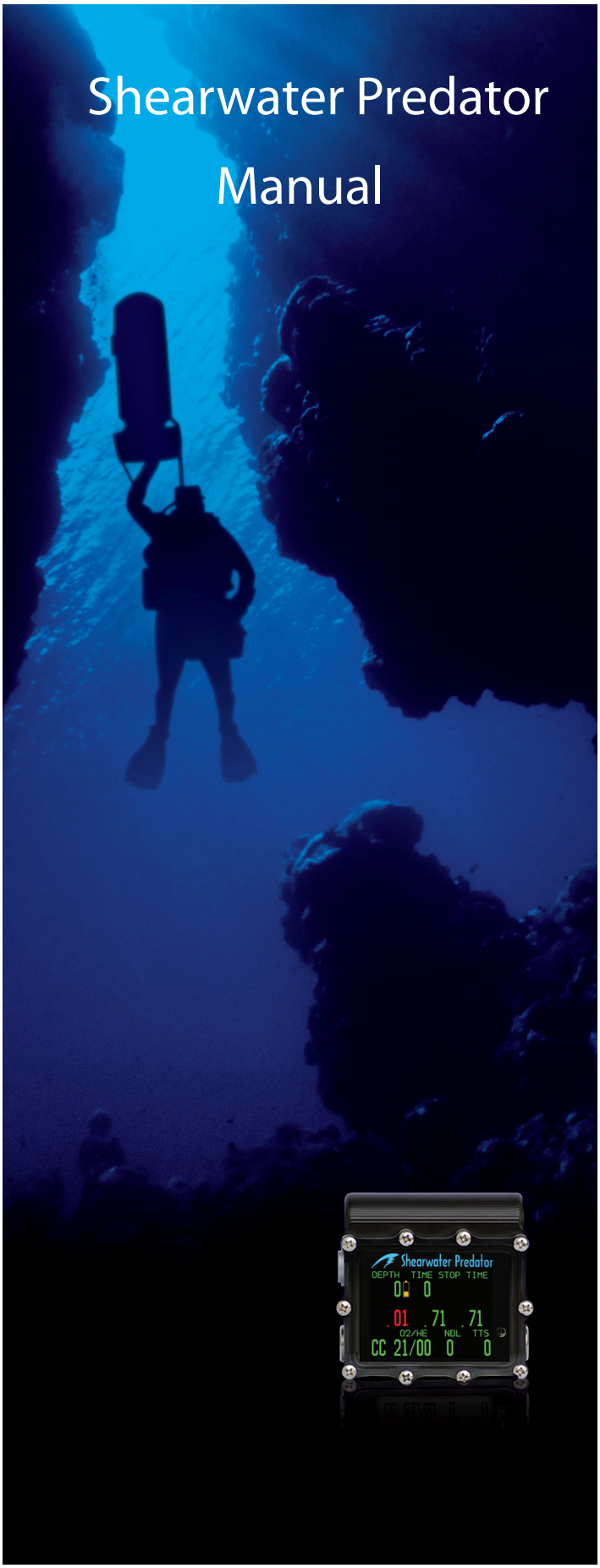
Shearwater Predator Manual



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DANGER

This computer is capable of calculating deco stop requirements. These calculations are at best a guess of the real physiological decompression requirements. Dives requiring staged decompression are substantially more risky than dives that stay well within no-stop limits.

Diving with rebreathers and/or diving mixed gases and/or performing staged decompression dives and/or diving in overhead environments greatly increases the risk of scuba diving.

You really are risking your life with this activity.

WARNING

This computer has bugs. Although we haven't found them all yet, they are there. It is certain that there are things that this computer does that either we didn't think about, or planned for it to do something different. Never risk your life on only one source of information. Use a second computer or tables. If you choose to make riskier dives, obtain the proper training and work up to them slowly to gain experience.

This computer will fail. It is not whether it will fail but when it will fail. Do not depend on it. Always have a plan on how to handle failures. Automatic systems are no substitute for knowledge and training.

No technology will keep you alive. Knowledge, skill, and practiced procedures are your best defense. (Except for not doing the dive, of course.)

Introduction

Features

- Depth, time and oxygen sensor display
- Buhlmann algorithm with gradient factors conservatism
- Imperial and metric displays
- Two set points, each of which can be set between .4 and 1.5
- A menu system that adapts to diving status
- Automatic turn off after 30 minutes on the surface
- Depth sensor rated to 450 feet
- Dive Planner
- Any combination of oxygen, nitrogen, and helium
- Open and closed circuit, switchable during a dive
- 5 CC and 5 OC gases
- Gases can be changed and added during a dive
- CNS tracking
- No lockout
- Automatic setpoint switching (configurable)
- Battery life of over 100 hours of diving or 1 year of standby
- 20 hour dive log memory

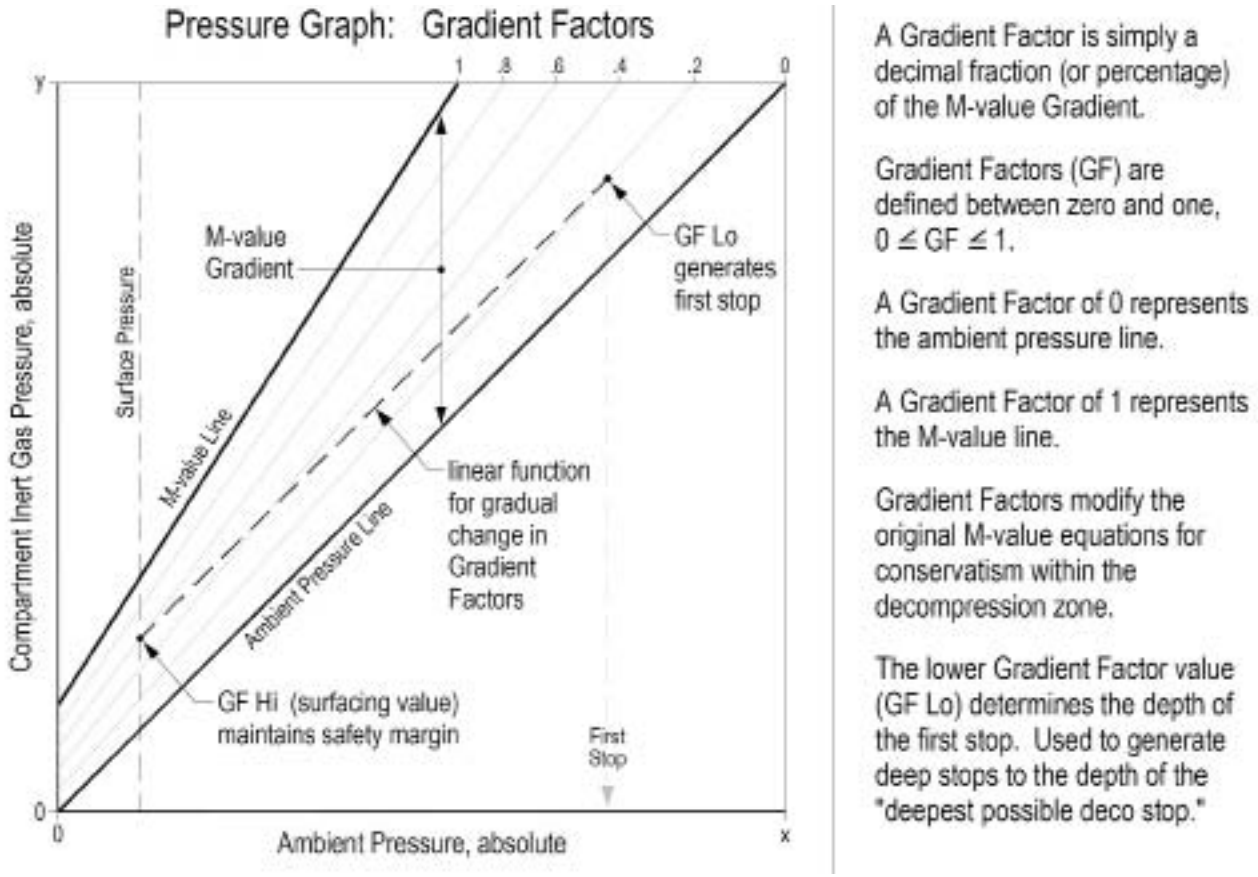
Decompression and Gradient Factors

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

The computer implements Gradient Factors by using levels of conservatism. The levels of conservatism are pairs of number like 30/85. For a more detailed explanation of their meaning, please refer to Erik Baker's excellent articles: *Clearing Up The Confusion About "Deep Stops"* and *Understanding M-values.* The articles are readily available on the web. You might also want to search for "Gradient Factors" on the web.

The default of the system is 30/85. The system provides several settings that are more aggressive than the default.

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



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

Display

The display has five areas. There are three title areas and three data display areas.

Across the top line is the title for the first row of information. This area only changes during the display of the dive log. The first data area shows depth, battery warning, dive time, ascent rate, first stop depth, and first stop time. It is showing a depth of 34.7 meters, a low battery alarm, 15 minute dive time, a 3 meter per minute ascent rate, and a stop at 24 meters for 1 minute.

The low battery indicator glows yellow after the battery is less than 3.28V for 30 seconds. Below 3.15V the battery indicator will flash red. You will need to change your battery immediately. It is recommended to change your battery when the battery indicator steadily glows yellow.

The ascent rate indicator shows 6 levels of ascent rate. Each block represents either 10 fpm or 3 mpm. 1, 2 and 3 bars will be green, 4 and 5 bars will be yellow, 6 bars will be red. When the ascent rate is greater than 6 units, the whole block will be filled in red, and it will flash.

If you are above the indicated stop depth, the stop depth will flash red.

The next data line has the three O2 sensor readings. If a sensor is voted out, it will display the current value, but it will flash yellow and the value will not be considered in the average PPO2. This area will also display fixed PPO2 or nothing in OC models.

The next area is the title for the bottom line. This title changes frequently in the menu system to provide additional information about the bottom line. The last line shows that the computer is in closed circuit (CC) mode with a gas containing 21% oxygen and 0% helium.

If there is a gas programmed in the current mode (OC or CC) that would normally be used at the current depth, the system will flash the gas contents in red to remind you to either switch gases, or remove the gas if you aren't using it.

In addition, there is a context sensitive area at the bottom which is implemented when cycling through menus.

The no decompression limit (NDL) is zero since we are in decompression, and the time to surface (TTS) is 15 minutes.

The computer works in both metric and imperial for depths and temperatures. The depth shows a decimal point when the depth is between 0 and 99 meters. It shows no decimal point if the display is set to feet.

To turn the computer on, press both the MENU and the SELECT buttons at the same time.

Buttons

MENU (Left)
- From the default display, pressing MENU brings up the menu.
- Once in the menu system, MENU moves to the next menu item.
- If the current function is an edit, pressing MENU increments the current display.

SELECT (Right)
- In the menu system, the select button saves the current value or executes the command.
- Out of the menu system, the select button brings up information displays.

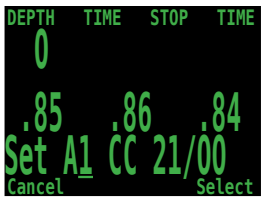
BOTH BUTTONS
- When the computer is off, pressing MENU and SELECT at the same time will turn the computer on.

The left button (MENU) can be used to scroll through the menu. Please note, the menus vary depending on the various models. When the “Switch Setpoint” menu item is displayed, MENU will move to the “Select Gas” menu item.

The right button (SELECT) is used to accept the current choice.

Pressing SELECT with this screen displayed will enter the Select Gas function.

In the “Select Gas” function, MENU increments the gas number.



SELECT would select closed circuit gas 2.

When the system is not in a menu, pushing SELECT will bring up information displays with various dive status information. This is the first information display showing the diluent PPO2 amount, the current CNS loading, the setpoint (if applicable), and the average PPO2 being used for decompression calculation.

Menu

The system is designed to make the selection of the common operational functions while diving easy. The menu selections are separated into two sets. The “Operation” menu is to provide easy access to commonly used functions. The “Setup” menu is to change system settings.

The system will continue to read the sensors and update the sensor display while you are in the menu system.

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

A key characteristic of the menu system is that it is adaptive. It uses the information that it knows about its current state to only ask questions or offer menu items that make sense given the current situation.

For example, on the surface, the first menu item you will see is Turn Off. During a dive, the Turn Off menu item doesn’t appear.

The second menu item is Calibrate. That item only shows on the surface. In addition, it only shows on models that have external sensors enabled, and on those models, only when they are in closed circuit mode.

The full menu structure is below:

- **Turn Off**
- **Calibrate**
- **Switch Setpoint**
- **Select Gas**
- **Switch Open Circuit / Closed Circuit (Open Circuit / Semi-Closed Circuit)**
- **Dive Setup**
  - **Edit Low Setpoint**
  - **Edit High Setpoint**
  - **Define Gases**
  - **Dive Planner**
  - **NDL Display**
  - **External PPO2 Monitoring**
  - **Brightness**
- **Dive Log**
  - **Display Log**
  - **Upload Log**
  - **Edit Log Number**
  - **Clear Log**
- **Setpoint -> .19**
- **System Setup**
  - **Dive Setup**
  - **OC Gases**
  - **CC Gases**
  - **O2 Setup**
  - **Auto SP Switch**
  - **Display Setup**
  - **System Setup**

The Turn Off, Calibrate, Dive Log, Setpoint -> .19, and System Setup menus are only available on the surface. This is the menu during a dive:

- **Switch Setpoint**
- **Select Gas**
- **Switch Open Circuit / Closed Circuit (Open Circuit / Semi-Closed Circuit)**
- **Dive Setup**
  - **Edit Low Setpoint**
  - **Edit High Setpoint**
  - **Define Gases**
  - **NDL Display**
  - **Brightness**

The status screens are:

- **Gases, no-decompression limit and time to surface**
- **Diluent PPO2, CNS, and average PPO2**
- **Oxygen sensor millivolts**
- **Max depth, average depth, average atmospheres**
- **Water temperature, current Gradient Factor, current fixed Oxygen**
- **GF99, decompression ceiling, time-to-surface in 5 minutes and time-to-surface**
- **Battery voltage**
- **Pressure**
- **Date and time**
- **Surface interval**
- **Serial number and version number**

Basic Setup

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

On a system with external oxygen sensors, calibrate the oxygen sensors.

In the System Setup menu set the units to metric or imperial, also set the date and time.

Depending on the model of computer, enter the gases that you will use for the closed circuit portion of your dive, and/or enter the gases for you will use for open circuit.

The system will use the gases that are available in the order of oxygen content during the Time To Surface (TTS) prediction. The system will use the next available gas that has a PPO2 of less than 1.0 for closed circuit diving.

If the computer is in open circuit or is switched to open circuit during a dive, the system will calculate the TTS based on the configured open circuit gases that are available. It will use the next available gas that has a PPO2 of less than 1.6 for open circuit diving.

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

Display Elements Description

Closed-Circuit Partial Pressure of O_2 (PP02):

The CC PPO2 display depends on the Predator model:
All models Flash Red PPO2 when less than 0.4 or greater than 1.6.

Controller (PRC):

Displays 3 sensors.
Displays PPO2 in Yellow when sensor is voted out.
Displays FAIL when calibration is not valid.
When in OC mode, the sensor values continue to display. This shows the state of the breathing loop, but not what is currently being breathed.

PROCT-E:

Can show external sensor PPO2 (will show three values) or internal PPO2.
See PROCT for internal PPO2 description.
Displays 3 sensors.
Option to show only middle sensor. To show middle sensor only, perform calibration with only sensor 2 connected.
Displays PPO2 in Yellow when sensor is voted out.
Displays FAIL when calibration is not valid.
When in OC mode, the sensor values continue to display. This shows the state of the breathing loop, but not what is currently being breathed.

PROCT (or PROCT-E in internal PPO2 mode):

Internal PPO2 mode only.
Shows the current setpoint, which is the PPO2 at which the Predator assumes the breathing loop is being maintained.
Shows 1 value only.
When in OC mode, the value disappears.

PROT (open circuit only model):

Not available. See Gas PPO2.

Fraction Inspired O_2 (FiO2):

The fraction of the breathing gas composed of O_2. This value is independent of pressure.

Ascent Bar graph:

Imperial: Shows 1 bar for every 10 feet per minute (fpm) of ascent rate.

Metric: Shows 1 bar for every 3 meters per minute (mpm) of ascent rate.

Green when 1 to 3 bars, Yellow when 4 to 5 bars, and Flashes Red when 6 bars or more.

Battery Symbol:

When the battery is good, the battery symbol does not display.

Displays Yellow when the battery needs to be changed.

Flashes Red when the battery is dangerously low and must be replaced immediately.

Depth:

Shows the depth in the currently selected units (feet or meters). Meters are displayed with 1 decimal place up to 99.9 meters. Feet are never displayed with a decimal place.

Note: If the depth shows a Flashing Red zero, then the depth sensor needs service.

Dive Time:

The length of the current dive in minutes. Does not display when not diving.

Stop Depth and Time:

Stop – the next stop depth in the currently selected units (feet or meters).

Time – the time in minutes to hold the stop.

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

Note on 10ft/3m last stops: The Predator uses 10ft/3m last stops. You may perform 20ft/6m stops with no penalty, since the Predator is always calculating tissue loading at your actual depth. The only difference is that the predicted time-to-surface will be shorter than the actual TTS since off-gasing is occurring slower then expected.

Average Depth:

Displays the average depth of the current dive, updated once per second.

When not diving, shows the average depth of the last dive.

Average Depth in Atmospheres (AvgATM):

The average depth of the current dive, measured in absolute atmospheres (i.e. a value of 1.0 at sea level).

When not diving, shows the average depth of the last dive.

Circuit Mode:

The current breathing configuration. One of:
OC = Open circuit
CC = Closed circuit
SC = Semi-closed circuit

Current Gas (O2/He):

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

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

Flashes Red when there is another programmed gas that is more appropriate at the current depth than the current gas.

No Decompression Limit (NDL):

The time remaining, in minutes, at the current depth until decompression stops will be necessary.

Displays in Yellow when the NDL is less than 5 minutes.

Once the NDL limit has been exceeded, this value can be set to optionally display other information. These options are:

CEIL: The current ceiling in the currently selected units (feet or meters). Flashes Red if you ascend shallower than the current ceiling.

GF99: The raw percentage of the Buhlmann allowable supersaturation at the current depth.

@+5: The time-to-surface (TTS) if you were to stay at the current depth for 5 more minutes.

Time-to-Surface (TTS):

The time-to-surface in minutes in the current circuit mode. Assumes an ascent rate of 30 feet per minute (10 meters per minute), that stops will be followed and programmed gases will be used as appropriate.

Maximum Depth:

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

CNS Toxicity Percentage:

Central Nervous System oxygen toxicity loading percentage.

Flashes Red when 100 or greater.

The CNS percentage is calculated continuously, even when on the surface and turned off. Removing the battery will reset the CNS percentage.

Setpoint:

The current PPO2 setpoint. Displays in Yellow when the setpoint is 0.19.

Average PPO2:

The average PPO2 of the current breathing gas.

In OC mode, displays in Flashing Red when less than 0.19 or greater than 1.65.

In CC mode, displays in Flashing Red when less than 0.40 or greater than 1.6. In CC mode, averages all sensors that are not voted out.

Diluent PPO2:

Only displayed in CC mode. Displays in Flashing Red when the partial pressure of the diluent is less than 0.19 or greater than 1.65.

Gas PPO2:

Only displayed in OC mode. Displays in Flashing Red when less than 0.19 or greater than 1.65.

Gradient Factor:

See “Clearing up the Confusion About Deep Stops” by Erik Baker.

Pressure:

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

The current pressure is only shown on the surface (i.e. when not diving).

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

Temperature:

The current temperature in degrees Fahrenheit (when depth in feet) or degrees Celsius (when depth in meters).

External Voltage:

The external voltage of the solenoid battery. Not available on all models.

Internal Voltage:

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

Millivolts:

The raw millivolt readings from the PPO2 sensors. Only available on models with external monitoring.

Date and Time

In the format mm/dd/yy
24-hour clock time.

Serial Number:

Unique serial number identifier for every Predator.

Version:

The version number indicates the features available on the Predator computer.

The last two numbers are the firmware version.

Surface Interval:

The time in days, hours and minutes since the last dive ended. Reset when the battery is removed.

Simple Example Dive

Here is an example of a simple air dive. It will help to introduce the screen displays as the diver progresses.

As the dive starts, the depth increases. The display is showing the computer programmed for open circuit (OC) air.

As we pass through 30 feet, the time-to-surface (TTS) shows one minute. This shows that the computer is expecting the diver to ascend at approximately 30 feet per minute or 1 meters per minute. The dive predictions are based on this ascent rate.

The no-decompression limit (NDL) starts off showing 99, but then starts to show a smaller number as the depth increases. The 3rd screen above shows that we will go into deco in 12 minutes.

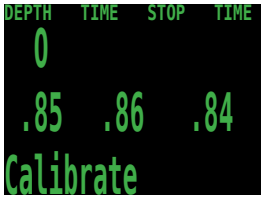
As we ascend, the ascent rate indicator shows about 30 fpm or 9 mpm. When we approach the first stop, our ascent rate slows to about 10 fpm and when we go shallower than our first stop, the stop depth starts to flash red.

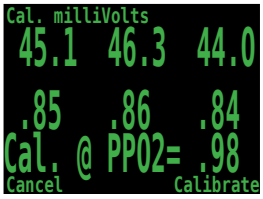
When we clear the last stop, the stop depth and time goes blank, and now we see a NDL of 99 minutes again. Once we surface, the depth is 0 and a minute later when the computer comes out of dive mode, the NDL goes to 0 as well.

Complex Example Dive

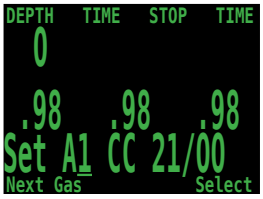
This is an example of the displays that might be seen on a dive. This example shows a complicated dive with multiple Closed Circuit (CC) gases and multiple Open Circuit (OC) bail-out gases. A normal, single gas CC or OC dive wouldn't have any button pushes at all, so there isn't much to show.

The first step is to calibrate. Since we are on the surface and not diving, MENU will bring up "Turn Off", then "Calibrate." Once the loop is flushed with oxygen, SELECT will bring up the confirmation display, and another SELECT will calibrate.



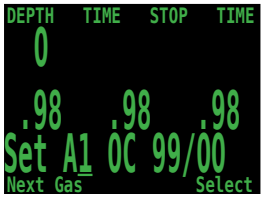


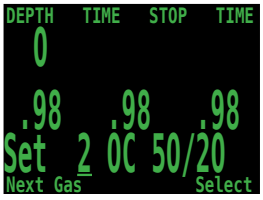
Next, we check the closed circuit gases that we have programmed. Entering the gas selection function by pressing SELECT with the "Select Gas" menu item showing will display the first CC gas that is available. MENU will increment to the next gas available. Another MENU takes us back to the "Select Gas" menu item. Those are the only two gases configured. We SELECT gas number 2, the Trimix 10/50.



The system will use both of these gases for our dive when calculating the TTS. It assumes a diluent switch at a PPO2 of 1.0. That means that it will assume that you have switched to an air diluent at 124 feet. This is only for TTS. The computer will always use the currently selected gas for tissue loading calculations.

Then we switch to open circuit to look at our bail-out gases. Flipping through the gases with MENU shows that we have three gases available. (Whether they are appropriate gases is a subject for one of the web forums.)





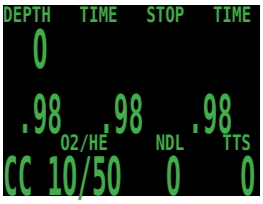
These are the gases that will be used to estimate TTS in the event that you switch to open circuit during a dive. The computer will assume that you will switch gases when the PPO2 of the next available gas is less than 1.6.

Automatic decisions of when to switch gases for the TTS calculation means that it is very easy to set up your CC and OC gases. There is no need to enter a depth or a PPO2 to switch gas. There is no need to keep track of which gases are turned on and off in which mode.

If a gas is available in the CC gas list it will be used in CC, and it will be used at an appropriate depth. The same is true for OC. It is always configured correctly if you actually have the gases you have created.

If it is necessary to switch to OC while diving, 4 button pushes will do it. You will be switched to OC and will be using the gas that has the highest PPO2 less than 1.61. Your OC gas list is likely very different from your diluent gas list, but all of the OC gases are automatically selected and available.

Now switch back to closed circuit and start the dive.



We have reached a depth now that will incur decompression soon. The NDL is 8 minutes, and the TTS is 4 minutes. The TTS just reflects the ascent time at 30 fpm.

The computer has automatically switched to the high setpoint. This can be disabled if automatic setpoint switching isn't required.

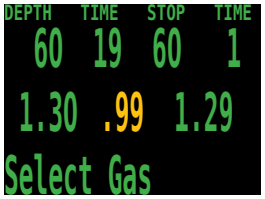
We are now at our maximum depth. Our first stop is at 90 feet.

The diver is ascending to the 90 foot stop. Note the ascent rate indicator showing a 30 fpm / 10 mpm ascent rate. Although the ascent rate is 30 fpm now, during the 7 minute ascent, the diver ascended slower than was predicted, and now there is a 100 foot stop.

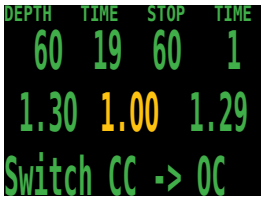
But the diver missed the stop, and has ascended to 95 feet. At this point, the stop depth and time is flashing red to show that the depth is above the recommended stop.

The diver switches to the other programmed CC gas, air. Note that if you change the diluent on the computer you must flush the loop to change the diluent in the loop. At the same time the 100 foot stop clears. It is common for the first stops to clear in less than a minute. They mainly just slow down the ascent.

At 60 feet a problem develops that causes the diver to bail out to open circuit. The first push on MENU brings up Select Gas.



The second push brings up Switch CC -> OC.



A push on SELECT does the switch. The system has switched the gas set from the closed circuit gas set to the open circuit gas set, picked the gas with the highest PPO2 less than 1.6, and recalculated the decompression based on the new profile.

At 20 feet, one push on MENU brings up select gas.

A push on SELECT enters the select gas menu, and another SELECT picks the O2. Since the gases are sorted by oxygen content, the O2 is the first gas offered.

This was a multi-gas trimix dive with a multi-gas open circuit bailout, and it required 9 button pushes.

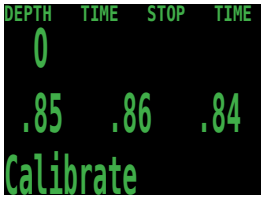
Menu Reference

Turn Off

The “Turn Off” item puts the computer to sleep. This menu item will only appear if the water contacts are dry on controllers. While sleeping, the screen is blank, but the tissue contents are maintained for repetitive diving. The “Turn Off” menu item will not appear during a dive on any model. It will also not appear for 2 minutes after a dive to allow for a continuation dive.

Calibration

This will calibrate the sensor displays to oxygen. Flood the breathing loop with pure oxygen, SELECT with “Calibrate” in the display, and the confirmation message will display. On the top line, the millivolt reading will show. Good sensors should be in the range of 35 - 60 mV at sea level in 100% oxygen. The valid millivolt range for calibration is 30 - 70 mV. This scales with percentage of oxygen and barometric pressure.



Pressing the MENU button will prevent the calibration. Pressing SELECT will calibrate the sensor displays. The displays should now all read .98. If any display shows FAIL, the calibration has failed because the mV reading is out of range.

The system defaults to a calibration gas of 98% oxygen. This is to compensate for the difficulty in completely filling the loop with 100% oxygen and also to allow for water vapour. If you are using a calibration kit with no water vapour and 100% O2, you can set the calibration gas to 100. It can also be set to other values if pure oxygen is not available.

The calibration takes into account the altitude at which the computer was turned on. For example, if the altitude was 885 mBar or .87 ATA, then with a 98% calibration gas, the sensors would calibrate to .85.

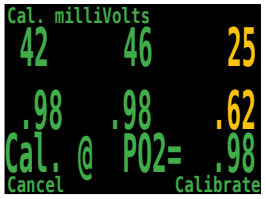
The “Calibrate” menu item will not display during a dive.

Calibration Problems

Here are some common calibration problems. In this display, one sensor is flashing yellow. This shows that the sensor is voted out. If it comes back within range, it will be voted back in, stop flashing yellow and return to green.

A failed sensor is a different situation. In this case, the sensor failed calibration. Changing the sensor won't make it register again. Once a sensor has failed calibration, the only way to bring it back is to successfully calibrate. If the computer were to display a value with a new sensor, it would be a meaningless value without calibration.

If this was the display, it would indicate a faulty sensor. It is not within the normal range for a sensor in oxygen. Most sensors are designed to output 10 mV +/- 3 mV in air. If the output is linear, then that translates to a range of 30 to 70 as valid mV readings in 98% oxygen. The computer will refuse to calibrate outside that range.



Three sensors all showing FAIL is usually caused by an accidental calibration in air, or a calibration with the cable unplugged. Plugging the cable back in won't change anything. A failed calibration can only be fixed by performing a successful calibration.

Switch Setpoint

With a controller, when SELECT is pushed with either of these displays, the displayed setpoint on the right will be selected.

During a dive, the “Switch Setpoint” menu item will be the first item displayed. The “Turn Off” and “Calibrate” displays are disabled.

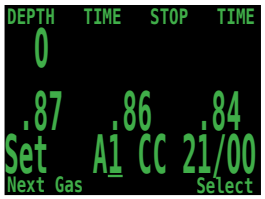
With a closed circuit computer that is not a controller, and does not have external monitoring turned on, the switch is between 2 user assigned set points.

Select Gas

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

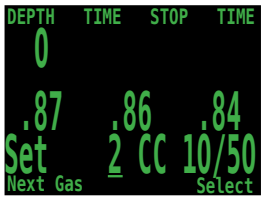
Gases are always sorted from most to least oxygen content.

Press the SELECT button when “Select Gas” is displayed, and the first available diluent/gas will be displayed.



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

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



Use the “Confirm” button to select a gas. The bottom line of the display shows the selected gas. An ‘A’ will appear next to the currently active gas.

Radio Station Gases

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

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

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

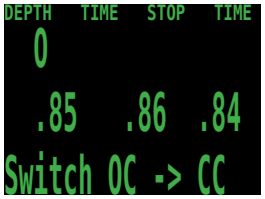
Similarly, if you are in the AM mode, adding or deleting a station would add or delete an AM station.

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

Switch to OC/CC

Depending on the current computer setting, this selection will show as either “Switch CC -> OC” or “Switch OC -> CC”.

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



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

On computers with external oxygen sensor monitoring, there is also an option to set the computer to calculate decompression predictions using semi-closed circuit. This is enabled in the System Setup menu.

You can also switch to from CC to OC on a fixed PPO2 model and vice versa.

Dive Setup+

These screens are showing controller displays.

Pressing SELECT will enter the Dive Setup sub-menu.

Low Setpoint

This item allows you to set the low setpoint value. It will display the currently selected value. Values from 0.4 to 1.5 are allowed.
A press of MENU will increment the setpoint.

Press the SELECT button when “Edit Low SP” is displayed and the edit display will be shown. It is set at the lowest valid value for setpoint, .4.

Another press of MENU will increment it again.

If SELECT is pushed, the currently displayed setpoint will be selected, and the display will return to the “Low SP” menu item.

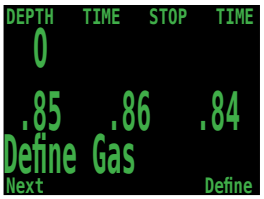
If the highest allowable value, 1.5, has been passed, the value will return to 0.4.

High Setpoint

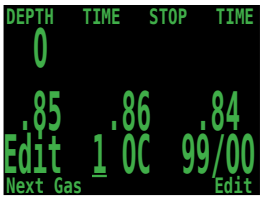
The high setpoint function works exactly like the low setpoint function.

Define Gas

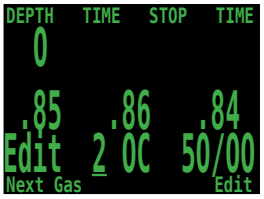
The function allows you to set up 5 gases in Closed Circuit and 5 gases in Open Circuit. You must be in Open Circuit to edit open circuit gases, and you must be in Closed Circuit to edit closed circuit diluents. For each gas, you can select the percentage of oxygen and helium in the gas.



Pushing SELECT when “Define Gas” is displayed presents the function to define gas number 1.

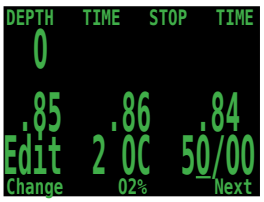


Pushing the MENU button will display the next gas.

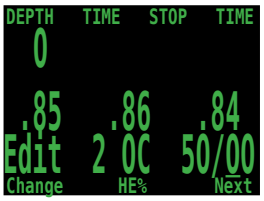


Pushing SELECT will allow you to edit the current gas. The gas contents are edited one digit at a time. The underline will show you the digit being edited.

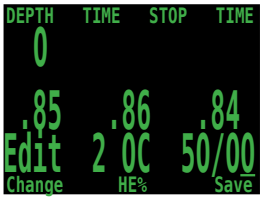
Each push of the MENU button will increment the digit being edited. When the digit reaches 9, it will roll over to 0.



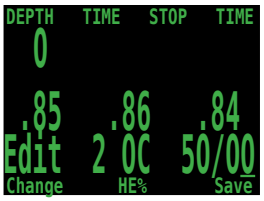
Pushing SELECT will lock in the current digit, and move on to the next digit.



Pushing SELECT on the last digit will finish editing that gas, and bring you back to the gas number.
Any gases that have both oxygen and helium set to 00 will not be displayed in the “Select Gas” function.

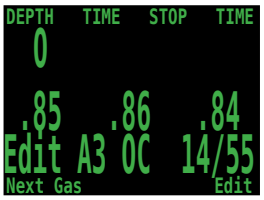


Pushing MENU will continue to increment the gas number.

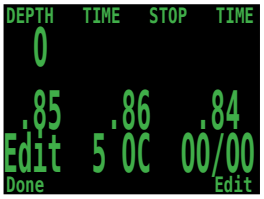


Note: The "A" denotes the active gas. You cannot delete the active gas. If you try, it will generate an error. You can edit it, but cannot set both the O2 and HE to 00.

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



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



Only enter the gases you are actually carrying on the dive. With radio station gases, the computer has a full picture of the OC and CC gases you are carrying and can make informed predictions about decompression times. There is no need to turn gases off and on when you switch from CC to OC, because the computer already knows what the gas sets are. You can still add or remove a gas during the dive if needed.

Dive Planner+

INTRODUCTION

- Calculates decompression profiles for simple dives.
- In closed-circuit (CC) mode, also calculates open-circuit (OC) bail-out (BO).

SETUP

Uses the current gases programmed into the Predator, as well as the current GF low/high settings.
Deco profile is computed for the current circuit mode (CC or OC).

ON THE SURFACE

Enter the dive bottom depth, bottom time, respiratory minute volume and PPO2 (closed-circuit only).

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

Dive Plan Setup

DURING A DIVE

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

LIMITATIONS

The Predator Dive Planner is intended for simple dives. Multi-level dives are not supported.

The Predator Dive Planner makes the following assumptions:

- Ascent and descent rates are 33ft/min (10m/min).
- For OC, the gas in use will be the gas with the highest PPO2 less than 1.61.
- For CC, the gas in use will be the gas with the highest PPO2 less than 1.05.
- Last stop is 10ft (3m).
- For CC, the PPO2 is constant for the entire dive.
- The RMV is the same while diving as during deco.
- Semi-closed is not currently supported.

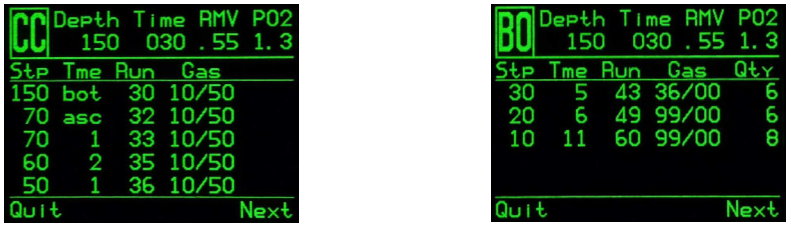
The Dive Planner does not provide any validation of the profile. It does not check for nitrogen narcosis limitations, gas usage limitations, CNS percentage violations, or isobaric counter-diffusion violations due to sudden helium switches. The user is responsible for ensuring a safe profile is followed.

RESULT SCREENS

The results are given in tables showing:

- Stp: Stop Depth In feet (or meters)
- Tme: Stop Time In minutes
- Run: Run Time In minutes
- Qty: Gas Quantity in CuFt (or liters). OC and BO only

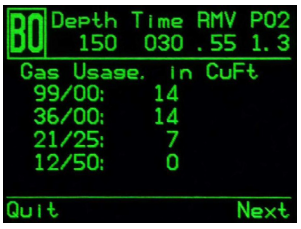
The first two rows are special, the first row showing the bottom time and the second showing the ascent to the first stop. When diving, these two rows are not displayed.



Example Results Table for Closed-Circuit and Bailout.

If more than 5 stops are needed, the results will be split onto on several screens. Use the right button to step through the screens.

For OC or BO profiles, a total gas consumption report is given.

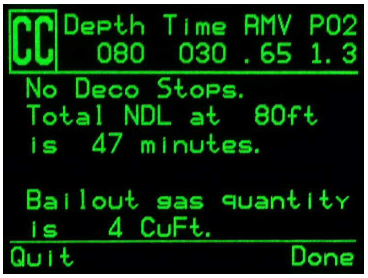


Gas Usage Report

The final result screen shows the total dive time, the time spent on deco and final CNS%.

Results Summary Screen

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



No Decompression Results Screen

NDL Display

The NDL Display option allows you to display four different values during the dive. The display can be changed during the dive to provide different information.

Pushing SELECT will make the NDL display editable. The first choice available will be **NDL**. If you select NDL, the NDL will always be displayed during the dive whether or not you have a decompression ceiling.

The next selection is **CEIL**. With this setting, as long as the NDL time is 0 (you have a decompression ceiling), the raw ceiling will be displayed instead of the NDL. This is the equivalent of the 'Man on a rope.' It will show your ceiling without it being rounded up to the next even 10 foot or 3 meter stop. Please note that there is very limited information on the effects of following a continuous ceiling instead of stopping at stops and only moving up to the next stop when the stop has cleared.

It is the author's opinion that all stops should be honored. It seems intuitive that if you have bubbles, and you stop, you give the bubbles an opportunity to be resorbed. If you continuously ascend, the ambient pressure is continuously reduced which prevents bubbles from shrinking. Because of this belief, the computer will give one MISSED DECO STOP message during the dive and one after the dive, and will flash the stop depth and time in red as long as you are above the stop depth. It will use the increased gradient though, and your calculated off-gassing will be faster than staying at the stops.

The next option is to display the actual supersaturation gradient for a pure Buhlmann (99/99) profile.

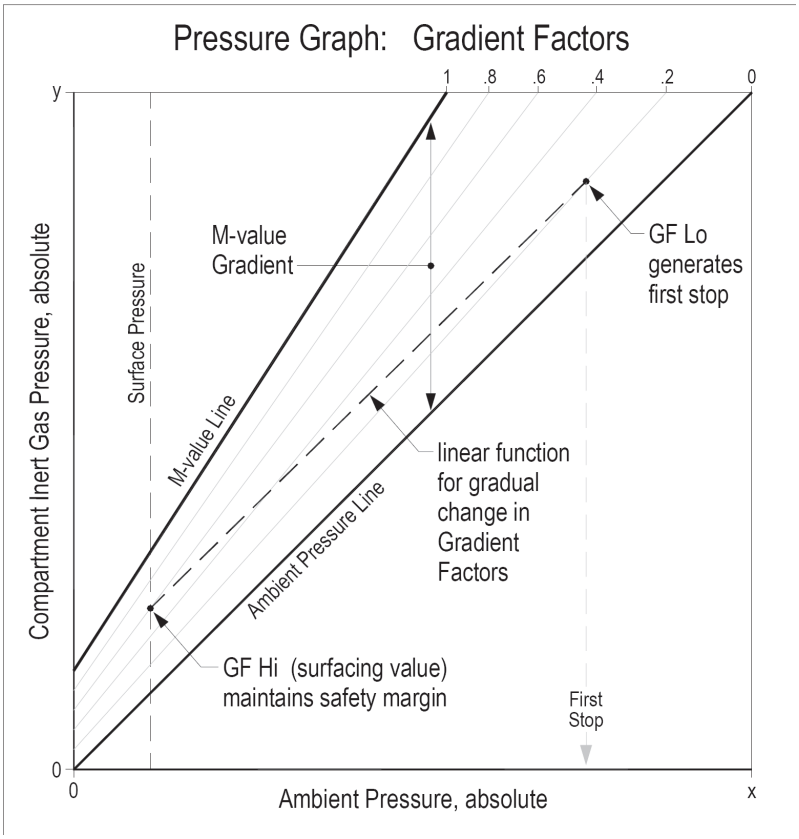
The selection is **GF99**. With this setting, as long as the NDL time is 0 (you have a decompression ceiling), the gradient will be displayed instead of the NDL.
The number shown is the percentage of supersaturation. The number is calculated by reference to the Ambient Pressure Line and the M-Value line. It can be thought of as the current GF, but it is different in a couple of ways. First, the current GF generates stops rounded to the nearest 10 feet or 3 meters. So a gradient of 40 may reflect a ceiling of 15 feet, but the computer will show a rounded-up 20 foot stop.

This number can be used in several ways. First, it can be used to calculate an aggressive ascent that still has some justification in decompression science. For example, if a diver were to lose a significant portion of their gas and needed to get shallow fast, they could ascend until they reached a gradient of 90, then stop until it dropped to 80, then ascend to 90 again, etc. That would produce a Buhlmann-like profile with very little conservatism. In an emergency, that may be an acceptable risk.

Another use might be to do a slower ascent on a dive to sightsee, but to stay in the decompression zone by keeping the gradient above 0.

Another use would be to observe the rapidly increasing gradient in the last 10 feet to the surface and slow that ascent.

All of this is based on gradient theory that may be completely false. There is significant disagreement in the decompression research community about the nature and practice of decompression. Any techniques described here should be considered experimental, but the concepts may be useful to the advanced diver.



The last selection is **@+5**. This feature has been borrowed from Dan Wible's CCR2000 computer. It is the time-to-surface (TTS) if you were to stay at the current depth for five more minutes.
This can be used as a measure of how much you are on-gassing or off-gassing.

External PPO2 Monitoring

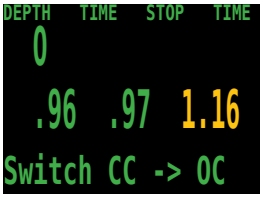
The next menu item is used to turn external PPO2 monitoring on and off. By default, external monitoring is turned off and reads “Int.” for Internal. To turn external monitoring on (Ext.), press the MENU button to change from Internal to External, then press the SELECT button on this menu item.

Now the PPO2 of the three sensors is displayed. In the displayed screens, we have three sensors and they have been calibrated at some point.

This system is plugged into three sensors and is the primary display for the system.

Note that since we are in Closed Circuit mode, that the PPO2 used to calculate decompression is the average of the three sensors after voting. In this case, sensor three has been voted out, and the decompression calculation will use the average of sensor 1 and 2.

Sensor 3 will be flashing yellow.



Switching to Open Circuit mode..

The PPO2 used for calculation is now is the PPO2 of the selected gas at the current depth.

If we now unplug sensor 1 and sensor 3, the computer will use voting logic to pick the two sensors that agree and will think the PPO2 is 0. Sensor 2 will be voted out and flashing yellow. This is one of those times that the user will have to determine which sensors are correct.

With sensors one and three unplugged, we simulate the situation with fourth sensor monitoring. If we calibrate in this situation, the system will assume that this computer is only attached to one sensor, and will re-configure for fourth sensor monitoring.

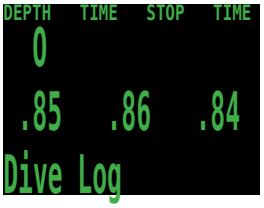
It will no longer average the sensors or vote on them. Now the single sensor is the only one considered and the PPO2 used for calculations is the PPO2 of the single sensor.

Setpoint -> .19

This menu item will only be displayed on controllers and only on the surface. It allows the solenoid to be turned off while on the surface when the loop is exposed to air. This prevents the solenoid from firing continuously. It is mainly used while uploading logs or other maintenance functions.

To switch back to normal low setpoint, select the Switch Setpoint menu item. The setpoint will also switch to normal low setpoint if a dive is started with the .19 setpoint selected.

Dive Log Menu



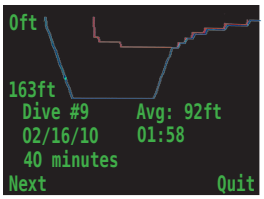
Display Log

At the “Display Log” prompt, press SELECT to view the most recent dive.

The profile of the dive is plotted in blue, with decompression stops plotted in red. The following information is displayed:

- Maximum and Average depth
- Dive number
- Date (mm/dd/yy) and time (24 hr clock) of dive start
- Length of dive in minutes

Press MENU to see the next dive, or SELECT to quit viewing logs.



Upload Log

See “Firmware Upload and Dive Log Download” instructions.

Edit Log Number

The dive log number can be edited. This is useful if you need to clear the dive log, but want the numbering to continue from where you left off.

At the “Edit Log Number” prompt, press SELECT to begin editing. While editing, use MENU to change the value of the currently underlined digit, and SELECT to move to the next digit.

The next dive number will be +1 from the value entered here. For example, if you enter 0015, then the next dive will be dive number 16.

Clear Log

At the “Clear Log” prompt, press SELECT. You will be asked to SELECT again. Press SELECT to begin clearing the log, or press MENU to cancel.

It will take about 1 minute to clear the log. Do not remove the battery during this time.

Clearing the log will not clear the dive number.

Note: The Predator has a 20 hour dive log memory.

If this limit is exceeded, the oldest dive logs will be overwritten by the newer dives.

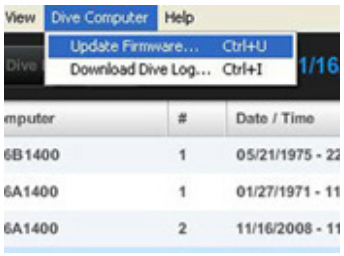
Firmware Upload and Dive Log Download

Plug the Bluetooth dongle into your PC.
Place the Predator within 6 inches of the Bluetooth dongle.

Go to www.shearwaterresearch.com/pages/library and download the most recent version of 'Shearwater Desktop with Air' and the latest firmware update. Uninstall any old versions and install the new Desktop.

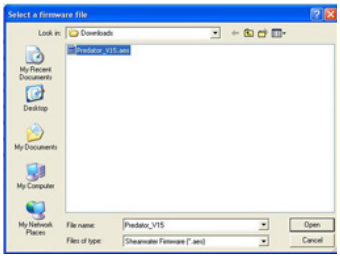
If "Dive Computer" menu item is greyed out, the PC cannot find a Bluetooth device plugged into it.

If you cannot connect to either "update firmware" or "download dive log" then you need to ensure that Bluetooth is working on your PC or laptop.



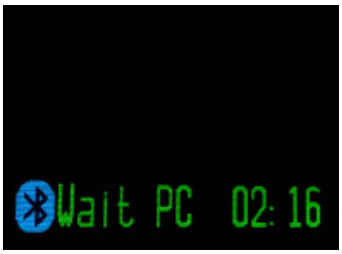
Once you can access "dive computer" run the program and select "Update Firmware" from the "Dive Computer Menu".

Select the Predator .AES file that is with the document.



Now on the Predator, go to the "Dive Log" menu and select "Upload Log".

The Predator screen will switch from ”Initializing” to “Wait PC” which will have a countdown.



Now go back to the Shearwater Desktop. Click start from the open “Update Firmware Box”, or “Download Log.” The PC will then connect to the Predator, and send the new firmware.

The Predator screen will give percentile updates of receiving the firmware, then the PC will read “Firmware successfully sent to the computer”.

The Predator will now Decrypt, which will take approximately 4 minutes.

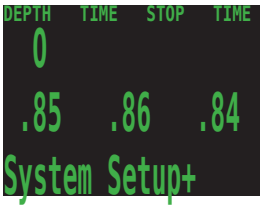
Warning: Do not remove the battery during this time.

After decryption the Predator will process, which will take an additional 4 minutes.

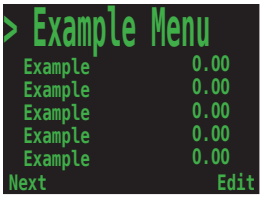
The screen upon completion of processing will read `Tissues Cleared` which must be confirmed. The screen will then read `Upgrade Reset` which also must be confirmed.

The Predator now has the most up to date firmware.

System Setup+

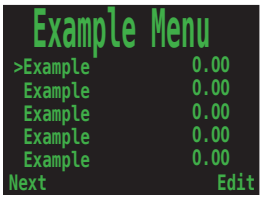


System Setup contains configuration settings that are only set between dives. This menu item doesn't appear during dives. Each of the items in the System Setup menu can only be accessed on the surface.

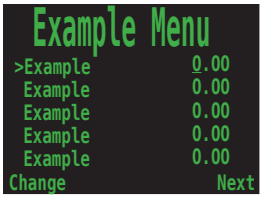


All of the submenus contained within System Setup make use of a convenient user interface. The MENU and SELECT buttons are context sensitive to each sub menu and individual setting.

When cycling through the sub-menus, MENU will carry the user to the next sub-menu, while SELECT will allow the user to edit the options in this submenu.



Once the user has pressed SELECT to edit a submenu, MENU will cycle the user through the different submenu listings, while SELECT will let the user edit those listings.



Once the user has pressed SELECT to edit a submenu listing MENU will be used to change the context sensitive variable, while the SELECT button will be used to move to the next field. Once the user has pressed SELECT through all the fields, the new user preferences will be saved.

Dive Setup

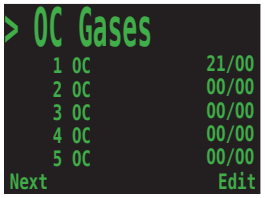
The first submenu is Dive Setup. The options contained here are the same as those accessed from the "Dive Setup" section described above, except under System Setup all of the functionality is conveniently placed on one screen as opposed to the multiple screens seen is the above described "Dive Setup" menu.

For a description of the functionality of each option, please see the above "Dive Setup" section.

Conservatism

The final setting in the Dive Setup Submenu, conservatism, is not found under the above 'Dive Setup' section. The Shearwater Predator implements Gradient Factors by using levels of conservatism. For a more detailed explanation of their meaning, please refer to Erik Baker's excellent articles: *Clearing Up The Confusion About "Deep Stops" and Understanding M-values.* The articles are readily available on the web. You might also want to search for "Gradient Factors" on the web.

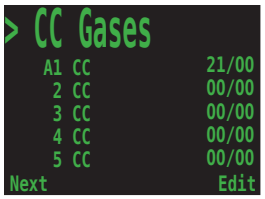
OC Gases



The second submenu is OC Gases. This menu allows the user to edit the open circuit gases. The options contained here are the same as those in the “Define Gases” subsection of the “Dive Setup” section contained earlier in this manual. The interface conveniently displays all five gases simultaneously.

For a description of how to appropriately set each gas, please see the above Define Gas section

CC Gases



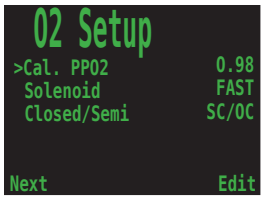
The third submenu is CC Gases. This menu allows the user to edit the closed circuit gases. The options contained here are the same as those in the “Define Gases” subsection of the “Dive Setup” section contained earlier in this manual. The interface conveniently displays all five gases simultaneously.

For a description of how to appropriately set each gas, please see the above Define Gas section

O2 Setup

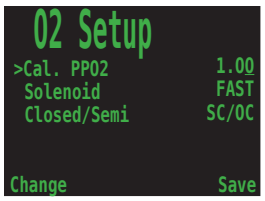
The fourth submenu is O2 Setup. This menu allows the user to edit the Oxygen settings.

Cal. PPO2



This allows the user to set the expected PPO2 for calibration. It is used in three situations.

The first is when pure oxygen isn’t available and the oxygen is being generated by a membrane system. The oxygen in that case might be 96% O2 and a few percent of Argon.



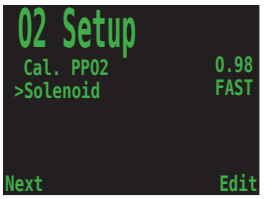
The second is when you are using a calibration kit and are assured of using 100% O2 with no water vapour.

The third situation is for Semi-Closed rebreather use. SCR users may not have oxygen available. If the SCR identity is selected, the computer may be calibrated in air.

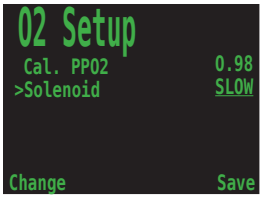
If any change is made in this screen, the current calibration will be discarded. The computer must be re-calibrated with the new settings.

Solenoid Speed

The firing pattern of the solenoid can be changed between fast and slow on controllers. The FAST setting uses frequent short injections of oxygen and is generally more accurate.



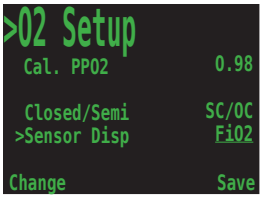
The SLOW setting is more familiar to many users.



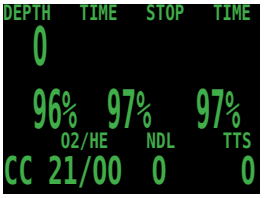
Set SC Identity

This function is used to switch between Semi-Closed circuit and Closed circuit operation and is only available on the PROCTE. It allows the computer to make accurate projections based on the way the PPO2 changes during ascents. It allows much more accurate predictions for Time To Surface (TTS) for Semi-Closed circuit divers.

It also allows SCR divers to set their calibration percentage to .21. Note: When in semi-closed mode the user cannot utilize internal monitoring.



In Semi-Closed mode you have the option of displaying the partial pressure of oxygen (PPO2) or the fraction of inspired oxygen (FiO2) for the three oxygen sensor displays in the default screen.



Auto SP Switch

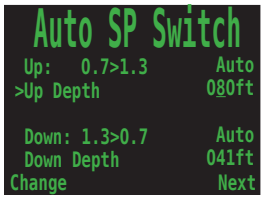
This feature is on controllers and computers with external monitoring turned off.

Auto Setpoint Switch configuration sets up the setpoint switching. It can be set up to switch up only, down only, both, or neither.

The first option is the switch up function. This configures the switch up from the low set point to the high setpoint. Pushing MENU switches it back and forth between “Auto” and “Manual.”

Note: The Up Auto SP switch occurs during the descent.

The next option is still a part of the switch up function, and enables the editing of the switch depth.



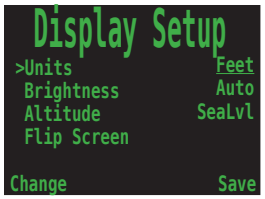
Next is the switch down function. This configures the switch up from the high set point to the low setpoint. Pushing MENU switches it back and forth between “Auto” and “Manual.”

The final option is still a part of the switch down function, and enables the editing of the switch depth.

Either switch can be turned on or off independent of the other switch.
The system limits the allowable setpoint settings. Switching up is allowed from 20-999 feet and from 6-999 meters. Switching down is allowed from 9-999 feet and from 2-999 meters.

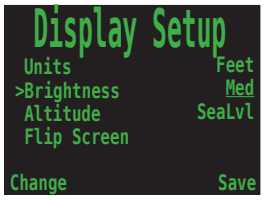
If you enter a setting that is outside the allowed range, the existing (valid) setting is retained with no change.

Display Setup



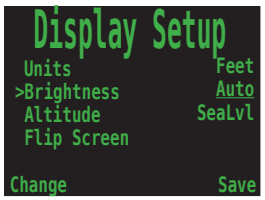
Units

The first ‘Display Setup’ changeable option is ‘Units,’ which allows the computer to switch back and forth between Metric and Imperial units of measurement.



Brightness Range

The next ‘Display Setup’ changeable option is ‘Brightness’ which allows the computer to switch between four brightness settings: Auto, Low, medium and High.



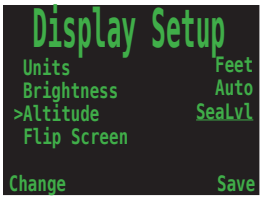
It should be noted that Shearwater Research suggests the use of the auto function, as it makes use of a light sensor to provide maximum brightness when there is an excess of ambient light, yet will dim when there is less ambient light in order to conserve battery life.

Altitude

The altitude setting when set to ‘Auto’ will compensate for pressure changes when diving at altitude. If all your diving is at sea level, then setting this to ‘SeaLvl’ will assume that surface pressure is always 1013 mBar (1 atmosphere).

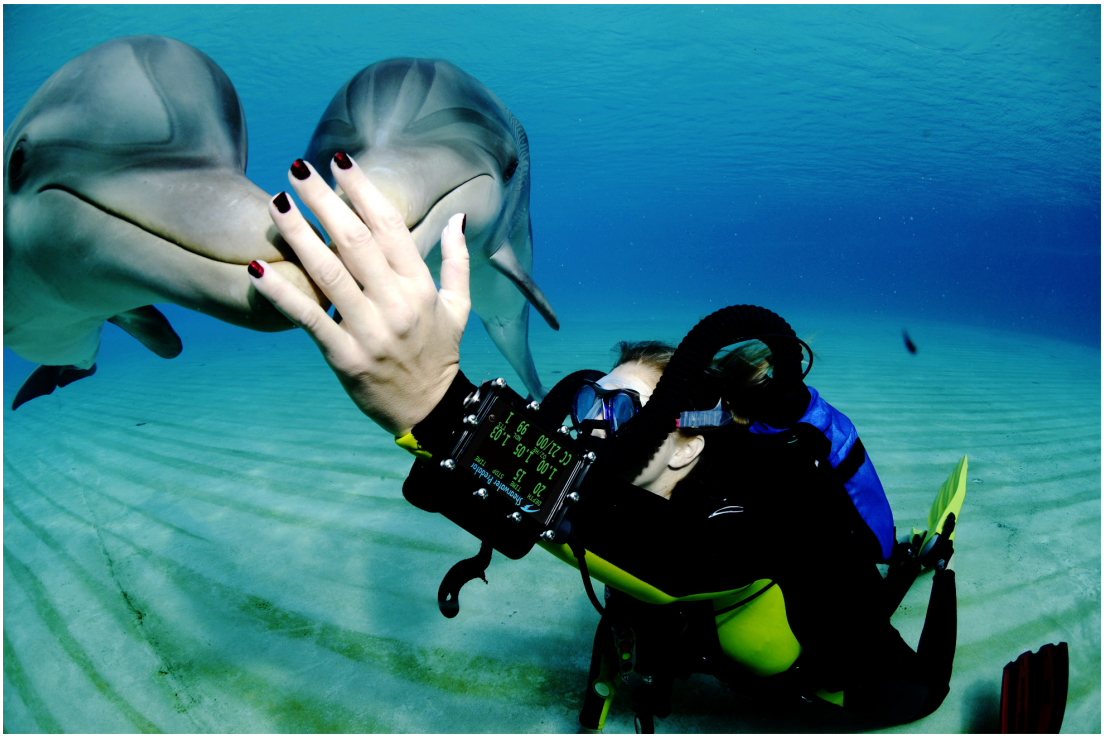
Important: When diving at altitude you must set this option to ‘Auto’ (the default setting is ‘SeaLvl’).

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



Flip Screen

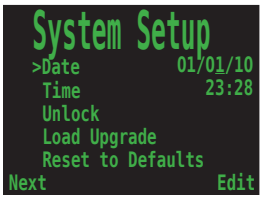
This function displays the contents of the screen upside down. This is used for systems with a permanent connection to a rebreather. It allows the computer to be worn on the right arm.



System Setup

Date

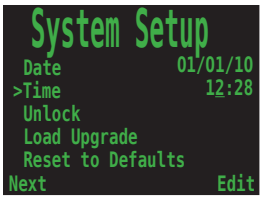
The first ‘System Setup’ changeable option is ‘Date,’ which allows the user to set the current date.



The date will have to be re-entered after a battery change.

Time

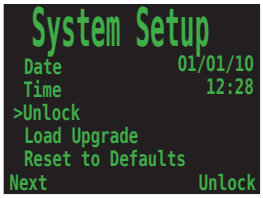
The next ‘System Setup’ changeable option is ‘Time’, which allows the user to set the current time.



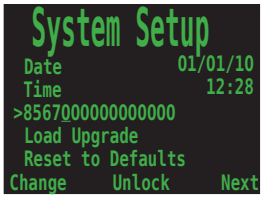
The time will have to be re-entered after a battery change.

Unlock Code

The next ‘System Setup’ changeable option is ‘Unlock’, which allows the user to enter in an unlock in order to change models and to set other features.



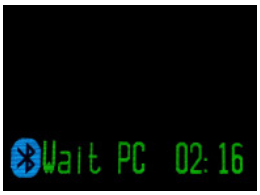
It can change a PROT, OC Trimix computer, to a PROCTE, OC/CC Trimix computer with external monitoring (only available on cases with a fischer connector).



It can also change a PROT-SA, OC Trimix (no fischer connector) to a PROCT-SA, OC/CC Trimix (no fischer connector).

Load Upgrade

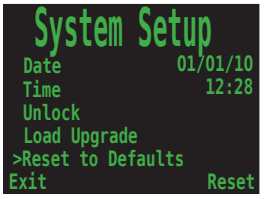
The next ‘System Setup’ changeable option is ‘Load Upgrade’, which allows for the user download version upgrades.



The documentation on how to use the ‘Load Upgrade’ option can be found in the above ‘Firmware Upload and Dive Log Download’ instructions.

Reset to Defaults

The final ‘System Setup’ option is ‘Reset to Defaults’. This will reset all user changed options to factory settings and clear the tissues on the Predator. ‘Reset to Defaults’ cannot be reversed.



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

Error Displays

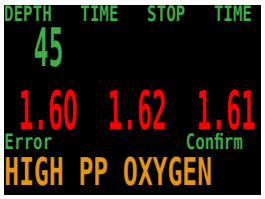
The system has several displays that alert an error condition. All of these displays share a common limitation of error alarms. There is no way to distinguish between an error alarm that is not in alarm, and an error alarm that is broken.

For example, if an alarm is silent when it is not in alarm and is silent when it is broken, then there is no way to be sure that the alarm isn't broken.

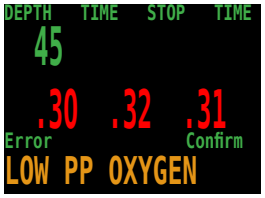
So by all means respond to these alarms if you see them, but NEVER depend on them.

Each of the alarms will display the message in yellow until dismissed. The error is dismissed by pressing SELECT.

Other functions continue to operate as normal, so that the MENU button will take you into the menu, and a push on both buttons will show the millivolt display. The error message will keep returning until it is dismissed with a SELECT.

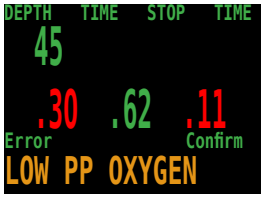


This message will appear if the average **PPO2** goes **above 1.6** for more than 10 seconds. It will come back after being dismissed if the situation occurs again.

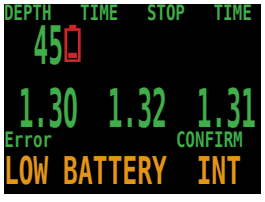


This message will appear if the average **PPO2** goes **below 0.4 (.25 for SC)** for more than a few seconds. It will come back after being dismissed if the situation occurs again.

It is not unusual to get this error immediately after submerging with a manual CCR and a hypoxic mix. The first breath after submerging floods the loop with low PPO2 gas. The situation is usually resolved by increasing depth such that when the error is noticed, the PPO2 is no longer low.

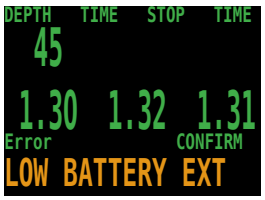


This condition will also cause the "LOW PP OXYGEN" display to appear. Here, the computer does not have two sensors that have confirming values. There is no way to know the actual PPO2, and the average PPO2 will be calculated as 0.00.



This message will appear when your internal battery reads less than 3.2V for 30 seconds. The battery needs to be changed. The computer will also flash the battery symbol red.

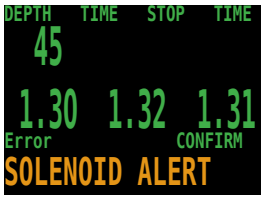
This alarm appears when the voltage on the external solenoid battery is low (controller only). The solenoid may still be firing, but the battery must be replaced before any further diving.



The external solenoid battery is measured during load, so it may appear even though the battery looks good on a voltmeter.

This alarm will only appear once during a dive. When it is dismissed, it will not return during the current dive.

This alarm alerts that the battery is not supplying enough power for the solenoid to fire correctly, or the solenoid has failed, or the connection to the solenoid has failed. (controller only)



If this alarm occurs, corrective action must be taken at once. Even if the solenoid can be heard to fire, it is not functioning correctly.

This alarm will only appear once during a dive. When it is dismissed, it will not return during the current dive.

This alarm is a notification that there has either been a very fast ascent for a short period of time, or that there has been an ascent of more than 66 fpm / 20 mpm maintained for over a minute.

This alarm may return after being dismissed if the condition occurs again.

The alarm occurs when the diver has been above the minimum depth for a decompression stop for more than one minute.

This alarm will only appear once during a dive, but it will also appear once on the surface after the dive.

This alarm will show every time the computer loses power. All decompression information has been lost.

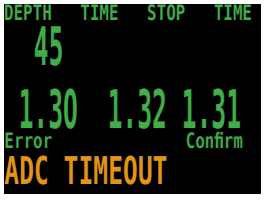
This alarm happens when the computer does not complete all of its tasks in the time allotted. It can happen occasionally from a transient problem like a battery bounce after an impact. It can also be the result of a hardware problem.

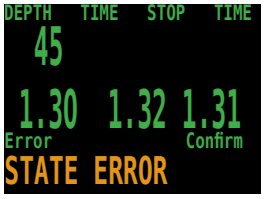
This reset shows up after a software update. This is the normal event that shows the computer has been rebooted after the software update.

This error usually occurs when the battery dies while the computer is asleep. If the battery gets too low to maintain system integrity, the hardware will force the system into reset.

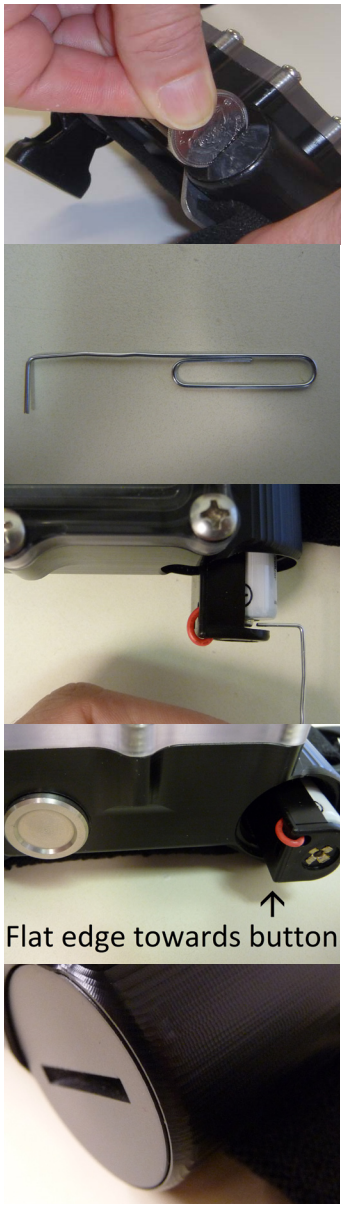
The following messages are reporting internal hardware failures. The system will continue to retry and may recover, but they would normally mean that something that should never happen, has happened. These messages should always be recorded and reported to the factory or your local service center.

This is not an exhaustive list. There are other errors that could be reported and more checks are added with each software update.





Battery Change



The Predator has a battery compartment in the side of the case.

Unscrew the battery cap counter-clockwise with a large coin.

Bend a paperclip into a hook shape.

Hook the battery holder with the paperclip and pull it out.

Replace the battery with a SAFT LS14500.

Push the wires into the battery compartment before inserting the battery holder.

Align the flat edge of the battery holder towards the button.

Gently press the battery holder into the battery compartment.

Tighten the battery cap clockwise with a large coin until it stops.

Storage and Maintenance

The Predator dive computer should be stored dry and clean. Do not allow salt deposits to build up on your dive computer. Wash your computer with fresh water to remove salt and other contaminants. **Do not use detergents or other cleaning chemicals** as they may damage the Predator dive computer. Allow to dry naturally before storing.

Do not wash under high pressure as it may cause damage to the depth sensor. Also do not remove the strap bracket assembly as it acts as protection for the depth sensor.

Store the Predator dive computer upright and out of direct sunlight in a cool, dry and dust free environment. Avoid exposure to direct ultra-violet radiation and radiant heat.

Warning

There are no user serviceable parts inside the Predator.
Do not tighten or remove the faceplate screws.
Clean with water ONLY. Any solvents may damage the Predator dive computer.
Service of the Predator may only be done at Shearwater Research, or by any of our authorized service centers. Your nearest service center can be found at www.shearwaterresearch.com/pages/contact

Specifications

Atmospheric Range: 800 - 1050 mBar

Transducer Depth Range: 14ATA
Transducer Depth Accuracy: +/- 2.5%

Depth of Dive Time - Start: 1.6m of Sea Water
Depth of Dive Time - Stop: 0.9m of Sea Water

Operating Temperature Range: +4ºC to +32ºC
Short-Term (hours) Temperature Range: -10ºC to +50ºC
Long-Term Storage Temperature Range: +5ºC to +20ºC

Crush Depth Limit: 185m

Weight: 0.4 kg

Recommended Battery: SAFT LS14500 3.6V Lithium 2250mAh AA Size

Battery Operating Life (Display Medium Brightness): 100 Hours Plus 1 Year Standby

FCC Warning

a) USA-Federal Communications Commission (FCC)
This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy. If not installed and used in accordance with the instructions, it may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by tuning the equipment off and on, the user is encouraged to try and correct the interference by one or more of the following measures:
- Reorient or relocate the receiving antenna
- Increase the distance between the equipment and the receiver.
- Connect the equipment to outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Caution: Exposure to Radio Frequency Radiation.
This device must not be co-located or operating in conjunction with any other antenna or transmitter.
Contains TX FCC ID: ED9LMX9838

Industry Canada Warning

b) Canada - Industry Canada (IC)
This device complies with RSS 210 of Industry Canada.
Operation is subject to the following two conditions:
(1) this device may not cause interference, and
(2) this device must accept any interference, including interference that may cause undesired operation of this device.
L'utilisation de ce dispositif est autorisée seulement aux conditions suivantes :
(1) il ne doit pas produire d'interference, et
(2) l'utilisateur du dispositif doit étre prêt à accepter toute interference radioélectrique reçu, même si celle-ci est susceptible de compromettre le fonctionnement du dispositif.

Caution: Exposure to Radio Frequency Radiation.
The installer of this radio equipment must ensure that the antenna is located or pointed such that it does not emit RF field in excess of Health Canada limits for the general population; consult Safety Code 6, obtainable from Health Canada's website www.hc-sc.gc.ca/ewh-semt/pubs/radiation/radio_guide-lignes_direct-eng.php#sc6
Contains TX IC: 1520A-LMX9838