



# APECS™ OPERATIONAL INSTRUCTIONS (v. 2.5)

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# APECS™ OPERATIONAL INSTRUCTIONS (v. 2.5)

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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 APECS™ are strongly advised to study this manual carefully and consult with an ISC approved instructor prior to using this release.

## Introduction

The ISC **Advanced Personal Environmental Controller System** (APECS™) is a family of CCR electronics designed to be used in a variety of diving roles to fit the operational needs of the end user. The APECS™ family is designed to be used in saturation, military, and recreational roles providing reliable, user friendly operation with room for ISC factory customization to further meet the end users needs. The APECS™ 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 and the ability to quickly change on the fly operational changes to the breathing media. Version 2.5 is the latest general release of the software and also incorporates significant changes to the electronics hardware and wiring. To help insure the continued viability of previous APECS™ 2.X systems ISC is also releasing APECS™ 2.06 which is compatible with most of the previous hardware versions and incorporates the software features of APECS™ 2.5.



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## Basic Functions/Features

- Simple self intuitive two button menu and confirm system.
- Independent isolated display system with pressure/gas resistant cabling.
- Independent pressure/water proofed primary and secondary electronics and power supplies.
- Jaksa power efficient automatic oxygen addition 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 with the Primary, usually 25-50 hours, then for the secondary subsystem at 50-100 operational hours.
- Average PO2 window. (**Bold annotation on display**)
- Tertiary redundant oxygen sensor system
- 3 sensor independent window.
- Voting logic automatic oxygen addition system.
- Voting logic indicator. Indicates what specific sensor is out of tolerance at that moment. (A sensor that may become disconnected or completely fail, the APECS™ will still average and maintain the current set point.)
- Current set point window.
- Breathing loop temp. (Monitors breathing loop temp that the diver is breathing)
- Ambient water temp.
- Set points selectable on the fly: Manual mode (0.20), 0.4, 0.7, 1.0, 1.1, 1.2, 1.3, 1.4, and ASP.
- 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).
- Version 2.06 for the older hardware provides a "snapshot" of the millivolt readings on the system as part of the **SYSTEM MONITOR** menu.
- 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



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- System status: It is the heart beat indicating to the diver that the electronics have not locked up and are functioning.
- Selectable oxygen dosage. May be adjusted on the fly to allow user to set to personal settings according to work effort and depth of dive, this may be used to minimize oxygen spikes. This is accomplished in two ways, by the Adaptive Injection Algorithm which controls the amount of time the solenoid is open and by the user selectable oxygen off time menu which increments in intervals of 4, 5, 6, 7, and 8 seconds off.
- 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 APECS™ 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.

**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 switches 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.**

## APECS™ Operating Instructions

Power on the battery box power switches inside the Megalodon head lid. Notice on the handsets the opening screen to both the Primary and Secondary displays. The opening screen is the ISC logo with the version of electronics and description of the individual display.

### Primary Handset

The main operational page screen will be the diver's primary information on the current status based on operational priorities. In bold letters will be **AVG**. The **AVG** is the average PO2 based off of the 3 sensors and the voting logic system. The **AVG** is what you want to observe primarily for decompression reasons and to see how close you are to your desired set point. Below the bold **AVG** is **S1**, **S2**, and **S3**, each sensor is depicted so the diver may observe sensor status. The diver at any time may observe a 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 APECS™ will self correct if the problem is temporary, if the sensor has failed or



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connection is broken the diver must abort the dive and exit the water as soon as possible observing both displays and being prepared to conduct an immediate action procedure (IAP).

**System Status Indicator:** The **SSI** is the “heart beat” of the APECS™ and is indicating the operational status of the electronics, the heartbeat (- & | + characters) is visible on every screen. The main page (PO2 Display) has an additional indicator (\*) which when present indicates the solenoid is firing (the diver should also be able to hear the solenoid fire).

**WARNING!** If for any reason the diver observes one single character instead of changing characters the APECS™ has “Locked up” and the primary system operating the solenoid has failed, the diver will have to use the secondary display / HUD to fly the Meg manually and the diver must exit the water as soon as possible and use IAP when necessary.

**MENU/CONFIRM:** Press the Menu button of the primary hand set and scroll through the menu options, the diver will see the following; **CHANGE SP? SYSTEM MONITOR, TEMPERATURE, OXY INJECT, BL ENBL/DISBL, KEEP BACKLITE ON, DISPLAY POWERSAVE, METRIC/IMPERIAL, CALIBRATE, SET OXYGEN PERCENT, ALTITUDE, MAX SET POINT.** Two 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 APECS™ or the system will time out in 5 seconds and go back to the main diving informational screen.

Note: The activation of any of the buttons on the primary display will deactivate the solenoid for 5 seconds. This is used for a possible reset of a failed solenoid in the open or closed position.

**WARNING!** Always insure that you have a breathable P02 in the loop, and set point that will also support your planned decompression.

**CHANGE SP?:** Set point selection is accessed from this option by pushing the **MENU** button to “**CHANGE SP?**” Push the **CONFIRM** button to lock in the option. The diver will see the first of the set points that can be locked in with the **CONFIRM** button. The first set point is **MAN.** **Man** stands for manual. The



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manual set point is an artificial set point of 0.20 and attempts to maintain a loop PO2 of .20 (Air) at all times. The desired use is for swimming pool training, surface swimming while breathing on the loop to avoid hypoxia, and for pre-diving the Megalodon to avoid wasting oxygen through solenoid injection.

**Set Points:** The diver has the following set points that may be set on the fly during the dive, or preset prior to entering the water; **MAN, 0.4, 0.7, 1.0, 1.1, 1.2, 1.3, 1.4,** and **ASP**. **ASP** stands for Auto Set Point. Auto Set Point is designed to be used during rapid descents. **ASP** is normally selected immediately prior to descent; as the diver descends and PO2 rises, **ASP** ensures that the PO2 does not fall below current PO2 at any point. Once the descent is complete the diver should select a fixed set point. The diver can select the maximum PO2 that ASP will maintain on the **SET MAX SET POINT** menu.

**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. So use the oxygen set points wisely.

**SYSTEM MONITOR:** The second menu option after the **CHANGE SP** selection 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** and **LOAD** voltages (**LOAD** voltage on primary handset only). The **NORM** battery indicator shows the drop in voltage when there is no load on the battery. The **LOAD** reading is the battery load for when the solenoid is activating and putting a strain on the battery, it is this indicator that the diver needs to be aware of for battery performance.

**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 primary handset main page and on the **BL ENABLE** page, the **KEEP BACKLITE ON** setting will be ignored in this state. The **LOW BATT** warning is triggered by a **LOAD** voltage of 5.2v or less, if the **LOAD** voltage rises above 5.2v when the solenoid is not firing the **LOW BATT** indicator will display only while the solenoid is firing, in both cases the back light is disabled and will not be available until the system power is reset. If the primary battery voltage should drop below ~4.5v the



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handset display will “go blank”, the processor will continue to operate, however the solenoid will cease “firing”. The diver will need to reference the secondary display and HUD to “fly” the system manually.

**DANGER! Terminate the dive as soon as practical considering decompression and other operational factors. Both conditions warrant the battery to be replaced prior to the next dive!**

In most diving scenarios, the diver has adequate time to exit the water without sacrificing safety.

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 on the primary handset and the loop temperature only on the secondary handset.

**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 has no effect on the CPU or solenoid operation. This option is ignored if **KEEP BACKLITE ON** is set to **ENABLE**.



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

**OXY INJECT:** The **OXY INJECT** setting is the means to adjust the oxygen injection by setting the timeout intervals. The possible “off time” (duration of time the solenoid will not “fire”) settings are 4,5,6,7 and 8 seconds. The purpose of controlling the required off time between solenoid “firing” is to allow time for the oxygen in the loop to homogenize to help avoid spikes in PO<sub>2</sub> and to facilitate the operation of the Adaptive Injection Algorithm. The duration of time the solenoid is permitted to “fire” is controlled by the Adaptive Injection Algorithm (AIA). The Adaptive Injection Algorithm monitors the current PO<sub>2</sub> and adjusts the permitted “firing” time to maintain the desired set point as determined by ASP (current set point on descent) or set via the **CHANGE SP** menu. The permitted solenoid “firing” durations range between a .25 second and 4 seconds depending on the rate of response of current PO<sub>2</sub> vs. desired PO<sub>2</sub>.

**WARNING! It is the diver's responsibility to monitor and maintain a safe PO<sub>2</sub> at all times, and to monitor the rate of change of PO<sub>2</sub> especially during times of high workload, descents and ascents! COMPLANCY KILLS!**

The APECS™ Primary and Secondary 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 sentinel monitoring the operating systems. At anytime below or above the water both displays may be accessed by pushing any button on the display desired as long as the power supplies are on. It is very convenient to push the out board buttons on handsets to quickly access the first menu page for PO<sub>2</sub> status.

**Settings:** The APECS™ 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 are common to both the primary and secondary systems and 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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## Secondary Handset

The secondary handset shares the same simple two button **MENU/CONFIRM** system as the primary handset. The secondary handset is totally isolated from the primary system in regards to information, power supplies, and calibration. The only commonality between the primary handset and the secondary handset are the sensors, each displaying the sensor output. The secondary and the primary handsets are truly isolated and independent from each other. It has been shown that a severed hand set cable (bare wires in salt water) on operational dives did not effect the other handset, (in this case the primary handset system).

Note: The secondary handset does not operate the solenoid in any way. The sole purpose for the secondary is to provide a proper isolated independent backup measuring the loop PO2 in the case of a primary system failure. The diver may operate the Megalodon manually by manually injecting oxygen into the breathing loop to maintain a manually fixed set point based off of the planned diving operation.

The secondary hand set displays the average PO2, individual sensor outputs, and the **SYSTEM MONITOR** (heart beat) along with the ISC logo. The secondary has the following menu options; **MAIN, SYSTEM MONITOR, TEMPERATURE, BL ENBL/DISBL, HUD ENBLE/DISBLE/TEST, HUD BRIGHTNESS, KEEP BACKLITE ON, DISPLAY POWERSAVE, METRIC/IMPERIAL, CALIBRATE, SET OXYGEN PERCENTAGE, and ALITUDE.**

The diver may scroll through the menus and access the menu options the same way as with the primary hand set. The diver will notice one difference in the **SYSTEM MONITOR** in that the **NORM** battery voltage only is displayed and not the **LOAD** voltage. The secondary does not operate the solenoid. The operation of the **MAIN, SYSTEM MONITOR, BL ENBL/DISBL, KEEP BACKLITE ON, and DISPLAY POWER SAVE** menus are as described above for the primary handset.

**TEMPERATURE:** The **TEMPERATURE** screen displays only loop temperature as the loop sensor is located in the head. The water temperature sensor is located in the primary handset.



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## HUD Operation

The HUD is only available on the secondary hand set system; it displays the 3 individual sensors by color and number of blinks. The diver may at any time turn off the HUD especially after the dive to save battery power and may turn it back on at any time. The HUD brightness may also be adjusted to bright and dim. 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 than 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. Care should be taken that both the primary and secondary system are set to the same setting to avoid calibration problems.



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## Calibration Procedures

The APECS™ 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 APECS™ 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. It is available on both the primary and secondary systems. 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.

**KNOW YOUR OXYGEN QUALITY!**



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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 maintained at the selected set point by the electronics and is appropriately 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 new 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 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



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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 PO2 = .21**”. This is the current setting as last calibrated.
4. Prompt line initially asks > 000 FT and shows = (the current PO2)....(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 HiPO2 result as just described.

Example, 100%O2, altitude is 6,500 feet. LoPO2=0.17, HiPO2=0.81 (.77x1.00).

The altitude menu calculates the high point PO2 to be the HiPo2 at 100% oxygen times the oxygen percentage currently set in the **MAX OXYGEN** menu and displays the result as the HiPo2 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 primary and secondary handsets menu and push the confirm button when the option is found. On the primary and secondary handsets 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.

**Note: You may only calibrate one display at a time under the following conditions; you have not changed the sensors or performed any electrical work, and the millivoltage is within the 7.0 to 13.5 mv ambient air specifications. Calibrating one display can help insure that you have one display to monitor the PO2 during the purge procedure to help insure that you are achieving the proper loop PO2 for calibration.**

**Warning! After calibration, both displays must be within 0.05 ATA/Bar of each other.**



# APECS™ OPERATIONAL INSTRUCTIONS (v. 2.5)

**DANGER!** The diver at all times must be aware of the proper operation of the primary and secondary systems. If the primary display at anytime fails to activate and display the PO<sub>2</sub>, your solenoid will not activate due to the failure. Both the primary and the secondary display systems are 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, normal oxygen injection, sensor voting logic and all other essential processing continues in the background.



# APECS™ OPERATIONAL INSTRUCTIONS (v. 2.5)

## REVISION INDEX

Date	Revision	CHANGES
06 August 2007	Original	
10 October 2007	A	Added "DOCUMENT REPRODUCTION AND LICENSING" policy to front.