



3D AT DEPTH



Wide Swath Subsea LiDAR- 2ND GENERATION (WiSSL-2G)

User's Hardware Manual

Rev 1.1

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0.3	04/21/2025	Updated Laser Safety Guidelines	JB
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1 Purpose

This document contains technical information to help the user with the integration, operation, and maintenance of the Wide Swath Subsea LiDAR (WiSSL-2G) system.

2 WiSSL-2G Overview

The WiSSL-Gen2 laser is an underwater Class 4 laser scanning system built to collect 3D point clouds from subsea targets, either natural or manmade. The WiSSL2 consists of one canister containing the optical scanning head and the computing and processing component. The optical system consists of the transmitter sub-system (laser and accompanying optics), the receiver sub-system (detector and accompanying optics) and the scanner sub-system consisting of a single-axis spinning mirror to allow programmable scanning in one direction as the vehicle provides motion in the orthogonal direction. The receiver sub-system also includes two red channels for collecting Raman-shifted light for calculating temperature. The electronics component consists of the power and communications components, a computer running 3D at Depth processing and collection software, and the signal processing subsystems. Communication is via an Ethernet (TCP/IP) connection, and 18-36V DC power is supplied either via an ROV or direct from the surface, through a standard subsea connector. The optical system uses a higher class laser (Class 4) than the first generation WiSSL sensor (Class 3B), so additional measures should be taken with the WiSSL-Gen2 sensor.

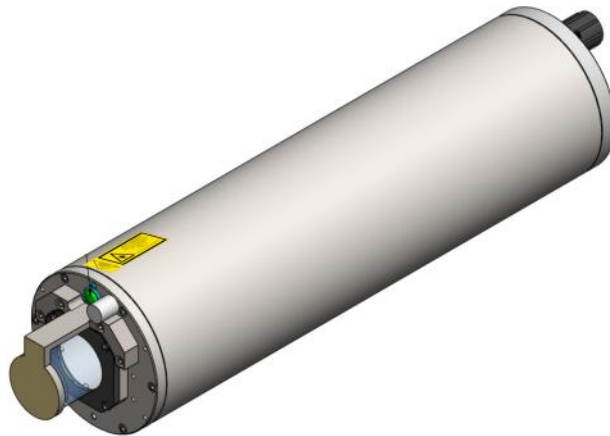


Figure 1 - WiSSL-Gen2 Sensor

3 Laser Safety

3.1 Overview

The WiSSL Gen 2 family of laser sensors can emit Class 4 visible laser radiation. Extreme care must be exercised during operation. The International Electrotechnical Commission (IEC) describes Class 4 as follows:

Class 4 laser products can cause injury from either the direct beam or its specular reflections and from diffuse reflections. They also present a potential fire hazard. The following controls should be employed.

Class 3B

1. The laser should only be operated in a controlled area
2. Care should be exercised to prevent unintentional specular reflections
3. Conditions for safe viewing of a diffuse reflection for Class 3B visible lasers are: minimum viewing distance of 13cm between the target and the cornea (eye) and a maximum viewing time of 10 s.
4. Eye protection is required if there is any possibility of viewing either the direct or specularly reflected beam, or of viewing a diffuse reflection not complying with the conditions of item (3).
5. The entrances to areas should be posted with a standard laser warning sign.

Class 4 (in addition to Class 3B controls)

1. Beam paths should be enclosed whenever practicable. Access to the laser environment during laser operation should be limited to persons wearing proper laser protective eyewear and protective clothing.
2. Beam paths should avoid work areas, where possible, and long sections of tubes should be mounted so that thermal expansion, vibration, and other sources of movements in them do not significantly affect the alignment of beam forming components.
3. Class 4 lasers should be operated by remote control whenever practicable, thus eliminating the need for personnel to be physically present in the laser environment.
4. Good room illumination is important in areas where laser eye protection is worn. Light-colored diffuse wall surfaces help to achieve this condition.
5. Fire, thermally induced aberrations in optical components, and the melting or vaporization of solid targets designed to contain the laser beam, are all potential hazards induced by the radiation from Class 4 lasers. A suitable beam stop should be provided, preferably in the form of an adequately cooled metal or graphite target. Very high power densities can be handled by absorbing the radiation over several reflections, each reflecting surface being inclined at such an angle to the incident radiation as to spread the laser power over a wide area.

The WiSSL-Gen2 series pulses at approximately 350,000 pulses per second.

For all devices in the WiSSL-Gen2 family, a single laser pulse emitted directly into the eye can cause serious eye damage and possible blindness.

For this reason, the 3D at Depth laser system should NEVER be used for topside scanning except in designated laser areas in the Longmont, Houston, or UK offices, as it is specifically designed for underwater laser scanning. In addition, the system will overheat if operated outside of water.

3.2 Personal Protective Equipment

If there is any chance that personnel may be exposed to laser radiation above class 1 levels due to intrabeam exposure or specular reflection, it is recommended to wear laser safety glasses. The laser safety glasses must have an OD (Optical Density) level of 4 or higher for the wavelength of 532nm. The OD level will be written for different wavelength ranges on the front of the lenses. In the example below, the laser safety glasses attenuate at a level of OD6 at a wavelength of 532nm

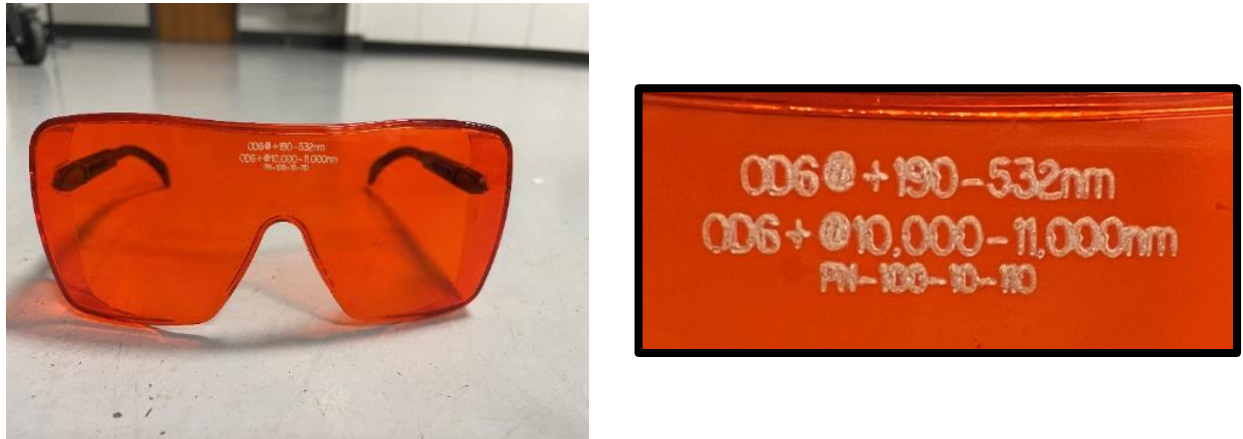


Figure 2 - Laser safety glasses for use with the WiSSL-Gen2 sensor

3.3 Laser Safety Recommendations

WARNING

When operating the laser system, it is recommended that you observe the following safety precautions:

1. While on land or on deck, always have the window cover in place when the laser is connected to line power and scanning is not necessary.
2. Limit access to the laser to those familiar with the equipment. Keep the laser out of the hands of inexperienced or untrained personnel.
3. The laser sensor should only be operated by a person trained on the safe operation of the product.
4. While on land or on deck and the laser is on, ensure the entire scan area is completely blocked. Tape barriers or personnel should be used to keep untrained persons out of the scan area.
5. NEVER LOOK DIRECTLY INTO THE MAIN LASER BEAM, NEVER SIGHT DOWN A BEAM INTO ITS SOURCE.
6. Do not allow reflective objects to be placed in the laser beam. Laser light scattered from a reflective surface can be as damaging as the original beam. Even objects such as rings, watchbands, and metal pens or pencils can be hazardous.
7. All personnel should stand behind the laser prior to starting a scan and during all scans. NO personnel should be in the scan area during a scan.
8. The SL system has an internal attenuator that attenuates the emitted beam to below maximum permissible exposure (MPE) limits. When operating the system on land or on deck, the system should ONLY be operated with Gains 1-4. When operating in this mode, all of the Safety Recommendations should still be followed to prevent direct viewing of the beam.
9. Once underwater, the system can be operated in Class 4 mode. For diver deployed operations, it is particularly important to follow the Safety Recommendations. The diver must always be behind the laser unit prior to laser light emission. A clear communications channel and operational protocol are required between the diver and the topside control to ensure the diver is in a safe position and not watching the scan prior to every laser activation.
10. CAUTION – Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.
11. NEVER LEAVE THE LASER ON, OPEN, AND UNATTENDED
12. The operator can reference ANSI Z136.1 for further guidance on the safe use of lasers.

3.4 Additional Laser Safety Information Sources

Sources for additional information and assistance on laser safety are:

Director (HFX-400)
Division of Compliance
Bureau of Radiological Health
5600 Fishers Lane
Rockville, MD 20857
(Regulations and Requirements)

American National Standards Institute, Inc.
1430 Broadway
New York, NY 10018
(Safety Guides)

Laser Institute of America
400 Executive Park Drive
Cincinnati, OH 45241
(Safety Guides)

3.5 Safety and Identification Labels

Adhered on each sensor is a warning, certification, and aperture warning label, which is used to identify the location of the aperture and the laser class. This label is shown in Figure 3 and its location on the sensor is shown in Figure 4.



Figure 3 - Warning, certification, and aperture warning label

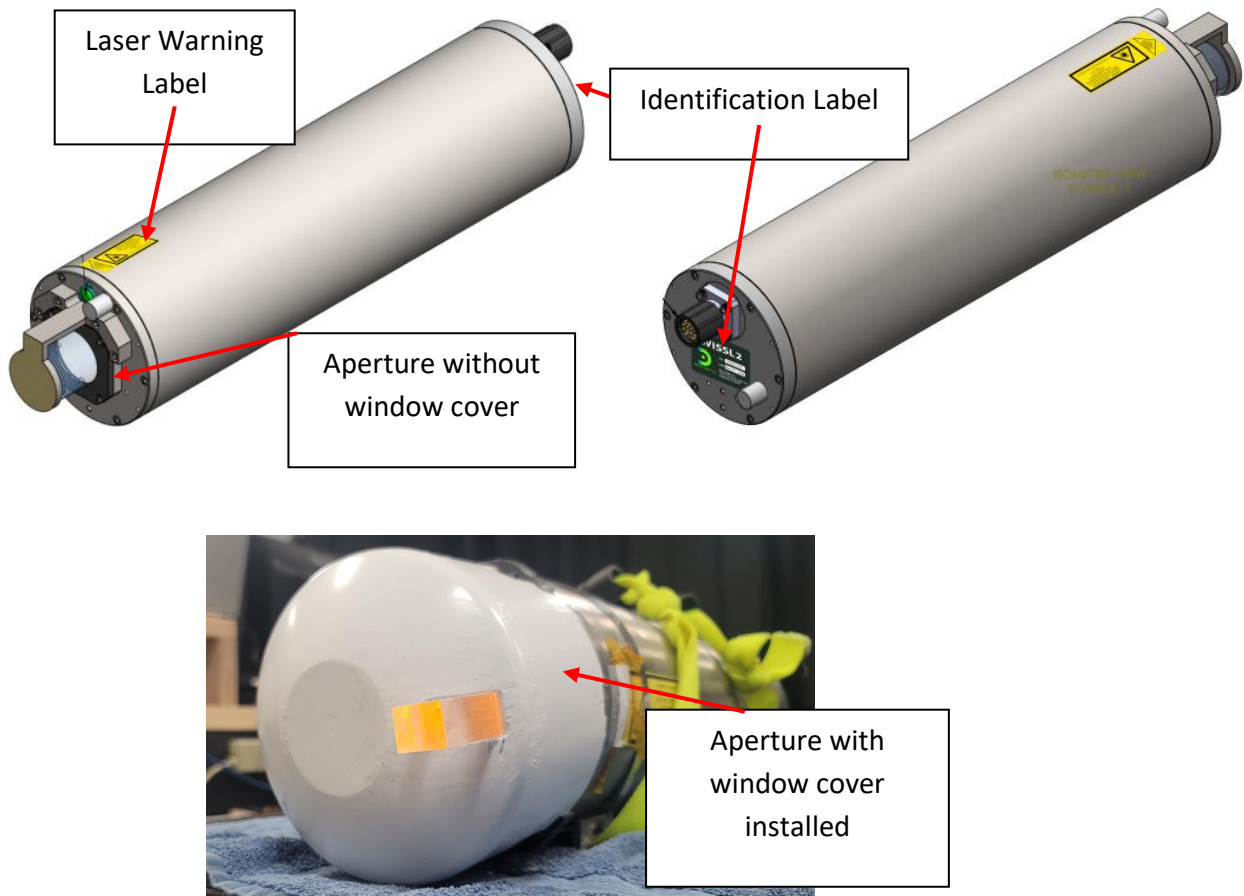


Figure 4 - Label location and laser aperture for WiSSL-Gen2

Also adhered to each sensor is the identification label which identifies the sensor serial number and the name and address of the manufacturer. This label is shown in Figure 5 and its location on the sensor is shown in Figure 4



Figure 5 - Identification labels for the WiSSL-Gen2 family of sensors. Each serial number (S/N) is tracked at the factory for the month, year, and location of manufacture.

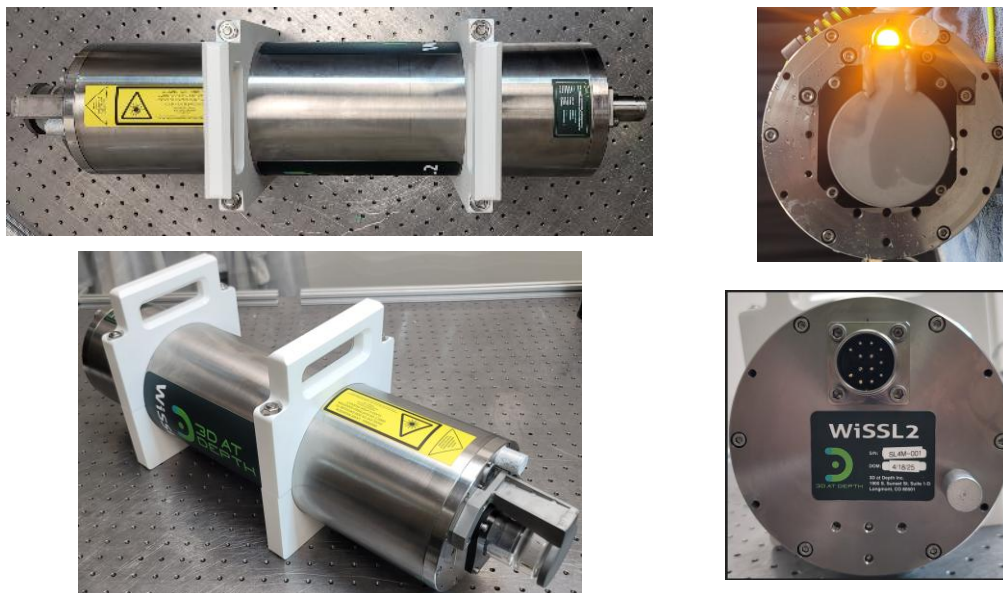


Figure 6 - Label Location and Laser Aperture.

3.6 General Information on Laser Output

Wavelength	532 nm
Maximum Average Radiant Power	< 1 W
Beam Divergence	~ 2 mrad
Beam Diameter at Laser Aperture	~ 2 mm
Pulse Duration	< 1 ns
Pulse Repetition Rate	~ 40-350 kHz

Table 1 Laser Output

3.7 WiSSL-Gen2 Specifications

Specification	Value	Note
Measuring Method	Time of Flight (ToF) Pulsed	
Pulse Repetition Rate	40-350kHz	
Range	Min 2m, Max 45m	Turbidity Dependent
Field of View	100°	Single Axis
Range Precision	<2.5mm single-point @2-40m, 1σ	<0.5mm multi-point @2-40m, 1σ
Distance Measurement Point-to-Point	3mm RMS proven subsea from a deep water project using a work class ROV	
Beam Divergence, 1/e2, Full Width	0.12°	Typical. Varies with water conditions
Beam Footprint, 1/e2, Full Width	@3m = 8mm, @10m = 23mm	Typical. Varies with water conditions
Angular Encoder Resolution	0.00137deg	
Operating Temperature	-5C to 35C	
Laser Class	Class 1 (Air) to Class 4 (Underwater)	
Ambient Lighting	Fully operational in bright sunlight and complete darkness	
Point Cloud Format	RIAAT (Proprietary data format) + Industry Standard (LAS, E57, XYZ)	
Power Supply	18-36VDC	
Data Transfer	Ethernet 100Mbps LAN	Internal 1 TB SSD
Physical Properties	Single Canister	
Length	28.1in (714mm)	
Outside Diameter	6.375in (162mm)	
Weight	70lb (in air)	
Depth	6000m	
Scan Speed	Up to 3,000 rpm	

Table 2 WiSSL-Gen2 Specifications

3.8 3D Collect – Scanning Interface

When the 3D Collect icon is clicked (or double clicked), the user is presented with the laser safety warning and requires a password. This password is provided to the customer and the password should only be shared with personnel who have undergone laser safety training.

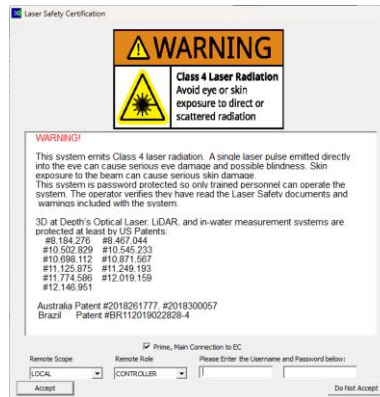


Figure 7 - 3D Collect Laser Safety Warning

4 Connectors and Cables

4.1 Cabling Diagram

Figure 8 below shows the WiSSL-2G temporary lab pigtail cabling diagram.

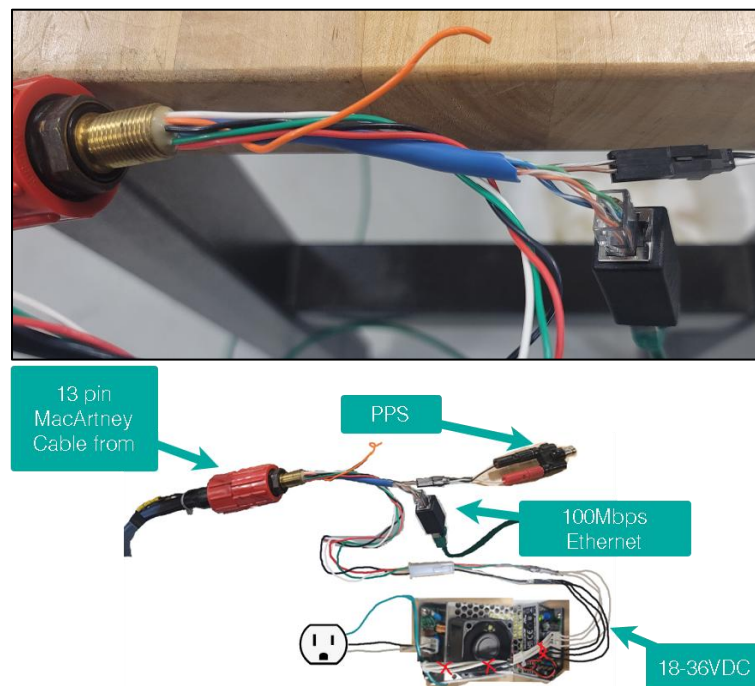


Figure 8 - Power and Ethernet Connections

4.2 Sensor Bottle Connectors

Figure 9 below shows the connectors for the WiSSL-2G Sensor. It is advised to ensure all bottle fasteners and connectors are tightened properly before each dive/campaign. Refer to Section 4.5 for Sensor Bottle connector part numbers.

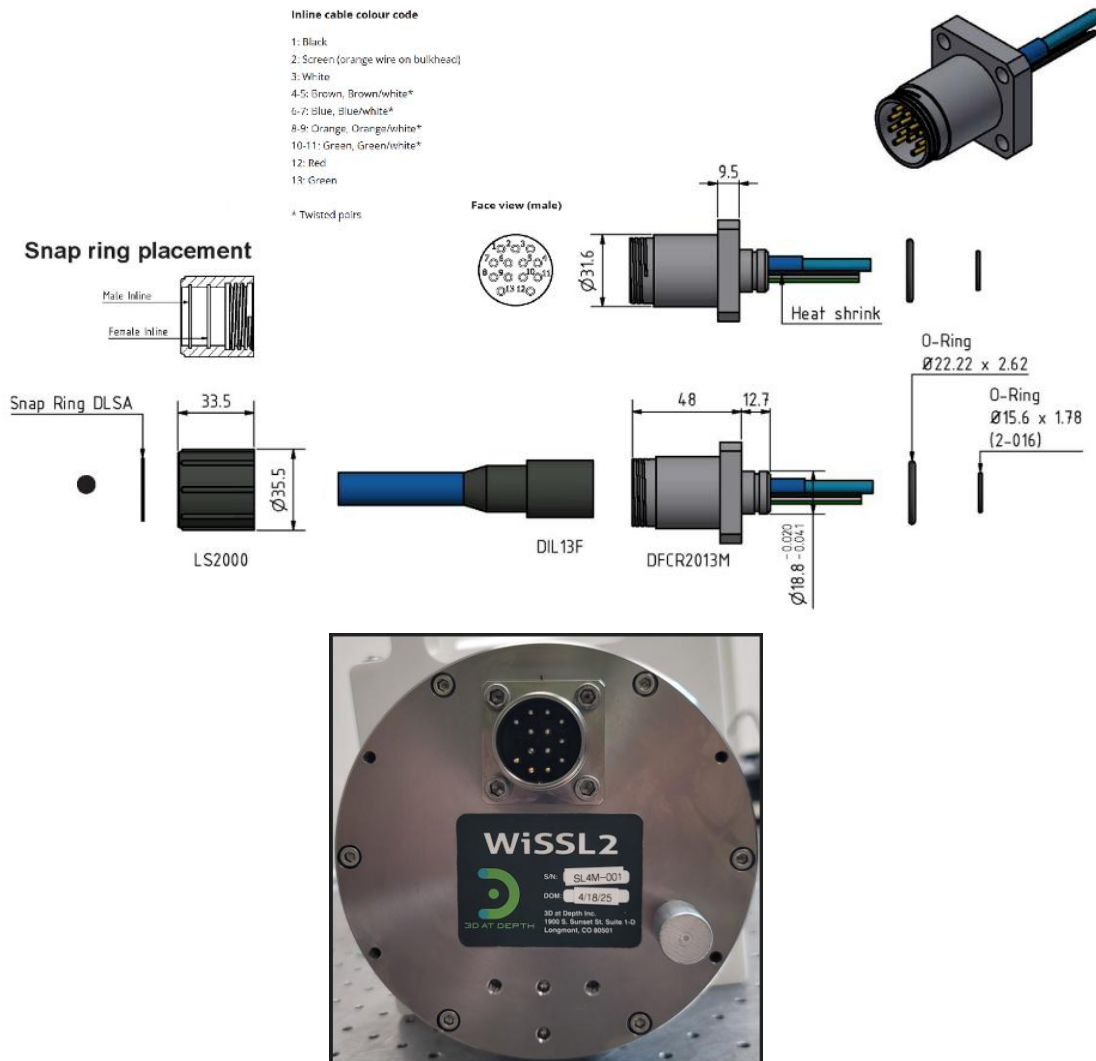


Figure 9 - Sensor Bottle connector – MacArtney 13-pin DFCR2013M-Ti

[SubConn Ethernet Metal Shell 2000 - 13 contacts](http://www.macartney.com/connectivity/subconn/subconn-ethernet-series/subconn-ethernet-metal-shell-2000-13-contacts/)

www.macartney.com/connectivity/subconn/subconn-ethernet-series/subconn-ethernet-metal-shell-2000-13-contacts/

Max Voltage Ratings for Pins on Connectors and Cables: 600V for pins 1-3,12,13 and 250 V for pins 4-11.

4.3 13-pin MacArtney Cable

The WiSSL-2 Bottle is connected via (1) 13-pin MacArtney cable. The 13-pin cables (SubConn D-P-P4TP24#/4C18#) are interchangeable. These cables have been custom molded with a right-angle connector on one end, as shown in Figure 10. The right-angle plug mates to the flange-mount connector and the straight plug mates to the ROV. Table 3 and Figure 11 describe the connector and cable pinouts.

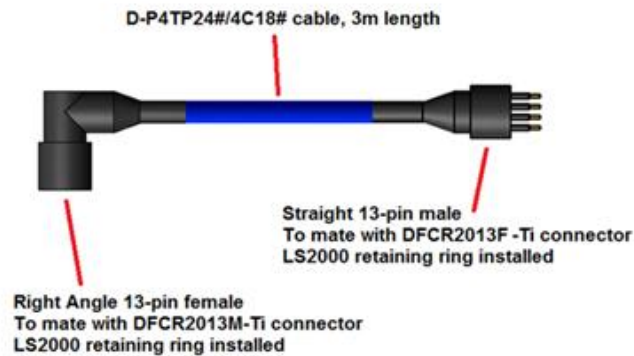
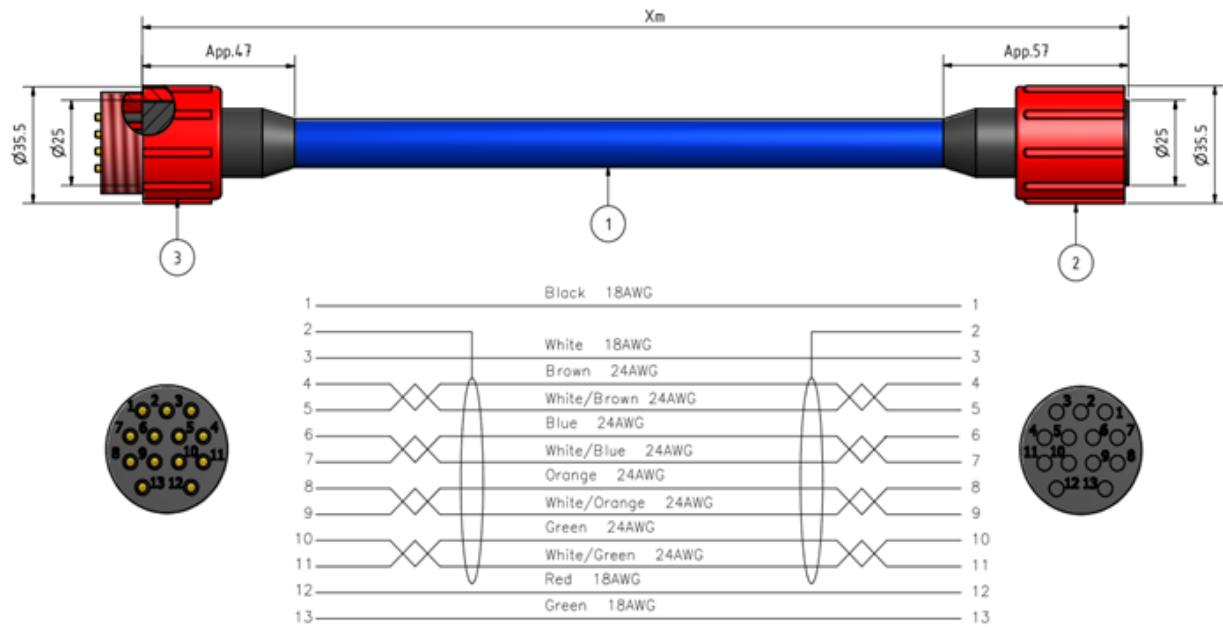


Figure 10 - MacArtney 13-pin Cable Details

Table 3 MacArtney 13-pin Pin-Out

<u>DIL13M</u>	<u>MacArtney:D-P-P4TP24#/4C18#</u>	<u>DIL13F</u>	<u>Signal</u>
1	Gnd: 18 AWG	1	Power Gnd
2	Shield	2	Not Connected
3	Gnd: 18 AWG	3	Power Gnd
4	TP1a: 24 AWG	4	PPS Signal
5	TP1b: 24 AWG	5	PPS Ground
6	TP2a: 24 AWG	6	Connected, Unused
7	TP2b: 24 AWG	7	Connected, Unused
8	TP3a: 24 AWG	8	Tx-
9	TP3b: 24 AWG	9	Tx+
10	TP4a: 24 AWG	10	Rx-
11	TP4b: 24 AWG	11	Rx+
12	+18V-36V: 18 AWG	12	+24V (Nominal)
13	+18V-36V: 18 AWG	13	+24V (Nominal)



Note: Actual connector is 90 degree connector.

Figure 11 - MacArtney 13-pin Wiring Diagram

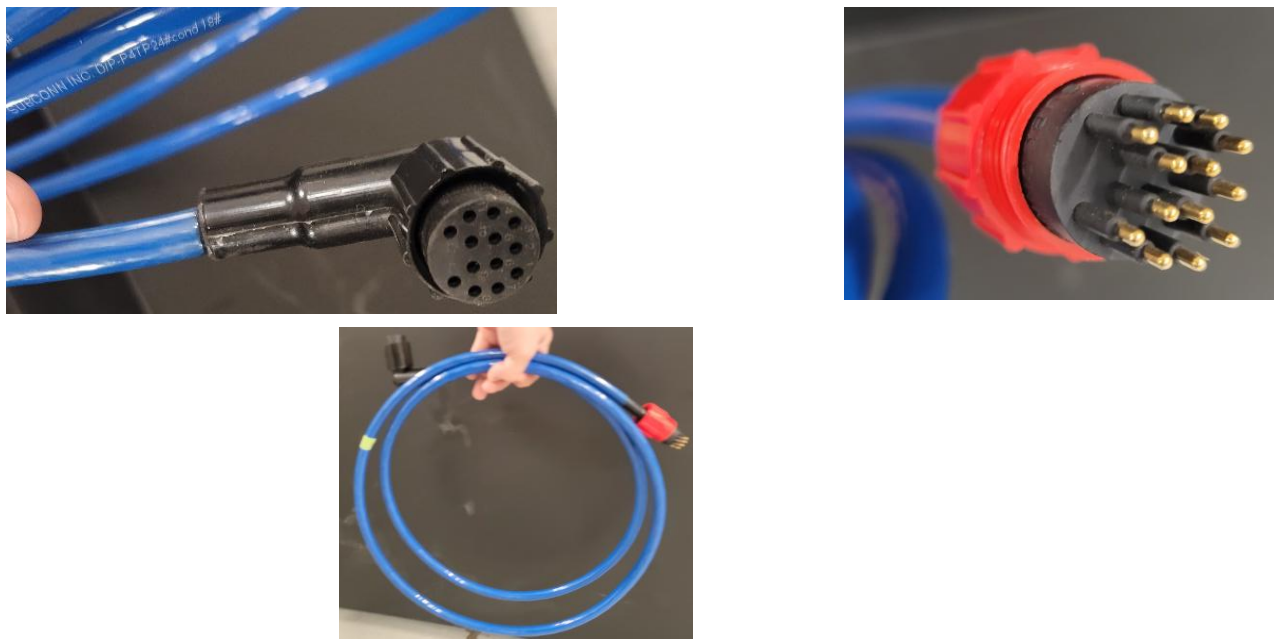


Figure 12 - 13 pin MacArtney Cable for power, comms, and PPS

4.4 PPS Specification

- PPS Isolation Spec: 2500 VRMS Isolation for 1 minute per UL 1577
- PPS Signal Active High
 - PPS High = 2.5V to 5V
 - PPS Low = 0V to 0.8V

4.5 Sensor Bottle Connector Part Numbers

Table 4 shows part numbers for bottle connectors, dummy plugs and locking sleeves. Table 4
WiSSL-2G Sensor Connector Part Numbers

Description	Part Number	Manufacturer	Qty
MacArtney 13-pin connector, male, dual o-ring, flange-mount, titanium	DFCR2013M-Ti	MacArtney	1
MacArtney 13-pin dummy plug, female	DDC13F	MacArtney	1
MacArtney Locking sleeve, female (BLACK) w/ snap ring	LS2000 (BLACK)	MacArtney	1

4.6 Tools, Accessories Part Numbers

Table 5 shows part numbers for the Electronics connectors, dummy plugs and locking sleeves. Prices are at the time of purchase and may change if replacements are needed.

Table 5 WiSSL-2G Part Numbers

Description	Part Number	Manufacturer	Qty
Safety cover, solid	3DDINT-ME-PA-1156	3D at Depth	1
Safety cover, 100 degree	3DDINT-ME-PA-1164	3D at Depth	1
Screws, SHCS, #10-32 x 7/8", A286	92423A513 (NAS1351N3-14)	McMaster Carr	8
Washer #10, 18-8 SS	92141A011	McMaster Carr	8
Anode, Ø3/4" x 7/8" L, 1/4-20-UNC Hole, Aluminum	M000249	3D at Depth	5
SET SCREW, ¼-20 X .50, 18-8-SS	92311A537	McMaster Carr	5
HANDLE, WISSELE-2G, TOP	3DDINT-ME-PA-1147	3D at Depth	2
HANDLE, WISSELE-2G, BOTTOM	3DDINT-ME-PA-1148	3D at Depth	2

CARRIAGE BOLT, 3.8-16 X 8", 18-8 SS	92356A652	McMaster Carr	4
WASHER, 3.8, 18-8 SS	92141A031	McMaster Carr	4
LOCK NUT, NYLON INSERT, 3/8-16, 18-8 SS	91831A127	McMaster Carr	4

~~4.7-1.1~~

4.8 Cable Part Numbers

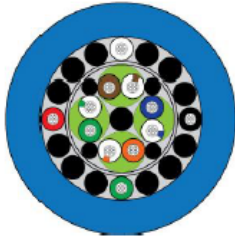
Table 6 shows part numbers for cables.

Table 6 WiSSL-2G Cable Part Numbers

Description	Part Number	Manufacturer	Qty
MacArtney 13-pin cable, 3m, female RA/male, LS2000 retaining rings, standard ethernet-series wiring	DILRA13F//LS2000F//5M D-P-P4TP24#/4C18#/LS2000F//DIL13 M	MacArtney	2

Subconn Power/Ethernet Cable

Type: D-P-P4TP24#/4C18#



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Approved by KL

Construction Characteristics

Power conductor	0,80 mm ² (18 AWG) stranded tin-plated copper conductors insulated with tefzel (4 ea.)
Twisted pairs	0,20 mm ² (24 AWG) Two silver-plated copper conductors insulated with teflon and twisted together (4 ea.) Each pair has a different twist-rate for crosstalk performance and each pair has a TPE belt-to round jacket for performance at pressure. Colour code for twisted pairs: 1. TP = White/Blue + Blue 2. TP = White/Orange + Orange 3. TP = White/Green + Green 4. TP = White/Brown + Brown
Shield	Aluminium/polyester tape and tinned copper braiding (85% coverage) with an overall polyester tape.
Filler	The cable is filled with cable filling compound
Outer jacket	Polyurethane jacket. Colour blue

Mechanical Characteristics

Diameter	13,97 mm nom. (0550 ± 0,010 inch)
Weight in air	246 kg/km nom. (165 lbs/1,000 feet nom.)
Weight in seawater	90 kg/km nom. (60 lbs/1,000 feet nom.)
Min. bending radius	130 mm (5 inch)
Depth Rating	6000 metres (8700 psi)

Electrical Characteristics

Power operating voltage (18 AWG)	600V, max. 4 amp
Power operating voltage (24 AWG)	250V, max. 1 amp
Conductor resistance (18 AWG)	≤ 21 ohm/km (6,5 ohm/1,000 feet)
Conductor resistance (24 AWG)	≤ 85 ohm/km (26 ohm/1,000-feet)
Capacitance (TP 24 AWG)	42 pF/m to for 55 pF/m (13 pF/feet to for 17 pF/feet)
Impedance (TP 24 AWG)	85 ohm to 115 ohm

Figure 13 - MacArtney 13-pin Power/Ethernet Cable Datasheet

5 Power

5.1 Power Requirements

Primary operational input voltage is 24VDC. The system is designed to operate on voltages ranging from 18-36VDC. Input power is isolated and fused with a 3000V Isolation Rating from Input to Output.

Table 7 WiSSL-2G Estimated Power Draw

WiSSL-2G Measured Current and Calculated Power Draw					
Voltage (V)	Steady State(A)	Steady State (W)	Scanning (A)	Scanning (W)	Inrush (A)
18	3.8	68.4	5.32	95.76	11.52
24	2.5	60	4	96	7.6
36	1.96	70.56	TBD	TBD	6.4

6 Service and Maintenance

6.1 Service

No specific servicing is required for the WiSSL-2G system in the field. Any issues encountered during operation should be reported back to 3D at Depth for assessment. All servicing of the Sensor is to be performed exclusively by 3D at Depth.

Note: Warranty is void if any of the bottles are opened.

6.2 Routine Maintenance

3D at Depth recommends the following routine maintenance tasks to be performed before and after each dive/campaign:

- Rinse all equipment with fresh water to wash off salt deposits and deter corrosion.
- Rinse the Optical head output windows with fresh water for approximately 30 seconds. This is usually all the maintenance that is required for keeping the window clean.
- Remove any grease/residue from the bottles using a *minimal* amount of mild detergent (dish soap works well), degreaser or isopropyl alcohol. Do not soak or submerge the equipment in any solution other than fresh water or salt water as this could damage the housing and connector o-rings.
- Check all fasteners to ensure they have not loosened during use.
- Check all cables for damage.

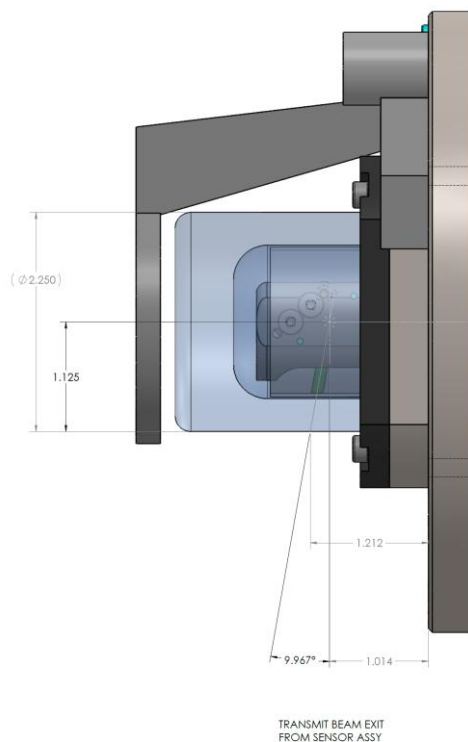
If smudges or oil appear on the window, a window cleaning kit is included with the system. Window cleaning steps include:

1. Never put force on window or support Sensor by window.
2. Ensure the laser sensor is off prior to cleaning the window.
3. Use the Nitrile gloves to prevent getting fingerprints on the window while cleaning
4. Open one of the alcohol swabs and squeeze the alcohol onto the lens tissue
5. Clean the area of the window with the wet lens tissue using circular motions, moving contaminants toward the outer edge of the window.

7 Mechanical Specifications

Refer to drawing number: 3DDINT-ME-SP-0924 "WISSL-2G MECHANICAL INTERFACE CONTROL DRAWING"

7.1 Range Reference Point



TBD

8 Software Install Instructions

The 3D at Depth control software can be installed on a Windows 11 computer following the below steps:

1. Run the 3D_Tools.msi installer file to install system files
2. Run the 2010 C++ redistribution installer
3. Remove any desktop shortcuts installed by the msi installer

4. Place 3D Collect in the folder C:\3D at Depth
5. Place access.bin in C:\3D\CFG
6. Make a copy of the RTV file and rename to RTV.exe. Place the original and renamed files in C:\3D at Depth\x64
7. Place 2D Viewer in C:\3D at Depth\x64
8. Place 3D Cloud motion in C:\3D at Depth\x64
9. Make desktop shortcuts as desired
10. Run 3D Collect and validate that it opens RTV and that it accepts the username and password
11. Run 2D Viewer – validate that it runs.