# 2 VIT END DEVICES MANUAL

IODP VIT Assembly Part Number OV7000

IODP JRSO

Version 3

9/25/22

| Revision | Date | Originator | Approval |
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| 0 | 3/5/19 | Mike Meiring | Mike Meiring |
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| 2 | 4/1/20 | Mike Meiring | Andrew Howard |
| 3 | 9/25/22 | Andrew Howard | Andrew Howard |
| | | | |

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# CHAPTER 1.0 TELEMETRY POD

## 1.1 MULTIPLEXER (SEAVIEW SYSTEMS)

All of the schematic diagrams referenced in the various VIT manuals are on Confluence (http://confluence.ship.iodp.tamu.edu:8090/) under Engineering and Tools > VIT > Schematic Diagrams. Multiplexer information can be found on the ship server at U:\Operations\2-Engineering\1 VIT\7 SEAVIEW MULTIPLEXER

### MULTIPLEXER COMPONENT OVERVIEW

#### POD CARDS

The S309 pod card set (**Fig. 1**) converts two HD-SDI video signals from the reentry and survey cameras to optical and transmits it to the surface card (**Fig. 2**) where it is converted back to two channels of HD-SDI Video for distribution and display.

**Figure 1. Seaview System Cards in Telemetry Pod.**

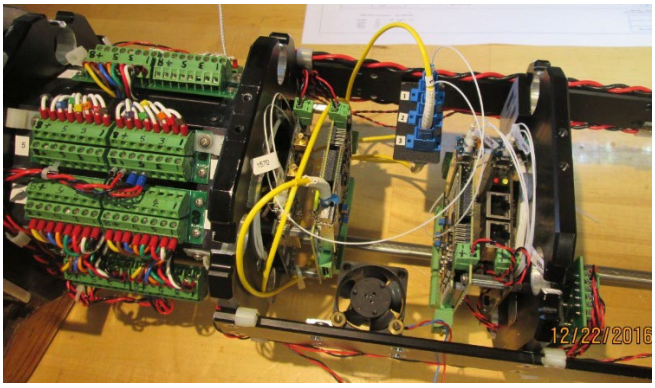
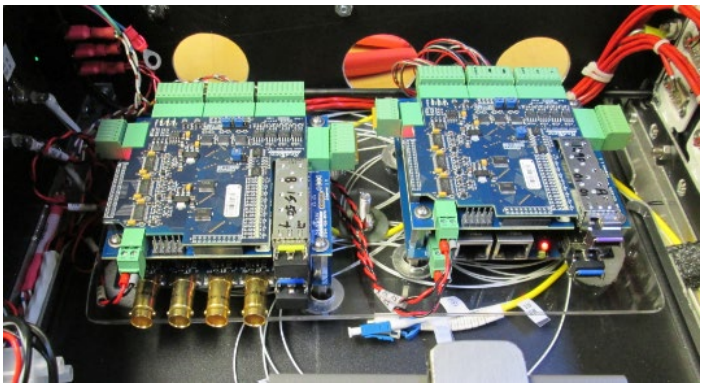



**Figure 2. Seaview Systems Cards in Surface Multiplexer Box.**



The S-109 Multiplexer cards support National Television System Committee (NTSC) Video for search and emergency camera use and transmit RS-232/485 serial control data to the

cameras, LEDs, and Pan/Tilt devices. Serial data is also received from the sonar, altimeter, and the Gyro. It also supports a 2Channel 10/100 Mb Ethernet switch between pod and surface.

The SS-209 cards extend surface GBit Ethernet to a 4-port switch in the pod. Serial, Video, Ethernet, and Optical Inputs/Outputs are all wired to the Surface Multiplexer Box backplane (**Fig. 3**).

**Figure 3. Surface Multiplexer Box.**

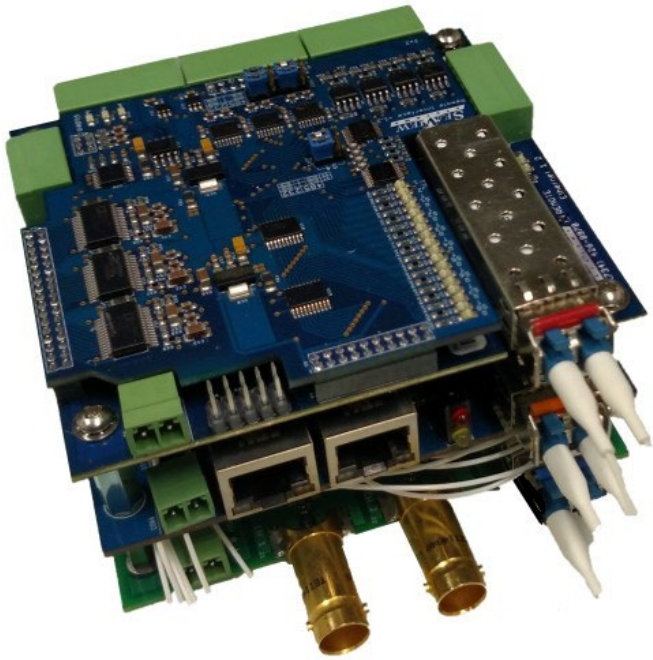

## OPTICAL LINKS

Optical links from the Telemetry Pod enter the box on the rear backplane. The optical links are routed to their appropriate cards via Coarse Wavelength Division Multiplexing (CWDM) combining/splitting devices.

## SEAVIEW SYSTEM CARDS

Seaview System cards (**Fig. 4**) are powered from two 5 VDC Supplies, A and B. The cards are stacked, share power supplies and optical links, but other than that, they function completely independently.

## Figure 4. Seaview Systems Multiplexer Card Stack.

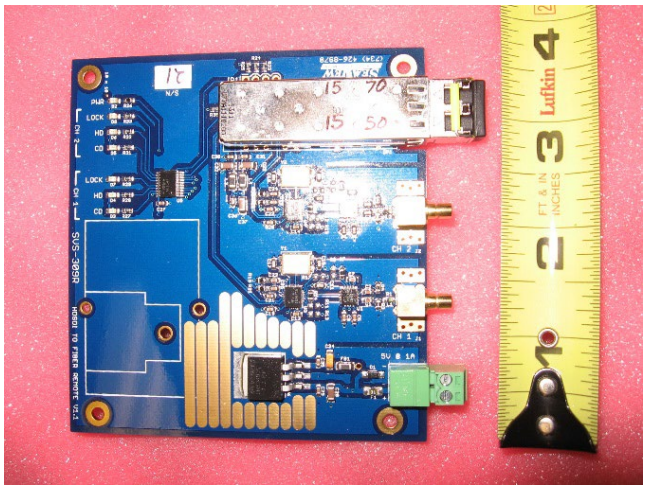


## SVS-309 HD-SDI DATA CONVERTER

The SVS-309R (OV9013; **Fig. 5**) in the pod converts 2 channels of HD-SDI video and transmits it to surface on fiber where the SVS-309L (OV9014; **Fig. 6**) converts it back to HD-SDI for viewing, recording and distribution. No data compression is performed in the conversion, so no artifacts are introduced. The surface card (local) is provided with four BNC connectors, two each for CH1 and CH2.

The subsea card (Remote) has two SMB connectors, one each for CH1 and CH2.

## Figure 5. SVS-309R (OV9013) (Remote).



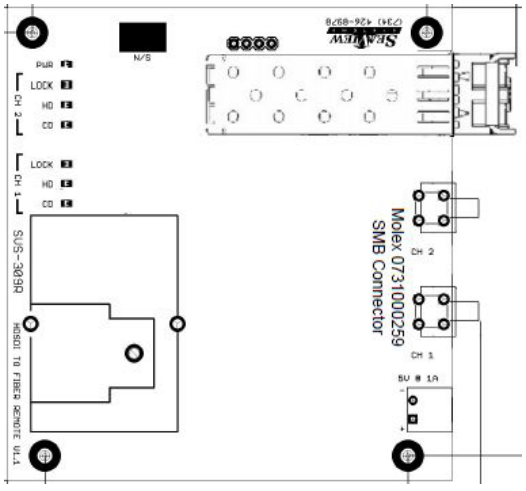
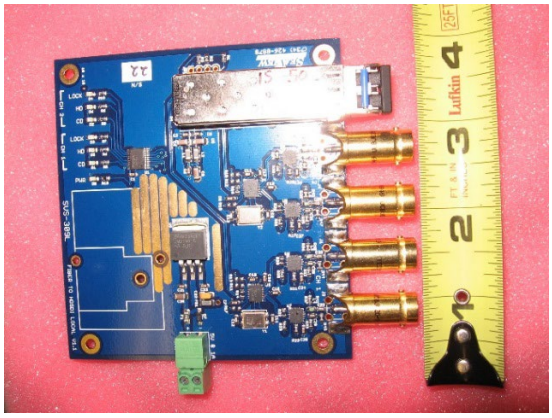
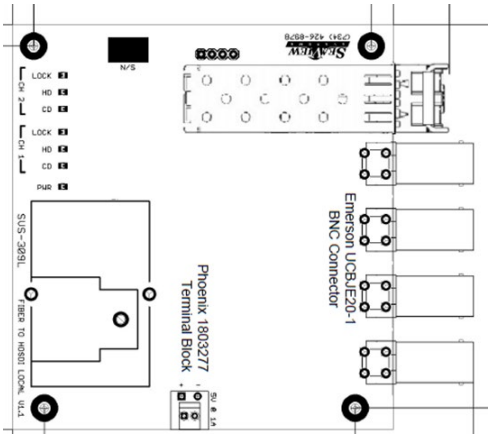


**Figure 6. SVS-309L (OV9014) (Local).**






## SVS-309 HD-SDI DATA CONVERTER SPECIFICATIONS

Video Formats Supported:

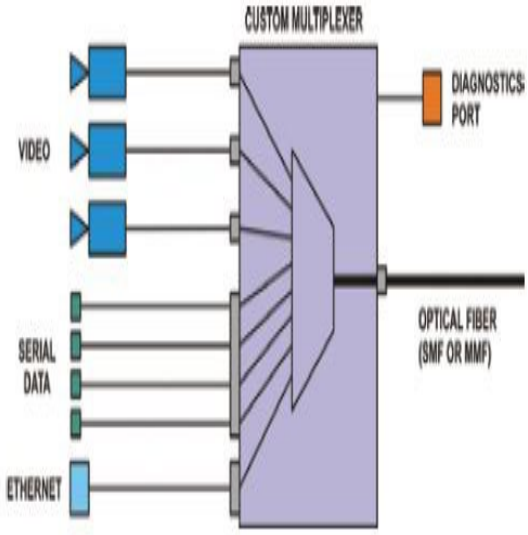
- 1080p (3G-SDI, 2.97 Gbit/s and 2.97 Gbit/1.001 Gbit/s)
- 720p, 1080i (HD-SDI, 1.485 Gbit/s)
- 480i, 576i (SD-SDI, 270, 360, 143, and 177 Mbit/s)

| | |
|---|---|
| Diagnostic LEDs: | Power<br>Lock to SDI data stream<br>HD Signal detected<br>CD: SDI signal detected on Remote, Optical link established on Local |
| Power Requirements: | 5 VDC @ 900 ma |

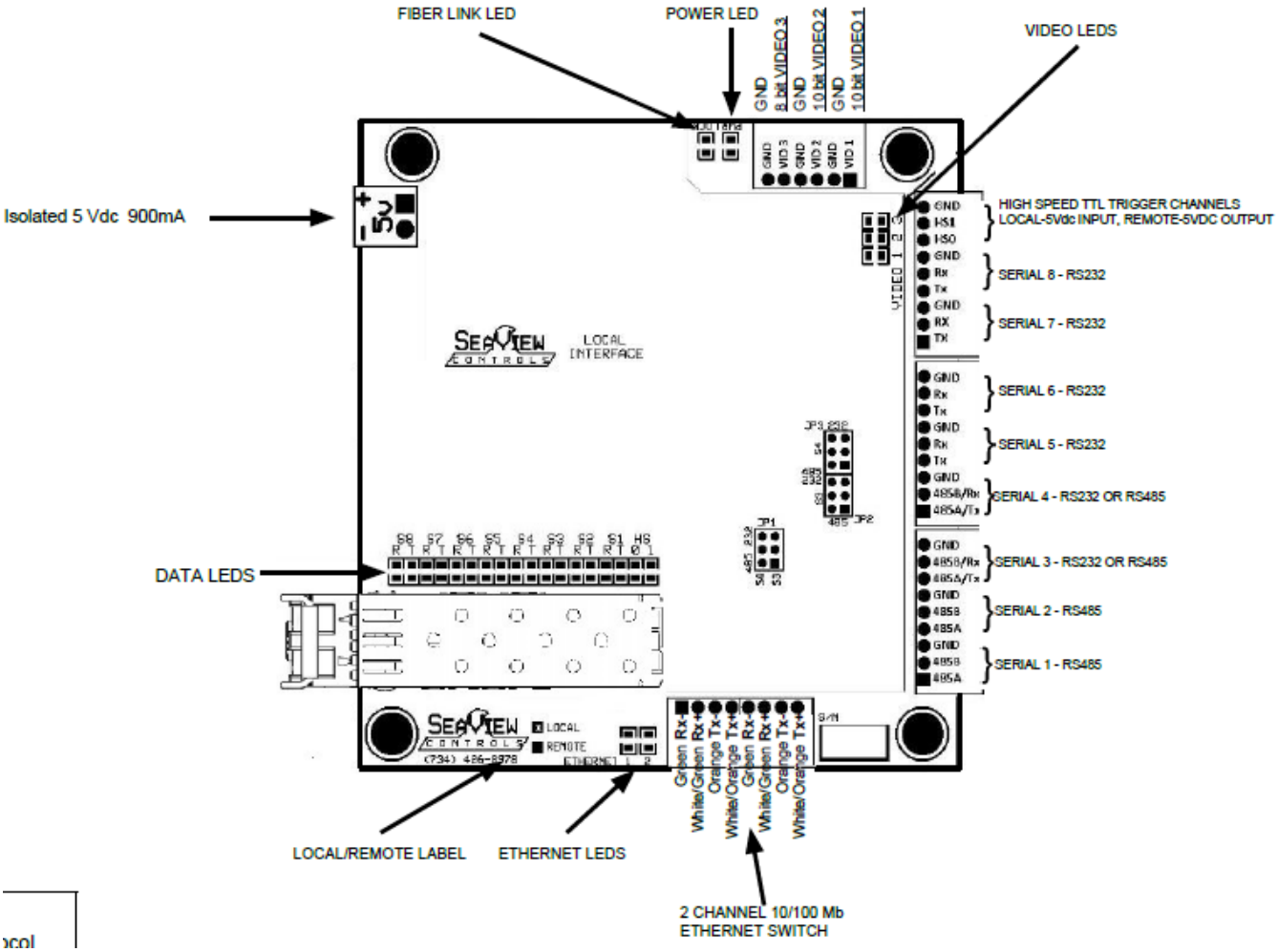
## SVS-109 MULTIPLEXER

An SVS-109 Multiplexer is a card set comprised of Remote (R) (OV0911) and Local (L) (OV0919). Although they are electrically different, they look similar. **Figure 7** is a photograph of one SVS-109 card in a set. ***Figure 8*** is a labeled drawing of an SVS-109 card. The cards in the two figures could be L or R. The two cards support a common Specification set.

**Figure 7. One SVS-109 Multiplexer Card from a Set.**

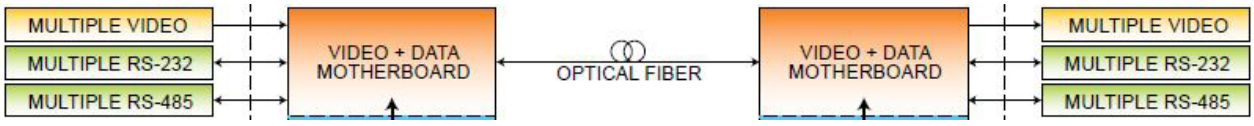

CUSTOM MULTIPLEXER
VIDEO
SERIAL DATA
ETHERNET
DIAGNOSTICS PORT
OPTICAL FIBER (SMF OR MMF)

## Figure 8. Labeled Drawing of an SVS-109 Multiplexer Card.




The card set (**Fig. 9**) supports three channels of NTSC video, two 100 Mb Ethernet ports, eight RS-232/485 Serial channels, and two high-speed triggers. It has baud-rate tolerant circuitry. Two serial channels will internally convert between RS-485 subsea to RS-232 on the surface (or vice versa), eliminating the need for inline converters.

## Figure 9. Multiplexer Layout.




A link requires one SVS-109L (Local) (OV9019) card on the surface, an SVS-109R (Remote) (OV9011) card in the pod, and a duplex optical link (TX/RX). The IODP VIT system has two S-109 card sets, designated 109-A and 109-B.

## MULTIPLEXER SPECIFICATIONS

| | |
|---|---|
| Video: | 2 X Ch 10-bit analog video<br>1 X Ch 8-bit analog video<br>(NTSC, PAL, SECAM) |
| Serial: | 2 X RS-485<br>4 X RS-232<br>2 X either RS-232 or RS-485 |

Onboard 232 to 485 conversion. All channels are baud-rate transparent.

| | |
|---|---|
| Trigger: | 2 X High speed TTL triggers |
| Ethernet: | 1 X 100 Mb with inbuilt 2 port switch |
| LED Indicators: | Power (red)<br>Link established (amber)<br>2 X Ethernet active<br>RX/TX for each Serial port<br>3 X Video signal present |
| Input Power: | 5 VDC @ 1 A |

## SVS-209 GBIT ETHERNET

SVS-209 Gbit Ethernet converter (OV9012; **Fig. 10**) is autosensing and will run in 10 mb/s, 100 mb/s or a 1000 mb/s. A 4-Ch switch with onboard headers makes for simple integration. Two identical cards, one each in the Telemetry Pod and on surface, provide 1 Gbit Ethernet over a duplex optical link.

**Figure 10. SVS-209 Gbit Ethernet Converter.**

## CONVERTER SPECIFICATIONS

| | |
|---|---|
| Flow control: | 10/100/1000M self-adapting<br>Auto negotiation<br>Auto MDI/MDIX |
| Supported formats: | 4 X 1000Base-TX<br>1 X 1000Base-FX<br>4 port switches |
| Interface: | RJ-45 (TX) |
| Power: | 5 VDC/1 A |

## BLACK MAGIC VIDEO CONVERTERS

See Schematic: 2. VIDEO DISTRIBUTION (Confluence > Engineering and Tools > VIT > Schematic Diagrams). The Black Magic (**Fig. 11**) mini converters are found in the surface Multiplexer Box and Subsea VIT J-Box and convert camera HD-SDI video to HDMI and NTSC video formats for surface display.

| | | | |
|---|---|---|---|
| Black Magic Mini | Converter | SDI to HDMI | OV0864 |
| Black Magic Mini | Converter | SDI to NTSC | OV0866 |

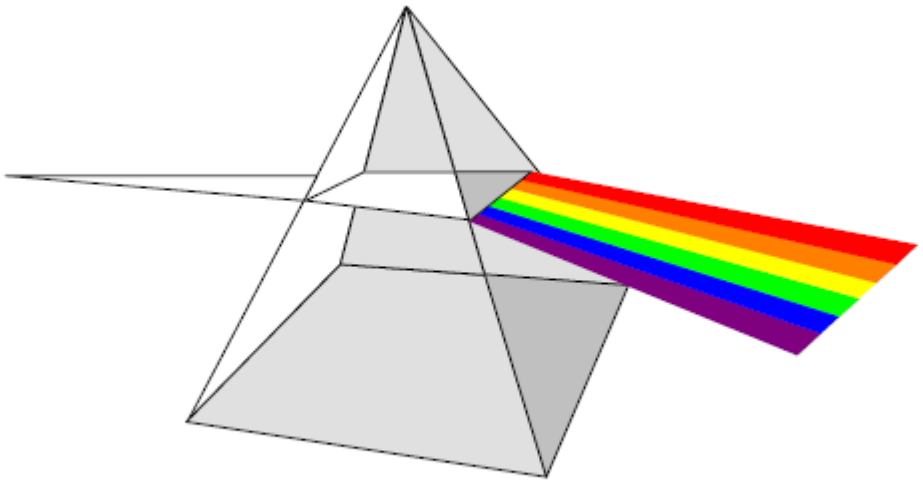
**Figure 11. Black Magic Video Converters.**


When replacing these converters, check the dipswitch settings on the side (**Fig. 12**).

**Figure 12. NTSC 1 & 5 ON (Left) and HDMI 1 ON Dipswitch Settings (Right).**


Black Magic devices are powered from a 12 VDC supply.

## 1.2 OPTICAL LINK



### OVERVIEW

The Pod and Surface Multiplexers are optically connected through:

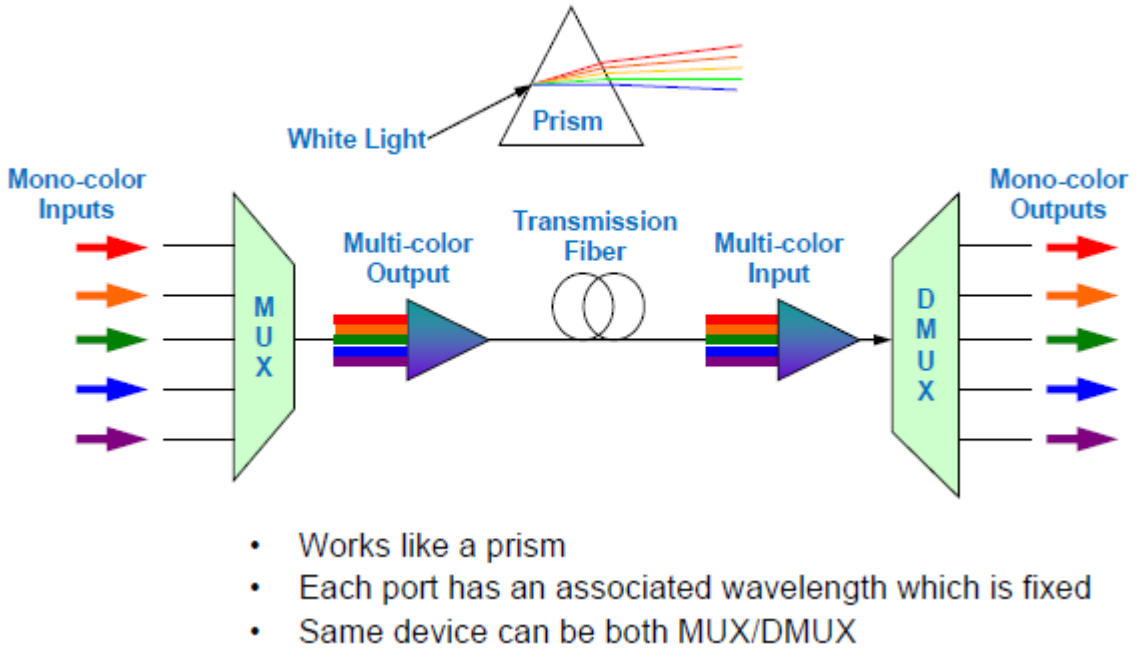
1. Umbilical with a 7000 m loose tube FO element with 4 X SM fibers.
2. Hybrid Slipring/Fiber Optic Rotator Joint (FORJ) on the winch with 4 X SM channels
3. Six core interconnecting SM FO Cable from Winch to Subsea and on to DP.

### COARSE WAVELENGTH DIVISION MULTIPLEXING (CWDM)

The S-309R two CH HD Video card requires 2 x links to surface, one for each video channel. One way of accomplishing this is by using two optical fibers, one for each channel. However, CWDM allows one to combine multiple optical channels of different wavelengths and transmit them over a single optic fiber link. At the far end, the different channel wavelengths are

"refracted" back to the multiple individual channels. The CWDM is a passive device with ~1 dB insertion loss. CWDM optical principles are graphically shown in **Figure 13**.

**Figure 13. CWDM Principles.**




Special lasers with tighter tolerances and lower temperature drift are used with CWDM to allow for the combination of up to 18 different wavelengths on a single fiber. Standard CWDM wavelengths and channel windows are defined by international standards with a nominal separation of 20 nanometers (nm) starting at 1270 nm through to 1610 nm (**Fig. 14**).

**Figure 14. CWDM Channels as Allocated by ITU.**

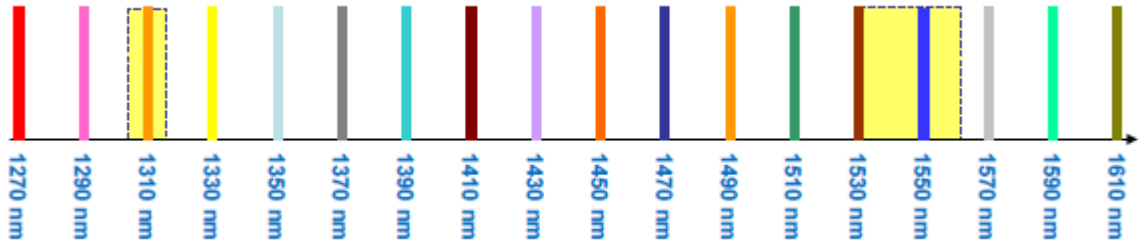
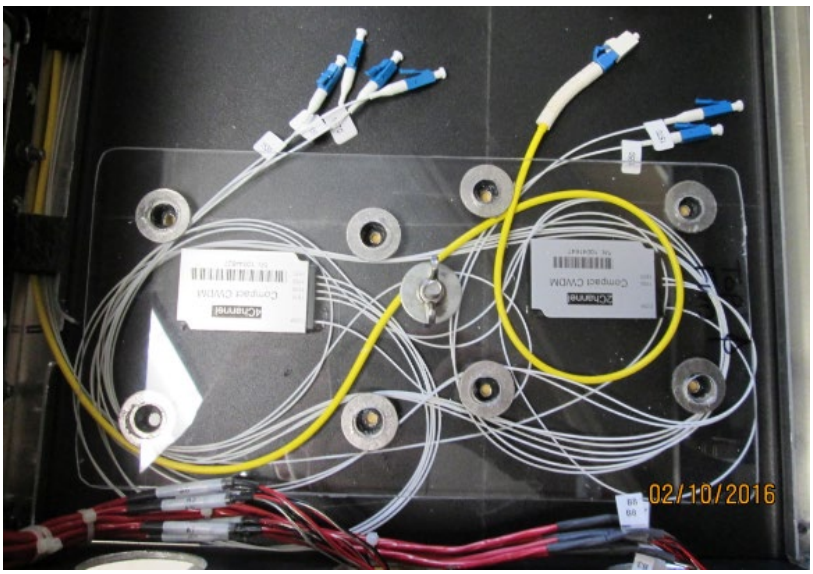


**Figure 15** is a photograph of the CWDM Devices in the Surface Multiplexer Box.

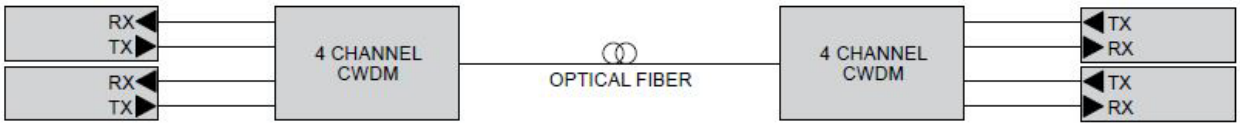
### Figure 15. CWDM Devices in Surface Multiplexer Box.




## WAVELENGTH ALLOCATION

- On the IODP VIT design, two channels, 1550 nm and 1570 nm are allocated to the S-309 HD Video card, combined in a 2 CH CWDM (OV9015) and connected via a single fiber to the surface equipment.
- Two channels, 1510 nm and 1530 nm were allocated to the S-209 Ethernet card and two channels, 1550 nm and 1570 nm, to the S-109 (B) Multiplexer card set.
- All four of these channels were combined with a 4 CH CWDM (OV9017) and connected to the surface equipment via a second single fiber (**Fig. 16**).

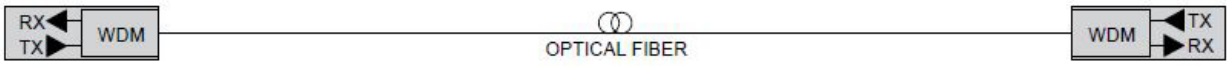
### Figure 16. 4-Wavelength CWDM.




*4-Wavelength CWDM*

The second S-109 (A) Multiplexer card set was allocated two wavelengths, 1490 nm and 1550 nm (**Fig. 17**). In this case combining/splitting is done internal to the SFP. A single optical fiber completes the link.

**Figure 17. Integrated CWDM for 1490/1550 nm on One Fiber.**




With proper CWDM channel allocation, all circuits above could have been combined and launched on a single fiber, but three fibers offer redundancy.

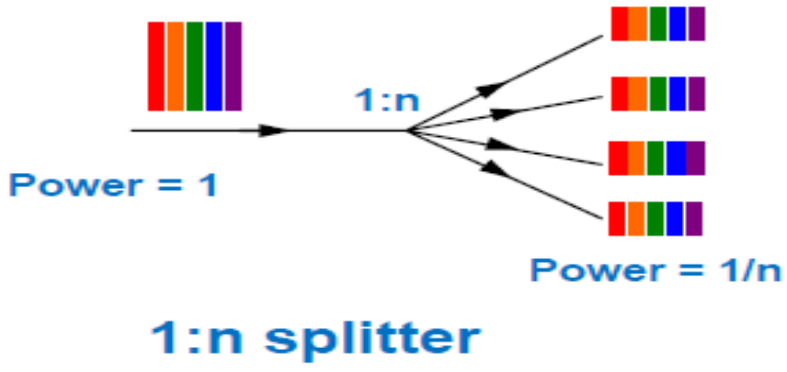
All optical connectors on SFPs are LC and on IODP cables/devices SC.

| Device | Surface Multiplexer Box | Telemetry Pod |
|---|---|---|
| S109 (A): | RX 1550 nm | TX 1550 nm |
| | TX 1490 nm | RX 1490 nm |
| S109 (B): | RX 1570 nm | TX 1570 nm |
| | TX 1550 nm | RX 1550 nm |
| S209: | RX 1530 nm | TX 1530 nm |
| | TX 1510 nm | RX 1510 nm |
| S309: | RX 1570 nm | TX 1570 nm |
| | RX 1550 nm | TX 1550 nm |

## SUBSEA OPTICAL SPLITTER (OV9016)

See Schematic *7. OPTICAL LINK* (Confluence > Engineering and Tools > VIT > Schematic Diagrams). Unlike the CWDM devices, an optical splitter is wavelength agnostic. It will split the incoming signal into two or more identical signals (**Fig. 18**), each containing all the information.

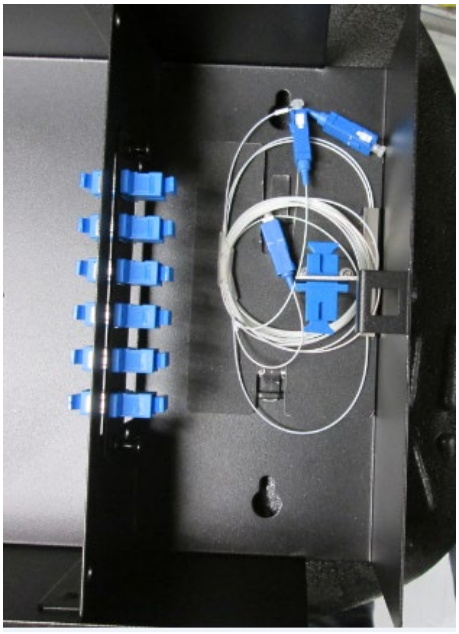
**Figure 18. Optical Splitter.**




Insertion loss for a 2-way Splitter device equals ~3.5 dB.

In the *Subsea FO J-Box*, the ORG and GRN fibers from the Winch cable are patched to the FO cable going to DP. The blue fiber carrying the HD-SDI video channels from the pod is split by a two-way optical splitter mounted in the Subsea FO J-Box (**Fig. 19**). See Schematic 7. OPTICAL LINK (Confluence > Engineering and Tools > VIT > Schematic Diagrams).

### Figure 19. Optical Splitters in Subsea Boxes.



Splitter in *Subsea FO J-Box*

SVS-309L in *Subsea VIT J-Box*

One output from the splitter is patched to DP on the blue fiber, while the second output is patched to a SVS-309L HD-SDI card, mounted in the *Subsea VIT J-Box* (**Fig. 19**). The reentry camera HD-SDI output from this S309 card is converted to HDMI by a Black Magic device and displayed on a monitor at the VIT winch operator's station. A re-clocked SDI output from the same device is transmitted to the Drill Shack via a coaxial cable, where it is converted to HDMI and displayed on a monitor for the Driller.

## SMALL FORM-FACTOR PLUGGABLE (SFP)

*See Schematic 7. OPTICAL LINK* (Confluence > Engineering and Tools > VIT > Schematic Diagrams). As the name suggests, the SFPs (**Fig. 20**) are modular and pluggable and many wavelengths and configurations are available for the designer to choose from. They convert electrical signals to optical at specific wavelengths and convert received optical signals back to electrical. While the Optical Transmitter is at a very specific wavelength, the receiver is wavelength agnostic. **Figure 21** displays the S-309R Card with the SFP unplugged. **Figure 22** is a photograph of the S109 card showing the SFP and the FO Connectors.

**Figure 20. Small Form-Factor Pluggable (SFP).**


**Figure 21. S-309R Card with SFP Unplugged.**

**Figure 22. S109 Card with SFP and FO Connectors.**


Many SFP variants are available. For example, in the IODP VIT design, the S-309R 2 ch HD Video card in the pod has an SFP that has two transmit optical sources at 1550 nm and 1570

nm, one for each video channel. At the surface, the S-309R HD Video card has an SFP with two optical receivers (note that optical receivers are wavelength agnostic).

The S-109R Serial card in the pod has a two channel SFP, one TX channel at 1570 nm and one optical RX channel. The same link at the surface has an SFP with a 1550 TX and an optical RX.

SFPs used with the S-309 HD Video cards can support a higher bitrate (3 Gbit) but CAN only tolerate a 20 dB link attenuation while the S-109 and S-209 cards only support 1.25 Gbit bitrate, but tolerate a -25 dB link attenuation.

SFP devices used in the IODP VIT system:

| **Seaview Card** | **SFP** | **AMS #** |
|---|---|---|
| SVS-109L (A) | ABL45-24-80-D | OV0932 |
| SVS-109L (B) | ASF55-24-80-D | OV0934 |
| SVS-209 (Surface) | ASF51-24-80-D | OV0937 |
| SVS-309L | YACRR-XX3X-1L4D | OV0938 |
| SVS-109R (A) | ABL54-24-80-D | OV0933 |
| SVS-109R (B) | ASF57-24-80-D | OV0935 |
| SVS-209 (Pod) | ASF53-24-80-D | OV0936 |
| SVS-309R | YACTT-5557-1L4D | OV0939 |

## LINK BUDGET

See schematic 8. *LINK LEVELS* (Confluence > Engineering and Tools > VIT > Schematic Diagrams). The SFP optical output power is ~1 dBm. Minimum received level for S-309 link is -20 dBm and for the S-109/209 cards -25 dBm. Thus, maximum link attenuation allowed will be -20 dB and -25 dB for the S309 and S-109/209 links respectively.

The actual link attenuation, Pod to Surface, is ~-8 dB +/-2 dB, depending on the wavelength and FORJ channel in use. Add -3 dB for the splitter in Subsea on the S-309 link. Safety margin for the S309 link is ~6 dB and for the S-209 and S-109 links ~10 dB.

Main contributors to attenuation are:

| | |
|---|---|
| Umbilical | ~-3 dB |
| FORJ/Slipring | -1 to -3 dB |
| Splitter in Subsea (S-309 link) | ~-3.5 dB |

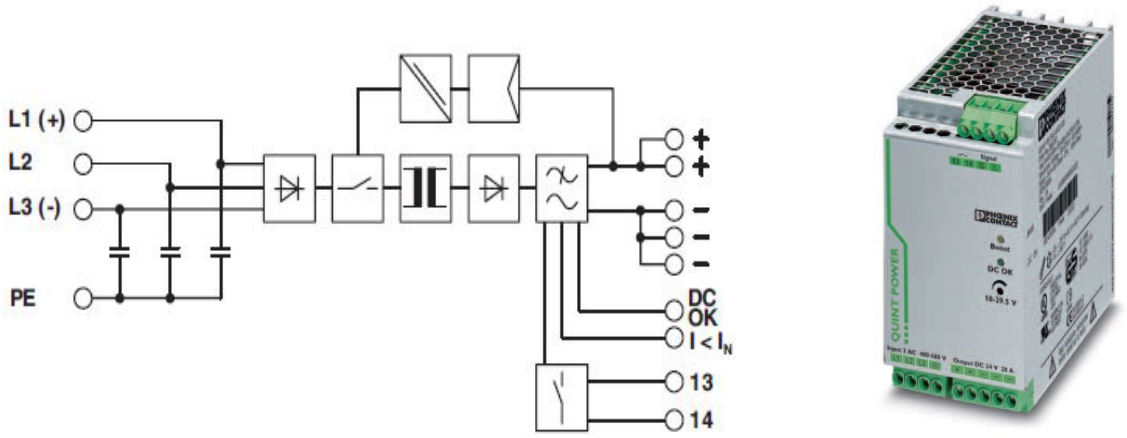
## 1.3 POD POWER SUPPLY

*See 13. Power Schematic Supply Pod* (Confluence > Engineering and Tools > VIT > Schematic Diagrams).

### TWENTY-FOUR (24) VDC POWER SUPPLY (OV0830)

Primary power to the pod is 3-phase 480 VAC. Two Quint wide range switch mode power supplies (**Fig. 23**) provide 24 VDC to all the subsea devices.

**Figure 23. QUINT-PS/ 3AC/24/20 Switch Mode Power Supply (OV0830).**




This design incorporates two QUINT-PS/ 3AC/24DC/20 switch mode power supplies (OV0830). Each deliver 24 V/20 A continuously at Tamb < 70°C and 24 V/26 A at Tamb < 40°C. However, the total output current is limited to ~35 A by the voltage drop across the umbilical. The maximum anticipated load at the Telemetry Pod for this design is ~20 A. At this power level the supply voltage at the VIT frame, due to umbilical drop, will be ~420 VAC at a current of ~0.8 A. The 24 VDC outputs of the two supplies are paralleled and provide redundancy in the event of one supply failing. The operator will be alerted of a power supply failure by an indication on the VITOFF control software. For additional technical data, see **Figure 24**.

The **wide range** input of the Quint Power Supply is a critical parameter, as it compensates for the voltage drop across the 7000m umbilical.

**WARNING:**

1. To allow power sharing between supplies, adjust outputs to within a tenth of a volt.
4. The ship 3-phase 480 VAC supply will have its neutral (Earth) connected via the umbilical armor and ocean to the frame/pod. This will result in a potential difference of ~270 VAC between the pod body and each of the phases. **Take care.**

## Figure 24. QUINT Technical Data.

# 4 Technical data

| Input data | |
|---|---|
| Input nominal voltage range | 3x 400 V AC ... 500 V AC |
| AC input voltage range | 3x 320 V AC ... 575 V AC<br>2x 360 V AC ... 575 V AC |
| DC input voltage range | 450 V DC ... 800 V DC |
| AC frequency range | 45 Hz ... 65 Hz |
| DC frequency range | 0 Hz |
| Current consumption | Approx. 3x 1.6 A (400 V AC)<br>Approx. 3x 1.3 A (500 V AC)<br>Approx. 2x 3.2 A (400 V AC)<br>Approx. 2x 2.8 A (500 V AC) |
| Inrush current limitation | < 20 A (typical) |
| $I^2t$ | < 3.2 $A^2s$ |
| Power failure bypass | > 20 ms (400 V AC)<br>> 30 ms (500 V AC) |
| Typical response time | < 0.5 s |
| Protective circuitry | Transient surge protection Varistor, gas-filled surge arrester |
| Recommended backup fuse for mains protection | 6 A (characteristic B)<br>10 A (characteristic B)<br>16 A (characteristic B) |
| Discharge current to PE | < 3.5 mA |

| Output data | |
|---|---|
| Nominal output voltage | 24 V DC ±1% |
| Setting range of the output voltage | 18 V DC ... 29.5 V DC (> 24 V constant capacity) |
| Output current | 20 A (-25°C ... 70°C, $U_{OUT}$ = 24 V DC)<br>26 A (with POWER BOOST, -25°C ... 40°C permanently, $U_{OUT}$ = 24 V DC)<br>120 A (with SFB technology, 12 ms) |
| Magnetic fuse tripping | max 16 A (characteristic B)<br>max 6 A (Characteristic C) |
| Derating | From +60°C 2.5% per Kelvin |
| Power loss nominal load max. | 40 W |
| Maximum power dissipation idling | 11 W |
| Efficiency | > 93 % (at 400 V AC and nominal values) |
| Ascent time | < 0.5 s ($U_{OUT}$ (10% ... 90%)) |
| Residual ripple | < 40 $mV_{PP}$ (with nominal values) |
| Peak switching voltages | < 40 $mV_{PP}$ (at nominal values, 20 MHz) |
| Connection in parallel | Yes, for redundancy and increased capacity |

Although the two supplies are capable of sourcing 25 A each, the umbilical resistance limits the total 24 V current to ~35 A. The maximum power available in the pod currently is ~850 W. At the Insulation voltage for the umbilical conductors of 1.5 kV, ~3 kW is potentially available subsea.

**Figure 25** is a screen capture of a table that indicates the power available down to the allowable minimum input (320 VAC) for the Quint P-Supply.

### Figure 25. Telemetry Pod Power Chart.

| Cortland cable RM0021 | | | | | |
|---|---|---|---|---|---|
| POWER AVAILABLE AT TELEMETRY POD AND DISSIPATED IN CABLE RESISTANCE | | | | | |
| 3 Phase rms | | | | | |
| Current A | VAC Cable | VAC Pod | PWR cable 3ph | PWR pod 3ph | I at 24VDC (90% eff) |
| 0.1 | 9 | 471 | 1 | 81 | 3 |
| 0.2 | 18 | 462 | 5 | 160 | 6 |
| 0.3 | 27 | 453 | 12 | 235 | 9 |
| 0.4 | 36 | 444 | 21 | 307 | 12 |
| 0.5 | 46 | 435 | 33 | 376 | 14 |
| 0.6 | 55 | 425 | 47 | 442 | 17 |
| 0.7 | 64 | 416 | 64 | 504 | 19 |
| 0.8 | 73 | 407 | 84 | 564 | 21 |
| 0.9 | 82 | 398 | 106 | 620 | 23 |
| 1 | 91 | 389 | 131 | 673 | 25 |
| 1.1 | 100 | 380 | 159 | 723 | 27 |
| 1.2 | 109 | 371 | 189 | 770 | 29 |
| 1.3 | 118 | 362 | 222 | 813 | 31 |
| 1.4 | 127 | 353 | 257 | 854 | 32 |
| 1.5 | 137 | 344 | 295 | 891 | 33 |
| 1.6 | 146 | 334 | 336 | 926 | 35 |
| 1.7 | 155 | 325 | 379 | 957 | 36 |
| 1.8 | 164 | 316 | 425 | 985 | 37 |

## FIVE (5) VDC POWER SUPPLY

Two VICOR DC-DC converters (OV0839; **Fig. 26**) provide 5 VDC to the Seaview systems' multiplexer cards and the Gyro. See **Figure 27** to review the power supply specifications or schematic 13. *Power Supply Schematic Pod* (Confluence > Engineering and Tools > VIT > Schematic Diagrams).

### Figure 26. VICOR 5 V Power Supply.

## Figure 27. Power Supply Specifications.

**$5V_{OUT}$, 50W (e.g. S24C5C50BL, V24C5C50BL)**

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| **Efficiency** | | | | | |
| S24C5C50BL (enhanced efficiency) | 86.5 | 87.8 | | % | Nominal input; full load; 25°C |
| V24C5C50BL (standard efficiency) | 83.0 | 84.5 | | | |
| Ripple and noise | | 80 | 100 | mV | p-p; Nominal input; full load; 20MHz bandwidth |
| Output OVP setpoint | 6.03 | 6.25 | 6.47 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 1.3 | 2.1 | Watts | No load |
| Load regulation | | ±0.02 | ±0.2 | % | No load to full load; nominal input |
| Load current | 0 | | 10 | Amps | |
| Current limit | 10.2 | 11.5 | 13.5 | Amps | Output voltage 95% of nominal |
| Short circuit current | 2 | 11.5 | 13.5 | Amps | Output voltage <250mV |

Each 5 VDC supply can source 10 A and has three-fuse protected outputs. Loads are assigned to the supplies in a way to provide redundancy in the event of a failure. The Gyro and four Seaview System cards each draw ~1 A.

# CHAPTER 2.0 CAMERAS

## 2.1 OVERVIEW

Three cameras are mounted to the VIT frame:

- Sony FCB-H11 High Definition (HD; reentries)
- Panasonic WV-CW3141L Color Phase Alternating Line (PAL; searching)
- IMENCO OE14-522 HD (surveying and inspection)

The Panasonic WV-CW3141L Color PAL (**Fig. 28**), Sony FCB-H11 HD (**Fig. 28**), and Imenco OE14-522 PTZ (**Fig. 28**) cameras were installed in existing camera pressure vessels. The smaller pressure vessel was fitted with the Sony HD camera for reentry use. **Fig. 29** shows the current camera locations on the VIT frame. See schematic *17. Cameras* (Confluence > Engineering and Tools > VIT > Schematic Diagrams).

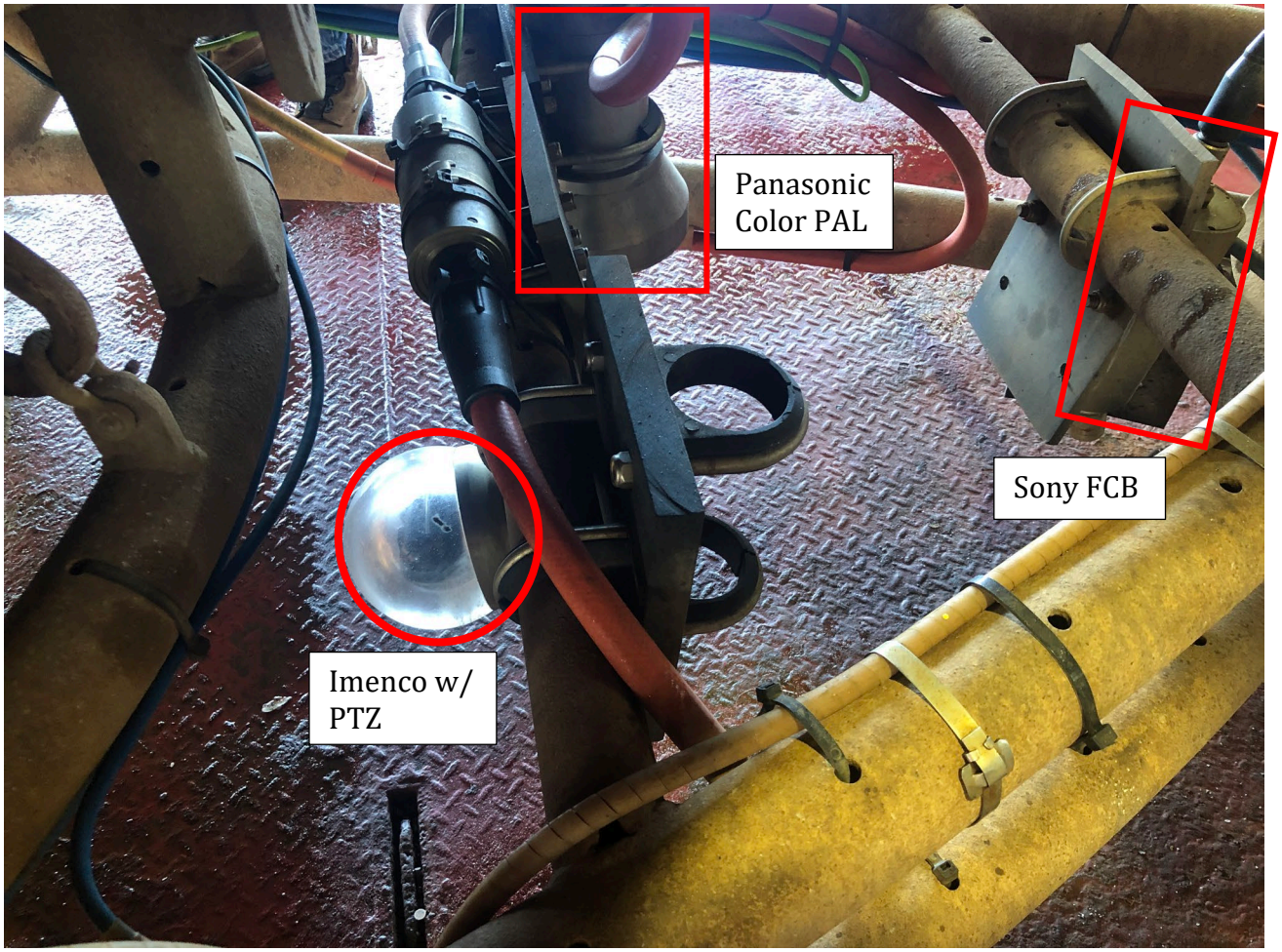
**Figure 28. Sony, Panasonic, and Imenco Pan/Tilt/Zoom, Cameras (from left to right).**

Sony FCB-H11

Panasonic WV-CW3141L Color PAL

Imenco OE14-522 PTZ

**Figure 29. VIT Frame locations for the 3 Cameras: Sony FCB-H11, Panasonic WV-CW3141L Color PAL, and IMENCO OE14-522 with Pan/Tilt/Zoom.**




The main camera functions are:

- The Panasonic WV-CW3141L search camera has a wide field-of-view (~95°) and is used by the DP Operators to find the reentry cone on the seafloor and then position the ship to allow the drillers to perform a reentry.
- The Sony FCB-H11 reentry camera provides imaging to the Driller and VIT winch operator to allow them to position the drill string, and consequently the VIT Frame, above the reentry cone to perform the actual reentry.
- The Imenco OE14-522 HD camera with pan/tilt/zoom functionality via a joystick will be used by the science personnel when seafloor surveys are required. It will also be used by operational and engineering personnel to inspect subsea installations like CORKS. In low contrast conditions, the autofocus can hunt. Selecting *Infinity focus* allows fixed focus from ~2 ft to infinity when the camera is on autofocus. The infinity focus prevents the camera from focusing on a dirt spot on the pressure vessel window and everything else is out of focus.

**Note: Always add a bag of desiccant to each pressure vessel to prevent condensation forming on the inside of the port window at low temperatures.**

## CAMERA HOUSING CONNECTORS

All camera housings are fitted with a Seacon MINL-1CX, 6#22-FCRL connector.

## TELEMETRY POD PORTS

Port 2 on the Telemetry Pod supports PAL/NTSC formats, while Ports 3 and 4 support HD SDI video format.

## CAMERA OUTPUTS

The Sony FCB-H11 (OV0807) and IMENCO outputs HD-SDI 720p/1080i video while the Panasonic WV-CW3141L outputs composite PAL video.

## SONY FCB-H11 HD CAMERA

The Sony HD reentry camera video format is HD-SDI 1080i/59. It has controllable features such as focus, zoom, exposure, etc. that can be executed from the VIT IRIS software on the VIT PC. The Sony HD camera was fitted with interface boards from I-Shot to output Industry standard video formats and RS-232 serial communication. The minimum illumination of 1.0 lux at F1.8 for the camera is sufficient as either increased lighting or improved camera sensitivity accentuates the effect of backscatter negating image quality. The horizontal field-of-view (FOV) for the camera is ~55°.

## PANASONIC WV-CW3141L COLOR PAL CAMERA

The Panasonic WV-CW3141L Color PAL camera (OV0100) has a wide FOV (~95°) ideal for searching. The wide FOV allows the user to view almost twice as much area at any one time than is possible with the Sony camera, which could save time searching for reentry cones and positioning for actual reentry. It has a higher light sensitivity than the other two cameras with 0.08 lx (color) and 0.008 lx (B/W). This camera has a manual zoom and focus control that has to be set initially with installation and is installed in the larger older camera pressure vessels.

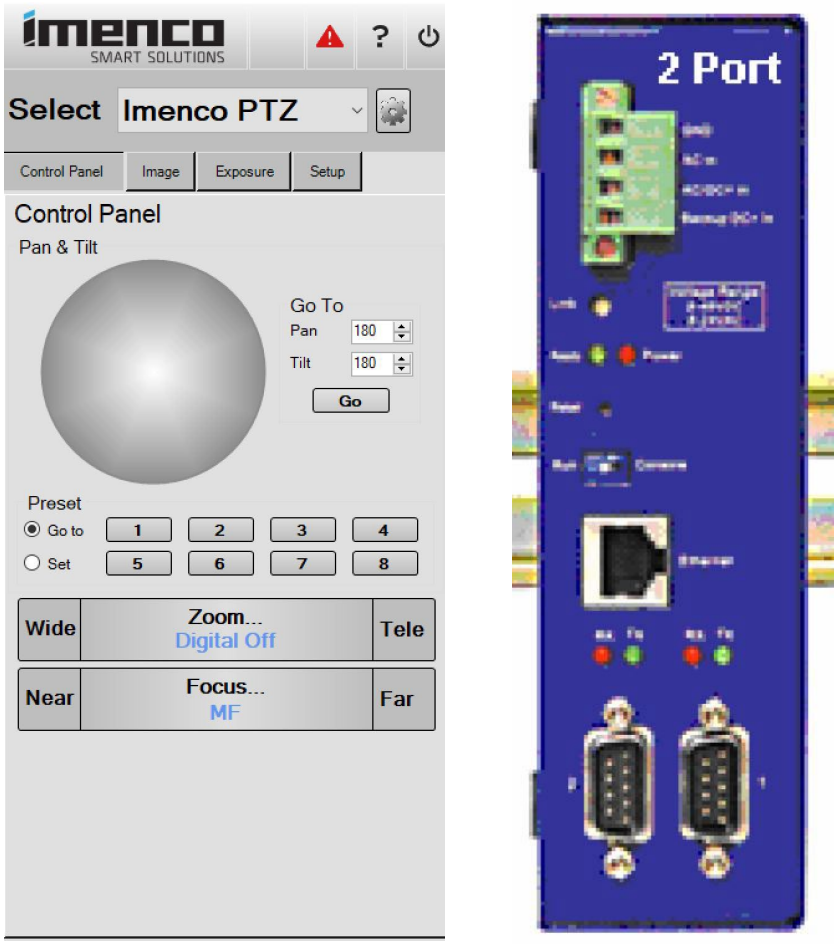
## IMENCO OE14-522 CAMERA

The IMENCO OE14-522 HD survey camera (OV0952) with pan/tilt/zoom functionality (**Fig. 29**), can be controlled from the surface with the IMENCO GUI software (**Fig. 30, left**) from the dynamic positioning room and with the IMENCO GUI software and joystick from the OPS office It is used for surveying the seafloor and inspections.

Communication from the controlling PC to the VIT Surface Multiplexer box is via a Black Box serial server (**Fig. 30, right**) installed in DP. See *3.VIT Data Distribution* schematic (Confluence > Engineering and Tools > VIT > Schematic Diagrams) for details.

The dome material is acrylic and should be treated with care.

**Figure 30. Imenco Camera Software and Black Box Serial Server.**




Serial Port 2 from the Black Box Serial server (IP 192.168.1.28) in DP is connected to port (A5) on the VIT surface multiplexer. Connections via a virtual COM (IP 192.168.1.28 > COM port) are established on the VIT computer (COM12) and the Ops Computer (COM4), going to the Imenco PTZ survey camera. Only one of these stations can have the Imenco GUI activated at any one time.

Although a joystick is not required for control, one was installed on the OPS PC.

Joystick setup:
Z-Axis *Zoom.*
Button 1 *Auto Focus On/Off*
Button 2 *Focus Near*
Button 3 *Focus Far*

The optics on this camera are optimized for use in water; this camera will not achieve infinity focus when used in air.

## 2.2 CAMERA SPECIFICATIONS

A. Panasonic WV-CW314L Specifications

| | |
|---|---|
| Power Source | 12 VDC/560 mA |
| Image Sensor | 1/3 type interline transfer CCD |
| Video Format | PAL |
| Output | 1.0 V ptp PAL, composite |
| Resolution | 650 TV lines (H), 350 TV lines (V) |
| Sensitivity | 0.09 lx (Color, 0.008 lx (B/W) at F1.3 |
| FOW | 100° (H), 70° (V) |
| Ambient Oper. Temp | -10°C to 50°C |

B. FCB-H11 HD-SDI Camera (**Fig. 31**)

**Figure 31. FCB-H11 HD-SDI Camera Specifications.**

# Specifications

| | |
|---|---|
| Effective picture elements | Approx. 2,000,000 pixels |
| Video signal | HD: 1080i/59.94, 1080i/50, 720p/59.94, 720p/50<br>SD: NTSC (CROP), NTSC (SQUEEZE), PAL (CROP), PAL (SQUEEZE) |
| Lens | 10× zoom (F1.8 to F2.1)<br>f= 5.1 mm (WIDE) to 51 mm (TELE) |
| | Zoom movement speed<br>Optical WIDE/Optical TELE Approx. 1.0 sec<br>Optical WIDE/Digital 4× TELE Approx. 1.5 sec<br>Optical WIDE/Digital 4× TELE Approx. 0.5 sec |
| | Focus Movement time<br>∞ to Near Approx. 0.1 sec |
| Digital zoom | 12× (120× with optical zoom) |
| Angle of view (H) | Approx. 50 degree (WIDE end) to Approx. 5.4 degree (TELE end) (When an HD or SD (SQUEEZE) signal is output) |
| Minimum object distance | 10 mm (WIDE end), 800 mm (TELE end) |
| Minimum illumination (Typical) | 12 lux (F1.8) with 50 IRE<br>1.0 lux ICR On (F1.8) with 50 IRE |
| Recommended illumination | 100 to 100,000 lux |
| S/N ratio | 50 dB or more |
| Electronic shutter speed | 1/2 to 1/10000 sec. (21 steps) |
| Focus | Full Auto (Normal AF/Interval AF/ Zoom Trigger AF)<br>One Push Trigger/Manual/Infinity/ Near Limit setting |
| White balance | Auto WB/Indoor/Outdoor/One Push WB/Manual WB |
| Gain | Auto/Manual (–3 to +18 dB, 8 steps) |
| AE control | Full Auto/Shutter Priority/Iris Priority/Manual/Bright/Spot AE |
| Exposure compensation | ± 10.5 dB (15 steps in a unit of 1.5 dB) |
| Backlight Compensation | ON/OFF |
| Gamma | Normal/Cinema Type 1/Cinema Type 2 |
| Auto ICR | ON/OFF (Auto/Manual) |
| Picture effect | Black & white/Negative positive reveral, still image (frozen) |
| Aperture control | 16 steps |
| Preset | Position preset; 6 presets<br>Custom preset; 1 preset |
| Camera control interface | VISCA protocol (signal level:TTL/ CMOS)<br>Communication speed: 9.6 Kbps/ 19.2 Kbps/38.4 Kbps<br>Bit length: 8 bits<br>Stop bit: 1 bit |
| Video Output | HD: ANALOG COMPONENT (Y/Pb/Pr)<br>SD: VBS, Y/C |
| Storage temperature/Humidity | –20 to +60 °C (–4 to +140 °F)/20 to 95% |
| Operating temperature/Humidity | 0 to 45 °C (32 to 113 °F)/20 to 80% |
| Power requirements/Power consumption | 6 to 12 V DC/4.8 W |
| Weight | 120 g (2 lb 10 oz.) |
| Dimensions | 47.2× 43.1 × 72.2 mm (1 7/8 × 1 11/16 × 3 in.) (w/h/d) (Including the projecting parts) |
| Supplied accessories | 24-pin flexible flat cable (1) |

Design and specifications are subject to change without notice.

C. IMENCO OE14-522 Camera (**Fig. 32**)

**Figure 32. IMENCO OE14-522 Camera Specifications.**

# Camera Specifications

| | | | |
|---|---|---|---|
| **PERFORMANCE** | | | |
| Sensitivity | | : | 0.1 lux Faceplate at minimum useful picture |
| Resolution | 50i | : | >800 lines (h) |
| | 60i | : | >800 lines (h) |
| Signal-to-noise Ratio | 50i | : | >48dB (Weighted) |
| | 60i | : | >48dB (Weighted) |
| Boot Up Time | | : | 8 seconds |
| **ELECTRICAL** | | | |
| Signal System | | : | 1080/50i |
| | | : | 1080/60i |
| | | : | 720/50p |
| | | : | 720/60p |
| | | : | PAL/NTSC |
| Sensing Device | | : | 1/3" Interline Transfer CCD |
| Picture Elements | 50i | : | 1920 (h) x 1080 (v) |
| | 60i | : | 1920 (h) x 1080 (v) |
| Field Frequency | 50i | : | 50 Hz |
| | 60i | : | 60 Hz |
| Line Frequency | 50i | : | 27 kHz |
| | 60i | : | 32.4 kHz |
| Video Signal | | : | Analogue Components<br>Y, Pb, Pr<br>HD-SDI[1] |
| Power | | : | +16 to +24 Vd.c.<br>1A Max |
| **OPTICAL** | | | |
| Lens | | : | 5.1mm to 51mm, F1.8 |
| Focus Range (in water[2]) | (wide angle) | : | Front Port to infinity |
| | (narrow angle) | : | 700mm to infinity |
| Angle of View (in water) | Horizontal | : | 0.3 to 45 degrees |
| | Vertical | : | 0.2 to 29 degrees |
| | Diagonal | : | 0.4 to 50.5 degrees |
| Swept Angle of Movement | Horizontal | : | ± 100° |
| | Vertical | : | ± 100° |

[1] On supported options only

[2] The optics on this camera are optimised for use in water, this camera will not achieve infinity focus when used in air

**MECHANICAL**

| | | | |
|---|---|---|---|
| Size | Length | : | 253 mm<br>excluding connector |
| | Diameter (Body) | : | 150 mm |
| | Diameter (Dome) | : | 191 mm |
| Material | | : | Titanium Alloy 6AL/4V<br>ASTM B348 Grade 5 |
| Camera Weight | In Air | : | 4.3 Kg |
| | In Water | : | 9.5 Kg |
| Shipping Weight | | : | 16.7 kg |
| Shipping Dimensions | | : | 540mm x 570mm x 530mm |
| External Connector | | : | Seacon MINL 6W + Coax FCR |

**ENVIRONMENTAL**

| | | | |
|---|---|---|---|
| Operating Depth | | : | 5800 m (19,029 ft) maximum |
| Operating Temperature | | : | -5°C to 40°C (23°F to 104°F) |
| In Air Operating Duration | | : | Continuous operation at 20°C |
| Storage Temperature | | : | -20°C to 60°C (-4°F to 140°F) |
| Vibration | | : | The camera shall withstand without damage an excitation of 10g, from 20 to 150 Hz, in all three axes. |
| Shock | | : | The camera shall withstand without damage, in any direction, 30 G peak acceleration, 25 ms half sine duration |

# CHAPTER 3.0 SONAR

## 3.1 OVERVIEW

The Tritech Super SeaKing has a dual frequency head, 300 kHz CHIRP sonar with a true operational range of up to 300 m for long-range target acquisition, and a 670 kHz CHIRP sonar for ultra-high definition images up to 100 m.

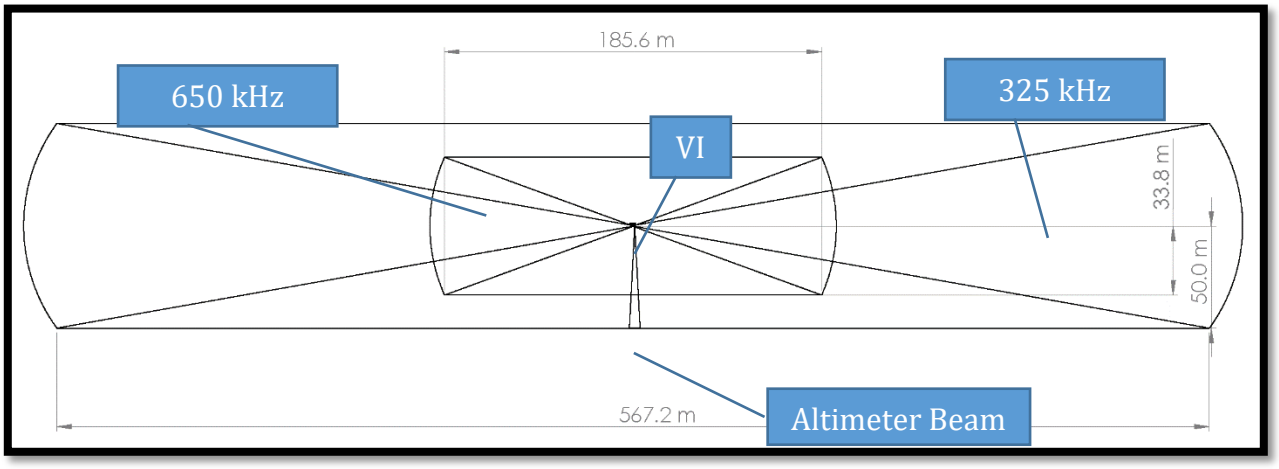
## 3.2 MAINTENANCE

Wash the unit with fresh water after each deployment and periodically when not in use.

## 3.3 THOUGHTS ON SONAR USAGE

Firstly, as can be seen in **Figure 33**, at an altitude above 50 m there is no seafloor coverage for the sonar using the longest-range setting of 325 kHz. Lowering the VIT to within 50 m of seafloor begins to reflect some objects on the seafloor, but there is still very little coverage and a huge sonar blind spot beneath the VIT. It would be very easy to overlook a reentry cone, even if it were located within the maximum range of the sonar. It is important to understand how the altitude and frequency setting of the sonar affect coverage. Obviously the closer the VIT is to the seafloor, the better the coverage. Hopefully, the addition of the altimeter will help the operator to get closer to the seafloor safely.

**Figure 33. Sonar Coverage**




Secondly, the sonar threshold needs to be adjusted so that we can see some seafloor reflection, while the gain should be adjusted to show some contrast between the soft reflection of the seafloor and hard reflection of the reentry cone. I would think that these settings would vary based on the hardness of the seafloor. I would suggest at the next opportunity, the VIT sonar be tested and settings adjusted while at a known location from a cone or another object. This could be done just before a reentry by offsetting from a visibly found reentry cone a given distance which would fall within the sonar coverage area, then making gain and threshold adjustments. This way the operator could get a feel for how these settings work in our application.

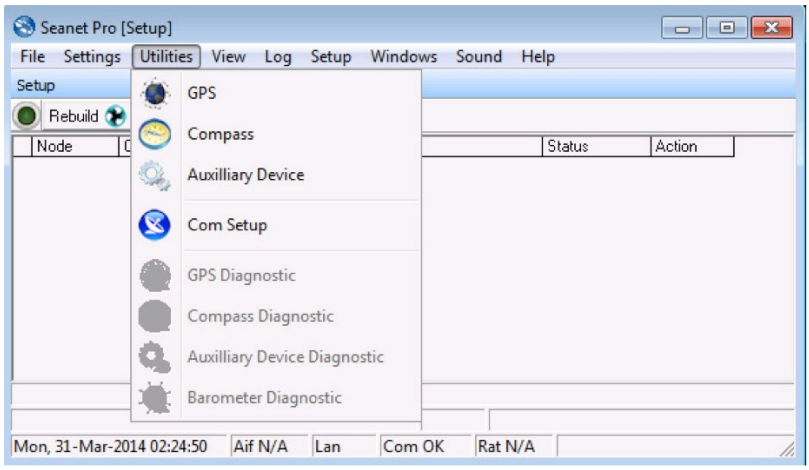
## 3.4 TROUBLESHOOTING

| | |
|---|---|
| Continuous Status “Timeout 2” message. | Communication failure. |
| Status “Centre Err 2” message. | Damage to head. |

## 3.5 SETUP PROCEDURE

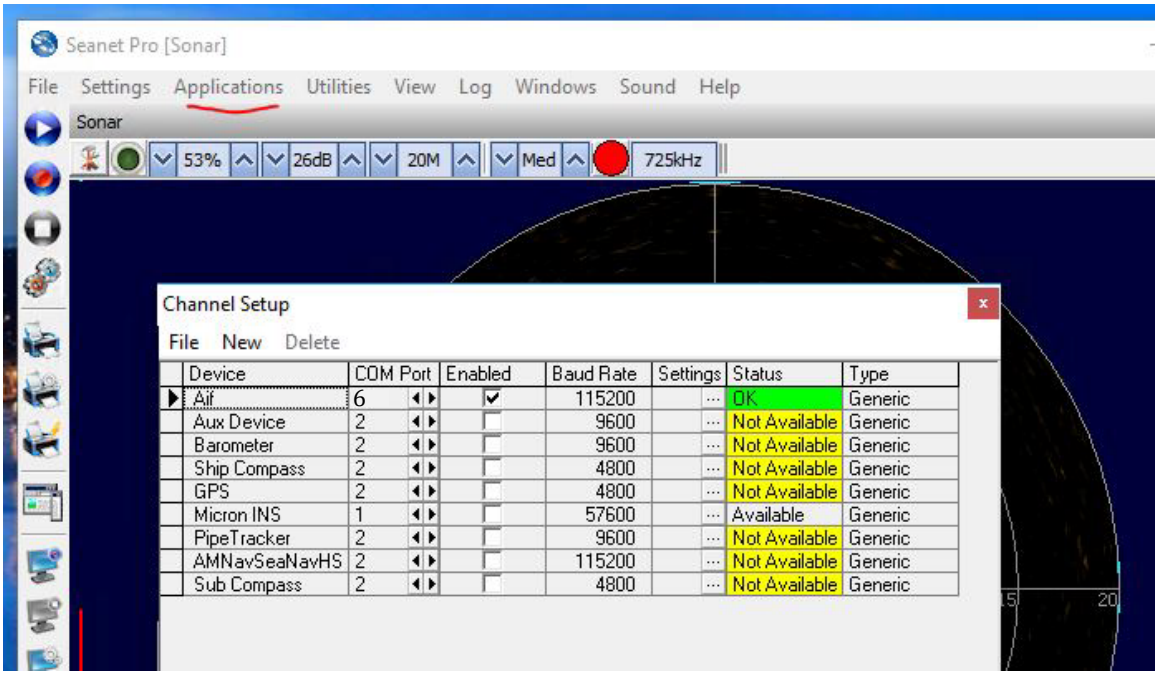
1. Run *Seanet* Pro software.
2. Click Utilities (**Fig. 34**).
3. Click Com Setup.

**Figure 34. Seanet Pro Setup Window.**



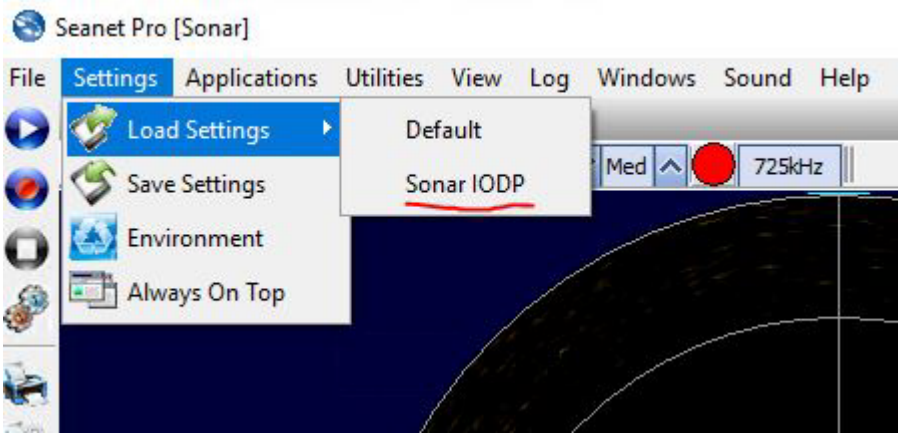

4. Select Aif in the Channel Setup window (**Fig. 35**).
5. Change the Aif COM Port to 6.
6. Enter Baud Rate 115200.
7. Click the *Enabled* check box.

## Figure 35. AIF in Channel Setup.




8. Click Settings > Load Settings > Sonar IODP (**Fig. 36**).

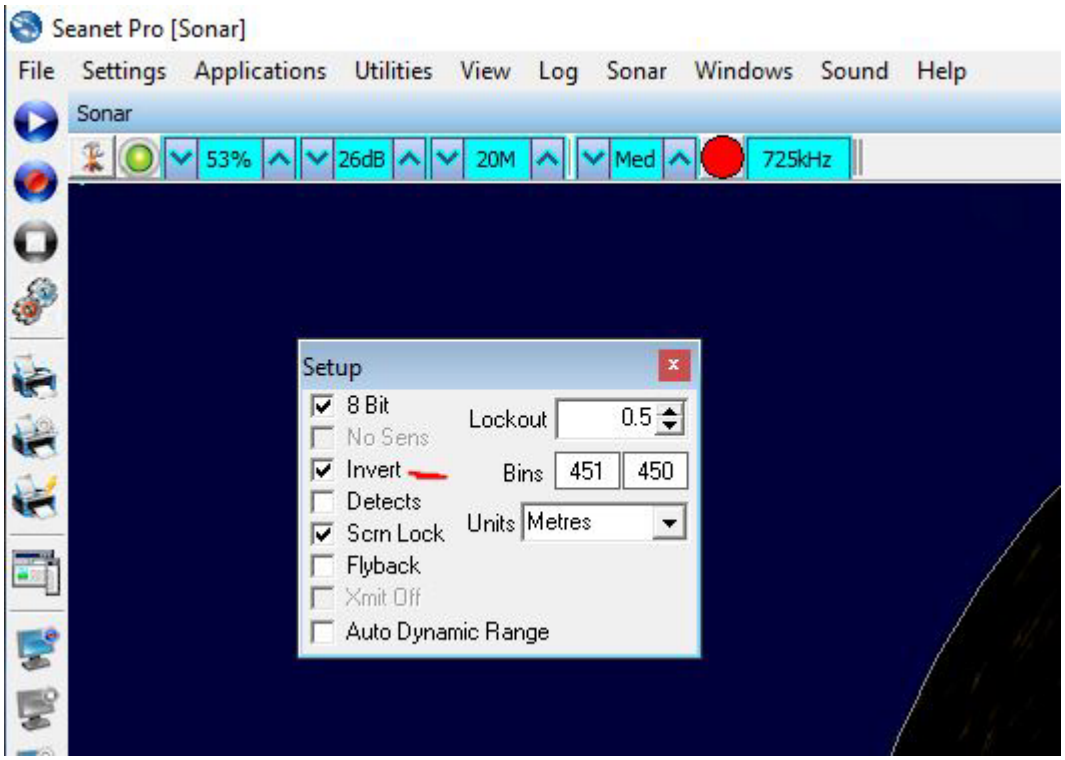
## Figure 36. Selecting IODP Configuration File.




The sonar on the IODP VIT Frame is mounted upside-down to the normal mounting position. For this reason, the scanning image needs to be inverted. To invert, follow these steps:

1. Right click anywhere on display.
2. Confirm that the *Invert* checkbox on the Setup screen is selected (**Fig. 37**).

## Figure 37. Inverting Scanning Image.



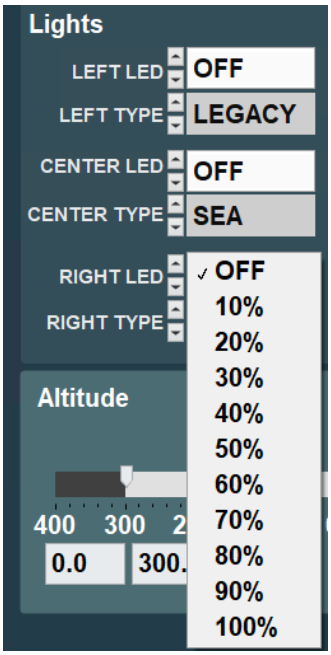
# CHAPTER 4.0 LIGHTING

See schematic *16. External Devices* (Confluence > Engineering and Tools > VIT > Schematic Diagrams) for wiring detail.

## 4.1 OVERVIEW

In IRIS VIT (**Fig. 38**), the current lights can be controlled using the "Legacy" setting and changing the % intensity by increments of 10 from 0% (off) to 100%. The SeaStar LEDs (if the communication issues get resolved) will use the "SeaStar" setting and likewise can have their intensity incremented by 10 from 0% (off) to 100%.

**Figure 38. IRIS VIT light control panel.**




Current VIT lighting is provided by 3 x ROS Lightning LED lights (OV0812; **Fig. 39**). The 10,000 lumens 36 LED light design includes self-regulating dimming protection. RS-485 allows full dimming and on/off control. Unique IDs, "L" (Port) and "D" (STBD) allows the fixed lights to be powered and controlled from a common cable. The Aft LED ID is "D". The lights are powered from 24 V and draw ~6 A at full power. Beam angle is 90° flood and operating depth is 6000 m. Current LED defaults to OFF status on a power cycle.

New replacement ROS SeaStar LED lights are available and have been programed to default to ON at 60% intensity following a power cycle. They have also been programmed to ID's 1, 2, and 3 for port, starboard, and rear-center positions respectively. They are currently to be used as backup as communicating with them consistently has proven elusive when installed on the VIT. They use the same connection cables as the current ROS lights.

Connector: Seacon 5507-1508

## Figure 39. ROS Lightning LED Lights (OV0812).


## 4.3 ROS LIGHTNING SPECIFICATIONS (FIG. 40)

## Figure 40. ROS Lightning Specifications.

**ROS LIGHTNING™** — **SPECIFICATIONS**

| | |
|---|---|
| **PERFORMANCE** | |
| Lamp Type: | Utra High-Intensity White LED Array |
| Light Color Temperature: | 6300°K (typical) |
| Thermal Protection: | Smooth automatic dimming (1) |
| Beam Angle: | Flood 90° or Spot 38° conical (Half-intensity angle) |
| Dimming Options: | Phase control (AC), RS485 or analog, 0-5 VDC or 0-10 VDC |
| Lumens: | 10,000 lm @ 150 Watts |
| Lux Output | 6,000 lux Floodlight, 18,000 lux for Spotlight @ 1m, at150 Watts maximum power |
| **ELECTRONICS** | |
| Power Consumption: | Programmable, 0-150 Watts for all models |
| Operating Voltage: | 108 - 132 VAC, 50-60 Hz or 18-30 VDC |
| **MECHANICAL** | |
| Housing Material: | |
| Alumium | Annodized 6061 -T6 Aluminum |
| Staninless Steel | Electro-polished |
| Size: (w/o connector): | 114mm (4.5 in) Diameter x 139mm (5.5 in) Long |
| Mounting: | 6x 1/4-20 screws in endcap |
| Connectors: | Variety available, easy to service or change out |
| **ENVIRONMENTAL** | |
| Weight in Air: | 3.17 kg (7 lbs) Aluminum |
| Weight in Water: | 1.36 kg (3 lbs) Aluminum |
| Operating Depth: | 6000 m (19,000 ft) |
| Operating Temperature: | Operates in water temperatures of -10°C to 40°C at full intensity (1) |

*Note: (1) The light protects itself from overheating by dimming as necessary. This feature allows accidental operation in air as well as in water temperatures >40°C*

# CHAPTER 5.0 GYRO, FIBER-OPTIC

## 5.1 OVERVIEW

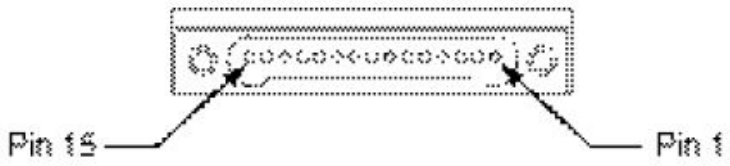
The DSP-3000 is a single-axis interferometric fiber optic gyro (OV0850). The gyro measures angular rate of rotation, which can be integrated to allow the turning angle to be measured accurately. Operating from a nominal 5 VDC, it outputs a digital RS-232 message with input rates of up to ±375°/sec. The DSP-3000 is self-initializing and ready for use ~5 seconds after power is applied. The device has an inherent drift rate of ~1°/hr. The gyro is mounted internal to the Telemetry Pod. A DC/DC converter provides the 5 VDC supply. LabVIEW software acquires data from the Gyro and compensates for Earth's drift rate before displaying. Reference heading must be entered prior to deployment. Software can calculate the number of clockwise/ counterclockwise turns made by the VIT frame, to determine if and how the umbilical is wrapped around the drill string.

The DSP-3000 senses rotation on an axis perpendicular to the plane of the baseplate. Looking at the gyro from overhead, a clockwise rotation will produce a positive output. If this alignment is not observed, the output data will vary as a function of the cosine of the misalignment angle. VIT IRIS LabVIEW application receives ship heading from a local source as reference for the Gyro. The same local source also provides location latitude information for *Earth rotation* correction.

## 5.2 CONNECTOR PINOUT

**Figure 41** shows the gyro connector pins.

**Figure 41. Gyro Connector Pins (Head-on View).**




| Pin | Function |
|---|---|
| 1 | Positive 5 VDC Supply |
| 2 | Return GND |
| 3 | Shield GND |
| 9 | TX RS-232 |
| 10 | RX RS-232 |
| 11 | DIGITAL GND |

# CHAPTER 6.0 ALTIMETER

VIT sonar coverage is very dependent on distance above seafloor (altitude). Basically, the lower the VIT frame the better the sonar coverage. To measure an accurate distance above the seafloor, an altimeter has been added to the VIT system. This provides a quick altitude indication on the VIT software interface and is available for use on the VIT CCTV image overlay. Maximum range of the altimeter is 50 m; at distances above this the indication should be zero. However, there is a possibility that there will be an erroneous reading when the VIT is more than 30 m above the end of the drill string. This is due to the 6° beam width that may reflect off the pipe.

The altimeter is mounted just below the reentry camera to the rear vertical using a universal VIT mounting bracket. The location of this mounting bracket was selected to maximize the distance from the drill string, which in turn should minimize drill string reflection that could cause a false altitude. In this configuration, reflection from the drill string should not occur when the VIT frame is within 30 meters from the end of the drill string or 30 m altitude from the seafloor. The altimeter outputs 50 m, which is its maximum output when the device is in air.

The PA500 (OVO790) is a sonar ranging device, which when mounted vertically, gives the height above the sea bed.

Specifications:

| | |
|---|---|
| Freq. | 500 kHz |
| Beam width | 6 deg Conical |
| Range | 0.3-50 m |
| Resolution | 1 mm |
| Power | 24 VDC/80 Ma |
| Data Comms | RS-232 |
| Depth Rating | 6800 m |

# CHAPTER 7.0 UNDERWATER CONNECTORS/CABLES

## 7.1 OPTO CONNECTORS

Due to the low probability of successfully terminating an optical connector to the umbilical at sea, we decided to go with a connector pre-terminated to a pigtail. Splicing the pigtail to the umbilical in the PBOF FRAME J-Box is well within our means and the probability of success is high. Seacon molded their MIN3F/3CCPL003 (OV0819) connector to the umbilical pigtail we supplied. The flange-mounted connector on the Pod is a MIN3F/3FCRL018 (OV0818) with optic fibers terminating into type LC connectors. The MIN3F/3CCPL003 (OV0819) connector will support the 3-phase AC Power and three Single mode Optic Fibers.

## 7.2 ELECTRICAL CONNECTORS

Burton has manufactured a line of rugged reliable connectors for extreme environments for many years. These connectors are an industry standard and available worldwide. For these reasons, it was decided to specify Burton connectors (**Fig. 42**) on the Pod and all end devices.

**Figure 42. Burton-type Connectors.**

All connectors have an operating pressure of 10,000 psi and pins are rated to 600 VAC/2 A each.

All end devices have the 8 pin 5500 series 1508 connectors (OV0904) with pins in the receptacles. The pod has 8 pin 6600 series 6607-1608 type connectors (OV0816) with sockets in the receptacles. This was done for safety reasons and does not allow live potentials on pins of an exposed connector.

Connector pins and UW cable conductors are 18 AWG. This should be good for ~7 Amp per pin/conductor when submerged.

### ENGAGING CONNECTORS PROCEDURE

1. Always be sure the power is turned off before either engaging or disengaging a connector.
2. Lightly coat the face, sides and sealing surface with clean Dow Corning silicone grease (nothing more than a light coat).

3. Align polarizing keyway in plug and receptacle and push to engage the contacts. When sealing surfaces touch, spin the coupling nut on until it just touches. For a 1608 connector, give an additional half turn, for a 1508 connector give one full turn.

## 7.3 COAXIAL CONNECTOR (OV0840)

The coaxial connector is a Seacon Mini-Con MIN-L FCRL-1 Coax/6 Electric (**Fig. 43**).

**Figure 43. Seacon Mini-Con MIN-L FCRL-1 Coax Connector.**


The high data rates of HD-SDI video signals (1.5Gbit/s) require impedance matched connectors and lines. This connector was specially developed to comply with this need. It has one coaxial and six 22 AWG electrical contacts. Ports 2, 3 and 4 on the Pod and all cameras are equipped with this connector type.

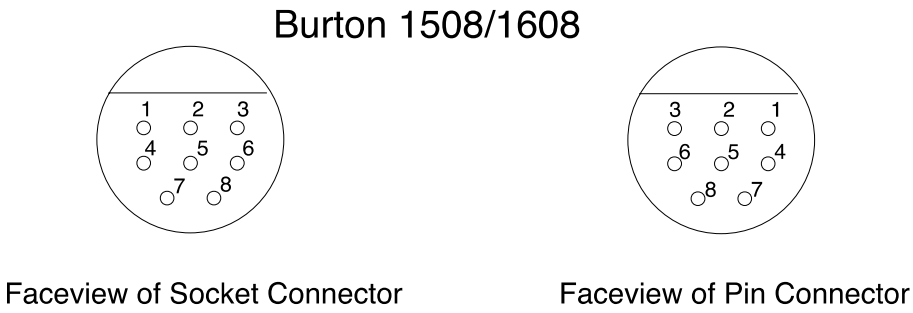
## 7.4 UNDERWATER CABLES

See cable *Schematics* (Confluence > Engineering and Tools > VIT > Schematic Diagrams, Numbers 18-23). Specifying Burton 1508 connectors for the end devices and 1608 connectors on the Pod, allow us to use standard interconnecting underwater cables.

Most cables have a Burton 6601-1608 connector at the Pod end and a 5501-1508 connector at the device end (**Fig. 44**). The connectors are wired pin-to-pin with four twisted pairs. Although wire AWG differs between some cables, all cables can accommodate the maximum current of 3 A per connector pin on pins 5-8. The Sonar cable has a plastic 5501-1508 polyether ether ketone (PEEK) connector to mate with a plastic 1505 (PEEK) connector on the sonar. Although not advisable, the plastic connectors can be connected to steel and vice versa.

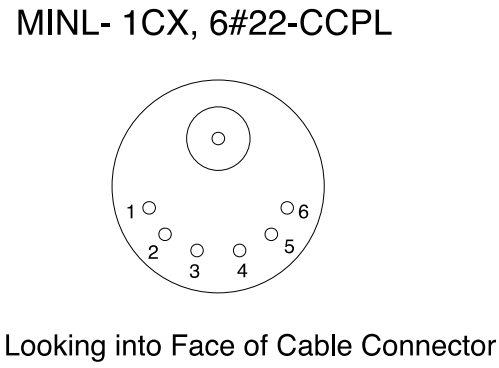
The LED 1 and 2 lighting cables have two 5501-1508 connectors each wire in parallel with one 6601-1608 on the pod end. Because of the higher current drawn by these devices, two pairs have been paralleled on the Pod and end device connectors.

## Figure 44. Burton 1508/1608 Pin Diagram.




All underwater cables, except the camera cables, have Burton 6601-1608 connectors on the Pod end and Burton 1508 on the end device end. The camera cables have MINL-1CX, 6#22-CCPL connectors (**Fig. 45**) by Seacon on both ends.

## Figure 45. Seacon MINL-1CX,6#22-CCPL Pin Diagram.



# CHAPTER 8.0 2 VIT END DEVICES REVISION LOG

## 8.1 REVISION DATA

Revisions to the manual are recorded in this table. Please include the page, section or Chapter numbers in the revision Details.

| Revision Date | Authority | Page | Revision Details |
|---|---|---|---|
| 1/29/19 | Graber | Title, Ch 9 | Added VIT Assembly part number to title page, added ch. 9 revision log and TOC, fixed footer file name, and added hyperlinks/bold text for fig citations. |
| 2/6/19 | Meiring | Removed Section 1.3 | Removed Optical Measurements and moved to document 6. |
| 3//5/19 | Meiring | Document | Approved document. |
| 11/5/19 | Graber | Ch 6 | Removed Pan and Tilt chapter per M. Meiring. Revised TOC inserted. |
| 11/5/19 | Graber | Ch 2 | Made updates to reflect camera changes per Meiring. Reordered camera text. Added photo of cameras on VIT. |
| 4/1/20 | Meiring | Variable | Made changes Mike made during Exp 378, his last expedition. Added Imenco Camera info. |
| 9/25/22 | Howard | Variable | Updated with new IRIS VIT and ROS lighting info and replaced Cumulus references with Confluence |
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