



# COPIST™ 2 OPERATIONAL INSTRUCTIONS (v. 1.0)

26 October 2007

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## Conventions

The various menus, commands and other screen information described in this manual are **CAPS BOLD** and truncated just as they appear on the actual menu screens for the sake of clarity. Conditions that could effect the safety of the diver are called out in **RED BOLD** to facilitate proper warning of potentially hazardous conditions. Closed Circuit Rebreathers artificially manipulate the divers breathing environment which creates the potential for injury and death if the apparatus is not properly assembled, tested, and calibrated. Divers certified on previous releases of COPIS™ 2 are strongly advised to study this manual carefully and consult with an ISC approved instructor prior to using this release.

## Introduction

The ISC **C**onstant **O**xxygen **P**ressure **I**njection **S**ystem (COPIS™ 2) is a family of Manual Closed Circuit Rebreathers (mCCR) designed to be used in a variety of diving roles to fit the operational needs of the end user. The COPIS™ 2 family is designed to be used in recreational / technical roles providing reliable, user friendly operation with room for ISC factory customization to further meet the end users needs. The COPIS™ 2 has a simple self intuitive menu and confirm system and essential information dive screen that minimizes the task loading of the diver by providing a “quick look” ability of essential information. Version 1.0 is the latest general release of the software and also incorporates significant changes to the electronics hardware and wiring.

COPIS™ 2 offers a significant upgrade in electronics affording the diver more information such as sensor millivolts, battery voltage, water temperature, and loop temperature, and advanced calibration options as well as an integrated Heads Up Display (HUD).

**NOTE: Both display and HUD share a common controller card. Redundancy is achieved via an optional 4<sup>th</sup> cell configuration.**



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## Basic Functions/Features

- Simple self intuitive two button menu and confirm system.
- Operational time is dependant on diver's use of backlight, ambient temperature, battery make, age of battery, and diver use.. Using the Alkaline AA battery packs, experience varies at 50-100 operational hours.
- Tertiary redundant oxygen sensor system
- 3 sensor independent window.
- Voting logic indicator. Indicates what specific sensor is out of tolerance at that moment. (A sensor that may become disconnected or completely fail, the COPIS™ 2 will still average and maintain the current set point.)
- Breathing loop temp. (Monitors breathing loop temp that the diver is breathing)
- Ambient water temp.
- Bilinear 2 point calibration system. (For accurate high and low point PO2 information).
- High Altitude Oxygen Sensor Calibration (Both Metric [meters] and Imperial [feet] altitudes).
- Sensor MV indicator. (Gives sensor output (Millivolts) on the fly to the diver in real time. This will indicate to the diver the health of the sensors and voting logic validation).
- Low battery indicators. **LOW BATT** annotation will appear blinking at 5.2 volts, with the auto disabling of the display backlight further indicating to the diver a low power situation for the primary electronics system.
- **BATTERY** no-load/load indicator. (Indicates to the diver the health of the power supply while under a load from the solenoid)
- **BACK LIGHT** enable/disable option.
- **KEEP BACK LITE ON** enable/disable option
- **DISPLAY POWER** option enable/disable option
- System status: It is the heart beat indicating to the diver that the electronics have not locked up and are functioning.
- No wet sensors.
- Two minute start up timeout for calibration, and altitude PO2 adjustment.

The Megalodon strengths come from a practical approach based off of designer experience and the application of design principles that closely follows function leading to form. Regarding the functions of the COPIS™ 2 electronics, it is encouraged that the diver feels free to punch the buttons on the handsets to see what they do, starting with the **Menu/Confirm** buttons.



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**DANGER!** The Megalodon operates by using batteries, the diver must insure that the batteries are fresh enough to conduct the planned diving operation or the batteries must be replaced if they are in question on reliability. Also, the power switch must be turned on prior to the diving operation. Maximum power is 10.0 volts, and minimum power is 5.2 under load volts. See pre dive check sheet.

## COPIS™ 2 Operating Instructions

Power on the battery box power switch inside the Megalodon head lid. Notice on the handset the opening screen on the display. The opening screen is the ISC logo with the version of the software.

### Handset

The main operational page screen will be the diver's primary information on the current status based on operational priorities. The main page displays **S1**, **S2**, and **S3**, each sensor is depicted so the diver may observe sensor status. The diver at any time may observe an inverse video around one of the depicted sensors, if this is observed, the voting logic is voting out the sensor and continuing the averaging of the two remaining sensors. The COPIS™ 2 will self correct if the problem is temporary, if the sensor has failed or connection is broken the diver must abort the dive and exit the water as soon as possible observing the display and being prepared to conduct an immediate action procedure (IAP).

**System Status Indicator:** The **SSI** is the "heart beat" of the COPIS™ 2 and is indicating the operational status of the electronics, the heartbeat (- & | + characters) is visible on every screen.

**WARNING!** If for any reason the diver observes one single character instead of changing characters the COPIS™ 2 has "Locked up" and the system has failed, the diver will have to use the 4<sup>th</sup> cell (optional) display to fly the COPIS OR switch to bailout gas and the diver must exit the water as soon as possible and use IAP when necessary.

**MENU/CONFIRM:** Press the Menu button of the handset and scroll through the menu options, the diver will see the following; **SYSTEM MONITOR**, **TEMPERATURE**, **BL ENBL/DISBL**, **KEEP BACKLITE ON**, **DISPLAY POWERSAVE**, **HUD ENBLE/DISABL/TEST**, **HUD BRIGHT/DIM**, **METRIC/IMPERIAL**, **CALIBRATE**, **SET OXYGEN PERCENT**, **ALTITUDE**. Two



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minutes after power on the **METRIC/IMPERIAL**, **CALIBRATE**, **SET OXYGEN PERCENT** and **ALTITUDE** menus will be unavailable. The diver may select an option from the menu and press the **CONFIRM** button and see the option lock into place into a submenu or some operational information the diver may want to see.

**WARNING!** It is imperative that the diver **NOT** enter the water within two minutes of power on to avoid the inadvertent selection of inappropriate options.

The Diver at any time may leave the selected option by making a selected operational change to the COPIS™ 2 or the system will time out in 5 seconds and go back to the main diving informational screen.

**WARNING!** The diver must ensure that they have a breathable PO2 at all times and maintain the planned PO2 to support the planned decompression.

Other considerations are **Oxygen CNS toxicity** and **Whole body Oxygen toxicity**, the planned PO2 must insure that all oxygen hazards are avoided by prudent CCR diving practices.

**SYSTEM MONITOR:** The first menu option is the **SYSTEM MONITOR**. The **SYSTEM MONITOR** page is the diagnoses page for the Megalodon. The diver may access **SYSTEM MONITOR** during the dive to monitor the sensor mv (sensor millivolts) and the **BATTERY: NORM** voltage. The **NORM** battery indicator shows the drop in voltage when there is no load on the battery.

**WARNING!** The lower limit is 5.2 volts and the diver must replace the battery!

The maximum indication is 10.0 volts. Early low battery indicators are the failure of the backlight to turn on when a button is pushed to see the display in low light conditions, a second indicator is the **LOW BATT** indicator flashing on the handset main page and on the **BL ENABLE** page, the **KEEP BACKLITE ON** setting will be ignored in this state.

**DANGER!** Terminate the dive as soon as practical considering decompression and other operational factors. Low battery condition warrants the battery to be replaced prior to the next dive!



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The sensor mv is an indicator of sensor degradation (health), the diver may see how the sensor is performing at all times during the pre-dive, dive, and post-dive, operations. The diver should record the information on the pre-dive/post-dive check sheet to monitor sensor life and performance over time. Normal sensor mv is 8 to 13.5 in air at sea level, 25°C. Sensor mv output will be less at higher elevations and or lower temperatures. It is a prudent habit to record the sensor mv at various set points during the dive and to do comparison check on later dives.

**TEMPERATURE:** The temperature sensors monitor the ambient water or air temperature and the breathing loop temperature.

**BL ENBL/DISBL:** The back light may be disabled at any time by the diver and maintain that setting for as long as the diver wishes. To disable the backlight the diver must access the option to **BL ENBL/DISBL** and push the menu button to **ENABLE** or **DISABLE** and push the **CONFIRM** button to lock in the selection.

**NOTE: The back light low battery indicator will also be disabled if the BL DISBL option is selected.**

**KEEP BACKLITE ON:** This option will force the back light to remain illuminated continuously while the system is powered on. It is ignored in the event of a low battery condition as described above and if the option is enabled the **DISPLAY POWERSAVE** option will be ignored. This options defaults to disabled anytime the system power is cycled.

**DISPLAY POWERSAVE:** When enabled under normal operating conditions (**KEEP BACKLITE ON / DISABLED**) the handset unit will “go blank” after ten minutes of inactivity (no button pushes) This option is ignored if **KEEP BACKLITE ON** is set to **ENABLE**.

With the above three options the diver has great flexibility with which to manage power and handset readability.

**WARNING! It is the diver's responsibility to monitor and maintain a safe PO2 at all times, and to monitor the rate of change of PO2 especially during times of high workload, descents and ascents! COMPLANCY KILLS!**

The COPIS™ 2 display will time out of all menus automatically after five seconds of in-activity and also fall asleep in surface or dive mode after approximately ten minutes (if **DISPLAY POWERSAVE** is enabled) to save power but will act as a



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sentinel monitoring the operating systems. At any time below or above the water the display may be accessed by pushing any button on the display desired as long as the power supply is on. It is very convenient to push the out board button on the handset to quickly access the front screen page for PO2 status.

**Settings:** The COPIS™ 2 may be configured for **CALIBRATION**, **IMPERIAL/METRIC**, **SET OXYGEN PERCENT** and **ALTITUDE** settings. These menus may only be accessed within a two minute time frame from turning the power on during the pre dive procedures; this is to prevent the diver from creating a hazardous condition during the dive. At anytime during the pre dive the diver may reset the two minute window by turning the power off and turning the power on again. These menus will be discussed at the end of this manual.

**Warning: At no time should the diver enter the water within the two minute time frame of turning the power on.**



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## HUD Operation

The HUD displays the 3 individual sensors by color and number of blinks. The diver may at any time turn off or test the HUD especially after the dive to save battery power and may turn it back on at any time by utilizing the **HUD ENBLE/DISABL/TEST** menu screen. The HUD brightness may also be adjusted to bright and dim utilizing the **HUD BRIGHT/DIM** menu screen. The dim may be used for when there is no ambient light and the bright may be too bright. The dim does not save any more power as the bright; in fact it uses more power.

The HUD is a powerful indicator to you and your buddy or student, at any time the buddy/instructor can see what you/buddy/student are breathing and the condition of each sensor by looking at the color and number of blinks.

The following is a brief explanation of the HUD color and number system.

Color	PO2	Blinks	Condition
Red	<0.40	1 long	Preliminary alert to a <b>HYPOXIC</b> loop.
Red	0.5	5 Short	Ambient air.
Red	0.6	4 Short	
Red	0.7	3 Short	
Red	0.9	1 Short	
Orange	1.0	1 Short	Post calibration on O2
Green	1.1	1 Short	
Green	1.2	2 Short	
Green	1.3	3 Short	
Green	1.4	4 Short	
Green	>1.5	1 Long	Preliminary alert to <b>HYPEROXIC</b> loop.

**Example:** During the dive the diver has a set point of 1.2, the diver will observe the following on the HUD, Sensor 1, green blink blink, pause, Sensor 2, green blink blink, pause, Sensor 3, green blink blink, long pause and back to Sensor one again.

Note: The system is very simple and is more complex to explain then to interpret.

**METRIC/IMPERIAL:** The **METRIC/IMPERIAL** menu allows the diver to choose between metric and imperial units of measurement. This screen is only available for the first two minutes after power on.



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## Calibration Procedures

The COPIS™ 2 is a two point calibration system with high altitude oxygen sensor adjustment. It is imperative that both the **MAXIMUM OXYGEN** and **ALTITUDE** are properly set prior to calibration. This system allows the diver to set the PO2 level based on the diver's altitude zone at time of calibration, the altitude ceiling is 14,700 feet (4,481m) at PO2 of 0.12 ata. The COPIS™ 2 also has a sensor millivolt output indicator displaying on both handsets during high point calibration procedures to aid the diver in a proper loop flush. The first point of calibration is ambient air and the second point is maximum oxygen. To best perform the calibration procedure, follow the pre dive check sheet and these instructions. When you select the calibration menu the first screen also displays the percentage of oxygen used for the highpoint and the altitude used for calibration. This will normally be 100% and 000 when used with pure oxygen and the Head Only Calibration Kit at sea level. Ensure this is set correctly. It may be adjusted via the **SET OXYGEN PERCENTAGE** menu.

**SET OXYGEN PERCENTAGE:** Adds the ability of selecting the calibration oxygen quality percentage from 70-100%. This allows the user to safely use oxygen of limited purity. This selection, like **CALIBRATE**, is only available within the first two minutes after powering on the system. To enter the oxygen quality menu, depress the **MENU** button until the "**SET OXYGEN PERCENT**" is displayed. It displays the current percentage the system has in its menu from recent or previous settings of this entry. Selecting the **CONFIRM** button enters this function. The user can decrement the current percentage to the next lower percentage, having a range from 70% to 100%. Stepping beyond 100 decreases the percentage in increments of one percent per button push i.e. 99, 98, 97 etc. There is a feature of the switch hits called a long switch which is used for making large changes in the percentage. A long switch is holding the switch for greater than two seconds. The **MENU** long switch has the effect here of subtracting ten percent from the current setting, allowing the user quicker setting of the desired oxygen percentage. We recommend watching the "heartbeat" character in the lower right corner of the display screen for the third character change, indicating approximately three seconds have passed, before releasing the switch to decrement by ten percent. This oxygen percentage is only used during the **CALIBRATE** mode to provide proper parameters for the determination of the mathematical formula later used in displaying the setpoint of each oxygen sensor during operation (i.e. sensor millivolt output vs. PO2 display calculations). It is highly recommended that the diver use an oxygen analyzer to determine the quality of the oxygen in the O2 cylinder used during calibration.



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## KNOW YOUR OXYGEN QUALITY!

One question frequently asked is “Will the oxygen percentage affect my PO<sub>2</sub> during the dive?” The answer is no. Once breathing from the loop, the partial pressure of oxygen in the mix you are breathing will be displayed on the handsets and HUD as that PO<sub>2</sub>. A low oxygen percentage results in more of the oxygen gas mix to be used up faster since the other gasses are treated as part of the diluent gas. The oxygen percentage setting is only used during calibration. The diver doesn’t need to recalibrate for each oxygen percentage change when changing oxygen sources.

**WARNING! IF THE OXYGEN PERCENTAGE IS SET INCORRECTLY THE UNIT WILL NOT CALIBRATE CORRECTLY RESULTING IN A POTENTIALLY LETHAL CONDITION!**

The **MAXIMUM OXYGEN** set point submenu has checks to attempt to prevent the user from selecting the maximum O<sub>2</sub> while the sensors are still exposed to ambient air. The effect is the **CONFIRM** switch is ignored until the system reads a millivolt reading on all three sensors exceeding 20 mv. Pushing the confirm button several times with no action should alert the user to read the millivolt output readings on that page of the display to determine that the oxygen level is not high enough for the HiPO<sub>2</sub> point. Many users have accidentally hit the confirm button for the air point calibration too many times and resulted in having to restart the entire calibration procedure needlessly. ISC recommends the user become familiar with the millivolt readings of the three oxygen sensors at various PO<sub>2</sub>s (in air, calibration gas, and at depth) to familiarize the healthy outputs of the sensors for later real-time analysis during a dive of the health of a suspected bad sensor. Becoming familiar with the normal voltage readings of each sensor at the normal set point used will assist in analyzing sensor behavior and add another tool for potential problem analysis during a dive, should the need arise, and during sensor calibration.

Next it is essential to ensure that the altitude is set correctly to provide accurate data for calibration. The calibration altitude can be seen on the **CALIBRATE** menu screen. If the diver needs to change the altitude it is accomplished by means of the **ALTITUDE** menu. Altitude calibration is accomplished by utilizing zones. Altitude selection is only used to effect the calibration adjustments and only needs to be set prior to calibration if the altitude has changed.

Altitude zone selections: The altitude submenu section of the sensor calibration has been enhanced to provide a High PO<sub>2</sub> limit. ISC has implemented an ambient air PO<sub>2</sub> for the low point calibration along with the Maximum O<sub>2</sub> PO<sub>2</sub> for



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the high point. The oxygen quality percentage is used to adjust the new high point PO<sub>2</sub> to properly represent the calibration maximum oxygen PO<sub>2</sub> for the selected altitude zone. This adjusted low and high point is displayed on the altitude menu during calibration and changes with each altitude zone selection. Altitude Zone selections during sensor calibration of both the primary and secondary subsystems are accomplished as follows:

1. Enter **ALTITUDE** menu within two minutes of power on.
2. Answer **CONFIRM** to “**ARE YOU SURE?**” and “**ARE YOU REALLY SURE?**”. **CALIBRATE ALTITUDE** submenu is displayed.
3. Initial display shows “**Current O2 = .21**”. This is the current setting as last calibrated.
4. Prompt line initially asks > 000 FT and shows = (the current PO<sub>2</sub>)....(current **MAX OXYGEN** setting) i.e. .21 .... 100.
5. The **MENU** button becomes **SELECT** in this submenu. **SELECT** increments to the next altitude zone. The bottom point in the zone represents the HiPO<sub>2</sub> result as just described.

Example, 100%O<sub>2</sub>, altitude is 6,500 feet. LoPO<sub>2</sub>=0.17, HiPO<sub>2</sub>=0.81 (.77x1.00).

The altitude menu calculates the high point PO<sub>2</sub> to be the HiPo<sub>2</sub> at 100% oxygen times the oxygen percentage currently set in the **MAX OXYGEN** menu and displays the result as the HiPo<sub>2</sub> as the diver selects the appropriate altitude zone.



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The following table illustrates the permissible altitude zones.

Altitude Zone in FEET (Meters)	LoPO2 in AIR	HiPO2 at 100% Oxygen
> 0 (0)	0.21	0.99
> 1,200 (380)	0.20	0.96
> 2,700 (840)	0.19	0.90
> 4,200 (1300)	0.18	0.86
> 5,700 (1750)	0.17	0.81
> 7,200 (2210)	0.16	0.76
> 9,000 (2740)	0.15	0.71
> 10,700 (3280)	0.14	0.67
> 12,700 (3890)	0.13	0.62
> 14,700 (4500)	0.12	0.57

Selecting the **CONFIRM** button at this point locks in the selected altitude zone for this calibration, and displays **ALTITUDE SAVED** then returns to the main screen. Once the altitude is set and the O2 percentage has been correctly selected, the user can then proceed with calibration.

Once calibrated, the breathing mix PO2s should properly display regardless of current altitude.

**WARNING! Prior to accomplishing the low point calibration the diver should remove the sensor carriage lid and ensure the sensors are properly aired in ambient air.**

During the pre dive check of the Megalodon the checklist will tell you to conduct the air point calibration. After turning the power on, the diver will scroll through the handset's menu and push the confirm button when the option is found. On the handset you will see the following after selecting the calibration option: **CALIBRATE**, and above that, it will ask "**ARE YOU REALLY SURE?**" You will see a **YES** or **NO** and you may push yes to go on or no to cancel. At this point of calibration you have just completed the calibration for air and the two minute time out is on hold for you to complete the next phase of calibration. The millivolts of each sensor are actively updated in real time on this screen.

There are two methods of high point calibration, the loop flush method and the Head Only Calibration Kit (preferred).



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## Loop Flush High Point Calibration

1. Perform all Pre-dive check procedures up to the step “Complete calibration if necessary”. To complete calibration, all performance checks prior to this need to be completed. Insure that negative pressure check step was good and apply another vacuum to the loop sucking all the ambient air out of the loop. Next, close the vent valve on the exhaust counterlung and fill the loop with 100% Oxygen until the vent valve vents gas. Let set for 10 seconds.
2. Vacuum the loop again and fill again until the vent valve vents and repeat above.
3. Open the vent valve all the way and tightly pinch the exhaust breathing hose to isolate the exhaust counterlung from the oxygen bypass on the inhalation counterlung.
4. Push the oxygen manual bypass for 3 seconds; this will blow 100% oxygen over the sensors without increasing the loop pressure giving a possible higher PO2 reading.
5. Repeat 4 above.
6. Repeat 4 again.
7. You now have a purged loop with nearly 100% Oxygen. You will observe the sensor millivolt output in both displays and the normal output is in the zone of 35 to 60 millivolts.

**Note: The lower the sensor mv output at both points of calibration the lower the sensor mv reading. Beware that the sensor is reaching its end of useful life.**

8. Push the **Yes** button on the displays and you have finished the two point calibration.



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## Head Only Calibration Kit

The optional Head Only Calibration Kit offers the distinct advantages of a more accurate gas environment for the sensors, is quicker, and uses less oxygen than the loop flush method.

1. Perform all Pre-dive check procedures up to the step “Complete calibration if necessary”. To complete calibration, all performance checks prior to this need to be completed. Your oxygen tank should be analyzed at this point.
2. Disconnect the quick disconnect O2 fitting from the manual O2 add valve on the inhale counterlung.
3. Insert the male plug from the kit to the center hose mount base on the head (inhale hose mount). Insert hose with flow restrictor into male plug and snap the other end of the hose (flow restrictor) into the LP Oxygen hose fitting.
4. Connect female cap from the kit to the male fitting on the bottom of the head. Insert hose about 3/4” into the female cap. Connect other end to oxygen analyzer.
5. Turn on oxygen bottle and observe the mv display on the handset and the PO2 reading on the analyzer.
6. Once the mv reading has stabilized at the highest reading obtainable and the analyzer reading matches the value obtained when you analyzed the O2 cylinder press the **CONFIRM** button and the highpoint calibration is complete.
7. Repeat the steps above for the remaining handset.

**DANGER! The diver at all times must be aware of the proper operation of the system. The display system is programmed to go to sleep for power conservation after 10 minutes of inactivity (i.e. no switch hits) during the dive until reawaked. Depressing the CONFIRM or MENU switch awakens the subsystem and this inactivity timeout will restart. While the displays are asleep sensor voting logic and all other essential processing continues in the background.**



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## REVISION INDEX

Date	Revision	CHANGES
26 October 2007	NEW	