

HS EXPLORER PPO₂ MONITOR OWNER'S MANUAL



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2 IF YOU READ NOTHING ELSE IN THIS MANUAL - READ THIS PAGE!

Scuba diving, especially technical diving, can be an extremely hazardous activity. While utilization of tools such as the *HS Explorer* PPO₂ Monitor can mitigate some of the risks associated with technical diving, misuse of this tool can actually increase or create new risks. Please read this Manual carefully before using your new *HS Explorer* PPO₂ Monitor, especially the warnings contained upon this page. We at HydroSpace Engineering hope that you will enjoy using your new *HS Explorer* PPO₂ Monitor and trust it will bring you years of service and safe diving.

The warnings contained in this section are designed to prevent harm to two things; you, and your new *HS Explorer* PPO₂ Monitor. Please read them carefully.

WARNING!

IMPROPER USE OF THIS DEVICE CAN RESULT IN SERIOUS INJURY OR DEATH.

Do not dive with a this device until you:

1. Have read the owner's manual
2. Understand fully how operate the device correctly
3. Have received proper training in the use of gas mixtures other than normal air
4. Have received proper training in conducting stage decompression dives.
5. Have received proper training in Open/Closed Circuit SCUBA diving.

Use of this device in any diving activity constitutes agreement by the user that he or she assumes and accepts full responsibility for all risks.

WARNING!

Insertion of the battery backward (reverse polarity) will ruin the computer and VOID the warranty.

The warranty is null and void if:

- The battery has been inserted backwards (reverse polarity).
- The unit has been dried with compressed air (gas).
- The lens has been removed or the lens screws loosened. The product has been modified in any way.
- The product has been abused.
- The product's limits have been exceeded or the product exposed dry (chamber) exposure.
- The product is not registered within 10 days of purchase.
- The product has been exposed to any material, which causes damage to the case, lens or o-rings.
- The product has been maintained in a manner inconsistent with is usage or standard practices.

REPAIR CHARGES WILL BE ASSESSED ON INVALIDATED UNITS!

- Minimum Charges, when there is no damage to electronics:
- Case Replacement - \$400.00, Lens Replacement - \$150.00, Battery Cap - \$15.00
- Do not remove the lens or loosen the screws. The transducer has been carefully sealed and when the seal is broken, the transducer calibration is no longer valid. In addition, an internal integrity seal will be broken if the electronics are opened. You will be assessed \$450.00 plus parts and labor to repair any *HS Explorer* PPO₂ Monitor found to have been opened!
- Repair prices are subject to change without notice.

WARNING!

Never use spray lubricants. The chemicals may attack and ruin the housing materials.

Questions ? Please email: support@hs-eng.com.

3 QUICK REFERENCE FIELD SETUP GUIDE -

First read the previous page: THEN IF YOU READ NOTHING ELSE IN THIS MANUAL - READ THIS PAGE!

Note

The *HS Explorer* PPO₂ Monitor is supplied with the display unit and O₂ cell connection cable. It is up to the user to furnish the O₂ cell and cell adapter (holder). The user is also responsible for the cable/cell holder installation.

3.1 General

1. Press and Release the LEFT Button (A) to activate the Explorer PPO₂ Monitor.
2. If calibration is lost, the left most display will alternate 'C' then 'R' for calibration alert.
3. Press Left Button (A) for a 9 count to activate the Calibration Function.
4. General Calibration Information:
 - The LEFT button (A) decreases the Percent (%) O₂ in the mix.
 - The RIGHT button (B) increases the Percent (%) O₂ in the mix.

3.2 Calibration

1. Place the O₂ fuel cell in the calibration gas and allow time for it to stabilize.
2. Press LEFT Button **or** place a coin over the middle and left water contact for 9 seconds.
3. The letter 'C' will appear on the left side of the screen and the oxygen percentage of the calibration gas will appear to the right.
4. Press Button A will decrease the calibration gas percentage.
5. Press Button B to increase the calibration gas percentage.
6. When the calibration gas percentage is showing in the window, simultaneously press Buttons A and B for 3 seconds (no count number is displayed). An 'E' for (Exit) will appear on the left side indicating that both buttons are pressed. At the end of the 3 seconds, unit will shift into cell voltage mode.
7. The cell voltage(s) will cycle through and display the cell voltages for 1 second each cell. Display is in millivolts. **NOTE: Replace the O₂ cell if the voltage is out of the range set by the cell manufacturer.**
8. To EXIT the cell voltage display mode and the calibration mode:
 - A. Press Button A for 3 seconds to EXIT AND CALIBRATE the monitor.
 - B. Press Button B for 3 seconds to EXIT AND ABORT the setup. **CALIBRATION WILL NOT TAKE PLACE AND THE EXISTING VALUES WILL BE USED FOR PPO₂ DETERMINATION.**
9. The display will now start counting. When the count is complete, the unit will go into the standby mode. The HS Explorer PPO₂ Monitor contains a water activation circuit and will activate on immersion.
10. *The HS Explorer PPO₂ Monitor is now setup and ready to use.* **CAUTION: CALIBRATION IS REQUIRED PRIOR TO EACH USE.**

3.3 Surface Operation Mode

1. Press RIGHT Button **or** place a coin over the middle and right water contact for 9 seconds. The monitor will enter the active mode for 10 minutes.

1 INTRODUCTION



Figure 1 – HS Explorer PPO₂ Monitor with Cable and O₂ Cell

The purpose of this manual is to acquaint the new user with the procedures and techniques for using the *HS Explorer* PPO₂ Monitor. It applies to both the 1 Cell and 3 Cell models. The calibration procedure is the same for both units. The PPO₂ 3 Monitor cycles between each cell every 2 second which will require 6 second to view all 3 readings,

Please read **this manual** fully prior to using the *HS Explorer* PPO₂. It is not uncommon for new users to spend several hours reading these instructions, and working with their new *HS Explorer* PPO₂ Monitor prior to understanding the functions sufficiently to utilize them during the dive.

Technical diving is an activity that involves many objective hazards and risks. While the *HS Explorer* PPO₂ Monitor can be used to mitigate some of those risks, if the PPO₂ Monitor is used improperly it can actually lead to a greater degree of risk associated with inert gas decompression sickness.

Use of the *HS Explorer* PPO₂ Monitor will not eliminate the chance of experiencing decompression sickness. Regardless of the decompression model that the diver uses, or how cautiously a diver dives, there's always risk of decompression sickness. This risk will be increased if the gas mixes are improperly set. Please take the time to read these directions, to insure that you know and understand the proper way of configuring your new *HS Explorer* PPO₂ Monitor.

HydroSpace Engineering appreciates comments or suggestions you have for future upgrades to its *HS Explorer* PPO₂ Monitor or the simulation software. Please address suggestions to support@hs-eng.com.

MANUAL CHANGES/UPDATES - Changes from the previous version are in light blue color. When the manual is updated, previous changes will be set to dark blue from light blue and any previous dark blue changes will be reset to the normal color (usually black) for that section/type of text.

1.1 Acknowledgements

The authors wish to thank the following individuals for there help and comments in preparing this manual: Jeff Bozanic, Patrick Duffy, Gary Gressett, Bob Hicks, Mark Johnson, Tom Mount, Joe Radomski, Peter Steggle, Forrest Wilson.

1.2 Thank You

A special "Thank You" to all of you who have offered comments and suggestions that have enabled us to improve the *HS Explorer* to a friendlier and easier to use PPO₂ Monitor. A sincere apology to anyone whose name was omitted. Any omission was unintentional.

2 GENERAL

WARNING!

IMPROPER USE OF THIS DEVICE CAN RESULT IN SERIOUS INJURY OR DEATH. Do not dive with this device until you (1) have read the owner's manual, and (2) understand fully how to operate the device correctly, and (3) have received proper training in the use of gas mixtures other than normal air, (4) have received proper training in conducting staged decompression dive's and (5) have received proper training in the equipment you are using. Use of this device in any diving activity constitutes agreement by the user that s/he assumes and accepts full responsibility for all risks.

The HS Explorer PPO₂ Monitor was designed to be a simple, easy to use monitor for PPO₂ levels when diving with Closed Circuit and Semi-Closed Circuit SCUBA equipment. Calibration requires that the O₂ fuel cell be placed in the appropriate calibration gas. The difference between the two models PPO₂ 1 and PPO₂ 3 is the number of O₂ cells each will read. The PPO₂ 1 reads one O₂ cell and the PPO₂ 3 reads 3 cells.

Button Terminology - The Left Button is 'Button A' and the Right Button is 'Button B'.

3 PREPARING YOUR HS EXPLORER PPO₂ MONITOR FOR USE

Battery installation

The *HS Explorer* PPO₂ Monitor is shipped with the battery installed. In the even the battery needs to be replaced, complete the following steps. **Warning: Removing the battery invalidates the O₂ cell(s) calibration.**

1. Unscrew the knob covering the battery compartment by turning it counterclockwise. Ensure that the brass tab rotates freely. If the brass tab does not rotate freely, unscrew the screw that holds that to the cap by one quarter turn. Confirm that the brass tab will now rotate freely. If it still does not do so, continue to unscrew the screw by one-eighth turn until it rotates freely.
2. Inspect the two O-rings on the sealing cap. Utilizing a suitable silicone lubricant, lightly lubricate the O-rings. Confirm that the O-rings are intact and clean.
3. Confirm that the flat end of the battery (the negative side) is the end being lowered into the battery compartment first. Insert the battery into the computer's battery compartment. With the brass tang positioned to the right (3 o'clock) (6 and 9 o'clock are secondary positions), slide the tang into the battery compartment between the battery and the brass sleeve (positive contact). The tang should slide smoothly in place. If you encounter any resistance, STOP inserting and pull the tang back, inspect for a damaged tang and/or sleeve. If no damage is visible, retry the tang insertion. **Failure to insert the battery properly will cause irreversible damage to the computer, and will void your warranty!**
 Note: The fit of the battery with the brass tang while being lowered in the battery compartment is snug. This is to insure that a positive contact is made for the battery electrodes to the rest of the computer. If you have trouble inserting the battery, do not force the battery into place. It may be that the tab has not slipped fully into place inside the brass sleeve inside the battery compartment. Forcing the battery and cap into place may damage the brass tab! Such damage may necessitate a return of the battery and *HS Explorer* PPO₂ Monitor to the factory for repair or replacement.
4. Once the tang has been inserted in the compartment, begin to screw the battery housing cap closed, by rotating the cap clockwise. At some point after the first O-ring has made a seal, but prior to the second O-ring making a seal, it is likely that the computer will turn itself on. This is normal. Continue to screw the battery compartment plug again until the second O-ring just provides a seal. If the computer has not turned on by this point, you may turn on the computer by depressing switch A. Do not tighten the battery compartment plug any further. Over tightening the battery compartment plug may cause permanent damage to the battery or crack the bottom of the battery compartment case. It may also result in over tightening of the retaining screw for the brass tab. This may lead to further damage of the brass tang and battery cap! The battery is now installed properly in your *HS Explorer* PPO₂ Monitor.

3.1 Battery Care and Information

Your *HS Explorer* PPO₂ Monitor utilizes a 3.6V lithium AA battery. To replace it, utilize a Tadiran® TL-2100, Saft LS 14500 or equivalent battery.

CAUTION!

The Saft battery is slightly longer than the Tadiran. Do not over-tighten the battery cap as it may cause the bottom of the battery compartment to crack.

They may be purchased directly from HydroSpace Engineering, Inc. utilizing the order form from the back of this manual, or may be available from many electronics stores, photographic stores, or pharmacies. Improper use of these batteries may result in explosion, fire, or severe burns! Proper battery care includes the following:

- Do not recharge these batteries. They are not rechargeable.
- Do not heat above 40°C (104°F). Do not expose to fire or high heat.
- Do not expose to water.
- Do not short the contacts.

3.2 Battery Duration

The length of time that the *HS Explorer* PPO₂ Monitor will run on a battery is dependent on usage. Whenever the battery is in the computer, there is always some power drain from the battery. Even when the computer is turned off, there is a continuous low-level power drain from the battery. The following table provides average battery life. Actual results may vary based on water temperature, frequency and duration of use.

Mode	Battery Life (hours)
Standby	~10 years (battery limit)
On (diving)	~2,000 hours

Your *HS Explorer* PPO₂ Monitor has an “Auto-Off” feature. On the surface, this places the *HS Explorer* PPO₂ Monitor in the sleep mode after 30 seconds. This state does minimize battery power consumption.

3.3 Battery Voltage

A fresh battery starts at 3.6 volts. As the battery is utilized, voltage drops until it reaches a level incapable of powering the computer properly. If battery voltage drops too low, the *HS Explorer* PPO₂ Monitor may spontaneously reboot, or cease operation. It is recommended that the battery be replaced after 8 years of usage.

Guidelines for maximizing battery life:

- Keep the *HS Explorer* PPO₂ Monitor warm before and between dives. Air temperatures below 50°F (10°C) will reduce battery current capacity (shorten apparent capacity).
- Never leave the computer in Setup or manual programming mode, as the battery will operate the computer until it is completely drained (This will take about 2 years).
- Always keep a spare battery on hand, and bring extra batteries when traveling to remote locations or on extended dive vacations.
- Prevent crushing or impact to battery when not in use.
- Store batteries in a cool environment when not in use.
- Allow batteries to warm to ambient temperature prior to installation.

3.4 Inspecting the PPO₂ Monitor

It is important to visually inspect your HydroSpace Engineering PPO₂ Monitor prior to using it in open water. Pay special attention to the following points:

1. Inspect the clear faceplate to insure that there are no cracks. Pay particular attention to the area around the screws that fasten the faceplate to the computer. Also look for any signs of moisture or water under the faceplate. If any cracks or moisture is observed, do not dive with the computer! Return the computer as quickly as possible to HydroSpace Engineering, Inc., at the address listed of the warranty service page at the back of this manual.

3. Inspect the two wrist wraps for cracks, tears, or other weak points. If any damage is found in the straps, replace the strap prior to diving.
4. Continue reading for programming instructions prior to beginning the dive.

WARNING!

Never use spray lubricants on the housing or wrist straps. The chemicals may attack and ruin the housing materials, seals and/or straps.

3.5 Oxygen Fuel Cell Setup And Calibration Procedure

Caution!

Calibration of the O₂ cells is required prior to each use.

Oxygen Cells are chemical batteries and therefore have a limited life span. While O₂ Cells can last longer than 12 months, HydroSpace Engineering, Inc. recommends replacement of the O₂ cell(s) on an annual basis. This will help insure the reliability and accuracy of the O₂ Cell's usage. An aged cell may calibrate successfully with 100% Oxygen at sea level but fail to provide adequate output at the higher PPO₂'s encountered while diving.

The *HS Explorer* has been tested with the Teledyne R-22D Oxygen Cell. While other O₂ Cells may perform satisfactory, their use has not been tested. It is the responsibility of the user to verify the accuracy and response of the O₂ Cell in use. The use of O₂ Cells other than the R-22D and the results obtained are the sole responsibility of the end user. Specifications and information on the R-22D may be found on the Teledyne web site: <http://www.teledyne-ai.com/oem/diving.html>

Inaccurate or false Oxygen sensor readings can be caused by many factors. Some of the preventable factors include: water on membrane, touching the sensor face, contaminants, CO₂ exposure, heat, temperature extremes and impact damage. Oxygen fuel cells are delicate devices. Treat them accordingly.

The *Explorer* only displays the PPO₂ in units, tenths and hundredths. For Example: A PPO₂ display of **1.30** will include 1.295 to 1.314.

The activation and calibration of the O₂ Cell is a three-step process.

1. Connect the O₂ Cell to the *Explorer*.
2. Activate the HS *Explorer* PPO₂ Monitor calibration mode.
3. Calibrate the O₂ Cell output.

3.6 O₂ CELL LOAD RESISTORS

The PPO₂-1 Monitor has a 10K Ohm balance resistor installed. The PPO₂-3 Monitor **has 220K Ohm resistors installed and** is intended to be used in conjunction with another device connected to the O₂ cell which provides the correct balance resistor for the O₂ cell in use. The HS Explorer PPO₂ Monitors were tested with Teledyne R22-D oxygen fuel cells. The monitor should work with other cells but it has not been tested with other O₂ cells. The R22-D requires a 10K Ohm load to balance the internal temperature compensating network. **The HS Explorer PPO₂-3 when shipped with a setpoint controller has 220K Ohm resistors across the O₂ Cell input. The HS Explorer PPO₂-3 when shipped alone has 220K Ohm resistors across the O₂ Cell input.** When connected in parallel with another 10.5K Ohm load resistor the resultant load is about 10K Ohms. This could result in a 5% change in the O₂ cell output temperature compensation over the temperature range. If the PPO₂-3 Monitor is used by itself a 10.5K Ohm resistor placed across each O₂ cell will provide the 10K Ohm load recommended by Teledyne.

$$R_t = \frac{R_1 * R_2}{R_1 + R_2} \qquad R_t = \frac{10000 * 220000}{10000 + 220000} \qquad R_t = 9.565K\Omega$$

WARNING!

It is YOUR responsibility to install the proper load resistors for the O₂ cell in use.

3.6.1 Connecting the O₂ Cell

The bulkhead receptacle on the HS *Explorer* and the corresponding cell connector are self aligning.

WARNING

Never force the connector and do not use tools on the connector. The connector/receptacle may be damaged or loosened on the housing causing a leak.

WARNING

The connector is NOT designed to be connected/disconnected under water. Never connect/disconnect the connector under water.

- Inspect the connector and receptacle for cleanliness. Remove any dust, dirt, salt crystals or other debris. **Be careful not to damage the sealing O-ring at the bottom of the receptacle.**
- Place a light coat of silicon grease on the outer portion of the connector shell where it goes into the receptacle.
- Align the pins with the receptacle contacts, gently insert the connector into the receptacle, screw in the connector. The connector is IP-68 rated only when fully connected.



Figure 2 – Connecting O₂ Cell Cable

- Press the left button on the HS *Explorer* PPO₂ Monitor for a '9' count. The HS *Explorer* PPO₂ Monitor is in the O₂ cell calibration mode.



Figure 3 - Calibration

- The screen will be cleared, "E" will be displayed on the left and the calibration gas percentage on the right. For example, "21" is 21% Oxygen (Air). The value used for calibration is 20.9.



Figure 4 – Calibration Oxygen Percentage

- Set the calibration gas percentage of oxygen. Please see the appendix for setting the correct percentage at altitude.
- To change the calibration gas percentage, press the LEFT button to decrease the percentage and press the RIGHT button to increase the percentage.
- When the O₂ cell is in equilibrium in the calibration gas, exit the calibration mode
- If you are not changing the O₂ calibration percentage, press and hold both buttons to set the calibration and exit the calibration mode. An "E" will be displayed on the left during the exit procedure and the 'count' will be displayed on the right.
- The monitor will now display the cell voltage in millivolts. [Replace any cell\(s\) that are not within the O₂ cell manufacturers limits.](#)
- Press and hold the LEFT button to exit the cell voltage display mode and calibrate the unit.
- Press and hold the RIGHT button to exit the cell voltage display mode without calibrating the unit.



Figure 5 – Normal PPO₂-1 Display

[After calibration, pressing and holding the right button for 9 seconds will activate the unit for 10 minutes.](#)

In the event calibration is lost and the unit is active, an “A” will be displayed on the center segment. This requires calibration to clear. Removing the battery is the currently known method for loss of calibration. Figure 6 below shows the monitor in the active mode with a calibration alarm.



Figure 6 – Going Active with Calibration Error



Figure 7 – Active with Loss of Calibration (Alarm)

The left most display will alternate ‘C’ then ‘A’ for calibration alert when the monitor is activated on the surface.



Figure 8 – “A” changing to “C” at 29 seconds

3.7 Post Dive

3.7.1 Post-Dive Care

Proper post-dive care will extend the life of your *HS Explorer* PPO₂ Monitor, and will minimize maintenance problems. Follow these simple guidelines after diving:

1. Rinse your *HS Explorer* PPO₂ Monitor immediately with fresh water after diving in salt water.
2. Soak your *HS Explorer* PPO₂ Monitor in fresh water for 15 minutes after a day's diving activities.
3. **NEVER blow the computer dry with compressed air.** This will force water past the o-rings, and ruin the electronics. It may also embolize the transducer protective gel. If you do this, your warranty is no longer valid and you will be charged for repairs.
4. Dry the water activation contacts with soft towel. These contacts are connected to the "wake-up" circuit. Any residual water will be sensed and the unit may not stay in the sleep mode, thus shortening battery life.
5. After drying, store your *HS Explorer* PPO₂ Monitor in a secure location, with the polycarbonate faceplate padded and protected from abrasion or impacts that might scratch the plastic cover.
6. Always, before reinstalling the battery cap, clean and remove any sand, grit, or other debris from the threads and O-ring. Lightly lubricate the O-ring with an appropriate silicone grease prior to installation.

WARNING!

Never use spray lubricants on the housing or wrist straps. The chemicals may attack and ruin the housing materials and or straps.

WARNING!

Under no circumstances should you open the monitor. If the internal tamper seal is broken (indicating the computer has been opened), there is a minimum \$450 service charge to service the computer.

4 GENERAL MAINTENANCE

While your *HS Explorer* PPO₂ Monitor is a robust and durable piece of diving equipment, it is also a sophisticated electronic tool with many sensitive parts and components. Many of these may be damaged if your *HS Explorer* PPO₂ Monitor is improperly treated. Abusive treatment or improper care of your *HS Explorer* PPO₂ Monitor will invalidate the warranty. Follow these guidelines to maintain your *HS Explorer* PPO₂ Monitor:

- Follow the Post-Dive Care guidelines provided in the previous section.
- Do not expose your *HS Explorer* PPO₂ Monitor to high temperatures.
- Always insert the battery properly with reference to the polarity.
- Use only approved 3.6V lithium batteries.
- Prevent abrasion or impacts to the polycarbonate faceplate.
- Never remove or tighten the screws connecting the polycarbonate faceplate to the computer.
- Do not over-tighten the battery cap when installing the battery.
- If any signs of water in the housing are noted, return the unit to HydroSpace Engineering, Inc. for inspection/repair as soon as possible.
- Do not expose your *HS Explorer* PPO₂ Meter to cleansers or other harsh chemicals.
- Never insert anything other than the battery into the battery compartment.
- Store your *HS Explorer* PPO₂ Monitor out of direct sunlight.
- Clean sand, grit, or other debris from battery cap threads prior to installing battery cap.
- Remove battery prior to long-term storage of your *HS Explorer* PPO₂ Monitor.
- Always install the battery cap prior to immersion in water.
- Do not immerse or dive with a computer if it shows signs of flooding or other damage, or if it seems to be operating improperly.
- Do not expose your *HS Explorer* PPO₂ Monitor to organic solvents, as they will damage the housing, polycarbonate faceplate, and O-rings.
- Insure the brass tab or tang in the battery compartment is capable of rotating freely at all times.

5 WARRANTY AND SERVICE

HydroSpace Engineering, Inc. remains committed to producing only the finest PPO₂ Monitors, and stands behind their product 100 percent. Should experience difficulties with your *HS Explorer* PPO₂ Monitor, follow the instructions below.

1. Contact HydroSpace Engineering at 904.794.7896, or e-mail us at support@hs-eng.com, to obtain a return merchandise authorization (RMA) number.
2. Return the *HS Explorer* PPO₂ Monitor to Repair Department , HydroSpace Engineering Inc., freight prepaid, at 6920 Cypress Lake Court, St. Augustine, Fla. 3206, USA.
3. Enclose a written explanation of the problems experienced with the unit. Be as specific as possible, explaining exactly what you were doing when the problem arose. Specify whether the problem occurred above or below the surface, and whether it occurred prior, during, or after a scuba dive.
4. Enclosed a sheet with the address to return the repaired *HS Explorer* PPO₂ Monitor to. Also enclose your daytime telephone number, and your e-mail address if available. Specify the best time for one of our technicians to contact you if we have further questions about the problem you experienced with your *HS Explorer* computer.
5. If your *HS Explorer* PPO₂ Monitor is being repaired under warranty, it will be repaired or replaced at no charge to you. To activate your warranty, you must have returned the *HS Explorer* product registration form sent to you with your *HS Explorer* Computer within 10 days of purchase. Please enclose a copy of that product registration form, along with a receipt from the vendor showing the date of purchase that you acquired the *HS Explorer* computer.
6. If your *HS Explorer* Computer is not being repaired under warranty, there is a minimum repair/evaluation charge of \$75. An estimate will be provided to you for the total cost of repair or replacement after our technicians have had an opportunity to evaluate your computer. If additional charges are indicated, the repair will not be completed until you have provided authorization, with prepayment of the repair charges.
7. The return merchandise authorization (RMA) number must be included inside your shipment container, and must also be written on the address label to HydroSpace Engineering, Inc.

HydroSpace Engineering reserves the right to determine if the user has invalidated the warranty by misuse of the *HS Explorer* PPO₂ Monitor, or by improper treatment or maintenance protocols.

6 REPAIR AND UPGRADE POLICY

1. Contact HydroSpace Engineering, Inc. for a Return Authorization Number. Write this number on the outside of the package. Be sure to include your name and address on the inside.
2. All units are to be returned freight prepaid.
3. Units requiring repair may be repaired or replaced as required by the circumstances.
4. Any return prepaid shipping will be per direction.
5. There is a \$10.00 (U.S.A.) and \$20.00 (International) shipping and handling charge assessed for firmware upgrades on units older than 30 days. Additional charges may apply to special courier.

7 RETURN POLICY

1. The *HS Explorer* may be returned unused within 30 days for a refund. A 20% restocking fee will be assessed.
2. After 30 days, no refunds will be given.

8 Appendix A - Equivalent Depth Tables

Depth	PPO ₂ Setpoint																
	0.21	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8
30	36	32	28	24	20	16	11	7	3	-1	-5	-9	-14	-18	-22	-26	-30
40	49	45	41	37	32	28	24	20	16	12	7	3	-1	-5	-9	-14	-18
50	61	58	53	49	45	41	37	33	28	24	20	16	12	7	3	-1	-5
60	76	72	68	64	60	55	51	47	43	39	35	30	26	22	18	14	10
70	87	83	79	75	70	66	62	58	54	49	45	41	37	33	29	24	20
80	99	96	91	87	83	79	75	71	66	62	58	54	50	45	41	37	33
90	112	108	104	100	96	92	87	83	79	75	71	66	62	58	54	50	46
100	125	121	117	113	108	104	100	96	92	87	83	79	75	71	67	62	58
110	137	134	129	125	121	117	113	108	104	100	96	92	88	83	79	75	71
120	150	146	142	138	134	129	125	121	117	113	109	104	100	96	92	88	84
130	163	159	155	151	146	142	138	134	130	125	121	117	113	109	105	100	96
140	175	172	167	163	159	155	151	146	142	138	134	130	126	121	117	113	109
150	188	184	180	176	172	167	163	159	155	151	147	142	138	134	130	126	122
160	201	197	193	188	184	180	176	172	168	163	159	155	151	147	143	138	134
170	213	209	205	201	197	193	189	184	180	176	172	168	164	159	155	151	147
180	226	222	218	214	210	205	201	197	193	189	185	180	176	172	168	164	159
190	239	235	231	226	222	218	214	210	206	201	197	193	189	185	181	176	172
200	251	247	243	239	235	231	227	222	218	214	210	206	202	197	193	189	185
210	264	260	256	252	248	243	239	235	231	227	223	218	214	210	206	202	197
220	277	273	269	264	260	256	252	248	244	239	235	231	227	223	218	214	210
230	289	285	281	277	273	269	265	260	256	252	248	244	239	235	231	227	223
240	302	298	294	290	286	281	277	273	269	265	261	256	252	248	244	240	235
250	315	311	307	302	298	294	290	286	282	277	273	269	265	261	256	252	248
260	327	323	319	315	311	307	303	298	294	290	286	282	277	273	269	265	261
270	340	336	332	328	324	319	315	311	307	303	298	294	290	286	282	278	273
280	352	349	345	340	336	332	328	324	319	315	311	307	303	299	294	290	286
290	365	361	357	353	349	345	341	336	332	328	324	320	315	311	307	303	299
300	378	374	370	366	362	357	353	349	345	341	336	332	328	324	320	316	311

Equivalent Depth in Feet

Inspired gas pressure compensated for water vapor pressure

Appendix A (continued)

Depth	PPO ₂ Setpoint																
	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8
30	1.65	1.56	1.46	1.36	1.26	1.16	1.06	0.96	0.86	0.76	0.66	0.56	0.46	0.36	0.26	0.16	0.06
40	1.96	1.87	1.77	1.67	1.57	1.47	1.37	1.27	1.17	1.07	0.97	0.87	0.77	0.67	0.57	0.47	0.37
50	2.26	2.17	2.07	1.97	1.87	1.77	1.67	1.57	1.47	1.37	1.27	1.17	1.07	0.97	0.87	0.77	0.67
60	2.56	2.47	2.37	2.27	2.17	2.07	1.97	1.87	1.77	1.67	1.57	1.47	1.37	1.27	1.17	1.07	0.97
70	2.86	2.77	2.67	2.57	2.47	2.37	2.27	2.17	2.07	1.97	1.87	1.77	1.67	1.57	1.47	1.37	1.27
80	3.17	3.08	2.98	2.88	2.78	2.68	2.58	2.48	2.38	2.28	2.18	2.08	1.98	1.88	1.78	1.68	1.58
90	3.47	3.38	3.28	3.18	3.08	2.98	2.88	2.78	2.68	2.58	2.48	2.38	2.28	2.18	2.08	1.98	1.88
100	3.77	3.68	3.58	3.48	3.38	3.28	3.18	3.08	2.98	2.88	2.78	2.68	2.58	2.48	2.38	2.28	2.18
110	4.08	3.99	3.89	3.79	3.69	3.59	3.49	3.39	3.29	3.19	3.09	2.99	2.89	2.79	2.69	2.59	2.49
120	4.38	4.29	4.19	4.09	3.99	3.89	3.79	3.69	3.59	3.49	3.39	3.29	3.19	3.09	2.99	2.89	2.79
130	4.68	4.59	4.49	4.39	4.29	4.19	4.09	3.99	3.89	3.79	3.69	3.59	3.49	3.39	3.29	3.19	3.09
140	4.99	4.90	4.80	4.70	4.60	4.50	4.40	4.30	4.20	4.10	4.00	3.90	3.80	3.70	3.60	3.50	3.40
150	5.29	5.20	5.10	5.00	4.90	4.80	4.70	4.60	4.50	4.40	4.30	4.20	4.10	4.00	3.90	3.80	3.70
160	5.59	5.50	5.40	5.30	5.20	5.10	5.00	4.90	4.80	4.70	4.60	4.50	4.40	4.30	4.20	4.10	4.00
170	5.90	5.81	5.71	5.61	5.51	5.41	5.31	5.21	5.11	5.01	4.91	4.81	4.71	4.61	4.51	4.41	4.31
180	6.20	6.11	6.01	5.91	5.81	5.71	5.61	5.51	5.41	5.31	5.21	5.11	5.01	4.91	4.81	4.71	4.61
190	6.50	6.41	6.31	6.21	6.11	6.01	5.91	5.81	5.71	5.61	5.51	5.41	5.31	5.21	5.11	5.01	4.91
200	6.80	6.71	6.61	6.51	6.41	6.31	6.21	6.11	6.01	5.91	5.81	5.71	5.61	5.51	5.41	5.31	5.21
210	7.11	7.02	6.92	6.82	6.72	6.62	6.52	6.42	6.32	6.22	6.12	6.02	5.92	5.82	5.72	5.62	5.52
220	7.41	7.32	7.22	7.12	7.02	6.92	6.82	6.72	6.62	6.52	6.42	6.32	6.22	6.12	6.02	5.92	5.82
230	7.71	7.62	7.52	7.42	7.32	7.22	7.12	7.02	6.92	6.82	6.72	6.62	6.52	6.42	6.32	6.22	6.12
240	8.02	7.93	7.83	7.73	7.63	7.53	7.43	7.33	7.23	7.13	7.03	6.93	6.83	6.73	6.63	6.53	6.43
250	8.32	8.23	8.13	8.03	7.93	7.83	7.73	7.63	7.53	7.43	7.33	7.23	7.13	7.03	6.93	6.83	6.73
260	8.62	8.53	8.43	8.33	8.23	8.13	8.03	7.93	7.83	7.73	7.63	7.53	7.43	7.33	7.23	7.13	7.03
270	8.93	8.84	8.74	8.64	8.54	8.44	8.34	8.24	8.14	8.04	7.94	7.84	7.74	7.64	7.54	7.44	7.34
280	9.23	9.14	9.04	8.94	8.84	8.74	8.64	8.54	8.44	8.34	8.24	8.14	8.04	7.94	7.84	7.74	7.64
290	9.53	9.44	9.34	9.24	9.14	9.04	8.94	8.84	8.74	8.64	8.54	8.44	8.34	8.24	8.14	8.04	7.94
300	9.83	9.74	9.64	9.54	9.44	9.34	9.24	9.14	9.04	8.94	8.84	8.74	8.64	8.54	8.44	8.34	8.24

10 Inert Gas Partial Pressure - Imperial

Appendix A (continued)

Depth	PPO2 Setpoint																
	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8
9	1.65	1.56	1.46	1.36	1.26	1.16	1.06	0.96	0.86	0.76	0.66	0.56	0.46	0.36	0.26	0.16	0.06
12	1.96	1.87	1.77	1.67	1.57	1.47	1.37	1.27	1.17	1.07	0.97	0.87	0.77	0.67	0.57	0.47	0.37
15	2.26	2.17	2.07	1.97	1.87	1.77	1.67	1.57	1.47	1.37	1.27	1.17	1.07	0.97	0.87	0.77	0.67
18	2.56	2.47	2.37	2.27	2.17	2.07	1.97	1.87	1.77	1.67	1.57	1.47	1.37	1.27	1.17	1.07	0.97
21	2.86	2.77	2.67	2.57	2.47	2.37	2.27	2.17	2.07	1.97	1.87	1.77	1.67	1.57	1.47	1.37	1.27
24	3.17	3.08	2.98	2.88	2.78	2.68	2.58	2.48	2.38	2.28	2.18	2.08	1.98	1.88	1.78	1.68	1.58
27	3.47	3.38	3.28	3.18	3.08	2.98	2.88	2.78	2.68	2.58	2.48	2.38	2.28	2.18	2.08	1.98	1.88
30	3.77	3.68	3.58	3.48	3.38	3.28	3.18	3.08	2.98	2.88	2.78	2.68	2.58	2.48	2.38	2.28	2.18
33	4.08	3.99	3.89	3.79	3.69	3.59	3.49	3.39	3.29	3.19	3.09	2.99	2.89	2.79	2.69	2.59	2.49
36	4.38	4.29	4.19	4.09	3.99	3.89	3.79	3.69	3.59	3.49	3.39	3.29	3.19	3.09	2.99	2.89	2.79
39	4.68	4.59	4.49	4.39	4.29	4.19	4.09	3.99	3.89	3.79	3.69	3.59	3.49	3.39	3.29	3.19	3.09
43	4.99	4.90	4.80	4.70	4.60	4.50	4.40	4.30	4.20	4.10	4.00	3.90	3.80	3.70	3.60	3.50	3.40
46	5.29	5.20	5.10	5.00	4.90	4.80	4.70	4.60	4.50	4.40	4.30	4.20	4.10	4.00	3.90	3.80	3.70
49	5.59	5.50	5.40	5.30	5.20	5.10	5.00	4.90	4.80	4.70	4.60	4.50	4.40	4.30	4.20	4.10	4.00
52	5.90	5.81	5.71	5.61	5.51	5.41	5.31	5.21	5.11	5.01	4.91	4.81	4.71	4.61	4.51	4.41	4.31
55	6.20	6.11	6.01	5.91	5.81	5.71	5.61	5.51	5.41	5.31	5.21	5.11	5.01	4.91	4.81	4.71	4.61
58	6.50	6.41	6.31	6.21	6.11	6.01	5.91	5.81	5.71	5.61	5.51	5.41	5.31	5.21	5.11	5.01	4.91
61	6.80	6.71	6.61	6.51	6.41	6.31	6.21	6.11	6.01	5.91	5.81	5.71	5.61	5.51	5.41	5.31	5.21
64	7.11	7.02	6.92	6.82	6.72	6.62	6.52	6.42	6.32	6.22	6.12	6.02	5.92	5.82	5.72	5.62	5.52
67	7.41	7.32	7.22	7.12	7.02	6.92	6.82	6.72	6.62	6.52	6.42	6.32	6.22	6.12	6.02	5.92	5.82
70	7.71	7.62	7.52	7.42	7.32	7.22	7.12	7.02	6.92	6.82	6.72	6.62	6.52	6.42	6.32	6.22	6.12
73	8.02	7.93	7.83	7.73	7.63	7.53	7.43	7.33	7.23	7.13	7.03	6.93	6.83	6.73	6.63	6.53	6.43
76	8.32	8.23	8.13	8.03	7.93	7.83	7.73	7.63	7.53	7.43	7.33	7.23	7.13	7.03	6.93	6.83	6.73
79	8.62	8.53	8.43	8.33	8.23	8.13	8.03	7.93	7.83	7.73	7.63	7.53	7.43	7.33	7.23	7.13	7.03
82	8.93	8.84	8.74	8.64	8.54	8.44	8.34	8.24	8.14	8.04	7.94	7.84	7.74	7.64	7.54	7.44	7.34
85	9.23	9.14	9.04	8.94	8.84	8.74	8.64	8.54	8.44	8.34	8.24	8.14	8.04	7.94	7.84	7.74	7.64
88	9.53	9.44	9.34	9.24	9.14	9.04	8.94	8.84	8.74	8.64	8.54	8.44	8.34	8.24	8.14	8.04	7.94
91	9.83	9.74	9.64	9.54	9.44	9.34	9.24	9.14	9.04	8.94	8.84	8.74	8.64	8.54	8.44	8.34	8.24

Inert Gas Partial Pressure - Metric

11 APPENDIX B - PRESSURE CONVERSIONS

Units of pressure are converted according to the following primary definitions (Ref. 1):

$$\begin{aligned} 1 \text{ atm} &= 760.000 \text{ torr} \\ 1 \text{ bar} &= 100,000 \text{ Pa} \\ 1 \text{ psi} &= 6,894.76 \text{ Pa} \\ 1 \text{ torr} &= 133.322 \text{ Pa} \end{aligned}$$

Units of pressure expressed as water depth below sea-level are converted using the following additional standard definitions as adopted by the Undersea and Hyperbaric Medical Society:

$$\begin{aligned} 1 \text{ bar} &= 32.6457 \text{ fsw (assumes seawater density} = 1.02480 \text{ gm/cc)} \\ 1 \text{ msw} &= 10.0000 \text{ kPa (assumes seawater density} = 1.01972 \text{ gm/cc)} \\ 1 \text{ bar} &= 33.4702 \text{ fsw (assumes freshwater density} = 0.999552 \text{ gm/cc)} \\ 1 \text{ msw} &= 9.80229 \text{ kPa (assumes freshwater density} = 0.999552 \text{ gm/cc)} \end{aligned}$$

Units of pressure expressed in terms of geometric altitude above sea level are converted using defining equations for the *U.S. Standard Atmosphere, 1976* (Ref. 2). These equations give pressure P in atmospheres absolute (atm abs) as functions of geometric altitude above sea-level A in kilometers (km):

$$P = \left[\frac{288.15}{288.15 - 6.5A} \right]^{-5.25588} ; A < 11 \text{ km}$$

$$P = 0.22336 \cdot \exp[0.15769 \cdot (11 - A)] ; 20\text{km} > A \geq 11 \text{ km.}$$

These equations are inverted to obtain the following expressions for geometric altitude A in kilometers (km) as functions of pressure P in atmospheres absolute (atm abs):

$$A = \left\{ \frac{288.15 - \exp \left[\ln(288.15) + \frac{\ln(P)}{5.25588} \right]}{6.5} \right\} ; P > 0.22336 \text{ atm abs}$$

$$A = 11 - \left\{ \frac{\ln \left(\frac{P}{0.22336} \right)}{0.15769} \right\} ; 0.05403 \text{ atm abs} < P \leq 0.22336 \text{ atm abs}$$

The above expressions cover the relationship between geometric altitude and atmospheric pressure over the entire physiological range; from below sea-level to above the Armstrong line at 62,800 ft (19.14 km), where atmospheric pressure equals the vapor pressure of water at 37°C (47 mm-Hg). In this physiological region, the *U.S. Standard Atmosphere, 1976*, of the United States Committee on Extension to the Standard Atmosphere (COESA) is the same as COESA's "*U.S. Standard Atmosphere, 1962*," and is identical with the International Civil Aviation Organization (ICAO) "*Manual of the ICAO Standard Atmosphere*," as revised in 1964. The definition of the Standard in this region was also adopted in the *ISO Standard Atmosphere* (ISO 1973) by the International Standards Organization (ISO) in 1973.

Note: 1 atm abs = 1.01325 bar,
1 bar = 0.9869 atm abs

12 Appendix C - Altitude/Pressure/Depth Correction/Oxygen Concentration Table

Altitude		Pressure		Depth Correction		100% O ₂	Oxygen Concentration			
KFt	KM	ATA	Bar	Ft FW	M FW	PPO ₂	20.9% (.3)	20.9% (.1)	21% (.3)	21% (.1)
0.0	0.0000	1.0000	1.0133	0.03	0.01	1.0000	20.900	20.9	21.000	21.0
1.0	0.3048	0.9626	0.9754	0.84	0.26	0.9626	20.119	20.1	20.215	20.2
2.0	0.6096	0.9266	0.9389	2.08	0.63	0.9266	19.367	19.4	19.459	19.5
3.0	0.9144	0.8920	0.9038	3.27	1.00	0.8920	18.643	18.6	18.732	18.7
4.0	1.2192	0.8586	0.8700	4.42	1.35	0.8586	17.946	17.9	18.032	18.0
5.0	1.5240	0.8265	0.8375	5.53	1.68	0.8265	17.275	17.3	17.357	17.4
6.0	1.8288	0.7956	0.8062	6.59	2.01	0.7956	16.629	16.6	16.709	16.7
7.0	2.1336	0.7659	0.7761	7.61	2.32	0.7659	16.007	16.0	16.084	16.1
8.0	2.4384	0.7373	0.7470	8.60	2.62	0.7373	15.409	15.4	15.483	15.5
9.0	2.7432	0.7097	0.7191	9.55	2.91	0.7097	14.833	14.8	14.904	14.9
10.0	3.0480	0.6832	0.6922	10.46	3.19	0.6832	14.278	14.3	14.347	14.3
11.0	3.3528	0.6576	0.6664	11.34	3.46	0.6576	13.745	13.7	13.810	13.8
12.0	3.6576	0.6331	0.6414	12.19	3.72	0.6331	13.231	13.2	13.294	13.3
13.0	3.9624	0.6094	0.6175	13.01	3.96	0.6094	12.736	12.7	12.797	12.8
14.0	4.2672	0.5866	0.5944	13.79	4.20	0.5866	12.260	12.3	12.319	12.3
15.0	4.5720	0.5647	0.5722	14.55	4.43	0.5647	11.802	11.8	11.858	11.9
16.0	4.8768	0.5436	0.5508	15.27	4.66	0.5436	11.361	11.4	11.415	11.4
17.0	5.1816	0.5232	0.5302	15.97	4.87	0.5232	10.936	10.9	10.988	11.0
18.0	5.4864	0.5037	0.5104	16.65	5.07	0.5037	10.527	10.5	10.577	10.6
19.0	5.7912	0.4849	0.4913	17.30	5.27	0.4849	10.134	10.1	10.182	10.2
20.0	6.0960	0.4667	0.4729	17.92	5.46	0.4667	9.755	9.8	9.801	9.8

The altitude settings on the HS Explorer range from 0 to 9 and correspond to the table altitudes of 0.0 to 9.0 KFt.

For depth gauges which display the depth as a function of absolute pressure or bar as the *HS Explorer* does, the linear depth to the surface can be calculated by adding the Depth Correction to the displayed depth. For example, when diving at 5000 Ft./1.52 KM add 5.53 Ft./1.68 M to the indicated depth.

13 References:

- 1) Standard Practice for Use of the International System of Units (SI). Document E380-89a, American Society for Testing and Materials. Philadelphia, PA, 1989.
- 2) U.S. Standard Atmosphere, 1976. United States Committee on Extension to the Standard Atmosphere. National Oceanic and Atmospheric Administration, Washington, D.C. (NOAA-S/T 76-15672): Supt. of Docs., U.S. Govt. Print. Off. (Stock No. 003-017-00323-0), 1976.
- 3) Decompression - Decompression Sickness, Professor Dr. med A. A. Bühlmann, Springer-Verlag (ISBN 3-540-12514-9), 1983.
- 4) Tauchmedizin, Professor Dr. med A. A. Bühlmann, Springer-Verlag (ISBN 3-540-58970-8), 1995.
- 5) NOAA Diving Manual, Diving for Science and Technology. United States Department of Commerce. National Oceanic and Atmospheric Administration, Washington, D.C, 1991.
- 6) U.S. Navy Air Decompression Table Handbook And Decompression Chamber Operators Handbook. United States Department of the Navy. Naval Sea Systems Command, Best Publishing Company.
- 7) Decompression Theory, a monograph by B. R. Wienke, Ph.D., Los Alamos National Laboratory.
- 8) Mastering Rebreathers, Jeffrey E. Bozanic, Best Publishing Company, (ISBN 0-941332-96-9), 2002

14 GLOSSARY

Many abbreviations are used in manual. The following listing provides a convenient listing if you cannot remember a particular abbreviation.

ATA	Atmosphere Absolute
ATM	Atmosphere
AVG	Average Dive Depth
BT	Bottom Time
CC	Closed circuit
CD	Change Depth
CF	Computational Formula or Calculation Formula
CO	Communication Mode (Mode 4)
COMP	Gas Mix Composition
Deco	Decompression
DN	Dive Number
END	Equivalent Nitrogen Depth
Err	Error
fsw	feet of sea water
ft	feet
He	Helium
HSE	HydroSpace Engineering, Inc
LCD	Liquid Crystal Display
LED	Light Emitting Diode
K or k	Kilo = 10^3 = Thousand
k£, k\$	Requirement for underwater photography
m	meters
min	minutes
msw	meters of sea water
N	Nitrogen
N He	TRIMIX, Nitrogen, Helium
N ₂	Nitrogen
ND	No-Decompression
O ₂	Oxygen
OC	Open Circuit
OTU	Oxygen Tolerance Units (Same as UPTD)
PC	Personal Computer
PPO ₂	Partial Pressure of Oxygen (in atmospheres)
sec	Second
SI	Surface Interval
TEMP	Temperature
TTF	Time To Fly
TTS	Time To Surface
UPTD	Unit Pulmonary Toxicity Dose
V	Volt

15 REGISTRATION FORMModel: PPO₂-____ Serial Number: _____(on green circuit board) Purchase Date: _____

Owners Name: _____

Address: _____

City, State, Zip _____

Phone, Fax _____

E-mail _____

WARNING!**IMPROPER USE OF THIS DEVICE CAN RESULT IN SERIOUS INJURY OR DEATH.**

Do not dive with this device until you

- (1) have read the owner's manual, and
- (2) understand fully how to operate the device correctly, and
- (3) have received proper training in the use of gas mixtures other than normal air, and
- (4) have received proper training in conducting staged decompression dives.

Use of this device and/or its simulator software in any diving activity constitutes agreement by the user that s/he assumes and accepts full responsibility for all risks.

Owners Signature: _____

Warranty

This *HS Explorer* PPO₂ Monitor was tested prior to shipment and found to be free from material defects and workmanship. Should the original owner experience any problems with this device, they should contact HydroSpace Engineering, Inc. at the address listed below preferably via email or fax. HydroSpace Engineering, Inc. will authorize a return and repair or replace the unit. The *HS Explorer* PPO₂ Monitor shall be returned freight prepaid. A return shipping and handling charge may be assessed on *HS Explorer* PPO₂ Monitor's from 30 days of original shipment. The owner will be contacted for expenses outside the scope of this warranty.

The warranty is null and void if:

- The battery has been inserted backwards (reverse polarity).
- The unit has been dried with compressed air (gas).
- The lens has been removed or the lens screws loosened.
- The product has been modified in any way.
- The product has been abused.
- The product's limits have been exceeded or the produce exposed to dry (chamber) exposure.
- The product is not registered within 10 days of purchase.
- The product has been exposed to any material that causes damage to the case, lens or o-rings.
- The product has been maintained in a manner inconsistent with is usage or standard practices.

REPAIR CHARGES WILL BE ASSESSED ON INVALIDATED UNITS!

Make a copy of this registration for your records and send the original to:

HydroSpace Engineering, Inc.
6920 Cypress Lake Ct.
St. Augustine, FL 32086 USA

Tel: 904.794.7896 Fax: 904.794.1529
E-mail: support@hs-eng.com