



## **!! Important Product Information: Do Not Discard !!**

01/03/2011

### Product Notice

### **Sentinel User Manual Rev B 12/10**

Dear Sentinel Rebreather Customer,

Thank you for your choice in using this VR Technology device. We would like you to be aware of the following information that has been updated since printing the Sentinel User Manual Rev **B** 12/09. This information applies to all Sentinel rebreathers manufactured after November 2010. If you have any questions, please contact VR Technology Customer Support for assistance.

#### **CORRECTIONS:**

#### **SUPPLEMENT TO MANUAL FOR USERS OF THE NEW OPTOCON UPGRADE**

##### **WARNING**

You should check the status of the battery level of the Triple O2 sender module regularly (please see page 6 of this manual for detail). If the Primary battery is no longer functioning and the backup battery is in use, you must change the Triple O2 Sender module as soon as possible after the dive is complete d

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## Optocon for the Sentinel Rebreather

### Introduction

The Sentinel rebreather now comes equipped with a new way of linking some of the electronics system together when compared to the conventional cables and connectors. This technique uses infrared (IR) light to transmit data to and from the rebreather's electronic devices either wirelessly or through a fibre optic cable (FOC) . This system is called **Optocon**.

Charging of the electronics remains the same and is provided through the dedicated Sentinel main's charger and a charging port located on the electronics cap of the Sentinel rebreather canister head.

Three sub-systems within the Sentinel now use the Optocon system;

1. The HP pressure gas sensors
2. The oxygen sensors
3. The TPM array

### Background

Since electrical systems have been used underwater, they have often been limited by the ability of interconnected devices to keep out water. In this respect, water getting into connectors and cables can be the main cause of system failures. With this overarching problem, VR Technology has devised an optical system called OPTOCON for interconnecting devices. This system has been released in their dive computer and life support product to increase the reliability of data communications underwater.

There are two basic optical systems employed in OPTOCON:

1. Polymer fibre optic cable to interconnect remote sensors that are not in line of sight – e.g. the HP sensors. The main advantage over electrical cable is that water flooding has no effect on either the connector or the cable.
2. Radiated Infra-red modulated transmission, for use in mainly internal system interconnections. No optical cable is required, reducing clutter and increasing reliability. This system is similar to that used in TV remote controls – hence a very reliable and error immune data link. In the Sentinel, this system is used for the PPO2 sensors and the TPM (Thermal Profile Monitor).

Both systems have batteries in the sending unit that can last around 3-5 years. Low power hibernate functions and intelligent transmission algorithms ensure reliable optical links and long battery life. Battery status as well as sensor status is transmitted to the host device, therefore battery replacement or module replacement can be done well in advance of critical battery levels.

## Feature overview

The Optocon system achieves improved reliability when compared to cable and connector interconnected systems.

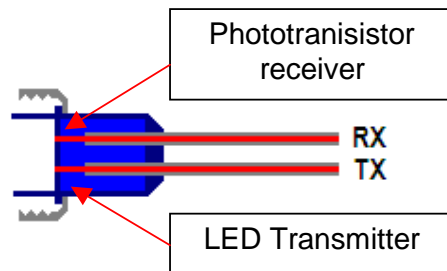
As the data transmission is optically digital, the system can receive data even with poor transmission paths.

System connection status accurately shows if there is a link or module fault. This gives improved data integrity compared to analogue electrically connected systems, whereby an unconnected or faulty cable/connector can not be detected reliably except by inference or as an 'unusual' reading. The OPTOCON system status clearly shows faulty or missing modules, allowing the user to take appropriate action.

Due to the encoding and error checking of the data streams, sunlight, TV remote controls and other extraneous light will not be interpreted as sensor data.

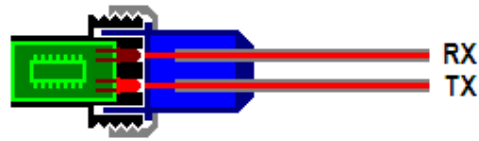
## Optocon Infra Red Technology – An overview

The Optocon system uses light to send encoded data to and from devices. Data is sent using an LED and received using a phototransistor. A Fibre Optic Cable (FOC) is used to carry the light to and from the remote device. A "transmitter" from one device is connected to the "receiver" on the mating device. The mating connector below shows two FOCs, one to send data, and one to receive.



FOC is flexible and robust but it can break. However, small cracks will still allow data to pass through and water can even assist in transmission since it fills the cracks better than air, allowing light to pass. The supplied FOCs are extra-long to allow for trimming after accidental breakage. From a service perspective, replacement cables are relatively inexpensive, and can be sent easily by post or retained in a spare parts kit.

When mated, the FOC should be placed very close to the LED and Phototransistor to ensure a good light coupling. A thin layer of water or air (2mm) can be tolerated between the FOC and the LED, but to achieve the best data quality, the connector faces should be well mated and clean.



To enable data transmission from for example, a remote HP Sensor to the Sentinel rebreather, the sensor housing contains a controller Printed Circuit Board (PCB) and very a small battery. The send device in the housing contains an intelligent control system called “Intellisend.” This system sends data frequently if the sensor reading is changing, but reduces power consumption and reduces the send rate if the readings are not changing. When any Optocon device is removed, i.e. the oxygen sensors for storage, no user action is required once the device is returned to the system. All data reconnection is carried out automatically. This system offers a potential battery module life of around 3-5 years (dependant on the sensor attached.)

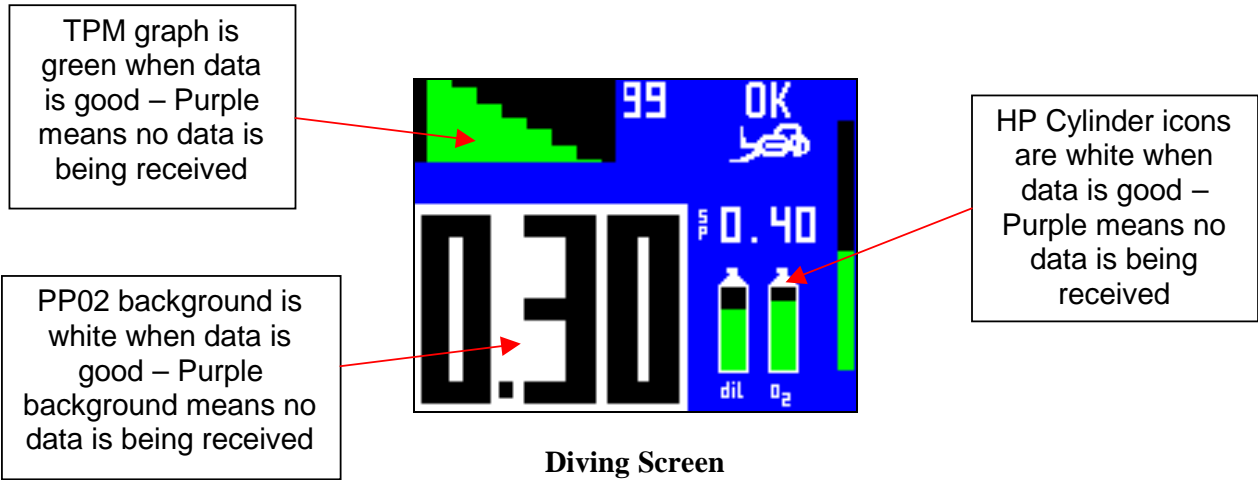
The Optocon send modules are equipped with a blue LED that flashes approximately every 3-5 seconds. This indicates that the system is operational and also functions as a battery level monitor. If the Blue LED does not flash, the battery is low, and the Optocon device should be returned to VR Technology for battery replacement. However, as a safety feature and for a short period, operation can still be achieved when the battery level is too low to flash the LED. Therefore as soon as you notice that the LED is not flashing you should return to VR Technology for battery replacement. The transmitter device is manufactured out of clear plastic to ensure this blue LED can be observed easily. It is recommended to monitor battery levels on the Optocon screen on the primary handset and to use the blue LED flash as a quick confirmation of correct operation of the Optocon device.

**Important:** All battery levels for the Optocon system can be found in the OPTOCON menu on the Sentinel handset. An alarm will be visible when the battery is too low (the background will turn cyan) for continued operation. At this point the battery/module should be replaced. Battery voltages lower than 2.6v will generate an alarm.

A loss of communications or lack of usable data on any sender will result in a software safety feature on the dive screen turning the screen area associated with the data yellow (waiting for data) then purple (no data received / useable) as opposed to the standard green (data received & good). To avoid confusion with PPO2 levels, white is substituted for the ‘green is good’ screen when displaying P PO2 on the diving screen. If no data is received from one of the PPO2 channels this part of the screen turns purple to warn that no rebreather PPO2 information is available on that channel.

### Warning

If purple is seen on the Primary display, the Secondary display should be checked to verify PO2. If that is also purple and no numbers are displayed, a bailout to open circuit is advised until a safe breathing mixture in the rebreather (all green) is established.



### Redundancy of the Optocon system

The safety concept of the Optocon system is to ensure that no single failure of wireless signal or electronic device will cause failure of the complete sub-system.

Infrared data is received by both a primary and secondary receiver for system redundancy inside the canister head.

Any potential user error has been minimized as the Optocon system components are auto-connecting and auto-calibrating to the Sentinel rebreather main electronics controller.

### Sentinel Optocon Status Screen



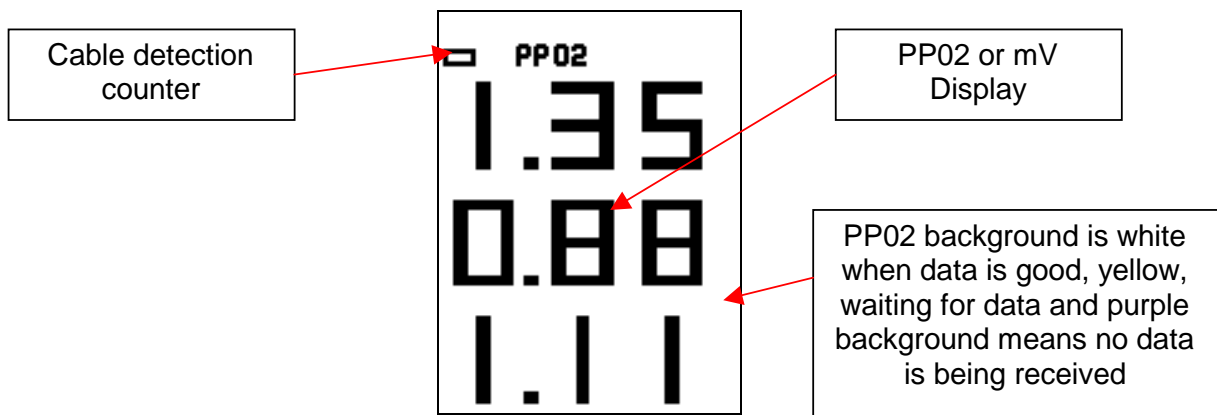
During pre-dive or by selecting the Optocon menu from the options list, the status of all the Optocon channels can be seen. The menu shows the connection status and battery level of each channel. In addition to this, alarms are shown on the alarms and status screens should there be any connection or battery level problems in any channel. The background of each channel will show green if all functionality is good.

A **yellow** background shows that data is a little late, but of no cause for major concern. The yellow background will show quickly when a device is removed.

A **cyan** (turquoise) background indicates that the battery level is low, or has not yet been received. Battery level changes very slowly, so battery level updates are infrequent to save power. A **purple** background indicates that no communication or valid data from the device has been received for over 2 minutes. For PPO2, red backgrounds are seen when both transmitting devices have no connection. When either purple or **red** are seen the connection should be checked, this could indicate that a device is not fitted, or that the OPTICAL CABLE CONNECTIONS or the FLOW CONE are too dirty for good connection to be maintained reliably.

### **Remember - Always keep your rebreather clean!**

#### **Sentinel PP02 Secondary Display Screen**



The status of the Optocon PP02 monitoring can be viewed using the Optocon Secondary handset. This handset works independently and in a similar way to the Sentinel iSec Secondary handset and displays the PP02 and mV level of each oxygen sensor separately. A similar white/yellow/purple background colouring system is now employed to indicate Optocon PP02 communication status. The top left hand of the screen also has a 'communication detection' counter which counts the number of approximate 10 second intervals after the last expected data send. This counter counts from zero to 999 displaying 'X' after the maximum count has been reached. As the secondary handset is powered separately this feature is designed to highlight if there has been a break in the main cable to the secondary handset. Therefore a low number means good communications is being achieved.

A long hold on both buttons will move you to the light configuration screen. The time the secondary backlight stays on can be set in this screen.

O2 Sensor		
	Light	50secs
1	0.21	11.3mV
2	0.21	10.9mV
3	0.21	11.0mV
	avg	0.21

**Backlight Calibration Screen**

A short hold on both buttons will move you to the oxygen cell calibration screen. This is where the oxygen cells can be calibrated manually.

O2 Sensor		
Bat	4.0V	
1	0.21	11.3mV
2	0.21	10.9mV
3	0.21	11.0mV
	avg	0.21

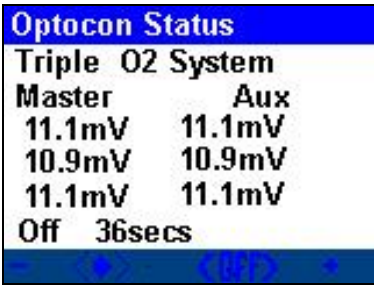
**Oxygen Cell Calibration Screen**

A short hold of both buttons jumps between cell readings, allowing you to then change it with a press of the left or right button. A long hold on both buttons will move you to the Optocon Status Screen. This screen gives information on the status of Optocon device communication and battery levels.

Optocon Status		
	BatV	RX
3xPO2	3.2	OK
TPM	3.1	OK
BakPO2	3.2	OK
Off	36secs	

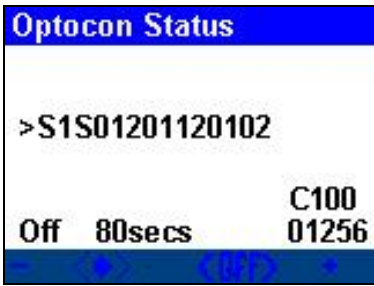
**Optocon Status Screen**

A short hold on both buttons will move you to triple O2 system master/auxiliary status screen. This screen gives oxygen cell milli-volt readings on both communication channels.



**Triple O2 master/auxiliary Status Screen**

A short hold on both buttons will move you to the Optocon status 'raw data' screen. This screen is for software diagnostics only and has no user-configurable features.



**Optocon 'raw data' Status Screen**

Finally, a short hold on both buttons will take you back to the Optocon status screen or a long hold on both buttons will turn the secondary handset off.

**Summary of Background Colour Alarms**

Primary Dive Display			Primary Optocon Status Screen	Secondary PPO2 Display
PO2 background	HP background	TPM graph	All sensor lines	PO2 background
White - OK	White - OK	Green - OK	Green OK	Green - OK
Yellow – waiting for data			Yellow – waiting for data. Last data good	Yellow – waiting for data. Last data good
Purple – No data, check Secondary. Consider bailout	Purple – No data.	Purple – No data.	Purple – No data. When associated with either PO2 sender, purple equals one signal failed, check Secondary. Consider bailout	Purple – No data, check Primary. Consider bailout
			Red – Both PO2 signals failed. Consider bailout	
			Cyan – low Optocon sensor battery	

**Warning: If purple (lost communications) is seen on the Primary PP02 display the Secondary handset PP02 display should immediately be checked. If the Secondary handset screen is purple and dashes are displayed rather than numbers, there has been a total loss of PPO2 communications.**

**Therefore a known breathable gas should be accessed until communications return (green screen) and the correct PPO 2 level is established.**

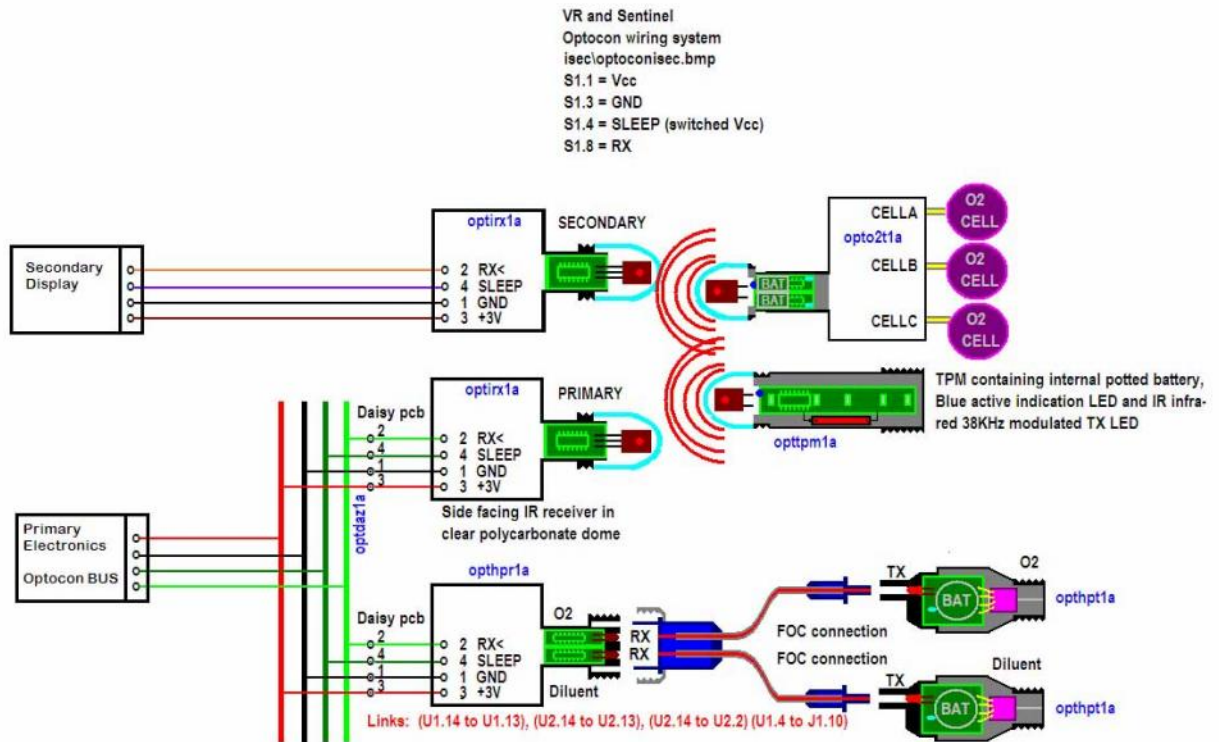
**Confirmation of good communications can be found on the Optocon Status Screen of both handsets.**

**OK = Data received & good**

**DTA = Data late**

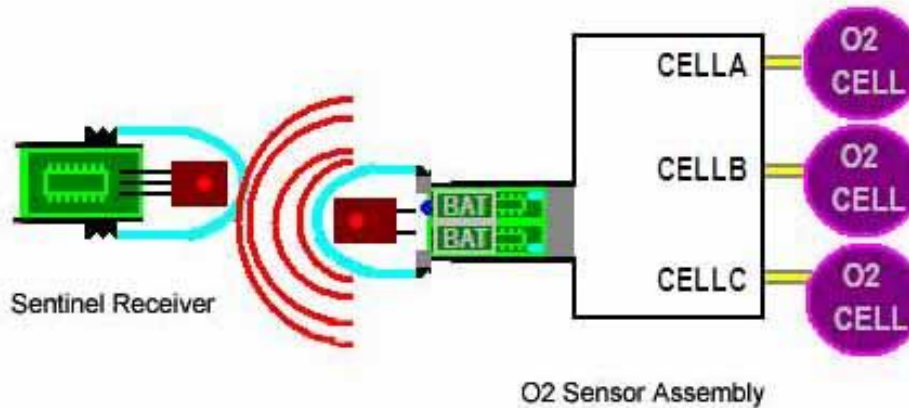
**??? = No data received / useable**

### Optocon System Diagram



## Rebreather Triple Oxygen Sensors Optocon Connection

Three oxygen sensors connect to the Sentinel rebreather using the wireless connection.



There are two, non user-replaceable batteries in the triple O2 IR sender. The sender must be sent back to VR Technology for an exchange unit when no blue flashing LED is seen. Battery life is expected to be around 3 years for the IR sender unit.

### Triple O2 system operation

This system is made up of four devices:

1. **Triple sensor module**, complete with dual redundant transmitters and batteries. Data transmission fundamentals are;
  - Data transmission approximately every 5 seconds if sensor levels are changing.
  - If sensor readings are stable, data transmission is reduced to once every 20 seconds to save battery power by not sending duplicate data over often. In this case, an “I am here” signal is still sent every 3 seconds to maintain link confidence.

Because of the fundamental importance of PPO2 readings in a rebreather, there are two senders, each with their own PPO2 measuring and battery systems. In addition, the cell readings are transmitted to both the primary control system and the secondary backup display. These systems combined give unparalleled cell signal confidence and improved redundancy over existing cable systems.

2. **Infra-red receiver module IR-RX**. This receives infra-red coded data from the transmitter. It is connected to and powered by the host electronics. It has no corrodible metal connections and is a “dead end” device reducing potential leakage points when compared to cable/connector systems.

The IR-RX constantly listens for data from the transmitter, and relays this data to the host as required.

In the sentinel rebreather there are two IR-RX modules: one for the primary electronics system and one for the secondary backup PPO2 display. Each IR-RX module is powered by its specific host.

3. **Host Primary Electronics** – this is connected directly to the IR-RX module. The host system is the main control system and display interface. This means it has to know which modules are connected to the system and their corresponding data and connection status. There are three operational modes of the host:
  - a. **Hibernating** – During hibernation, the host wakes momentarily to power the IR-RX module and waits for data from the sensor. When data is received the host uses this data to see if it should wake up fully – e.g. auto-breathe turn on mode when a low ppo2 has been detected. If data from the sensor is continually not received, then it is assumed that the module has been removed – e.g. – PPO2 module removed for maintenance.
  - b. **Waking** – During waking, the host needs to get connection and data information from all the sensor modules. Therefore there is a short 30 second wait period that ensures all the modules are connected and operating correctly. This forms part of the rebreathers' pre-dive sequence. In the event of the user diving without turning the system on, the system will turn on automatically due to depth or auto-breathe, and complete the full module checking in the background. The sensor modules are fast to react to changes in readings and so the system will achieve full module recognition within a few seconds.
  - c. **Active operation** – when operating normally, all readings will be updated quickly and reliably. However, should a module be removed or data transmission fail for some reason, then there is an additional warning to show this type of data failure. This is not available on analog systems, where a bad connection only shows up as incorrect values that the user needs to interpret as a bad connection if possible.
4. **Host Secondary backup PPO2 display**

The secondary PPO2 system has an additional independent battery, and can remain operational even if the primary system fails. The secondary display performs no control function, but is a backup PPO2 display should the user need to run the life support system manually, or just need confidence that the PPO2 readings are correct. The secondary system uses the same hibernate, waking and active logic as the primary system to ensure quality data is available to the user during a dive. The secondary system remains on but in a low power mode for 30 minutes after a button press. However, should the user want to turn off the system (hibernate mode), this can be achieved from the Optocon status screen (see page 8 for details of this screen).

The triple o2 transmitter has a MASTER and BACKUP channel. This gives redundancy should the MASTER fail.

In addition, each channel has two transmitting infrared LEDs ensuring high light output and good quality communications even in poor conditions. (Not to be confused with the single blue operational status LED per channel).

Basic operation of the Triple o2 transmitter can be determined by checking that both the MASTER and BACKUP blue LEDs flash about every 5 seconds. In normal operation with both batteries in good condition, the BACKUP channel will flash about half a second after the MASTER.

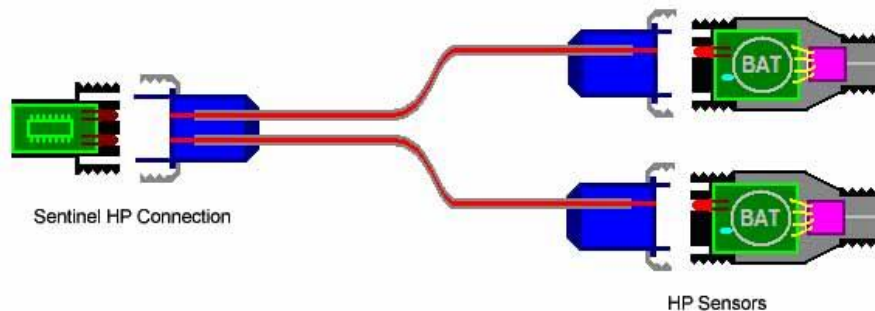
### Power saving features

The OXYGEN SENSOR system has 3 power saving features.

1. **Sleep mode** - The oxygen level is measured every few seconds. In between measurements the system uses very little power.
2. **Auto-TX mode** - If the oxygen level has changed, data is transmitted after every measurement. To save power and prolong battery life, if the oxygen level has not changed then no data will be transmitted unless it HAS NOT CHANGED FOR OVER 30 seconds since the last send of data. In this way optical date readings are always CURRENT in the Sentinel, but power is reduced by only sending data every 30 seconds if levels have not changed.
3. **Hibernate mode** - If all three cells are removed or the cell readings drop below 1mV, (removal of the sensors for storage/travel) hibernation mode will be activated. This reduces the power consumption to give an approximate shelf life of 5 years.

## Rebreather HP Sensors Optocon Connection

Two HP sensors connect to the Sentinel rebreather using two FOCs.



The Optocon HP sensors use a single lithium battery in each unit with a battery life expected to be around 3 years. The HP sensors have no user replaceable batteries and must be returned to VR Technology Limited for a battery replacement when no blue flashing LEDs are seen.

## HP system operation

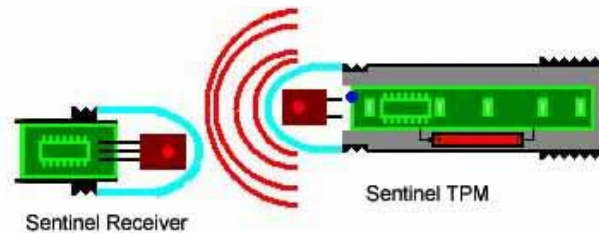
This system is made up of a number of parts:

1. HP sensor – on the Sentinel there are two HP sensors, one for diluent and one for oxygen. Each of these sensor modules are independent. Each module contains an HP sensor device that is calibrated at the factory, and outputs the cylinder bar pressure to the host (if required, the host converts the bar reading to PSI). The pressure is measured every 4 seconds. If the pressure has changed, the revised data is transmitted to the host. If sensor readings are stable, data transmission is reduced to once every 25 seconds to save battery power by not sending duplicate data over-often. Data is transmitted using visible red light sent through a fibre optic cable.
2. Fibre optic cable interconnection – there is a fibre optic cable for each sensor. This cable is made of plastic and is very strong. The transmission through the fibre is maintained even with water and some cracking of the fibre. The user can replace the fibre without returning to the factory. However, the optical ends of the fibre and the optical connector should be cleaned routinely to ensure the highest level of optical signal is maintained.
3. Dual receiver module – this receives light from each of the fibre optic cables and relays this data to the host as required.
4. Host Electronics – this is connected directly to the dual receiver module. The host system is the main control system and display interface. This means it has to know what modules are connected to the system and their corresponding data and connection status. There are three operational modes of the host:
  - a. **Hibernating** – During hibernation, the host wakes momentarily to power the IR-RX module and wait for data from the HP sensor. However, if HP data is received during this period, then the link status and HP content will be updated also.
  - b. **Waking** – During waking, the host needs to get connection and data information from all the sensor modules. Therefore there is a short 30 second wait period that ensures all the modules are connected and operating correctly. This forms part of the rebreather pre-dive sequence. In the event of the user diving without turning the system on, the system will turn on automatically due to depth or auto -breathe, and achieve the full module checking in the background. The sensor modules are fast to react to changes in readings and so the system will achieve full module recognition within a few seconds.
  - c. **Active operation** – when operating normally, all readings will be updated quickly and reliably. However, should a module be removed or data transmission fail for some reason, then there is an additional warning to show this data failure. This is not available on analog

systems, where a bad connection only shows up as incorrect values that the user needs to interpret as a bad connection is possible.

## Rebreather TPM Optocon Connection

The Sentinel TPM connects to the Sentinel rebreather using the wireless connection.



The Optocon TPM use a single lithium battery with a life expected to be around 5 years. The TPM has no user replaceable battery and must be returned to VR Technology Limited for a battery replacement when no blue flashing LED is seen.

### TPM system operation

This system is made up of three devices:

1. TPM module – this measures the thermal profile along the CO<sub>2</sub> filter.  
There are temperature sensors along the length of the monitor. These measure the temperature every 5 seconds. If the temperature has changed, the revised data is transmitted to the host. If the sensor readings are stable, data transmission is reduced to once every 30 seconds to save battery power by not sending duplicate data over-often. In this case, an “I am here” signal is still sent every 5 seconds to maintain link confidence.
2. Infra-red receiver module IR-RX. This receives infra-red coded data from the transmitter.  
This is connected to and powered by the host electronics. It has no corroddible metal connections and is a “dead end” device that has no potential extra leakage points.  
The IRRX constantly listens for data from the transmittter, and relays this data to the host as required.
3. Host Electronics – this is connected directly to the IR-RX module.  
The host system is the main control system and display interface. This means it has to know which modules are connected to the system and their corresponding data and connection status. There are three operational modes of the host:
  - d. **Hibernating** – During hibernation, the host wakes momentarily to power the IRRX module and wait for data from the TPM module. However, if TPM data is received during this period, then the link status and thermal profile will be updated also.

- e. **Waking** – During waking, the host needs to get connection and data information from all the sensor modules. Therefore there is a short 30second wait period that ensures all the modules are connected and operating correctly. This forms part of the pre-dive sequence. In the event of the user diving without turning the system on, the system will turn on automatically due to depth or auto-breathe, and achieve the full module checking in the background. The sensor modules are fast to react to changes in readings and so the system will achieve full module recognition within a few seconds.
  
- f. **Active operation** – when operating normally, all readings will be updated quickly and reliably. However, should a module be removed or data transmission fail for some reason, then there is an additional warning to show this data failure. This is not available on analogue systems, where a bad connection only shows up as incorrect values that the user needs to interpret as a bad connection is possible.

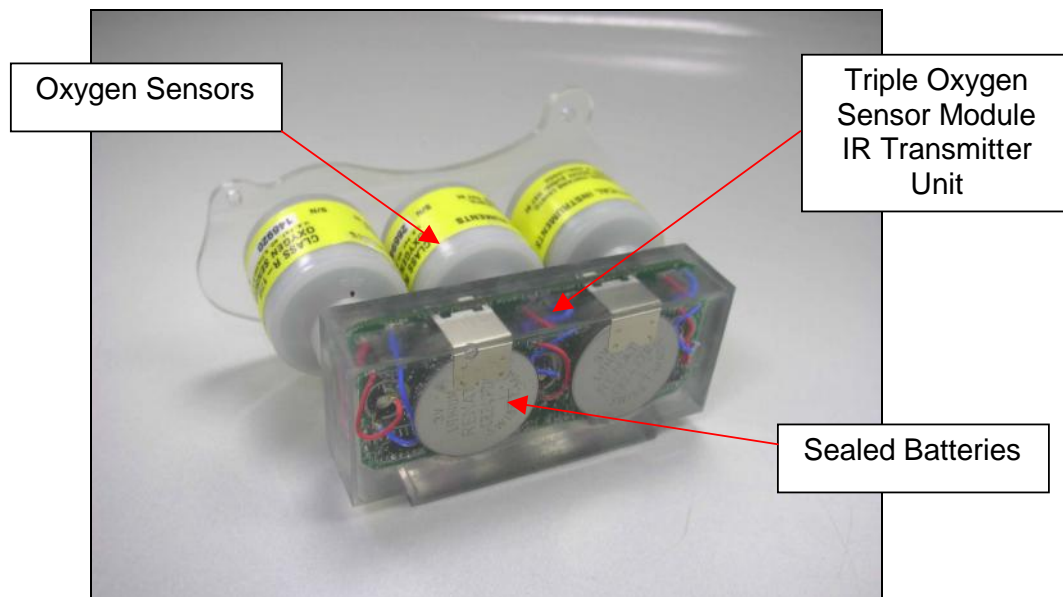
## Mechanical Layout for the Optocon of the Sentinel Rebreather

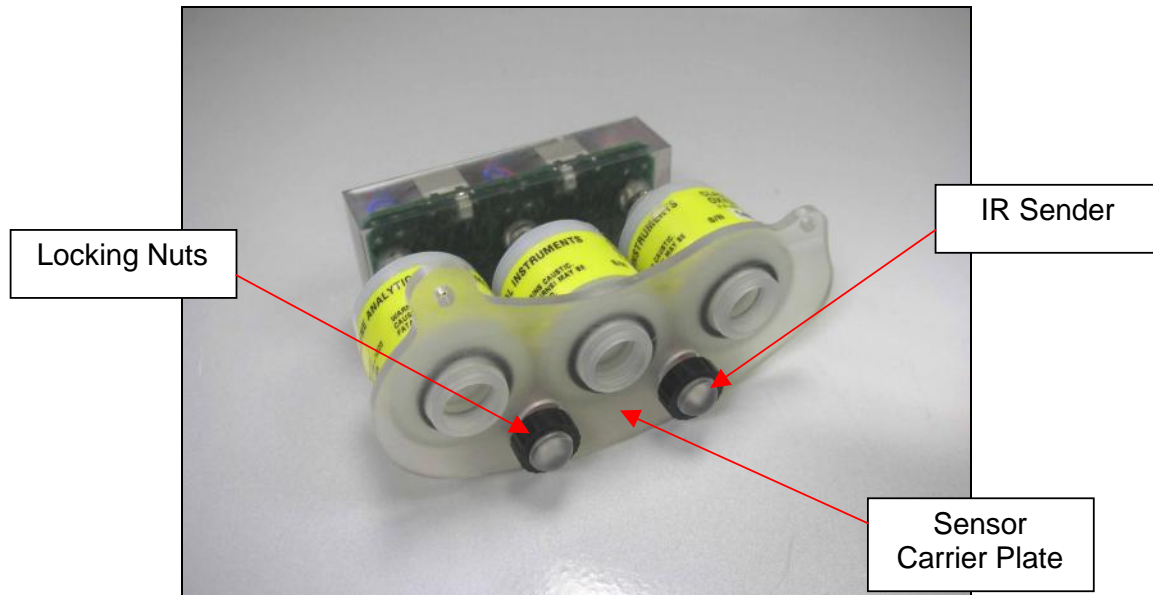
### Triple Oxygen Sensor Optocon Connection

Three oxygen sensors communicate with the Sentinel rebreather through a wireless connection.



The redundant batteries in the Triple O<sub>2</sub> IR Transmitter are not user-replaceable. The transmitter must be sent back to VR Technology for an exchange unit when battery failure occurs. Battery life is expected to be around 5 years for the IR Transmitter Unit.



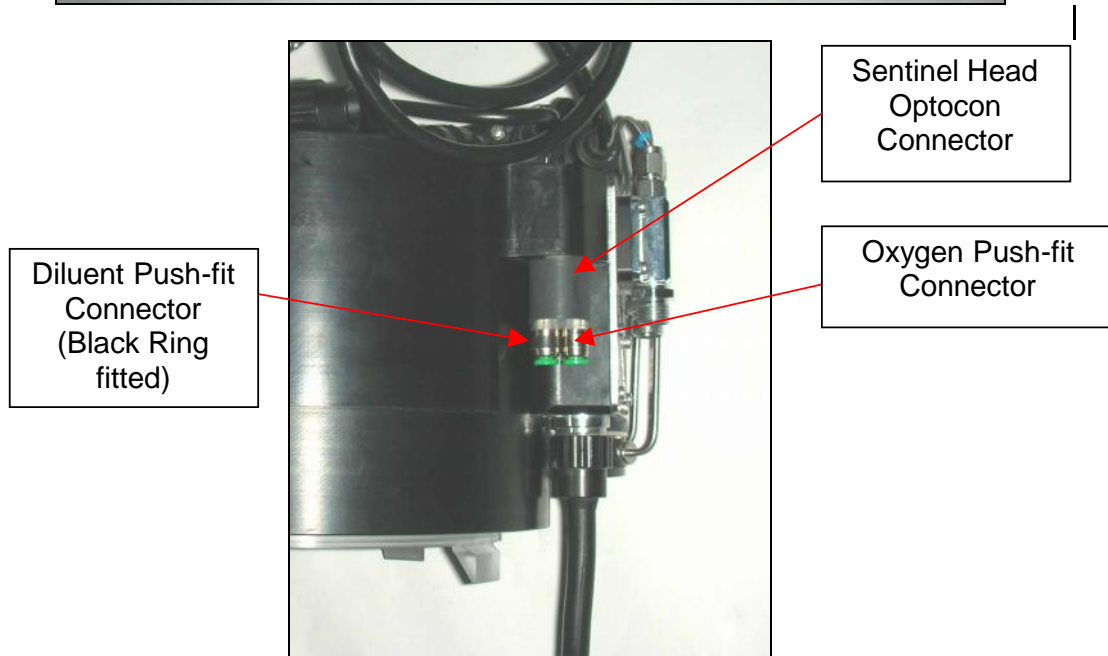
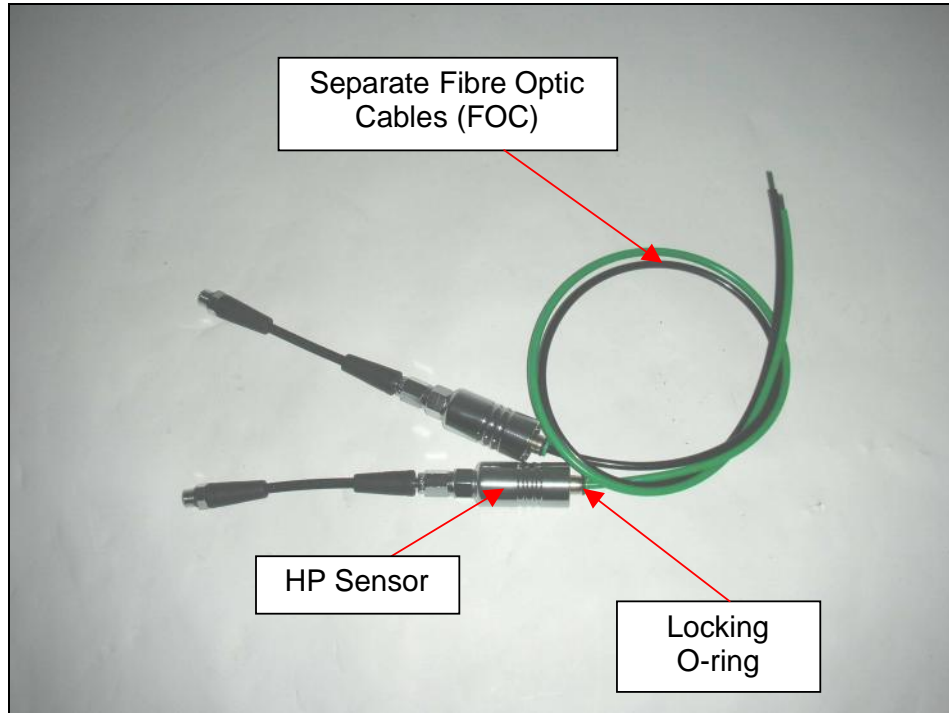


**IMPORTANT NOTICE: Use only VR 1700 Oxygen Sensors in the Sentinel Rebreather. The performance of other sensors cannot be guaranteed and may give unsafe readings.**

**For sensor replacement information see page 23 of this addendum.**

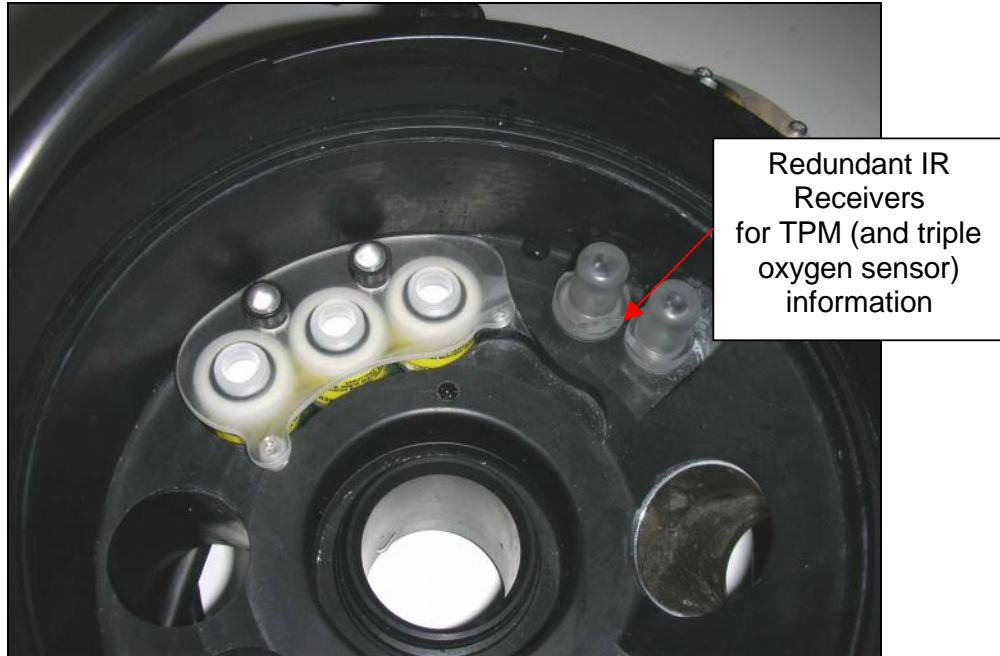
### Rebreather HP Sensors Optocon Connection

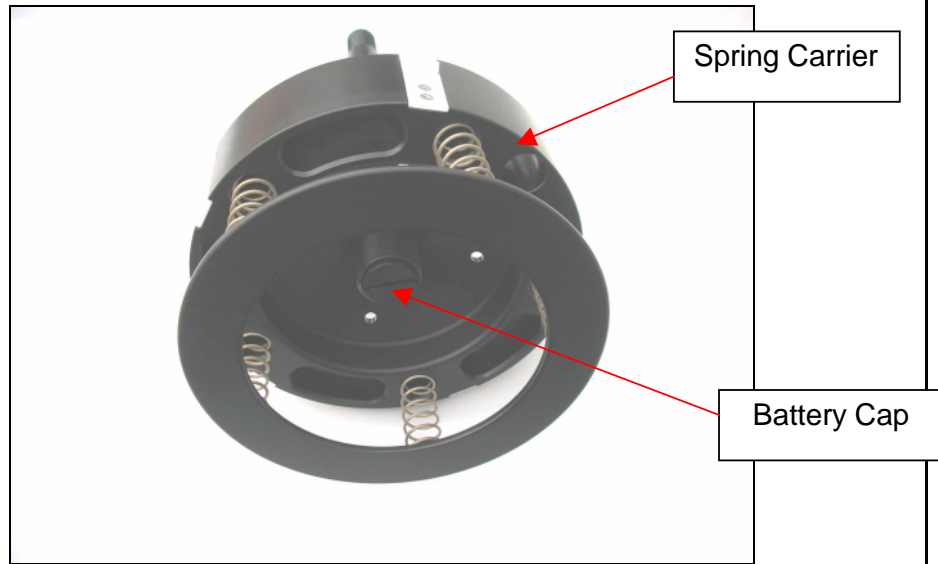
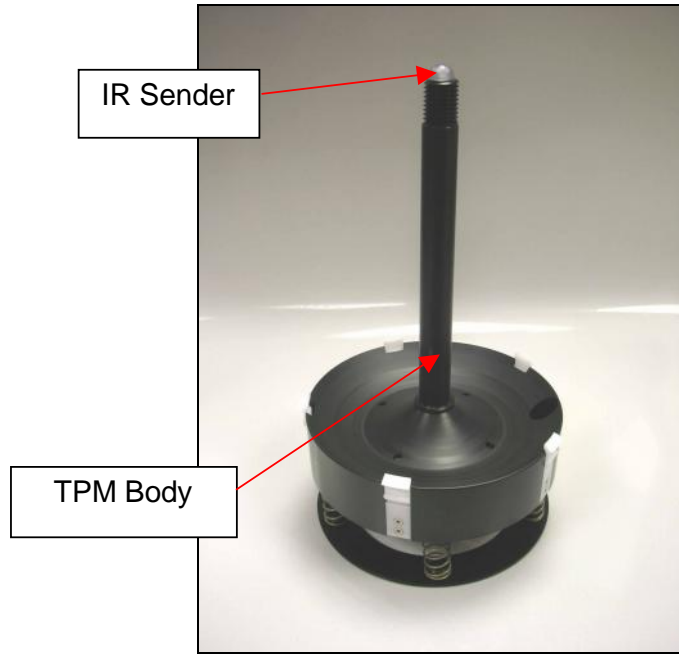
Two HP Sensors connect to the Sentinel rebreather head using two separate FOCs. One is attached to the oxygen first stage (green) and the second is attached to the diluent side (black).



### Optocon TPM Connection

The Sentinel TPM communicates with the Sentinel rebreather using a wireless connection.





## Connecting the system

### Connecting the Optocon HP Assembly to the Sentinel Rebreather Head

- Either the Diluent or the Oxygen FOC can be installed first.
- Inspect the first FOC end for any damage – approximately 12-14 mm of FOC core should be exposed from the protective outer. If not please refer to the maintenance section on how to trim the cable to the correct length.
- Slip a Push-Fit Locking O-ring over the FOC cable.
- Present the FOC core to the correct Push-Fit Connector – the black Diluent cable goes to the black-sleeved Push-Fit Connector.
- Push fully home the FOC into the push-fit connector.
- Roll the Locking O-ring into the gap between the Push-Fit fitting and its green Locking Ring.
- Repeat the steps again for the connection of the remaining cable.
- Signal connection and calibration is performed automatically on all modules.

### Disconnecting the Optocon HP Assembly from the Sentinel Rebreather Head

- Remove the Locking O-ring from between the green Locking Ring and the Push-Fit Connector with a dental pick or similar tool.
- Press down on the gently on the green Push-Fit Locking Ring and pull back on the cable to disengage it from the Bulkhead Connector.
- Repeat the steps again for the disconnection of the remaining cable.

### Disassembling the Optocon Triple Oxygen Sensor Assembly

If you need to replace one or more oxygen sensors or the oxygen sensor module itself, use the following procedure:

- Remove the two M3 screws and lift the oxygen sensor assembly from the rebreather head.
- Be careful not to lose the small locking washers located beneath the screws.
- Unscrew the black locking nuts from the transmitter posts then gently pull the Sensor Carrier Plate and sensors from the IR transmitter module.
- The O<sub>2</sub> sensors can be removed from the sensor plate by unscrewing anti-clockwise.
- Do not lose the sensor o-rings.
- Reassembly is the reverse of this procedure.

**WARNING.** On re-assembly you should ensure the rebreather is properly calibrated. Follow the instructions in the Sentinel Operations Manual.

**Disassembling the Optocon HP Sensor Assembly**

- Remove Locking O-ring from between the green Locking Ring and the Push-fit Connector with a dental pick or similar tool.
- Depress the green Locking Ring and gently pull the Optocon FOC.
- The HP Sensors can be disconnected from the Sentinel first stage HP Whips by using 14 & 17 mm spanners.
- Reassembly is the reverse of this procedure. The FOC core end should be coated with a very thin layer of silicone grease & touching the bottom of the hole, a minimal gap can be tolerated between the FOC core and the bottom of the hole. The sheath should be pushed fully home into the Push-fit Connector and the Locking O-ring replaced.

**Disassembling the Optocon TPM Connection**

- Remove the TPM assembly from the rebreather.
- Unscrew the locking nut from the underside of the spring carrier.
- Unscrew the TPM from the spring carrier .
- Reassembly is the reverse of this procedure.

## Maintenance and Field Repairs

### Trimming Optocon Cables-HP Sensor End

The Optocon cable consists of an FOC core sheathed by a protective coloured carrier sleeve. If you need to trim or shorten Optocon Cables, use the following procedure:

- Leave the FOC cable attached to the Sentinel rebreather head and trim at the lower HP Sensor end of the cable.
- Remove Locking O-ring from between the green Locking Ring and the Push-fit Connector with a dental pick or similar tool.
- Depress the green Locking Ring and gently pull away the Optocon FOC.
- Trim cable to the desired length with a very sharp blade, ensuring that the cable end is as smooth and flat as possible.
- Remove Locking O-ring from between the green Locking Ring and the Push-fit Connector at the Sentinel Head end of the cable.
- Depress the green Locking Ring and gently pull away the Optocon FOC from the head bulkhead connector.
- Withdraw at least 50 mm of the core from the outer sleeve & using a sharp knife cut approximately 12-14 mm off the end of the free outer sleeve.
- Replace the FOC cable into the Optocon Bulkhead connector using the procedure described on page 23.
- Replace the FOC cable in Optocon HP Sensor using the procedure described on page 23.
- Remember, the core should be touching the bottom of the hole. The sheath should be pushed fully home into the Push-fit Connector. A minimal gap can be tolerated between the FOC core and the bottom of the hole.

### Replacement of a broken HP Fibre Optic Cable

**IMPORTANT.** The protective sleeve lengths and FOC lengths are important as it is vital that the FOC is fully engaged with the fitting at each end to ensure data is transferred correctly.

If a FOC is accidentally broken, follow the procedures below:

- At the Bulkhead Connector end remove Locking O-ring from between the green Locking Ring and the Push-fit Connector with a dental pick or similar tool.
- Depress the green Locking Ring and gently pull the Optocon FOC away.
- Disconnect the broken FOC from the HP Sensor by removing the Locking O-ring then pressing down on the green Locking Ring on the HP Sensor's rear face and pulling the FOC free.
- Pull the broken inner core clear of the protective sheath from either end.
- Push a replacement core through one side of the protective sheath.
- Connect the FOC to the Sentinel Head Bulkhead Connector using the procedure described on page 23.
- There should be approximately 12-14 mm of core left exposed on the free end of the cable. If not, trim the cable sheath using the procedure described above.

- Replace the FOC into the rear face of the HP sensor module. Push the outer sleeve firmly into its push-fit connector; this will press the fibre end into the correct position inside the HP sensor.
- Now that the FOC cable has been replaced, the HP sensor will perform its reconnection and self-calibration routine.
- Check the system to ensure communication has been established before diving.

**WARNING: If bubbles are seen from the back face of the HP sensor during immersion and when the regulator is pressurised, the Optocon HP unit must be returned immediately to VR Technology for inspection.**

## Battery Replacements

### Replacement of Optocon HP Sensor Battery

The batteries inside the Optocon HP Sensor unit should last over 3 years. When replacement is required, send the sensing unit back to VR Technology for replacement. A spare Optocon HP unit can be kept in a spares kit.

**WARNING:** These batteries are not meant to be user-serviceable. Damage to the actual HP sensor may occur if the unit is mishandled.

### Replacement of an Optocon TPM Battery

The Optocon TPM Battery should last over 3 years. When replacement is required, send the TPM stick back to VR Technology for replacement.

**WARNING:** These batteries are not meant to be user-serviceable. Damage to the TPM electronics may occur if the unit is dis-assembled without the correct tools and training.

## Alarms

The table below shows extra alarm conditions associated with OPTOCON and HUD status where appropriate.

### Triple PPO2 alarms shown on the Primary Display

Module	Receiver	DATA MAIN	DATA AUX	'I'm here' ACK	<u>Optocon</u> Battery Status	Host	HUD	PPO2 display Background	Control system	Primary display Alarm status
3xPO2	ir-rx	OK	OK	Don't care	OK	Primary	Green	WHITE	Operational	OK
3xPO2	ir-rx	No data	No data	OK	OK	Primary	Green /Blue	YELLOW	Operational using last good data	DTA
3xPO2	ir-rx	No data	No data	No ACK	OK	Primary	Red	PURPLE	PPO2 valve control turned off	???
3xPO2	ir-rx	OK	OK	Don't care	LOW	Primary	Green /Blue	WHITE	Operational but low Optocon battery. Check status screen	LoBAT
3xPO2	ir-rx	OK	No data	Don't care	OK	Primary	Green	WHITE	Operational	AUX
3xPO2	ir-rx	No data	OK	Don't care	OK	Primary	Green	WHITE	Operational	AUX

### Triple PPO2 alarms shown on the Secondary (Backup) display

Module	Receiver	DATA MAIN	DATA AUX	'I'm here' ACK	<u>Optocon</u> Battery Status	Host	PPO2 display background	Status and Action (Shown on the Optocon Status screen on the Primary/Secondary)
3xPO2	ir-rx	OK	OK	Don't care	OK	Secondary	WHITE	OK
3xPO2	ir-rx	No data	No data	OK	OK	Secondary	YELLOW	DISPLAY OF PP02 – WAIT FOR PP02 UPDATE
3xPO2	ir-rx	No data	No data	No ACK	OK	Secondary	PURPLE	NO DISPLAY OF PP02 - NO PPO2 UPDATE - <b>CONSIDER BAILOUT FROM REBREATHER</b>
3xPO2	ir-rx	OK	OK	Don't care	LOW	Secondary	WHITE	CYAN (shown on Primary Optocon

Module	Receiver	DATA MAIN	DATA AUX	'I'm here' ACK	<b>Optocon</b> Battery Status	Host	PPO2 display background	Status and Action (Shown on the Optocon Status screen on the Primary/Secondary) Status Screen only)
3xPO2	ir-rx	OK	No data	Don't care	OK	Secondary	WHITE	OK
xPO2	ir-rx	No data	OK	Don't care	OK	Secondary	WHITE	OK

**TPM Alarms shown on the Primary display**

Module	Receiver	DATA	'I'm here' ACK	Battery Status	Host	HUD	TPM display background	Primary display Alarm status
TPM	ir-rx	OK	Don't care	OK	Primary	Green	GREEN	OK
TPM	ir-rx	No data	OK	OK	Primary	Green /Blue	YELLOW	DTA
TPM	ir-rx	No data	No ACK	OK	Primary	Green /Blue	PURPLE	???
TPM	ir-rx	OK	Don't care	LOW	Primary	Green /Blue	CYAN	LOW BAT

**HP Diluent Alarms shown on the Primary display**

Module	Receiver	DATA	Battery Status	Host	HUD	HP display background	Primary display Alarm status
HP Dil	Fibre- optic	OK	OK	Primary	Green	GREEN	OK
HP Dil	Fibre- optic	Waiting	OK	Primary	Green /Blue	YELLOW	DTA
HP Dil	Fibre- optic	No data	OK	Primary	Green /Blue	PURPLE	???
HP Dil	Fibre- optic	OK	LOW	Primary	Green	CYAN	LOW BAT

Module	Receiver	DATA	Battery Status	Host	HUD	HP display background	Primary display Alarm status
					/Blue		

**HP Oxygen Alarms shown on the Primary display**

Module	Receiver	DATA	Battery Status	Host	HUD	HP display background	Primary display Alarm status
HP O2	Fibre- optic	OK	OK	Primary	Green	GREEN	OK
HP O2	Fibre- optic	Waiting	OK	Primary	Red	YELLOW	DTA
HP O2	Fibre- optic	No data	OK	Primary	Red	PURPLE	???
HP O2	Fibre- optic	OK	LOW	Primary	Red	CYAN	LOW BAT

**Sentinel Rebreather spares ordering codes**

<b>Part Name</b>	<b>Ordering <u>C</u>ode</b>
Triple O2 IR sender module	<u>2146</u>
Cable End O-ring	<u>301</u>
Blanking Cap O-ring	<u>150</u>
<u>Small Push-fit Fitting O-ring</u>	<u>143</u>
<u>large Push-fit Fitting O-ring</u>	<u>226</u>
<u>HP Sensor FOC Loom</u>	<u>2149</u>