



APECS USER GUIDE

Version 1.05

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Introduction:

The ISC **A**dvanced **P**ersonal **E**nvironmental **C**ontroller **S**ystem (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 reliability, 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.

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.
- Watt miser 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.) Estimated operational swing time is 100 to 200 hours on Primary system. Secondary electronics system is estimated considerably over 200 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.
- Current depth. (**Bold annotation on display**)
- Max depth indicator.
- Calibrated to 600 fsw.
- Bottom time. (**Bold annotation on display**)
- Surface interval time.
- Breathing loop temp. (Monitors breathing loop temp that the diver is breathing)
- Ambient water temp.
- Pre dive pre set point selection. (Preset a diving set point prior to dive. Pre selected set point will enable below 4 ft).
- Set points selectable on the fly: Manual mode (0.20), 0.4, 0.7, 1.0, 1.1, 1.2, 1.3, 1.4.
- Bilinear 2 point calibration system. (For accurate high and low point PO2 information)
- In water 0.4 set point auto switch. (Auto switch from current selected set point to 0.4 at the 4ft. depth on ascent).
- Sensor MV indicator. (Gives sensor output (Milivolts) on the fly to the diver in real time. This will indicate to the diver the health of the sensors)
- Low battery indicators. LOW BATT annotation will appear blinking at 5.0 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)
- Fresh water, sea water settings.
- Metric/imperial settings.

- Back light enable/disable option.
- System monitor: It is the heart beat indicating to the diver that the electronics have not locked up and is functioning.
- Selectable oxygen dosage and time of analysis. May be adjusted on the fly to allow user to set to personal settings according to work effort. (2 each, 0.5 sec. injection period and 2 each, 1 sec. injection period each has a 6 sec. and 8 sec. analyzation period between injections of O2. Default is 0.5 injection dosage/6 second analysis period.
- No wet sensors.
- Two minute start up time out for calibration, and setting of the Imperial/Metric scale, and fresh/sea water scales.

The Megalodon strengths comes 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 just punch the buttons on the hand sets 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 there are in questions on reliability. Also, the power switches must be turned on prior to the diving operation. See pre dive check sheet.

APECS operating instructions:

Power on the power switches on the battery boxes inside the Megalodon head lid and notice on the hand sets 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. (See example 1.0)

Primary handset: (See example 1.1) 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 anytime may observe a **black outline** 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 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, 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 to fly the Meg manually and the diver must exit the water ASAP and use IAP' when necessary.

Unit Measurement indicator: The **UMI** is the current unit of measurement preset by the diver depending on what measurement the diver wants for depth. Any change in the measurements must be done within two minutes of turning the power on. **Note:** At

anytime during pre dive procedures the diver may turn the power off and turn on again to in order to restart the time.

Current Depth Indicator: The **CDI** is in bold numbers to indicate current depth. The Max depth indicator (**MDI**) will be indicated 10 minutes after the diver has surfaced from the dive. If the diver dives within the time limit the deepest depth will be recorded and indicated on the **MDI**.

Run time indicator: The **RTI** Temporally records the current running dive time of the entire dive, and at 10 minutes of the diver surfacing, the **RTI** will indicate the **Surface interval time (SIT)**.

Note: The APECS will not remember the MD and SIT after being turned off, the diver must record information prior to shutting down the APECS after the operational day of diving.

Menu/Confirm system:

Press the Menu button of the primary hand set and scroll through the menu options, the diver will see the following; **Change set point? System Monitor, Temperature, BL ENBL/DISBL,** and **OXY INJECT**. 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.

The Diver at any time may leave the selected option by making a selected operational change to the APEKS 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 PO2 in the loop, and set point that will also support your planned decompression.

Change Set point: Set point selection is accessed from this option pushing the **Menu** button to "Change Set point? And then pushing 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 **Manual** set point maintains a loop PO2 of .21 (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.

0.4: The set point of 0.4 is used as a set point for a lower loop PO2 and **also** for the **automatic lower set point** for any of the **higher** set points that may be **pre selected** for the dive. The diver may select any of the higher set points above the 0.4 set point and upon diving below 4 ft the unit will auto select from the 0.4 set point to the pre selected set point and slowly start injecting O2 into the loop. Upon surfacing above 0.4 ft. APECS will auto select to the 0.4 set point for breathing on the surface while surface swimming.

Other 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, and 1.4. The diver may use any of the following at anytime during the dive. The diver must insure that

they have a **breathable PO2 at anytime and maintain the planned PO2 to support 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 set point selection is the System Monitor. The system Monitor is the diagnoses page for the Meg, the System Monitor page has two other pages that may be accessed by the diver, they are meaningless and are for **ISC factory diagnoses** only. The diver may access System Monitor during the dive to monitor the **sensor millivoltage** and the **battery no load (Normal) and load**. The **Normal** battery indicator shows the drop in voltage when there is a **no load** on the battery. **The load** 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**. The **lower limit is 5.0 volts** and the diver **must replace** the battery. **Early low battery indicators** is 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 battery indicator flashing** on the primary hand set. Both conditions warrant the battery to be replaced ASAP! and the termination of the dive. In most diving scenarios the diver as adequate time to exit the water safely without sacrificing safety.

The **Sensor millivoltage** (mv) is an indicator of sensor degradation (health), the diver may see how the sensor is performing at all times during the dive. The diver may also record the information on the pre-dive check sheet to monitor sensor life and performance over time. Normal sensor mv is 11.5 to 13.5 in **air**. It is a prudent habit to record the sensor mv at various set points during the dive and to comparison check at later dives.

Temperature: The temperature monitors the ambient water or air temperature and the breathing loop temperature.

BL (Back light) The back light may be disabled at anytime 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** 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 disabled option is selected.**

Oxy Inject: The Oxy Inject is the means to adjust the oxygen injection by setting two injection dosages and two timeout intervals. The **first** setting of **0.5 OFF 6** is the **default setting** and may be changed at anytime during the dive to increase or decrease the oxygen injection dosage. The first number is a **half second** time that the solenoid is open to inject a set dosage of oxygen into the loop, the second number is the interval of a time out of the solenoid. The opening of the solenoid may be changed to a **one second** time to increase the dosage of the injection. The **interval times** may be changed from **6 sec. to 8 sec.** time out intervals. **WARNING! Do not use the 1 second injection dosage for fast descents or an Oxygen spike will occur! This condition will increase inappropriate exposure to high concentrations of oxygen.**

Defaults, Time outs, and Settings:

The oxygen injection **default (0.5 OFF 6)** is adequate for most diving scenarios with supplementation of oxygen using the oxygen manual bypass. The 1 sec. dosage is good for fast ascents or swimming into a heavy current where the diver is consuming greater oxygen

due to a higher work loads, and diver desires more oxygen to maintain a closer set point for physiological advantage decompression.

Time out and sleep modes: The APECS **Primary display** will time out of all options automatically and also fall asleep when not in the dive mode. The **secondary display** will time out in dive mode 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**.

Settings: The APECS may be set for calibration, fresh water and salt water measurements, and Imperial/Metric measurements. The settings may only be accessed within a 2 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 2 minute window by turning the power off and turning the power on again.

Warning: At no time should the diver enter the water within the 2 minute time frame of turning the power on.

Secondary handset: The secondary hand set shares the same simple two button Menu/Confirm system as the primary hand set. The Secondary hand set is totally isolated from the primary system in regards to information, power supplies, and calibration. The only common between the primary hand set and the secondary handset of course is the sensors, each displaying the sensor output. The Secondary and the Primary hand sets are truly isolated and independent from each other, it has been shown on that a severed hand set cable (Bare wires in Salt water) on a operational dive did not effect the other hand set in this case the Primary hand set system.

Note: The secondary hand set does not operate the solenoid in any way or display the depth and runtime. 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 **AVG PO2**, **Individual sensor out puts**, and the **system monitor** (Heart beat) along with the ISC logo. The secondary has the following menu options; **Main page**, **System Monitor**, **Back light Enable/Disable**, and for those Megalodons that have the option the **Heads Up Display (HUD) Enable/Disable**, and the **HUD brightness control**.

The diver may scroll through the **menu** and access the **menu options** the same way as the primary hand set. The diver will notice **one difference** in the **System Monitor** and that the **Normal battery power is displayed** and **not the load**. The secondary does **not operate the solenoid** so such a feature is not needed. The additional features the secondary features is the HUD when equipped.

HUD Operation: The HUD **is** the secondary hand set system; it displays the 3 individual sensors by color and number of blinks. The diver may at anytime turn off the HUD especially after the dive to save battery power and may turn it back on at anytime. 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 anytime 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	
Red	0.20	One long	Ambient Air and possible Hypoxia condition
Red	0.209	8 blinks	Ambient Air
Red	0.4	six	
Red	0.7	three	
Red	0.9	one	
Orange	1.0	one long	Calibration color after calibration procedure.
Green	1.1	one	
Green	1.2	two	
Green	1.3	three	
Green	1.4	four	
Green	1.8 +	One long	Hyperoxia potential.

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 harder to explain then to actually do.

Display calibration procedures: The Megalodon is a two point calibration system the first point is ambient air and the second point is 100% Oxygen. To best perform the calibration procedure follow the pre dive check sheet and these instructions.

1. During the pre dive check of the Megalodon performance check #23 will tell you to conduct the air point calibration after turning the power on (Performance check #22), 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 sure? You will see a **Yes** or **No** and you may **push** yes to go on or no to cancel. Pushing yes you will again see the question **Are you really sure?** And you will **push** the Yes or No option, after pushing Yes see **“Hit confirm when at ambient air”** or **“Menu for Cancel”** At this point of calibration you have just completed the calibration for Air and the **2 minute time out is on hold** for you to complete the next phase of calibration.
2. Perform Pre dive check procedures to performance check #38 and you will see “Complete calibration if necessary” **To complete calibration** all performance checks prior to #38 need to be completed. Insure that performance check #37 is 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 counter lung and fill the loop with 100% Oxygen until the vent valve vents gas let set for 10 seconds.
3. Vacuum the loop again and fill again until valve vents and repeat above.

4. 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.
5. Push the oxygen manual bypass for 3 seconds; this will blow 100% oxygen over the sensors with out increasing the loop pressure giving a possible higher PO2 reading.
6. Repeat 5 above.
7. Repeat 5 again.
8. You now have a purged loop with nearly 100% Oxygen.
9. Push the yes button on the displays and you have finished the two point calibration.

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 11.5 to 13.5 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.

Note: You may calibrate the other display at your convenience as long as the calibration procedure described above is followed.

Warning: After calibration both displays must be within half an ATA/Bar of each other

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 information such as depth, RT, and PO2 your solenoid will not activate due to the failure. The primary display does not have a sleep mode like the secondary for anytime during the dive, the secondary is programmed to go to sleep during the dive until reawaked.