



Cabled UV Biofouling Control User Manual



Version 1.18
19 April 2017

For use with models:
PDC-CUV-V-05-3m (shown)
PDC-CUV-H-05-3m
PDC-CUV-CUSTOM-05-3m

Revision History

Revision	Date	Description	Author
1.0	7 May 2014	Document created.	Q.C.
1.1	18 August 2014	Formatting edits	J.Z.
1.15	12 September 2014	Formatting edits	J.Z.
1.16	28 April 2015	Added new GLS codes	J.Z.
1.17	9 July 2015	Updated ordering codes	J.Z.
1.18	19 April 2017	Added regulatory information	A.B.T.

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General Description

Cabled UV Biofouling Control is a modular antifouling system designed to protect equipment during in-situ deployments. It uses ultraviolet light to prevent algae and other colonizing microorganisms from growing on target surfaces. By preventing initial colonization, the protected surfaces remain clear of larger, later-stage organisms such as barnacles and sea grass.

Ultraviolet light is emitted by individual UV LED modules housed within a quartz tube. Target surfaces are protected by fixing Cabled UV in proximity such that the surfaces are irradiated by the emitted UV light.

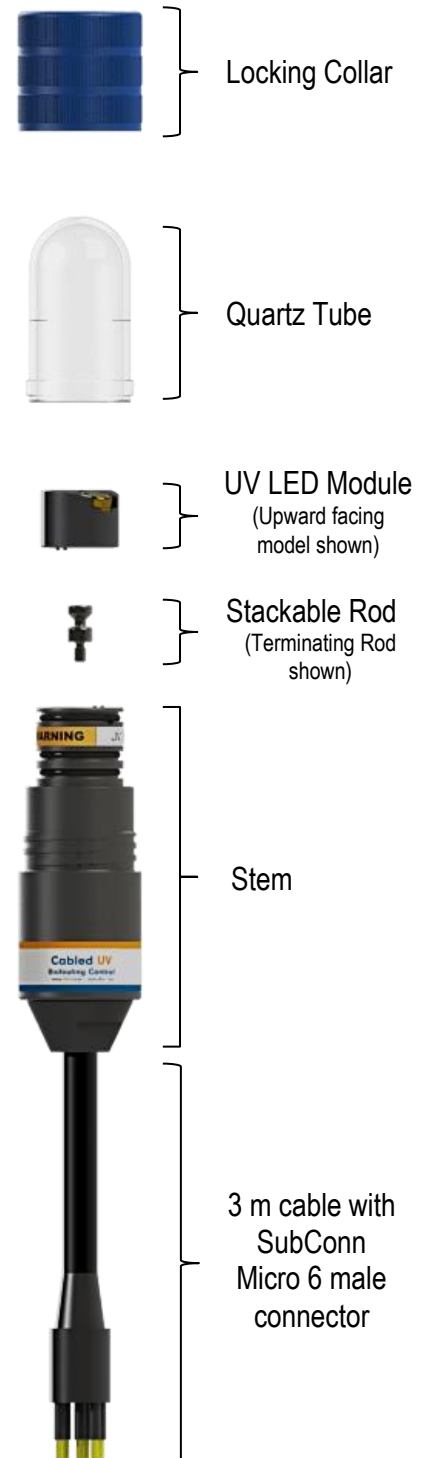
Cabled UV is configurable for a variety of different applications. The UV LED Modules are stackable such that up to four modules may be installed, each with a unique radial orientation. This allows multiple surfaces to be protected by one Cabled UV, or multiple LED Modules irradiating a common surface. Various removable glass tube lengths are available to accommodate different LED module stack heights. The LED modules are free to rotate a full 360° before being fixed in position via a setscrew opposite the LED. In general:

- modules may be removed or added;
- modules are free to rotate a full 360°;
- side-facing modules are invertible - allowing positive and negative pitch angles;
- rod height can be adjusted by adding or removing rods (from a single module up to a four module stack)

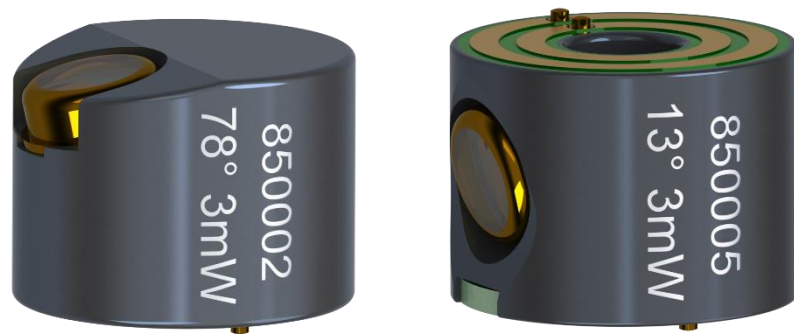
Cabled UV and UV LED modules are distinguishable by their unique serial numbers - 830000 series and 850000 series respectively. Each module is also labeled with its optical power, and pitch angle.

UV emission is controlled by modulating power to Cabled UV. In typical deployments, UV light is controlled via a duty cycle which consists of alternating periods of "on" and "off." This duty cycle is controlled by one of the following two methods:

1. AML's Duty Cycle Controller, available as a standalone OEM board (AML part number SUB-G0749), or housed in a submersible housing that is installed in-line with Cabled UV (PDC-DCC-05).
2. Customer-provided power control to Cabled UV.



For instructions on the use of the Duty Cycle Controller (PDC-DCC-05), please refer to its respective user manual.



Close-up of the UV LED module engraving showing serial number, pitch angle, and optical power. Downward (negative) pitch orientation of horizontal module (right) is visible.

Where Do I Start?

If you are performing instrument maintenance or require more information on the use of Cabled UV Biofouling Control, begin with this manual.

If you are setting or changing the duty cycle and are using an AML Duty Cycle Controller, begin with its respective manual.

Shipping and Receiving

Receiving the Product

When receiving a new Cabled UV Biofouling Control device, perform the following steps to ensure the product will be ready for deployment when required:

- Inspect the shipping container, looking for signs of damage. Damage to the shipping container could indicate damage to the product inside.
- Inspect for damage
 - Check the housing for cracks or bends
 - Check the quartz tube for cracks or chips
 - Check the internal components for damage
 - Check the connector for corrosion, dirt, and salt deposits

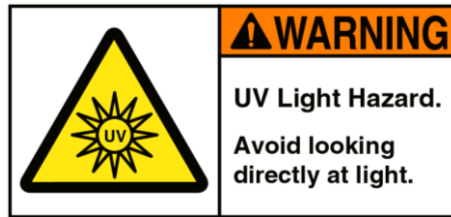
Returning a Product to the Factory

- If shipping for repair, obtain an RMA number from the service centre.
- Pack the product in its original shipping box to prevent damage during shipping.

An RMA number can be requested using the contact options given in the *Support* section of this manual.

Using the Product

Safety



This product produces UVC radiation, which can cause damage to eyes and skin. When working near UV light the following precautions are recommended:

- Wear UV-rated safety glasses
- If users will be exposed to UV light for a prolonged period of time (over 1 minute), wear long sleeves, gloves, and a UV resistant face shield to protect skin and eyes
- Place shields around the UV light source to limit the area of exposure

In general, the above precautions are only necessary when Cabled UV is powered out of water where light will travel much farther. Best practice is to install and align Cabled UV while the device is off (unpowered), as outlined in the *Installing the Product* section of this manual.

Pressure Rating

Cabled UV Biofouling Control™ is rated to operate to a maximum depth of 500 m [1,640 ft].

Adding/Removing the Quartz Tube

To access the LED module(s), the quartz tube must first be removed. This must be performed while Cabled UV is in air and is dry. **Do not remove the quartz tube while the instrument is wet.**

To remove the quartz tube, grip the stem with one hand and turn the blue plastic collar counter-clockwise with your other hand. Carefully remove the blue collar. The air contained within the quartz tube may be slightly above atmospheric pressure, which can cause the tube to slide past the lower sealing O-ring when the blue collar is removed. To remove the quartz tube, again grip the stem with one hand and the quartz tube in your other hand and carefully separate it from the stem. The quartz tube is installed in the reverse manner.

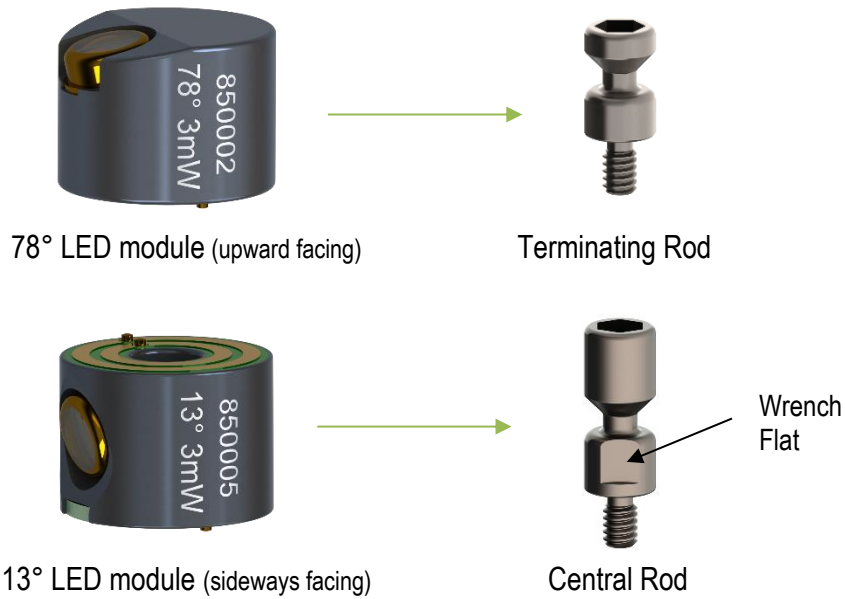


Before installing the quartz tube, ensure that it is free of cracks and chips. The silicone washer acts as a bearing surface for the tube while pressurized, so it must also be flat and free of debris. Trapping debris between the quartz tube and the seat may result in failure of the quartz tube under pressure. O-ring maintenance and replacement procedures are outlined later in *Inspecting and Replacing the O-rings*.

Adding/Removing LED Modules

Cabled UV allows for the addition or removal of LED modules such that one to four modules may be installed, each with a unique axial orientation. General rules of operation:

- There will always be the same number of rods as modules. To remove only the uppermost rod, it is necessary to grip the flat with a wrench on the rod below it. Use a 5/32 hex to screw rod into position. This feature is shown in the following figure.
- LED modules are fixed in position by setscrews. Loosening the setscrew allows them to slide freely along the central rod, or rotate freely around the central rod.
- Once aligned, tighten the bottom module first, followed by those at higher stack levels.
- To adjust a module, you will need to loosen its setscrew and the setscrew of all modules above it.
- Side-facing modules are reversible, that is, they have contact pads on both sides. This allows for two different pitch orientations of the LED.
- Never attempt to rotate an LED module without first loosening the set screw.
- A 78° LED module must only be fastened to a Terminating Rod, while a 13° LED module must only be fastened to a Central Rod. These components are shown below.



Angular Alignment of LED Modules

The LED modules may be rotated freely such that LEDs may be aligned to any angle. General rules for module alignment are listed below:

- Modules can be rotated freely once the setscrew has been sufficiently loosened on the module of interest, and on all those modules at higher stack levels.
- Module alignment can be performed by eye by pointing the LED at the target surface. Because the LED beam pattern is broad, greater than 70° when in water, alignment does not have to be exact. Refer to *LED Module Emission Pattern and Irradiance* later in this manual for more details.
- Push down on a module while tightening the setscrew.
- When tightening multiple modules, always start with the bottom or lowest stack level, and then work up.

Mounting

Cabled UV may be fixed in place by clamping its dedicated mounting surface, located directly adjacent to the product label as identified below. DO NOT clamp anywhere else on the device.



Cabled UV may be clamped by using its optional mounting bracket, sold separately. To install AML's mounting bracket (MBR-CUV-STD) for Cabled UV:

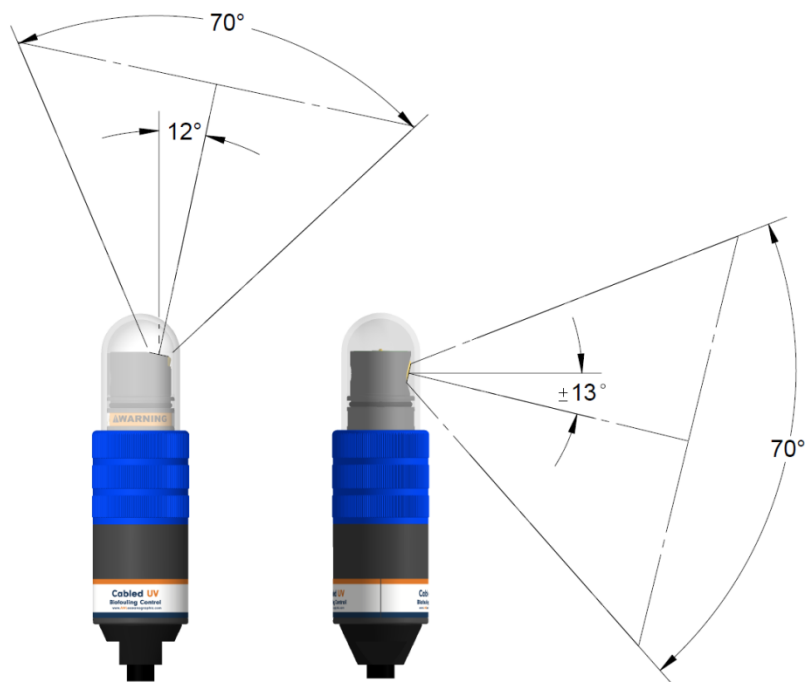
1. Ensure the clamping surface is clean on both the clamp and Cabled UV.
2. Loosen the clamp fastener with a 7/64" Hex Key.
3. Slide the 6 pin male connector of Cabled UV through the centre of the clamp and position the clamp in the middle of the mounting surface outlined above.
4. Fasten the clamp to the stem of Cabled UV with a 7/64" Hex Key. Orientation at this step is not crucial, as it can be adjusted once attached to the sensor/device.

Refer to the *Technical Overview Drawing* at the end of this manual for detailed mounting dimensions.

Installing the Product

The exact process of installation will be application specific. A general procedure for all installations typically consists of mounting the device adjacent to target surfaces, then orienting the individual LED module(s) such that the surfaces will be irradiated during device operation. In more detail, the procedure is generally as follows:

1. Remove the power source to Cabled UV.
2. Mount the device in a location close to the surface(s) to be protected. The exact mounting arrangement will be application-specific. For optimal biofouling protection, ensure that the distance between the UV LEDs and the target surface is no more than 10 cm [4.0 in] away and that the incident angle is as close to 90° as practical. More details on the emission patterns for the LED Modules are provided in *LED Module Emission Pattern, Irradiance and Dosage*, discussed later in this manual.



Approximate UV beam spread in seawater. Cabled UV device with single upwards facing module shown left (PDC-CUV-V-05-3m), and single sideways facing module shown right (PDC-CUV-H-05-3m).

- 2a. If the LED module requires further alignment, remove the quartz tube and adjust the module's orientation, as discussed in *Adding/Removing the Quartz Tube and Angular Alignment of LED Modules*.
3. If controlling Cabled UV via the Duty Cycle Controller, connect the male 6-pin connector of Cabled UV to the female connector of the DCC.
4. Confirm correct LED Module orientation. This can be done by fixing standard white-carbon paper (such as standard printer paper) to the target surface and powering Cabled UV. The incidental UV emission will be observable as the paper will fluoresce. Note that the UV beam spread in air is wider than in seawater: approximately 120° vs 70°, respectively.

Removing the Product

- If the product has been used in salt water, rinse it in fresh water.
- Dry the product before removal to protect the connector.
- Unscrew the black locking sleeve.
- Holding the cable at the connector, pull to remove it from the power/timing source

Duty Cycle Selection and Specification

What should the duty cycle be?

Selecting the correct duty cycle is key to optimizing the effectiveness of the product while minimizing power consumption. High duty cycles (50% or greater) provide more biofouling protection for deployments in environments with aggressive fouling but also results in increased power consumption. Alternatively, less aggressive fouling environments may allow for a reduced duty cycle, resulting in reduced power consumption. It is not possible to recommend one duty cycle that is appropriate for all deployments due the wide array of factors such as available power, aggressiveness of fouling in the environment, water turbidity, seasonal variation, depth, etc.

With these factors in mind, **AML Oceanographic generally recommends a duty cycle of 50%, consisting of 20 minutes on, 20 minutes off**. This duty cycle has been shown to be effective in aggressive biofouling environments: tropical locations, shallow depth, high insolation deployments, etc. Increasing or decreasing the duty cycle may be appropriate however, at the discretion of the user.

How is the duty cycle controlled?

The duty cycle is controlled by modulating power to Cabled UV. For instructions on how to set up the duty cycle when using AML's Duty Cycle Controller, please refer to its respective manual.

UV Bulb Life

The specified life of the UV LEDs is such that they diminish to 50% of their original power after 5,000 hours of total cumulative operational time. It should be noted that the LEDs will still operate at this time and that the reduction in intensity can be compensated for by increasing the duty cycle. It is recommended that the LED modules be replaced after 5,000 hours of operation. Refer to *Ordering Codes* for ordering information.

Maintaining the Product

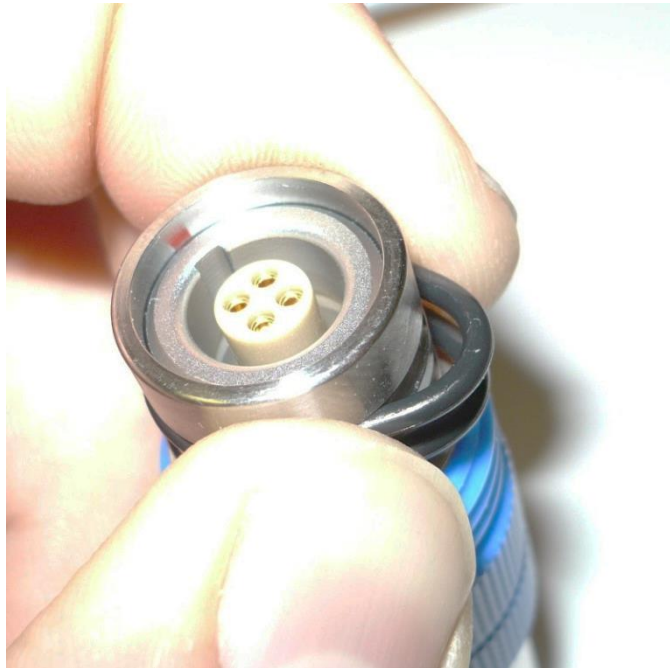
Inspecting and Replacing the O-rings

WARNING: Cabled UV uses Ethylene Propylene Diene Monomer (EPDM) O-rings. When replacing O-rings on Cabled UV, ensure they are made of EPDM rubber. Incident UV light will cause Buna Nitrile (Buna-N) and other standard O-rings to deteriorate, eventually resulting in failure of the product.

It is crucial to keep the O-rings clean and greased. Any fibres or dirt on the O-rings will allow water into the connector or into the housing. To gain access to the O-rings, perform the following steps:

- Remove the quartz tube, as previously outlined in *Adding/Removing the Quartz Tube*.
- Inspect the O-rings for dirt. Clean and reapply standard silicone grease, if necessary.
- Inspect the O-rings for nicks and cracks. If any are found, the O-rings must be replaced. Apply silicone grease to the new O-rings before using them.

Caution: Do not use a sharp instrument to remove the O-rings. If the O-ring grooves are scratched, the O-rings will not provide a waterproof seal. The O-rings can be removed easily with bare hands as shown below.



Close-up of how to properly remove exterior O-rings from a device

Technical Specifications

Power Consumption

Quantity of 3mW Modules	Total Current Draw [mA]
1	120
2	208
3	296
4	384

UV LED Modules

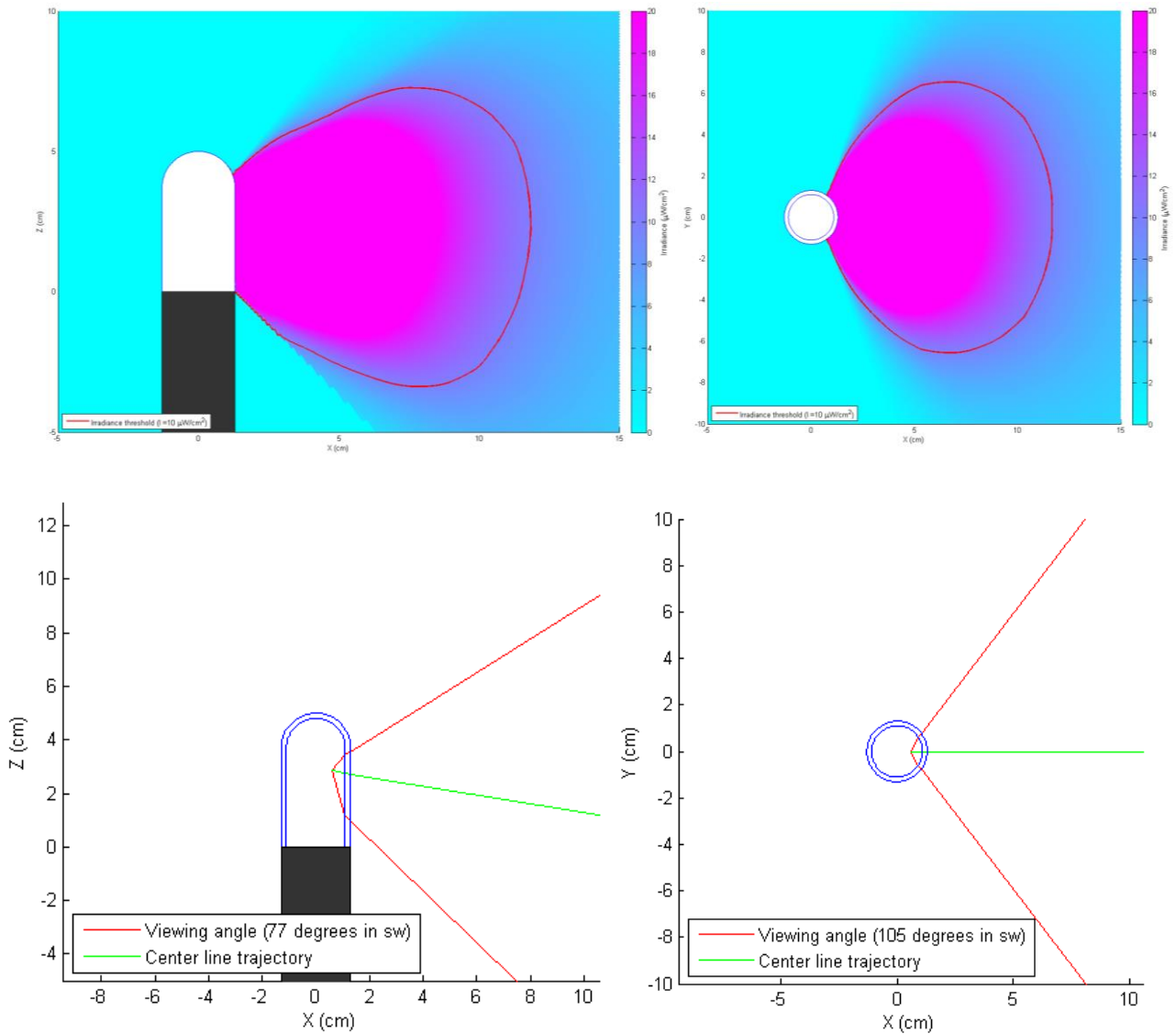
	Side Facing	Upward Facing
Viewing Angle (in air)	120°	120°
Viewing Angle (in water)	70°	70°
Optical Power	3 mW	3 mW
Operating Temperature Range	- 5 to +55°C	-5 to +55°C
Pitch (angle from horizontal)	+/- 13°	78°

Instrument

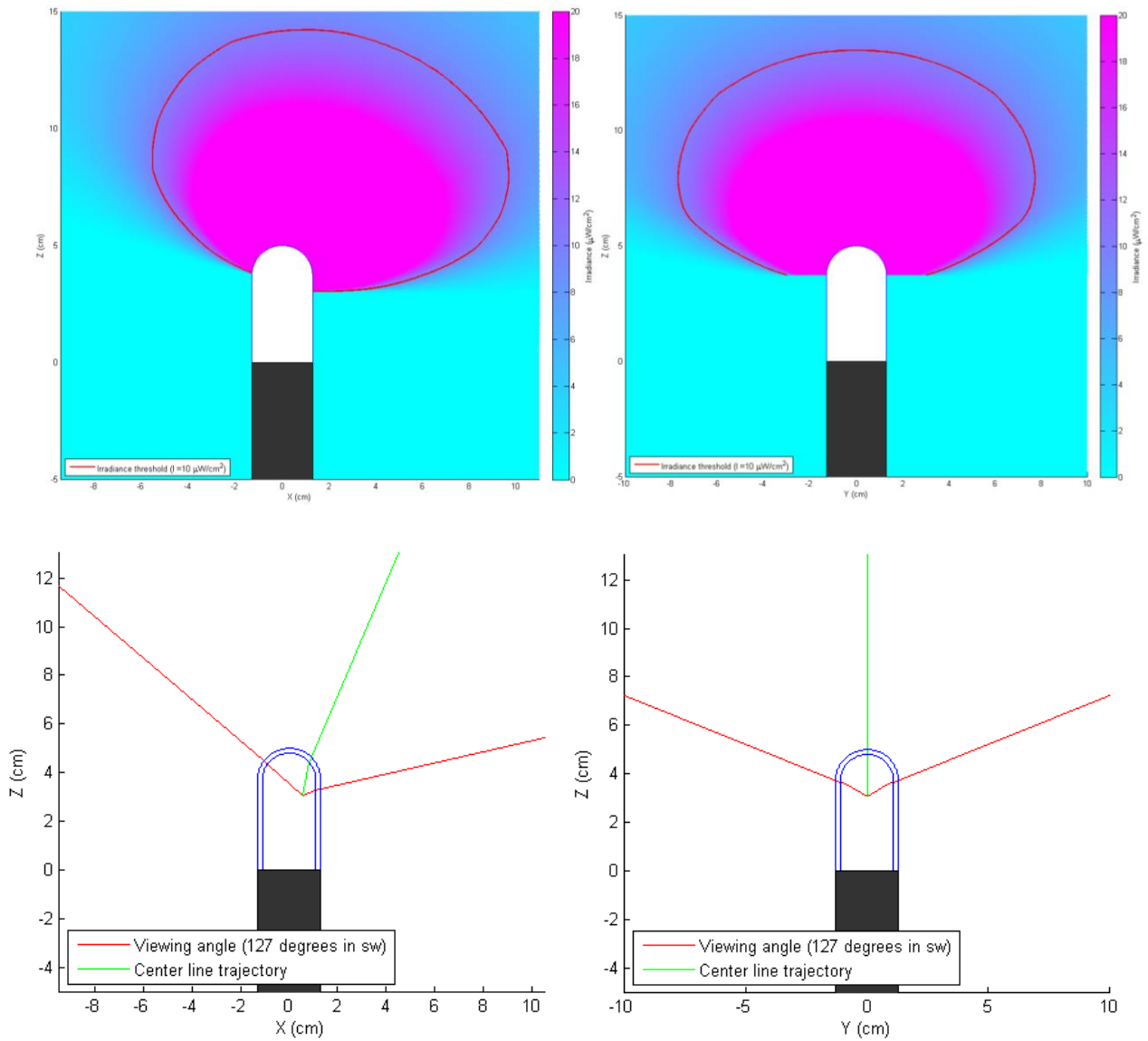
Tube Material	Quartz
Stem Material	Ultem
Depth Rating	500 m [1,640 ft]
Cable Length	3 m [9.8 ft]
Operating Voltage	12-26 VDC
Electrical Connector	MCIL6M

LED Module Emission Pattern, Irradiance and Dosage

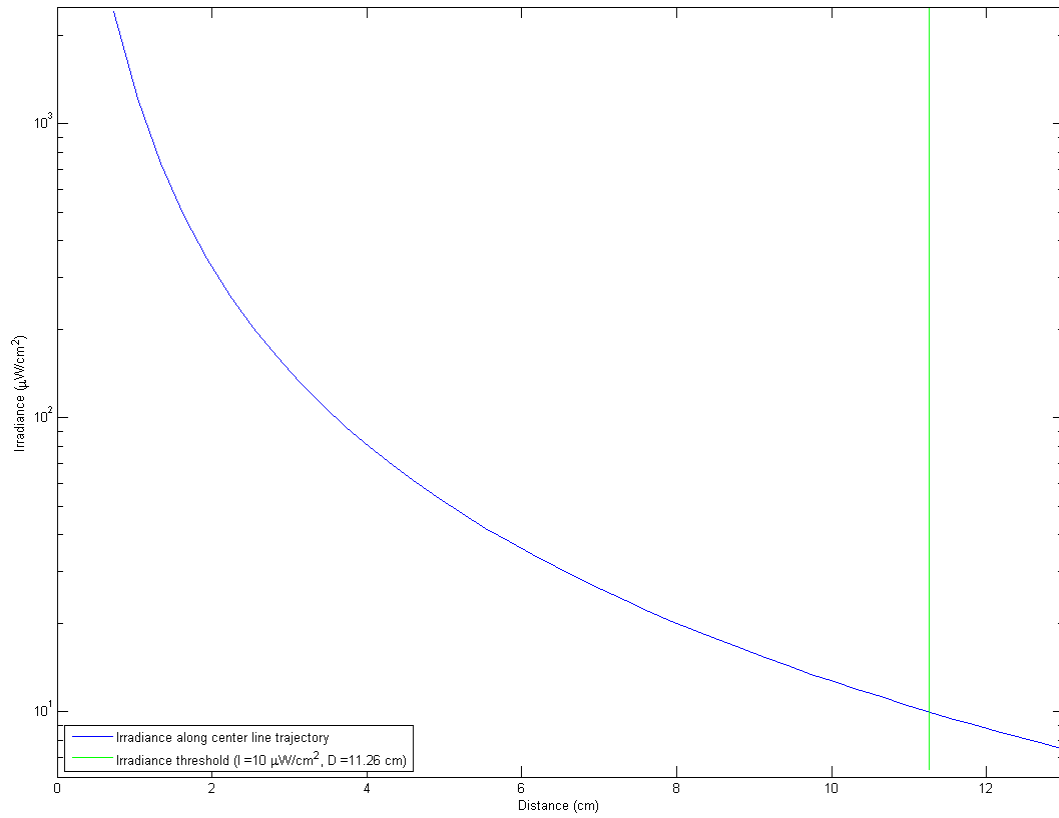
The following plots show the irradiance field of a 3 mW UV LED module in sea water at 0 NTU. A minimum irradiance of $10 \mu\text{W}/\text{cm}^2$ at a 20 minute on/20 minute off duty cycle is recommended to keep a target surface clear of biofouling. This minimum irradiance threshold is highlighted in red in the figure below. General best practice is to ensure that the target surface is within approximately 10 cm [4 in] for effective biofouling control. The following plots represent the intensity of the UV light. Contact AML Oceanographic to discuss optimal settings for your application.



Irradiance field and $10 \mu\text{W}/\text{cm}^2$ threshold of a 13° 3 mW LED module oriented with negative pitch in sea water at 0 NTU. Side view and top view on the left and right, respectively.



Irradiance field and $10 \mu\text{W}/\text{cm}^2$ threshold of a 78° 3 mW LED module in sea water at 0 NTU. Side view and back view on the left and right, respectively.



Irradiance level along the centre line of trajectory for a 3 mW UV LED module in sea water at 0 NTU

Support

Troubleshooting

LEDs fail to turn on:

- UV LED operation may be confirmed through fluorescence, standard carbon printer paper will fluoresce blue/purple when held within the beam path of an UV LED module.
- Is the timing/power circuit supplying 12-26VDC?
- Is timing/power circuit pinout correct? See Page 3 of the document *Cabled UV Biofouling Control – Customer Overview Drawing*
- Is the Subconn Micro6 connector connection dirty or corroded? Clean using electrical contact cleaner.
- Is the UV LED module receiving power? Check to make sure there is a 12 V potential between the inner and outer rings on the PCB that contacts the UV LED module pins.
- Are the electrical pins on the bottom of the LED Module making contact with the PCB? Try loosening the UV LED module's setscrew and re-tighten the module. See *Angular Alignment of LED Modules* for proper UV LED module installation steps.

Frequently Asked Questions

Can LED modules be stacked upside down?

Yes. The 13° modules are designed to operate in either orientation (LED facing up or down). This allows the system to accommodate a wide range of configurations.

Can you stack just three modules in a multi-module housing?

There is no minimum number of LED modules that must be present. It is acceptable to have between one and four in a multi-module quartz housing, in any orientation.

How can I tell if my LED modules are working?

Although it is not possible to directly observe the UV light as it is beyond the visual range of the human eye, ordinary white paper will fluoresce under UV light. Holding a strip of white paper in front of an LED module will indicate that the LED is working as the paper will fluoresce a deep blue. Note that caution should be exercised to avoid irradiating exposed skin.

How long will my LED modules last?

The rated life of the LEDs is 5,000 hours of total cumulative operational time. This means that the LEDs will lose 50% of their original intensity at their rated life. The LEDs will still operate beyond rated life and the reduction in intensity can be compensated for by increasing duty cycle.

Contact AML Oceanographic

Service

To request an RMA or technical support

Email: service@AMLOceanographic.com

Phone: 1-250-656-0771

Phone: 1-800-663-8721 (NA)

Fax: 1-250-655-3655

Sales

For all general sales inquiries

Email: sales@AMLOceanographic.com

Phone: 1-250-656-0771

Phone: 1-800-663-8721 (NA)

Fax: 1-250-655-3655

Website

<http://www.AMLOceanographic.com>

Customer Portal

My AML Oceanographic is AML's online data centre. This secure area within our website is designed to offer one easy location for interested individuals and organizations - distributors, customers, prospects, and other members of our community - to manage their interactions with AML. *My AML Oceanographic* will allow you to:

- View and manage your assets (instruments and sensors)
- Consult instrument diagnostic summaries
- View and download calibration and conformity certificates
- View and manage your technical support cases
- Consult and download sales estimates, sales orders, and invoice copies
- View account balances and generate account statements
- Assess inventory availability at AML

To access the Customer Portal, please navigate to the *Support* button - located on the top right of the AML Oceanographic home page - select *Customer Centre* from the options on the drop down menu and follow the instructions provided.

Mailing and Shipping Address

AML Oceanographic
2071 Malaview Ave.
Sidney, BC, Canada
V8L 5X6

Ordering Codes

AML Part No.	Optical Power (mW)	Angle from Horizontal, or Pitch (degrees)	Reversible	Rotatable	Image
SUB-G0720	3	+/-13	Yes	Yes	
SUB-G0713	3	+78	No	Yes	
ORG-H0039	Stabilizing and Sealing EPDM O-Rings				
PLS-M0058	Quartz Tube Seat - Silicone				
MTL-M0469	Rod – Terminating Section				
MTL-M0465	Rod – Central Section				
GLS-0033	Quartz Glass Tube – 1 module length				
GLS-0037	Quartz Glass Tube – 2 module length				
GLS-0038	Quartz Glass Tube – 3 module length				
GLS-0034	Quartz Glass Tube – 4 module length				
MBR-CUV-STD	Mounting Clamp for Cabled UV				

Regulatory Information

This product is compliant within the requirements of CE standards.



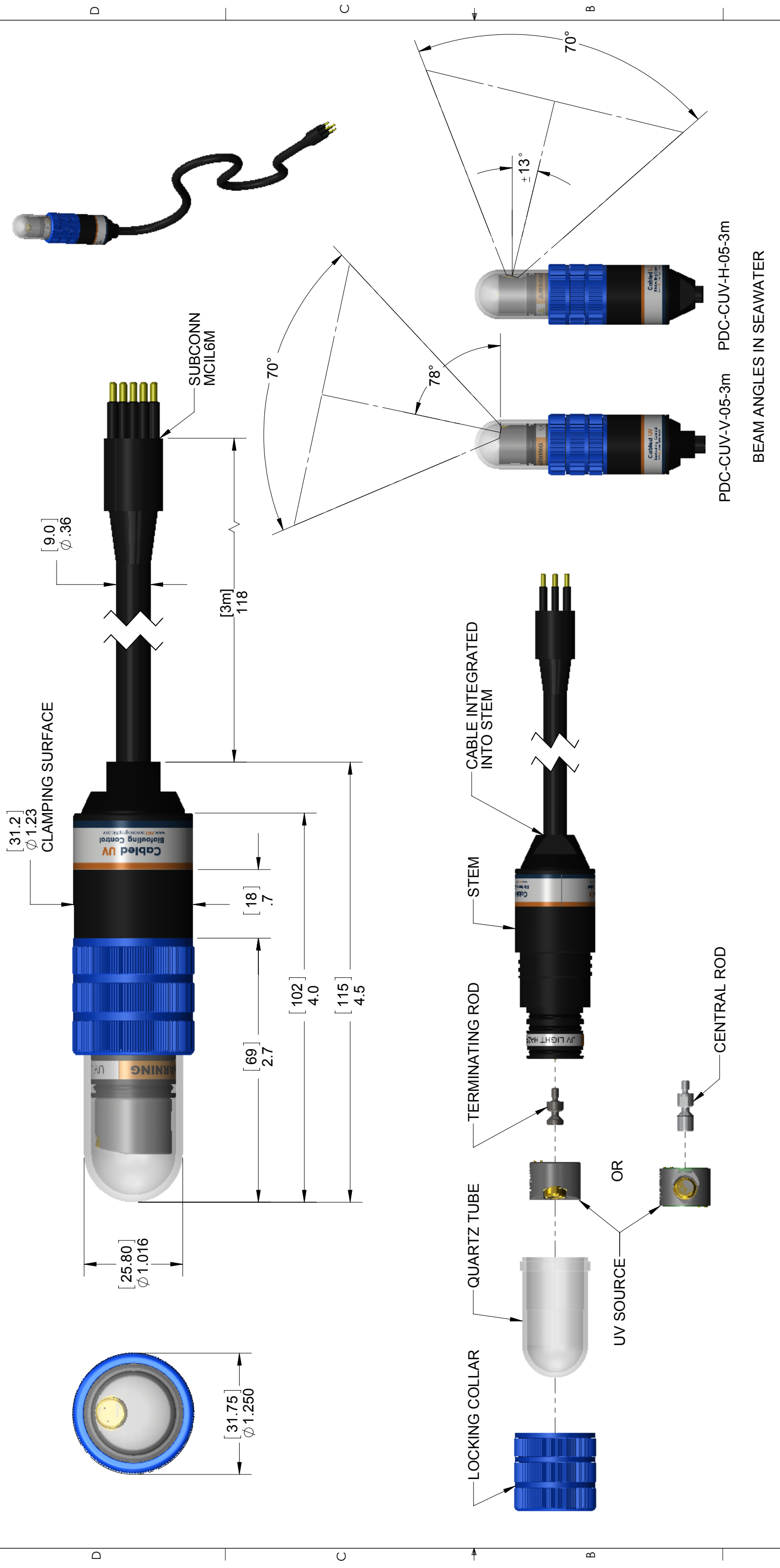
Warranty

AML Oceanographic warrants the instrument for a period of two years from the date of delivery. AML will repair or replace, at its option and at no charge, components found to be defective. This warranty applies only to the original purchaser of the instruments. The warranty does not apply if the instrument has been damaged, by accident or misuse, and is void if repairs or modifications are made by any other than AML authorized personnel.

This warranty is the only warranty given by AML. No warranties implied by law, including but not limited to the implied warranties of merchantability and fitness for a particular purpose shall apply. In no event will AML be liable for any direct, indirect, consequential, or incidental damages resulting from any defects or failure of performance of any products supplied by AML.

Technical Overview Drawings

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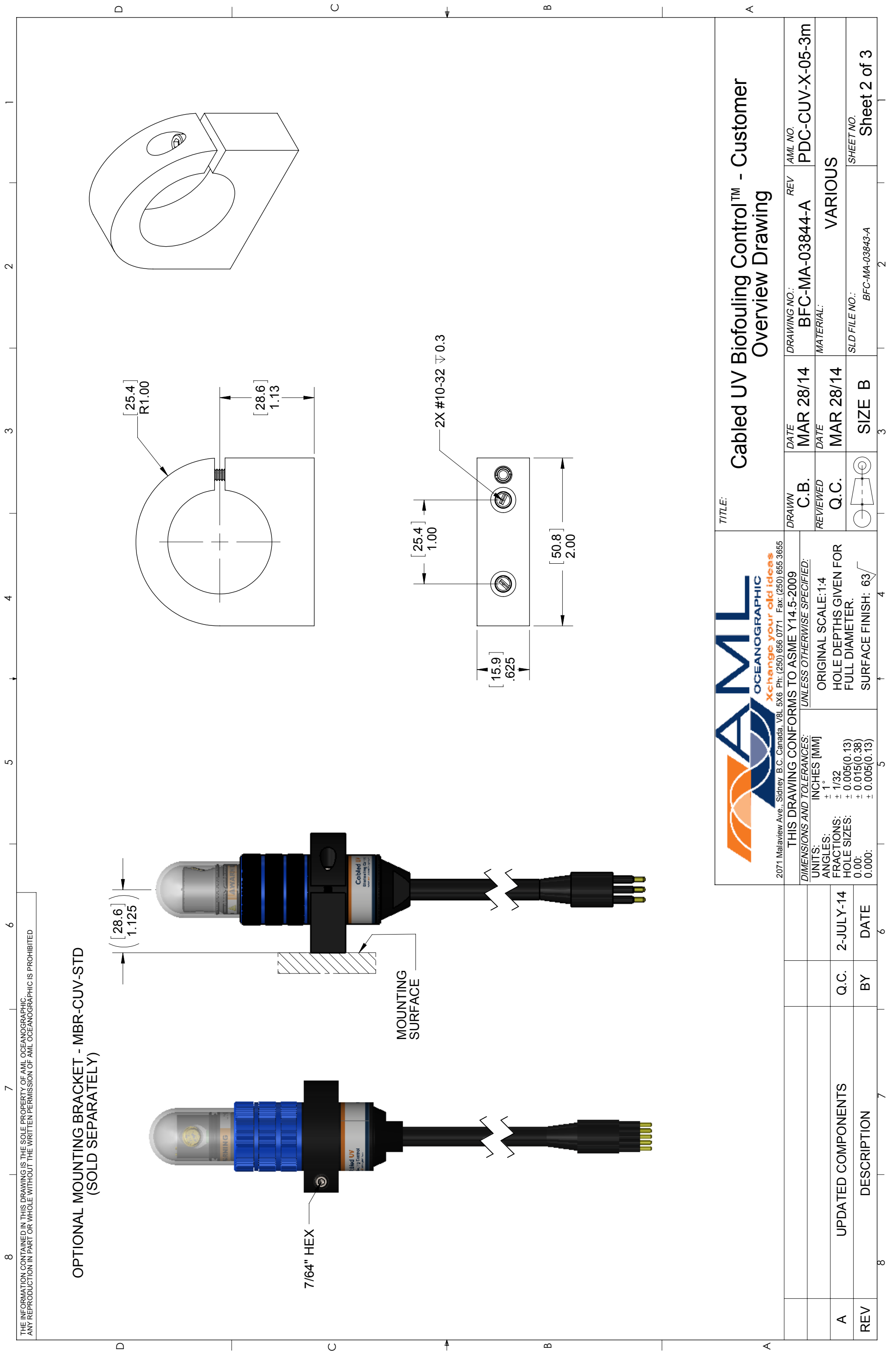
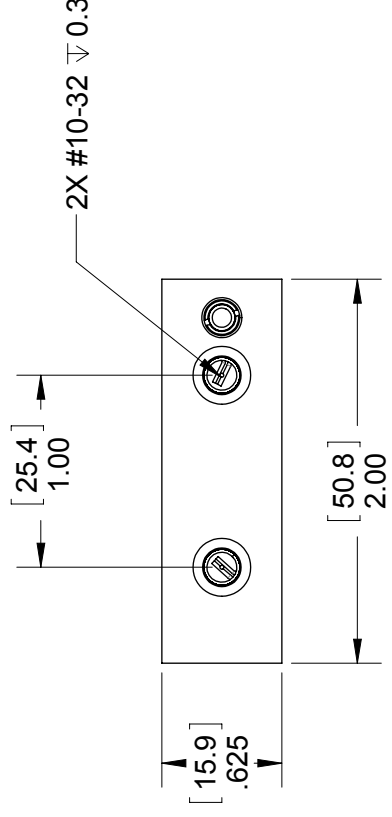
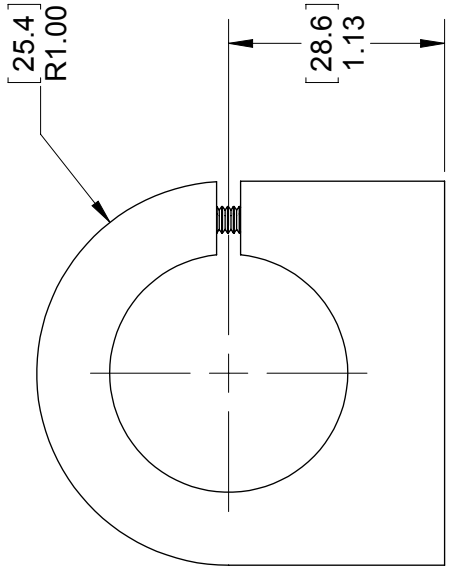
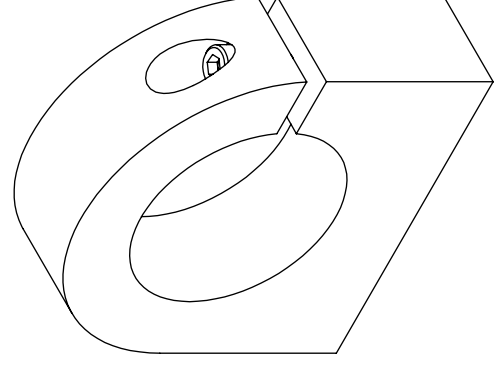
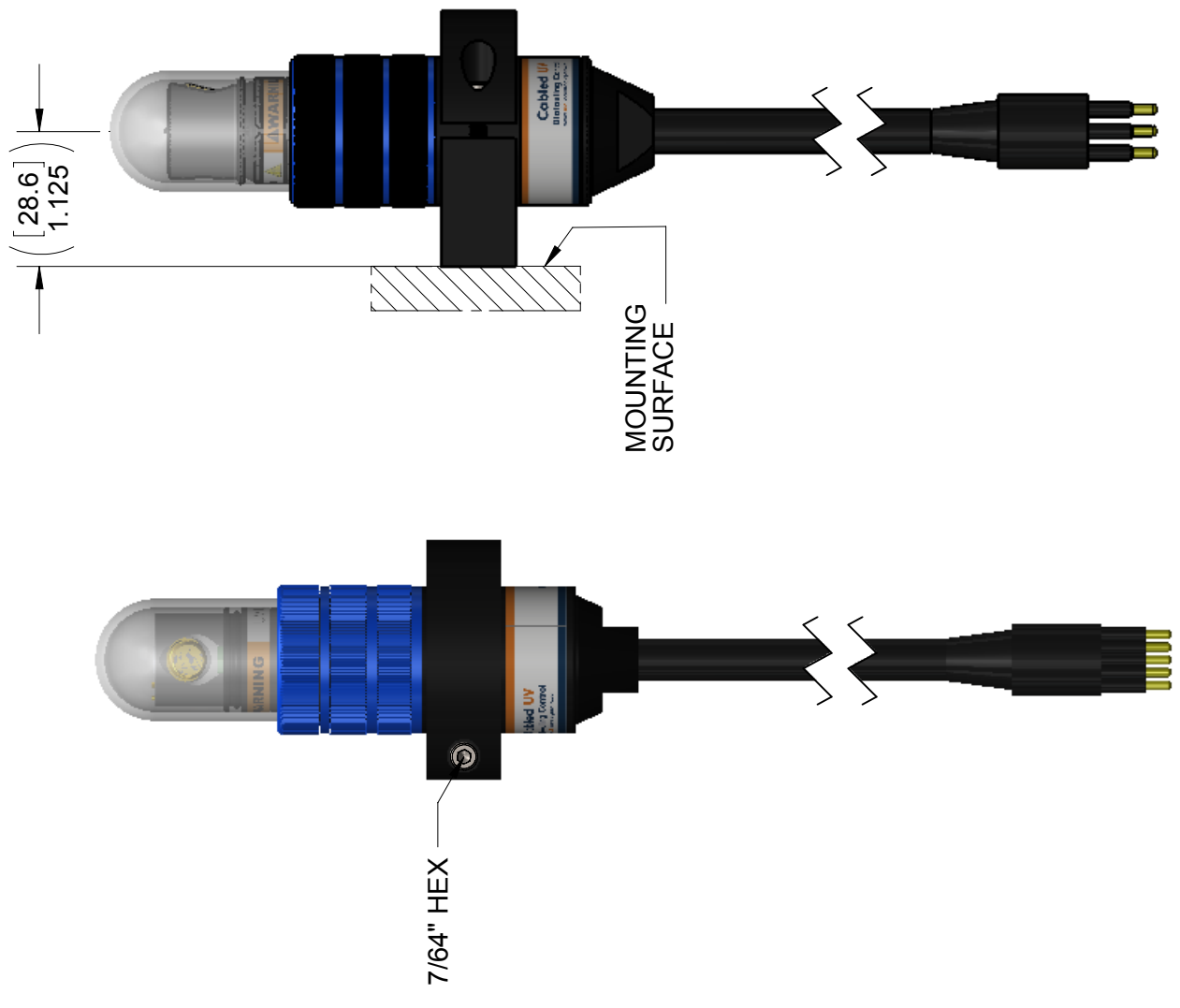


PDC-CUV-V-05-3m PDC-CUV-H-05-3m
BEAM ANGLES IN SEAWATER

TITLE:		 2071 Malview Ave., Sidney B.C. Canada, V8L 5X6 Ph: (250) 656 0771 Fax: (250) 655 3655 THIS DRAWING CONFORMS TO ASME Y14.5-2009 DIMENSIONS AND TOLERANCES: UNLESS OTHERWISE SPECIFIED: UNITS: INCHES [MM] ANGLES: ± 1° FRACTIONS: ± 1/32 HOLE SIZES: ± 0.005(0.13) 0.00: ± 0.015(0.38) 0.000: ± 0.005(0.13)		ORIGINAL SCALE: 1:2 HOLE DEPTHS GIVEN FOR FULL DIAMETER. SURFACE FINISH: 63√	
DRAWN	Q.C.	DATE	MAR 28/14	DRAWING NO.:	BFC-MA-03844-A
REVIEWED	C.B.	DATE	MAR 28/14	REV	VARIOUS
MATERIAL:		PDC-CUV-X-05-3m			
SIZE		B		SHEET NO. SHEET 1 of 3	
SLD FILE NO.:		BFC-MA-03843-A			

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**OPTIONAL MOUNTING BRACKET - MBR-CUV-STD
(SOLD SEPARATELY)**



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THIS DRAWING CONFORMS TO ASME Y14.5-2009
UNLESS OTHERWISE SPECIFIED:

DIMENSIONS AND TOLERANCES:
UNITS: INCHES [MM]
ANGLES: $\pm 1^\circ$
FRACTIONS: $\pm 1/32$
HOLE SIZES: $\pm 0.005(0.13)$
0.00: $\pm 0.015(0.38)$
0.000: $\pm 0.005(0.13)$

DRAWN		C.B.	DATE	MAR 28/14	DRAWING NO.:	BFC-MA-03844-A	REV		AML NO.	PDC-CUV-X-05-3m
REVIEWED		Q.C.	DATE	MAR 28/14	MATERIAL:	VARIOUS				
SIZE		B			SLD FILE NO.:	BFC-MA-03843-A		SHEET NO.	Sheet 2 of 3	

**Cabled UV Biofouling Control™ - Customer
Overview Drawing**

A	UPDATED COMPONENTS	Q.C.	2-JULY-14
REV	DESCRIPTION	BY	DATE

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CONTROL OPTIONS:

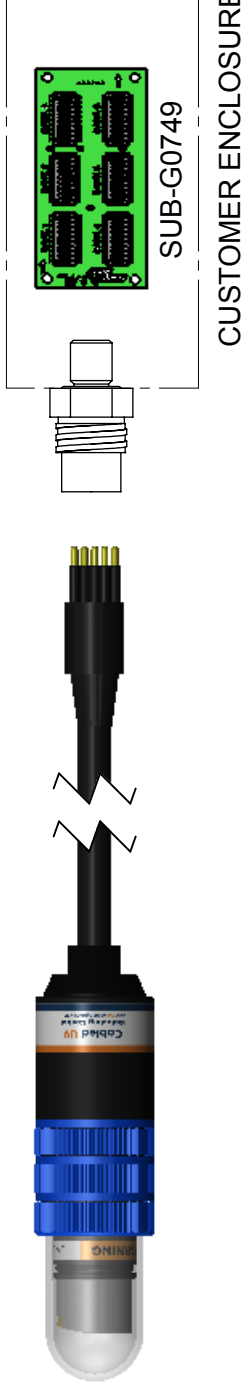
OPTION 1:
CONTROL UV EMISSION BY MODULATING POWER TO PIN 3.

OPTION 2:
CONNECT TO AML DUTY CYCLE CONTROL BOARD. BOARD AVAILABLE AS STANDALONE (OPTION 2A) OR WITHIN DUTY CYCLE CONTROL INSTRUMENT (OPTION 2B). REFER TO BFC-MA-03560 FOR DETAILS

OPTION 1 - CUSTOMER PROVIDED DUTY CYCLE CONTROL



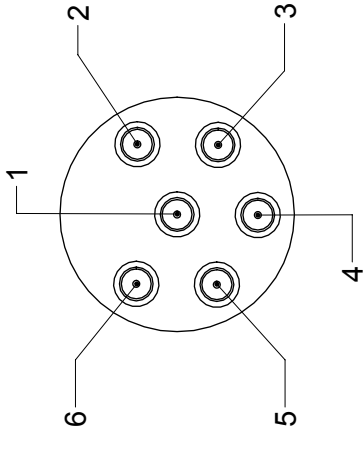
OPTION 2A - DUTY CYCLE CONTROL BOARD STANDALONE



OPTION 2B - DUTY CYCLE CONTROL INSTRUMENT



MALE FACE VIEW



PIN	FUNCTION
1	N/C
2	GND
3	PWR (12-26VDC)
4	N/C
5	N/C
6	N/C



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THIS DRAWING CONFORMS TO ASME Y14.5-2009
UNLESS OTHERWISE SPECIFIED:

DIMENSIONS AND TOLERANCES:
UNITS: INCHES [MM]
ANGLES: ± 1°
FRACTIONS: ± 1/32
HOLE SIZES: ± 0.005(0.13)
0.00: ± 0.015(0.38)
0.000: ± 0.005(0.13)

ORIGINAL SCALE: 1:2
HOLE DEPTHS GIVEN FOR FULL DIAMETER.
SURFACE FINISH: 63√

TITLE:

Cabled UV Biofouling Control™ - Customer Overview Drawing

DRAWN	DATE	DRAWING NO.:	REV	AML NO
Q.C.	MAR 28/14	BFC-MA-03844-A		PDC-CUV-X-05-3m
REVIEWED	DATE	MATERIAL:		
C.B.	MAR 28/14	VARIOUS		
SIZE	SLD FILE NO.:	SHEET NO.		
B	BFC-MA-03843-A	Sheet 3 of 3		