced by a qualified technician bi-annually or whenever there is an issue. The second stage internal components are standard Apeks brand and can be serviced by any qualified Apeks technician.

Spares Kit

Having spare parts on hand will always be helpful and may very well save a dive. Suggested items to include are:

- Oxygen sensor
- O-ring kit
- Mushroom valve
- Loop hose
- BC inflator cartridge for MAV
- SAFT LS14250 battery for HUD
- AA lithium battery for Shearwater handset
- Mouthpiece

Factory Service

The following services should be performed at least every two years:

- Replace all o-rings
- Replace DSV/BOV mushroom valves
- Clean and service DSV/BOV
- Clean and service oxygen regulator
- Clean and service dual MAV

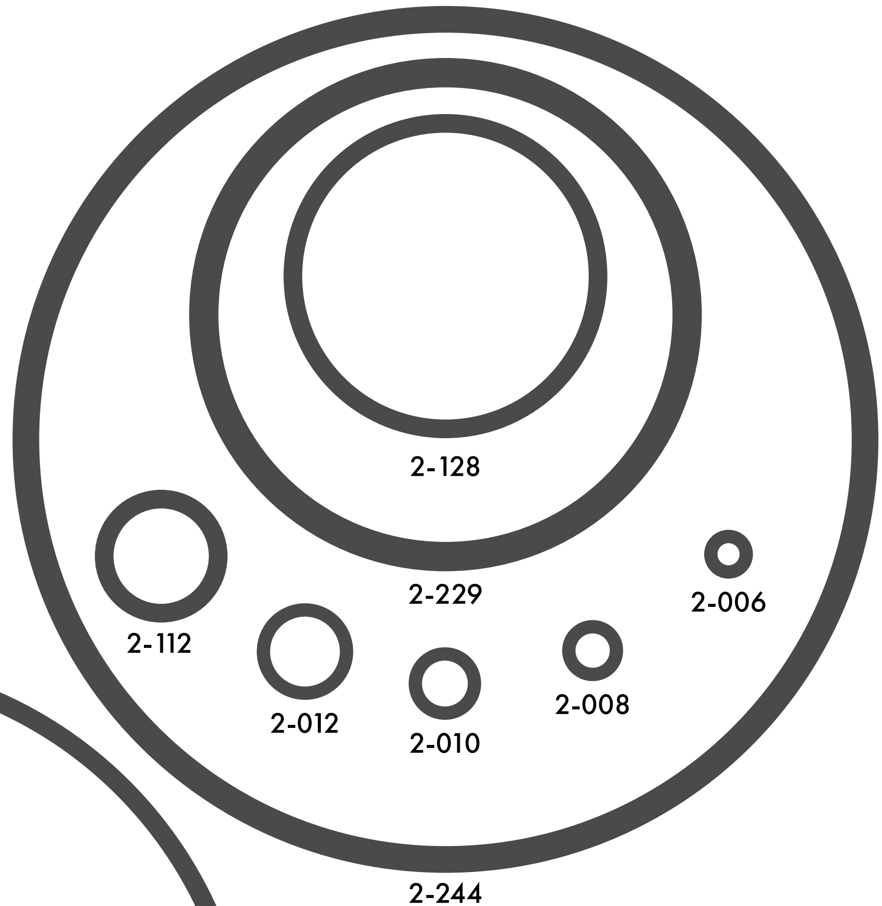
Technical Specifications

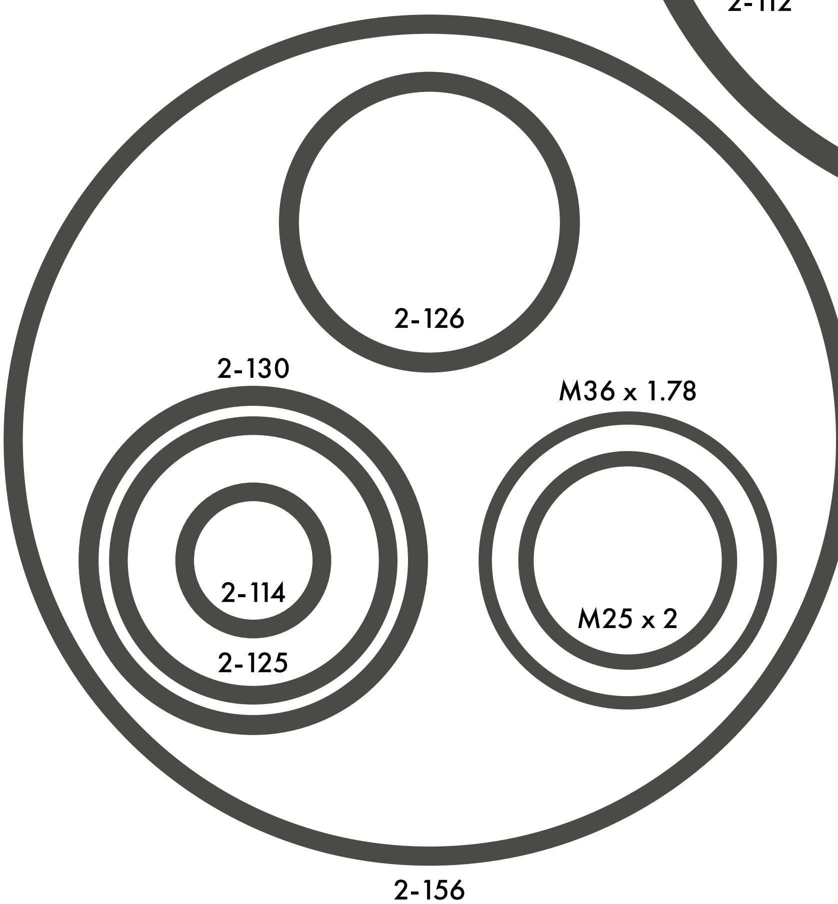
- Weight: 22 lb/10 kg without cylinders or scrubber material
- Dimensions: 5 in/13 cm dia. x 13 in/33 cm tall
- Recommended maximum depth: 330 fsw (100 msw)
- Scrubber duration: ~5 hrs @ 0.7 cfm/20 lpm breathing rate.

Appendix

A. Gemini CCR O-ring Kit
B. DSV O-ring Kit
C. Periodic Checklist
D. Build Checklist
E. On-site Checklist
F. Pre-dive Checklist

FATHOM DIVE SYSTEMS Gemini Gen2 CCR O-Ring Kit

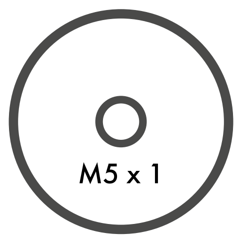




*All O-Rings are Viton FKM

Quantity	Size	Durometer	Application
4	2-006	90	MAV Inflator Cartridges
1	2-008	75	Needle Valve
1	2-010	75	Needle Valve
2	2-012	90	MAV Inflator Cartridges
2	2-112	90	MAV Inflator Cartridges
1	2-114	75	HUD Holder
4	2-125	75	Counterlung Barbs
6	2-126	75	(4) Head Bayonet Barbs, (2) Head Bayonet/Battery Cover
1	2-128	75	Head Bayonet
2	2-130	75	Counterlung Barb Seats
2	2-156	75	Scrubber Baskets
2	2-229	75	Counterlung Ports
8	2-244	75	(4) Heads, (4) Bottoms
1	M25 x 2	75	Oxygen Regulator Cap
2	M36 x 1.78	75	BOV/DSV Bayonet Barbs

DSV O-Ring Kit



2-023

*All O-Rings are Viton FKM

Quantity	Size	Durometer	Application
1	M5 x 1	75	DSV Lever
3	2-023	75	DSV Barrel

FATHOM DIVE SYSTEMS LLC | info@fathomdive.com | www.fathomdive.com
4113 NW 6th St, Suite A, Gainesville, FL 32609 | +1 352 213 8486

FATHOM CCR **PERIODIC CHECKLIST**

FATHOM DIVE SYSTEMS

FATHOM CCR **PERIODIC CHECKLIST**					
Oxygen first stage IP (205 - 290 psi/14 - 20 bar)					psi/bar
Oxygen MAV min flow (< 0.1 lpm)					initial
OXYGEN SENSORS					
Record Air mV (8.5 - 14 mV) on table and do initial math					initial
Flush with 100% oxygen					initial
Calibrate handset and HUD					initial
Record oxygen mV @ 1 ata					initial
Increase pressure to 2 ata (14.7 psi/1 bar) and record mV					initial
Evaluate for linearity and current limiting (<10% deviation)					initial
Cell	**Air @ 1 ata**	**/0.21**	**wx 2**	**O_2 @ 1 ata**	**O_2 @ 2 ata**
1	mV	mV	mV	mV	mV
2	mV	mV	mV	mV	mV
3	mV	mV	mV	mV	mV

Date

FATHOM DIVE SYSTEMS FATHOM CCR **BUILD CHECKLIST**

FATHOM CCR **BUILD CHECKLIST**			
CONSUMABLES			
Fill and analyze oxygen		psi/bar	O_2 %
Fill and analyze diluent		psi/bar	O_2/He %
Remaining scrubber duration			min
Handset battery			volt
HUD battery			volt
OXYGEN SENSORS			
O_2 cells < 1 year	mm/yy	mm/yy	mm/yy
Record Air mV (8.5 - 14 mV) on table and do initial math			initial
Cell	**Air @ 1 ata**	**/0.21**	**O_2 @ 1 ata**
1	mV	mV	mV
2	mV	mV	mV
3	mV	mV	mV
ASSEMBLY			
Insert scrubber, spacer, and chammies			initial
Inspect head o-rings (4 total)			initial
Install head w/line-lock			initial
Mount onboard cylinders			initial
Attach wing, counterlungs, & backplate			initial
Flow test BOV/DSV mushroom valves			initial
Assemble breathing loop, MAVs, & regs			initial
PRESSURE TESTS			
Positive (3-5 min w/gas off)			initial
Negative (3-5 min w/gas off)			initial
Pneumatics (MAVs, wing, drysuit)			initial
CALIBRATION			
Flush with 100% oxygen			initial
Record oxygen mV @ 1 ata			initial
Evaluate for linearity and current limiting (<10% deviation)			initial
Calibrate handset and HUD (if required)			initial

Date

FATHOM DIVE SYSTEMS
THE MEASURE OF EXPLORATION

FATHOM DIVE SYSTEMS LLC

4113 NW 6th St, Suite A, Gainesville, FL 32609

+1 352 213 8486

info@fathomdive.com
www.fathomdive.com