

PearlAqua Micro™



UV-C LED Water Disinfection System Operations Manual

Models: B & C

For commercial use only

Table of Contents

Table of Contents 1

List of Figures 2

List of Tables 3

Executive Summary 4

1. Safety & Regulatory 5

 a. Overview/Best Practices 5

 b. Safety Label 7

 c. Water Chemistry 7

 d. Summary of Regulatory Compliance 9

 e. Absolute Maximum Ratings 10

2. Basic Installation 11

 a. Product Parts and Dimensions 11

 b. Plumbing Installation 12

 c. Electrical Installation and Power Application 19

3. Detailed Specifications and Advanced Operation 25

 a. Unit Serial Number and Model Number Interpretation 26

 b. Electrical Block Diagrams 30

 c. Lamp Lifetime (All Models) 31

 d. PearlAqua Micro Models 3B and 6B 32

 e. PearlAqua Micro Models 3C and 6C 42

 f. PearlAqua Micro Models 9C and 12C 49

 g. Thermistor (All Models) 62

 h. Pulsed Operation without Flow 67

 i. Flow Sensor Package 68

4. Troubleshooting 70

5. Application Examples/Theory 71

6. Warranty 74

7. Legal 76

8. Revision/Change Log 77

9. Notes/Custom Specifications 78

List of Figures

Figure 1-1: Typical PearlAqua Micro safety label (may vary by product configuration) .. 7

Figure 1-2: Comparison of light and heat emitted from UV sources 8

Figure 2-1: Anatomy of a typical PearlAqua Micro unit..... 11

Figure 2-2: Recommended orientation of non-horizontal enclosure to prevent trapped air which may affect disinfection performance..... 16

Figure 2-3: Recommended orientation of unit with horizontal enclosure 17

Figure 2-4: Example of Micro units with plumbing installed 18

Figure 2-5: Standard power application electrical scheme for all units..... 21

Figure 3-1: General format for serial number (unique to each unit) 26

Figure 3-2: General format for Micro unit model numbers showing hardware configuration..... 27

Figure 3-3: Graph of UV-LED lifetime with varied drive current..... 31

Figure 3-4: Graph of UV Dose vs Flow in the Micro 3B 33

Figure 3-5: Graph of UV Dose vs Flow in the Micro 6B 33

Figure 3-6: Head loss in 'B' units, 3/8 Inch Inlet and Outlet, Vertical Orientation, flat side down..... 34

Figure 3-7: LED Status (LED Health) signal Measurement (Method A)..... 39

Figure 3-8: LED Status (LED Health) signal Measurement (Method B)..... 40

Figure 3-9: Graph of UV Dose versus Flow in the Micro 3C..... 43

Figure 3-10: Graph of UV Dose versus Flow in the Micro 6C 43

Figure 3-11: Graph of head loss in 'C' units, 3/8 Inch Inlet and Outlet, Vertical Orientation, flat-side down..... 44

Figure 3-12: Power Application scheme for all Micro units 45

Figure 3-13: Graph of UV Dose vs Flow in the Micro 9C..... 50

Figure 3-14: Graph of UV Dose vs Flow in the Micro 12C..... 50

Figure 3-15: Graph of head loss in "C" units, 3/8 Inch Inlet and Outlet, Vertical Orientation, flat-side down..... 51

Figure 3-16: Power Application scheme for all Micro units 52

Figure 3-17: LED Status (LED Health) signal Measurement (Method A)..... 56

Figure 3-18: LED Status (LED Health) signal Measurement (Method B)..... 57

Figure 3-19: Scheme for measuring the UV Intensity signal..... 60

Figure 3-20: Relationship between UVI signal and liquid UV-T, normalized to 98.4% UV-T, in a PAQ-12C-350..... 61

Figure 3-21: Methods A & B to measure the thermistor signal for unit temperature monitoring 62

Figure 3-22: Flow Sensor Package with External Indicators 68

List of Tables

Table 1-1: Water quality specifications for optimal disinfection performance 7

Table 1-2: Relevant regulations, guidelines, and certifications 9

Table 1-3: Absolute Maximum values 10

Table 2-1: Wire Function Identification by Color 20

Table 2-2: Power Application, Recommended Operating Conditions 21

Table 2-3: Specifications of Aquisense power supply offering 23

Table 3-1: Key for interpreting Micro model number; first 9 digits (Power and Reactor Size, LED Information) 28

Table 3-2: Key for interpreting Micro model number; 10th through the 12th digit (Sensor Options)..... 28

Table 3-3: Key for interpreting Micro model number; 13th through 16th digit (PCB and Cable Options) 28

Table 3-4: Key for interpreting Micro model number; 17th through 21st digit (External Interface Options)..... 29

Table 3-5: Lamp Operating Lifetime Information (All Models) 31

Table 3-6: “B-sized” PearlAqua Micro Mechanical Specifications 34

Table 3-7: PearlAqua Micro 3B Electrical Specifications for 12V Devices 36

Table 3-8: PearlAqua Micro 3B Electrical Specifications for 24V Devices 36

Table 3-9: PearlAqua Micro 6B Electrical Specifications for 12V Devices 37

Table 3-10: PearlAqua Micro 6B Electrical Specifications for 24V Devices 37

Table 3-11: LED Status Signal values for Micro 3B and 6B units 41

Table 3-12: “C-sized” PearlAqua Micro Mechanical Specifications..... 44

Table 3-13: PearlAqua Micro 3C Electrical Specifications 46

Table 3-14: PearlAqua Micro 6C Electrical Specifications 46

Table 3-15: “C-sized” PearlAqua Micro Mechanical Specifications..... 51

Table 3-16: PearlAqua Micro 9C Electrical Specifications 53

Table 3-17: PearlAqua Micro 12C Electrical Specifications 53

Table 3-18: LED Status Signal values for Micro 9C and 12C units..... 58

Table 3-19: On-board Thermistor Specifications 63

Table 3-20: Thermistor values, Table 1 64

Table 3-21: Thermistor values, Table 2 64

Table 3-22: Thermistor values, Table 3 65

Table 3-23: Thermistor values, Table 4 66

Table 3-24: Flow Switch Indicator Light Interpretation 68

Table 3-25: FL-308 Flow Sensor Specifications 69

Table 4-1: Troubleshooting, Potential issues and Solutions 70

Executive Summary

The PearlAqua Micro is the world's smallest UV disinfection system, ideal for point-of-use integration for OEMs. The Micro offers validated disinfection performance through UV-C LEDs and a patented flow cell design. PearlAqua Micro is designed to be integrated into point-of-use systems and processes.

Micro UV™

The PearlAqua Micro debuts the most compact UV system in the world. Highly configurable, this product can be installed directly at the point of use.



NSF/ANSI 55-2019

The PearlAqua Micro is Tested and Certified by NSF International against NSF/ANSI 55-2019. See our listing at the NSF website here: <https://www.nsf.org/certified-products-systems>.

Flexible Integration

The Micro platform is designed for integration in the tightest places. It allows for the application of UV technology in treatment processes never thought possible.

Comprehensive Model Line-Up

Multiple discrete models available for a broad range of flow rates. Allows the user to optimize based on process water conditions.

Energy Savings

UV-LEDs have low energy consumption. The Micro platform typically draws from 3-14W depending on the configuration. Units can be activated or deactivated instantly to save power and maximize lifetime, making them ideal for intermittent flows.

Temperature Independent

LEDs do not transfer heat to the water, thus limiting fouling. UV-LEDs have a constant UV output regardless of water temperature.

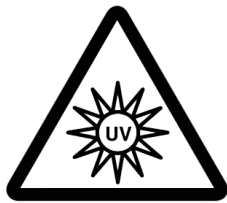
UV Intensity Monitoring

UV sensor option available to monitor real-time UV intensity within the reactor chamber for mission-critical applications.

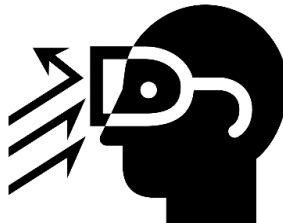
1. Safety & Regulatory

a. Overview/Best Practices

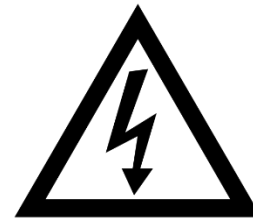
This device produces harmful ultraviolet (UV) radiation. Direct contact could damage the eyes and/or skin. Do not look directly into inlet or outlet ports without the use of UV resistant safety glasses.



UV Exposure
Possible



Wear UV
rated
protection



Electrical
shock
possible

The unit should only be operated according to the guidelines described herein

General

- Do not use the unit if there is any sign of damage,
- Not to be used by persons (including children) with reduced physical, sensory or mental capabilities, or lack of experience and knowledge, unless they have been given supervision or instruction,
- Not a toy; keep out of reach of children,
- Do not exceed rated maximum operating pressure. See [Section 1b](#), [Section 1e](#), and [Section 3](#).
- Do not exceed rated maximum ambient air temperatures and water temperatures. See [Section 1b](#), [Section 1e](#), and [Section 3](#).
- **Do not operate product without water flow**
- Always comply with local plumbing and electrical codes
- No user serviceable parts: do not attempt to dismantle,
- Component of a dedicated system only; not for installation as a stand-alone system,
- Read the instructions before opening and using the appliance.

UV Hazard – WARNING

- This product is intended for the treatment of water, and may cause unintended photochemical reactions in other substances passed through the reactor device.
- Do not operate if any portion of the exterior housing is compromised.
- Unintended use of the appliance or damage to the housing may result in the escape of dangerous UV-C radiation. UV-C radiation may, even in little doses, cause harm to the eyes and skin.
- Do not look directly into inlet or outlet ports whilst the unit is operational.

Electrical

- Always disconnect power from the unit before performing any type of maintenance or servicing,
- For supply with safety extra-low voltage only, as per IEC 60335-1:
 - Voltage not exceeding 42 V between conductors and between conductors and earth, the no-load voltage not exceeding 50 V,
 - When safety extra-low voltage is obtained from the supply mains, it is to be through a safety isolating transformer or a convertor with separate windings, the insulation of which complies with double insulation or reinforced insulation requirements.
- Do not reverse polarity of the device. Apply power in accordance with instructions herein.
- Do not use if power/signal cord is damaged. If damaged, remove unit from service and replace the unit.
- If using power supply, use EMC/EMI certified power supplies only
- FCC: Exempt under 15.103(c) and/or 15.103(d)
- ISED: Exempt under ICES 3 and 5 categorization
- CE: Exempt from Low-Voltage-Directive, EMC exempt

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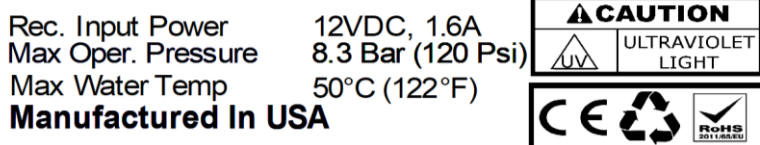


Figure 1-1: Typical PearlAqua Micro safety label (may vary by product configuration)

A safety label is affixed to each PearlAqua Micro unit. The label identifies several maximum thresholds for the product. For more details on each model and recommended operating specifications for your Micro unit, please see [Section 3 \(Detailed Specifications and Integration\)](#).

c. Water Chemistry

Requirements for Optimal Performance

UV disinfection can be affected by water quality conditions. The PearlAqua Micro is designed to ideally disinfect drinking water with the specifications shown in

Table 1-1. Failure to adhere to these specifications may reduce disinfection performance.

Table 1-1: Water quality specifications for optimal disinfection performance

<u>Parameter</u>	<u>Description</u>	<u>Threshold</u>	<u>Unit</u>
UV-Transmittance* (UV-T)	Measure of how well UV light can travel through a fluid. Defined as the ratio of UV light intensity after passing through a water sample to the UV light intensity at the light source.	≥90	%
Particulate Size	Dirt, dust, rust, sediment, and other solid particles	≤10	micron (µm)
Hardness	Lime scale, Calcium, Magnesium	≤7/120	gpg/ppm (mg/L)
Iron	Rust stains	≤0.3	ppm (mg/L)

*For low UV-T applications, contact AquisSense for recommendations.

UV-C LED lamps do not emit heat out of the process side (front) of the lamp module. As a result, there is generally a lower potential for inorganic fouling due to calcium, iron, or other inorganic chemicals which is normally exacerbated by heat compared to conventional UV technology.

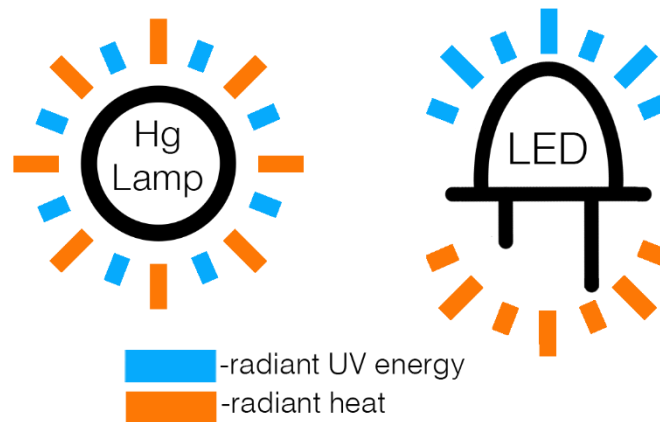


Figure 1-2: Comparison of light and heat emitted from UV sources

Despite this reduced potential, if you suspect that inorganic fouling is occurring inside your Micro unit, you can choose to flush the module with a mild cleaning agent such as 20% citric acid or similar substance.

d. Summary of Regulatory Compliance

Table 1-2: Relevant regulations, guidelines, and certifications

<u>Regulation/Guideline</u>	<u>Status</u>
NSF/ANSI 55:2019	Certified by NSF
WaterMark (AS/NZS 3497)	Certified by Global-Mark
IEC 60335	Certified by TUV Rhineland
ISO 9001:2015	Certified by Dekra
EMC (EN 55022)	Compliant
CE (2014/30/EU; 2011/65/EC; 2001/95/EC)	Compliant
RoHS 3 (Directive 2011/65/EU)	Compliant
REACH (EC No.1907/2006)	Compliant
WRAS / BS 6920	Pending

*Certificates available upon request, as applicable



e. Absolute Maximum Ratings

Do not exceed the following values when using your PearlAqua Micro device. Improper usage outside of these values may result in injury or damage to the PearlAqua Micro unit. Warranty may also be voided if these conditions are not followed.

Refer to the model number listed your unit's cable to identify the proper table to reference below. For full detail on reading and understanding your model number, see [Section 3a](#).

For complete specifications, see [Section 3](#).

Table 1-3: Absolute Maximum values

Specification	Min	Max	Unit
Operating Pressure	-	8.3 (120)	Bar (psi)
Tested Pressure	-	19.8 (288)	Bar (psi)
Water Temperature (while unit is powered) for models 3B, 6B, 3C, and 6C	>0 (>32)	50 (122)	°C (°F)
Water Temperature (while unit is powered) for models 9C and 12C	>0 (>32)	45 (113)	°C (°F)
Ambient Air Temperature (while unit is powered)	-	80 (176)	°C (°F)
Flow Rate (while unit is powered)	>0.1 (>0.03). Do not power without water flow.	Based on disinfection requirements; See Section 3 for performance information	LPM (GPM)
Input Voltage for 12V devices	11.4	14.0	V DC
Input Voltage for 24V devices	21.6	26.4	V DC

2. Basic Installation

a. Product Parts and Dimensions

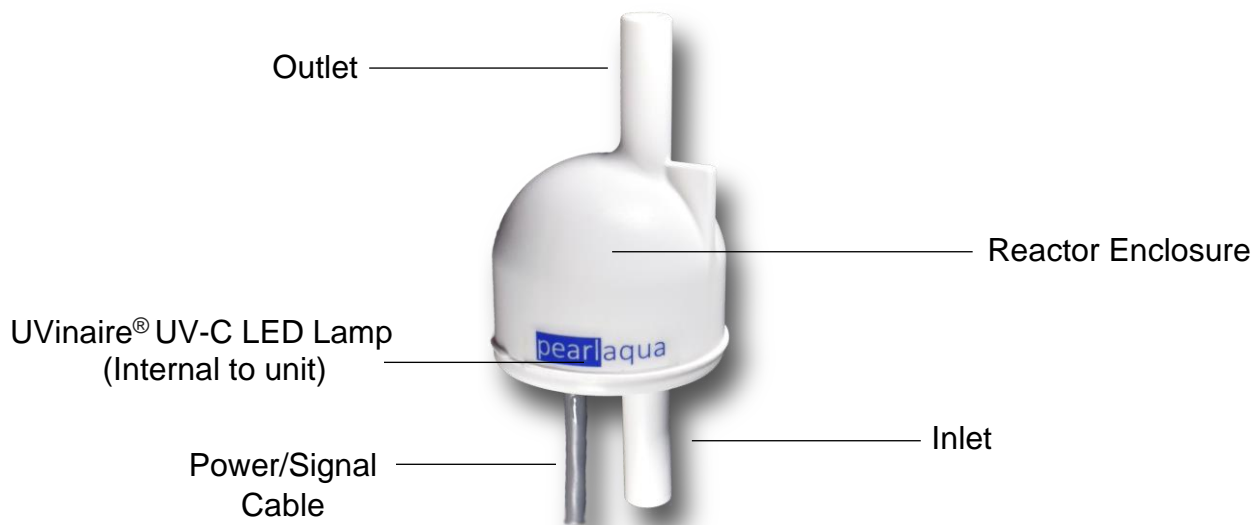


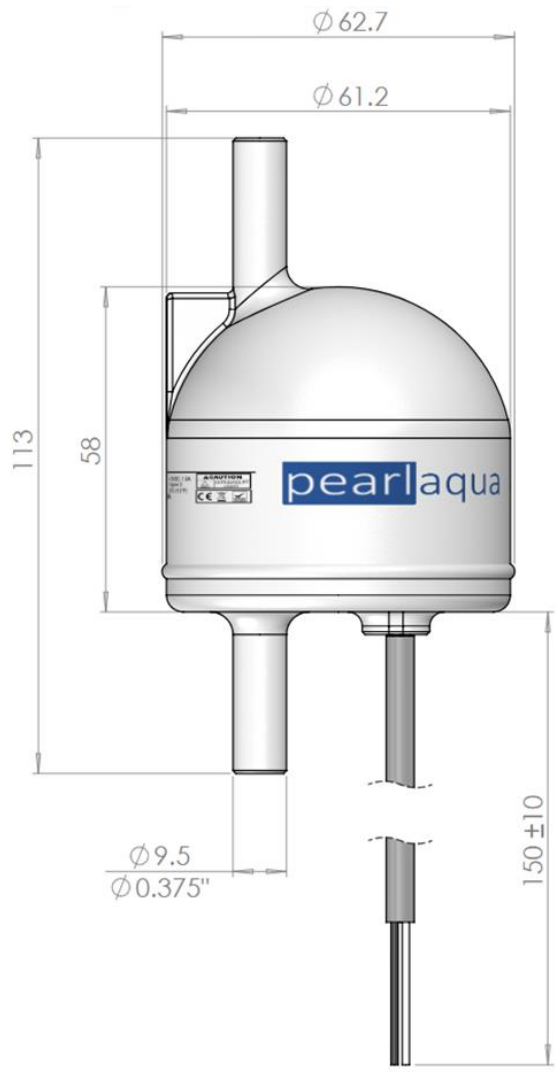
Figure 2-1: Anatomy of a typical PearlAqua Micro unit

b. Plumbing Installation

WARNING

- Install in accordance with local plumbing and electrical regulations.
- This product contains an ultraviolet (UV) light source. Please use caution; [see Section 1.](#)
- Do not use if there is any sign of damage to the unit.
- Do not exceed maximum flow and pressure allowed through the unit. Please refer to [Section 1b \(Safety Label\)](#) and/or [Section 3 \(Detailed Specifications and Integration\)](#) for details.

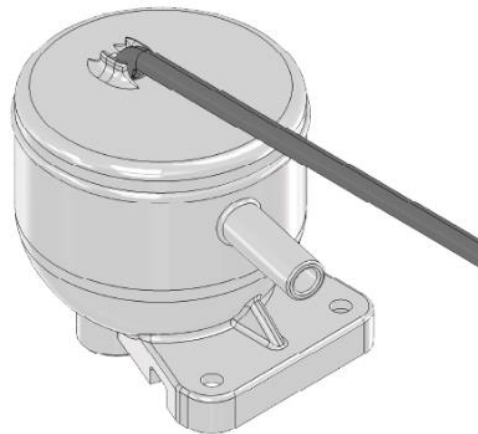
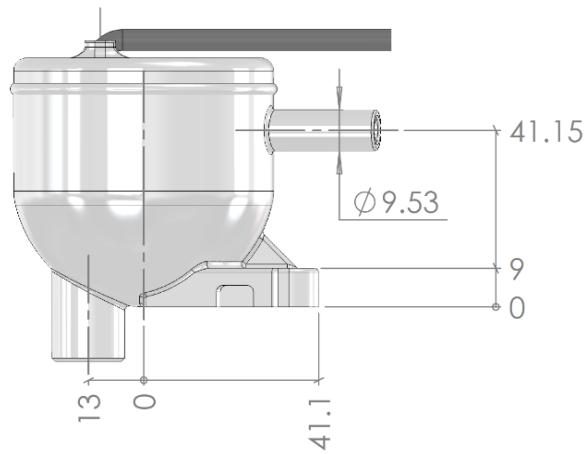
Available C-Sized Enclosures (Standard Options)



3/8 Inch Male Tube (S1000)

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH = 1.5 μ (RMS) OR BETTER TOOL RADIUS = 0.4 OR 0.8 DEBURR ALL EDGES	ANGLES $\pm 1.0^\circ$ X. ± 1.0 X.X ± 0.25 X.XX ± 0.10 X.XXX ± 0.05
THIRD ANGLE PROJECTION	
	ASME Y14.5 2009

Available C-Sized Enclosures (Standard Options)



Horizontal C Inlet, 3/8 Inch male Tube (H1000)

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH = 1.5 μ (RMS) OR BETTER TOOL RADIUS = 0.4 OR 0.8 DEBURR ALL EDGES	ANGLES ± 1.0° X. ± 1.0 X.X ± 0.25 X.XX ± 0.10 X.XXX ± 0.05
THIRD ANGLE PROJECTION	
	ASME Y14.5 2009

PearlAqua Micro can
utilize Push-to-
Connect fittings



- Please read all instructions before use.
- Remove the PearlAqua Micro™ from its packaging; ensure contents of the package are complete.
- **Do not power the PearlAqua Micro without flowing water.**
- For installation, consider ease of access, maximum length and minimum bend radii of piping, electrical connections, and air circulation when selecting the installation location.
- Do a quick test fit of the unit before beginning any installation
- Use appropriately sized tubing for the fittings selected. Polyethylene or nylon tubing should be used.

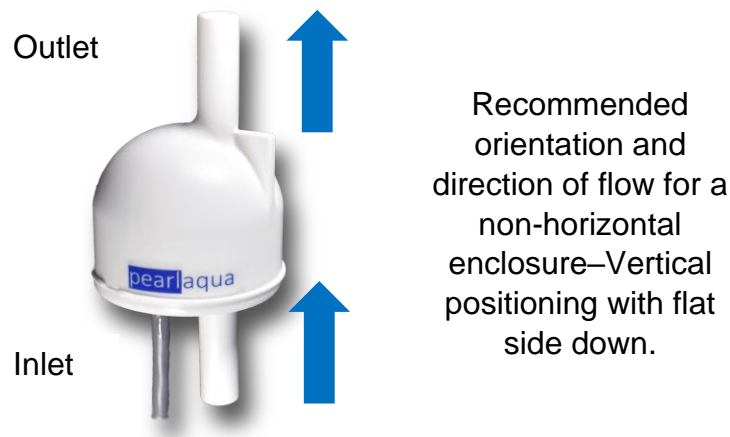


Figure 2-2: Recommended orientation of non-horizontal enclosure to prevent trapped air which may affect disinfection performance

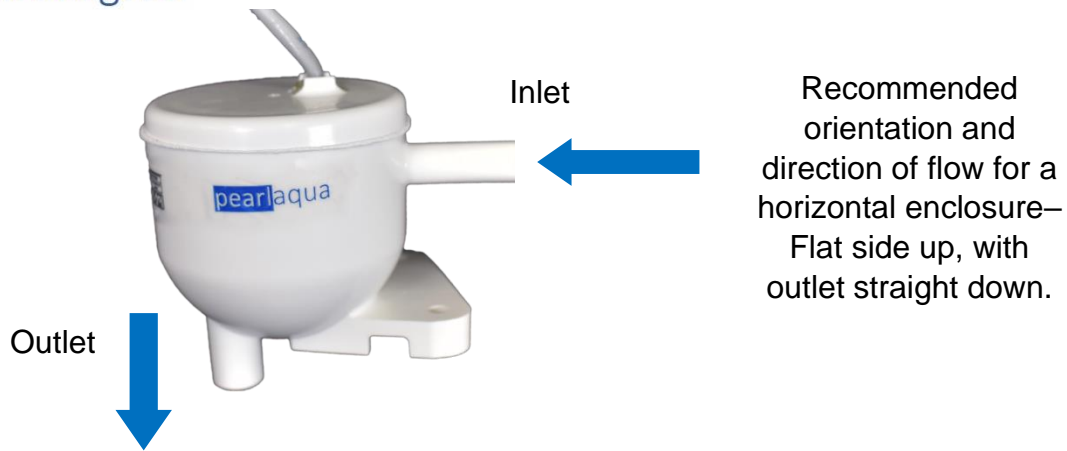


Figure 2-3: Recommended orientation of unit with horizontal enclosure

Recommended orientation and direction of flow for a horizontal enclosure— Flat side up, with outlet straight down.

Connection of Water Lines

The direction of flow, rate of flow, and unit orientation should be considered when installing a Micro unit to your process to prevent trapped air bubbles which may reduce performance. Each application may have a different way to achieve this. Please contact Aquisense for more information.

To connect your unit to plumbing:

1. Do a quick test fit of the unit before beginning any modifications. Remember to measure twice, cut once.
2. If applicable, mount the Micro securely in a safe location. Note the recommended orientation in **Figure 2-2** or **Figure 2-3** above.
3. Attach Push-to-Connect fittings to the Inlet and Outlet as applicable. Use the proper connector sized based on your unit's configuration.



Figure 2-4: Example of Micro units with plumbing installed

4. Connect water lines to the inlet and outlet of the PearlAqua Micro. Polyethylene or nylon tubing should be used. Use tubing appropriately sized for the fittings your unit uses.

c. Electrical Installation and Power Application

Electrical Connectors

The most commonly used electrical connections are the flying lead (Unterminated) and barrel plug options.

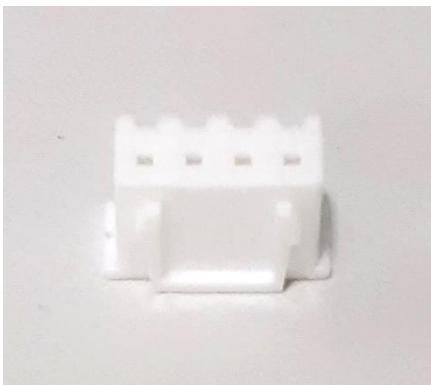


Flying Lead (Unterminated)
Connection

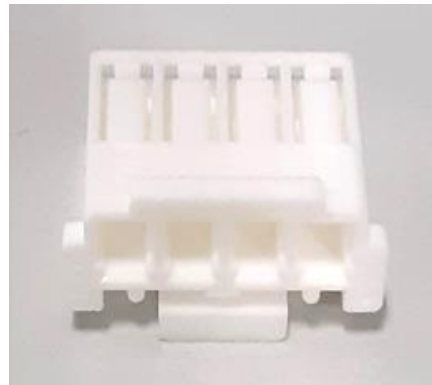


[Barrel Plug Connection](#)

Also available are the following:



[JSP #XHP-4 Rectangular Connector](#)
(2-Pin and 3-Pin versions also available)







[4-Pin Molex Connectors](#)
(2-Pin and 3-Pin versions also available)

Other connections may be installed during unit assembly upon request. Contact Aquisense for details.

Electrical Power Diagram for Non-Barrel Plug Connections



Table 2-1: Wire Function Identification by Color

Wire Color		Function*
Red		Power Input (V,in)
Black		Ground (GND)
Green		Thermistor (Advanced Function)
White or Yellow		Thermistor, LED Status or UV Intensity Sense (Advanced Functions)

*Exact function and usage may vary by configuration

For power application, the diagram below should be followed for 12V devices. 24V devices should use 24V power. See **Table 2-2** below.

Once power is applied, the UV-LEDs will activate and disinfection can commence.

Do NOT operate the unit without water flow to prevent overheating.

Running a unit without water may damage the unit. To prevent such operation, power application with a PLC, pump circuit, switch or other methods can be utilized.

See [Section 3](#) for advanced integration.

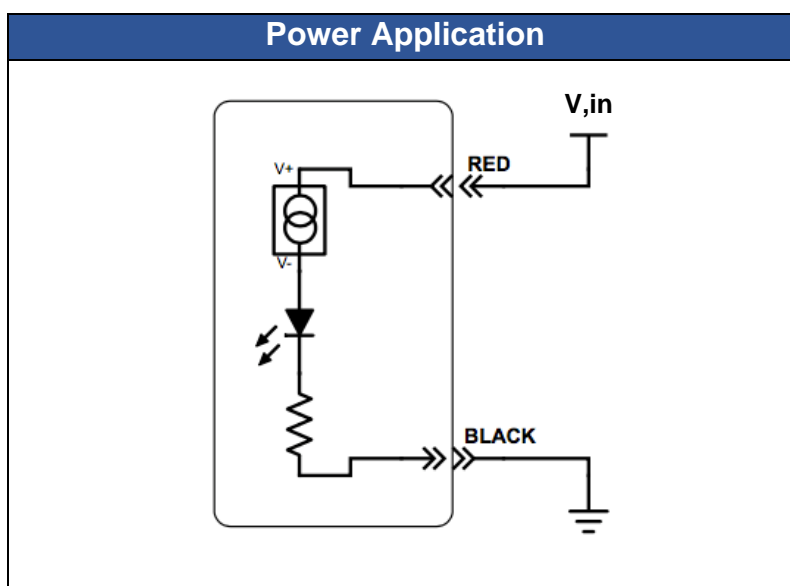


Figure 2-5: Standard power application electrical scheme for all units.

To determine if your unit is a 12V or 24V device, please refer to your unit's [Safety Label](#) or refer to [Section 3a](#) to read your product's full model number.

Table 2-2: Power Application, Recommended Operating Conditions

Specification	Min	Recommended	Max	Unit
Input Voltage for 12V devices	11.4	12	14	V DC
Input Voltage for 24V devices	21.6	24	26.4	V DC

For units with the barrel plug connection, a power supply may be used as a Plug-and-Play option. This option is often used by evaluators during product testing phases of projects.

Be advised that the barrel plug option only supplies power to the unit. There is no feature internal to the Micro unit to prevent the unit from operating without water flow. Do not power the Micro unit without water flow.

A power supply may be offered by AquisSense or sourced independently. See **Table 2-3** below for specifications related to the AquisSense offering.

To use the barrel plug option with an AquisSense supplied power supply unit:

1. Select desired outlet plug adaption to the main power supply unit. Ensure springs on the supply unit are up and aligned with outlet piece.
 - o Multiple outlet attachments are available to accommodate outlets globally



2. Connect desired outlet adaptation by snapping it into place on the main supply unit.
3. To apply power, connect main power supply unit to wall outlet (within the specifications shown in **Table 2-3** below). Connect to barrel plug on Micro unit.



Table 2-3: Specifications of AquisSense power supply offering

<u>Specification</u>	<u>Value</u>	<u>Units</u>
Manufacturer	CUI Inc	-
Manufacturer Model Number	SMI18-12	-
Supplier Part Number	102-3580-ND	-
Input Voltage	90 – 264	V
Input Current	0.48	A
Output Voltage	12	V
Max Output Current	1.6	A

For more information on the standard power supply option offered by AquisSense, click the links in **Table 2-3** or visit digikey.com and enter the Supplier Part Number.

On the standard cable, the Red and Black wires will always be for Power Application as described above.

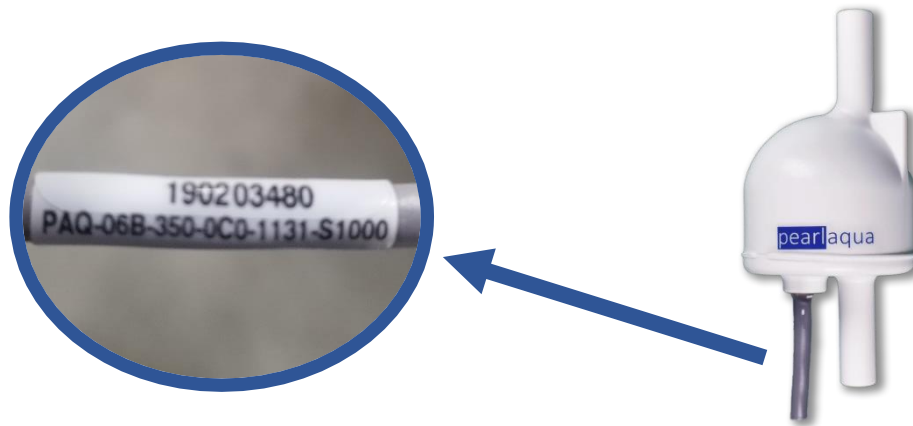
Any additional wires on the power cable aside from Red and Black are used for advanced features of the Micro device. For more information on using the advanced functions of the Micro including the Thermistor, LED Status, and Intensity Sensing; please refer to [Section 3 \(Detailed Specifications and Integration\)](#).

3. Detailed Specifications and Advanced Operation

Section Overview

- a. [Unit Serial Number and Model Number Interpretation](#)
- b. [Electrical Block Diagrams](#)
- c. [Lamp Lifetime \(All models\)](#)
- d. **[PearlAqua Micro Models 3B and 6B](#)**
 - [Disinfection Performance \(Flow Ratings\)](#)
 - [Mechanical/Hydraulic Data](#)
 - [Electrical Specifications](#)
 - [Thermistor](#)
 - [LED Status Signal in the 3B and 6B](#)
- e. **[PearlAqua Micro Models 3C and 6C](#)**
 - [Disinfection Performance \(Flow Ratings\)](#)
 - [Mechanical/Hydraulic Data](#)
 - [Electrical Specifications](#)
 - [Thermistor](#)
- f. **[PearlAqua Micro Models 9C and 12C](#)**
 - [Disinfection Performance \(Flow Ratings\)](#)
 - [Mechanical/Hydraulic Data](#)
 - [Electrical Specifications](#)
 - [Thermistor](#)
 - [LED Status Signal in the 9C and 12C](#)
 - [UV Intensity Sensing Option \(Photodiode\) in the 9C and 12C](#)
- g. [Thermistor \(for all models\)](#)
- h. [Pulsed Operation without Flow](#)
- i. [AquiSense Switching Products](#)

a. Unit Serial Number and Model Number Interpretation



Each Micro unit has a unique serial number, normally located on the cable. It describes the date of assembly followed by an incrementally assigned number.

The general format is described in **Figure 3-1** below.

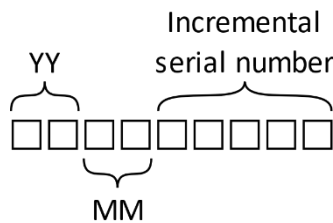


Figure 3-1: General format for serial number (unique to each unit)

For information on the unit’s hardware configuration, also listed on the cable is the product’s model number. This model number conveys important information about the functions available, voltage requirements, disinfection performance, lifetime, and more.

The general 21-digit format for this is shown in **Figure 3-2** below. **Refer to your unit’s model number as needed throughout the remainder of this manual.**

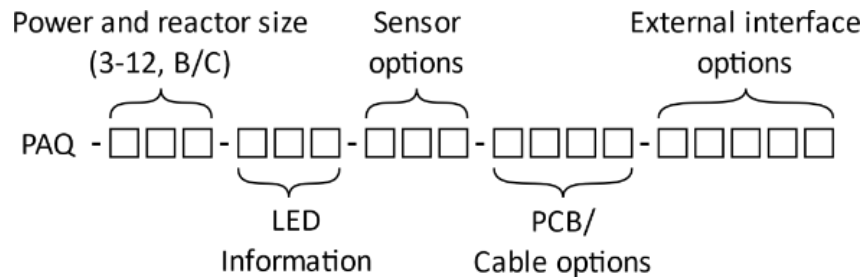


Figure 3-2: General format for Micro unit model numbers showing hardware configuration

See **Table 3-1** through **Table 3-4** below to interpret the model number in detail. Each table refers to a section of the model number shown in **Figure 3-2**. Other options than those listed in the tables may be available. Contact Aquisense for details.

Table 3-1: Key for interpreting Micro model number; first 9 digits (Power and Reactor Size, LED Information)

Base Model	UV-LED Type	UV-LED Drive Current	Visible LED
PAQ-03B PAQ-06B PAQ-03C PAQ-06C PAQ-09C PAQ-12C	0 = No UV Installed 2 = Variant A 3 = Variant B 4 = Standard 5 = Variant C	3 = Low 5 = Mid 7 = High	0 = Not installed 1 = Yes

Table 3-2: Key for interpreting Micro model number; 10th through the 12th digit (Sensor Options)

Thermistor	LED Status Signal	UV Intensity Sensing
0 = Not installed T = Installed	0 = Not installed C = Low Range (Gen 1) H = Hi Range (Standard, Gen 2)	0 = Not installed S = Sensor Installed

Table 3-3: Key for interpreting Micro model number; 13th through 16th digit (PCB and Cable Options)

Input Voltage	Cable Length (as assembled)	Cable Cores	Connector Option
1 = 12V dc 2 = 24V dc	1 = 150mm 2 = 300mm C = 500mm F = 1000mm 5 = 1200mm	2 = 2-Wire 3 = 3-Wire 4 = 4-Wire	1 = Flying Lead 2 = Barrel Plug 8 = 4-Pin JST F = Molex, 4-Pin X = Non-Standard

Table 3-4: Key for interpreting Micro model number; 17th through 21st digit (External Interface Options)

Enclosure Type	Fluid Connection Size	Flow Switch	External Indicator Board	Special Build/Other
S = Standard H = Horizontal X = Other	1 = 3/8 Inch 2 = 11mm 3 = 1/2 Inch 4 = Other	0 = None S = Semi-Integrated B = Bracketed	0 = None 1 = Yes	0 = None X = Yes

Model Number Interpretation Example

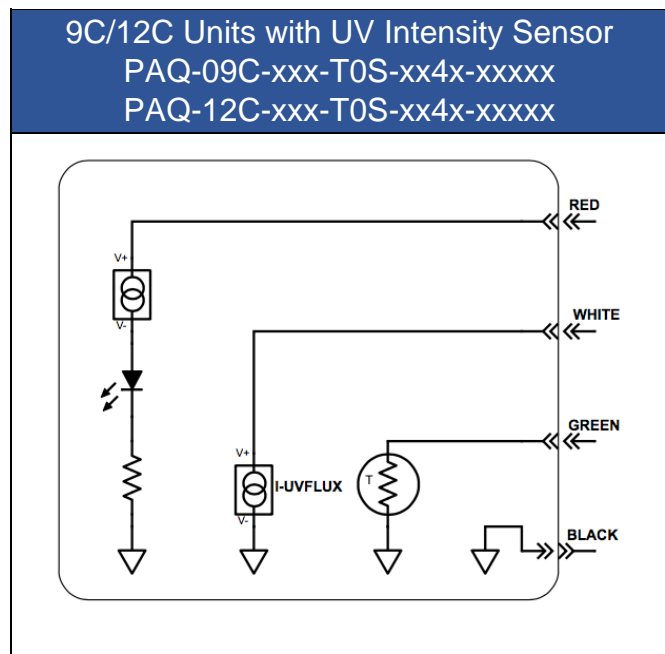
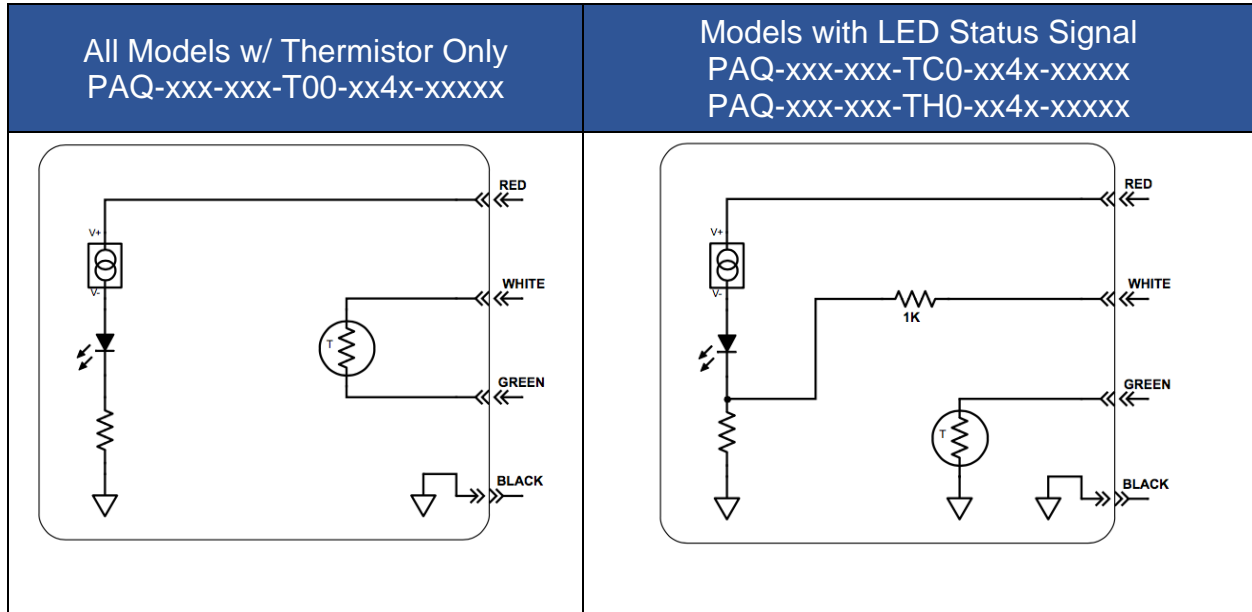
As an example, if a Micro unit had the following model number:

PAQ-06B-450-T00-2141-S1000

This Micro product would have the following:

- PearlAqua Micro 6B base model
- B-Sized reactor
- Standard UV-LED selection
- Medium Drive Current
- No Visible LED
- Thermistor (Temperature Sensing function)
- No LED Status signal function available
- No UV Intensity sensor Installed
- 24V Input Power specification
- 150mm Cable Length (as it left the factory)
- 4-Wire Cable Core
- Unterminated/Flying lead electrical connection
- Standard/Non-horizontal Enclosure with 3/8 Inch Male Tube plumbing connection
- No switching options, indicator board options, or special build considerations

b. Electrical Block Diagrams



c. Lamp Lifetime (All Models)

The lamp lifetime of a PearlAqua Micro unit can be adjusted during factory assembly. This is one of the unique functions of UV-LED technology. This allows a unit to be configured at a detailed level to meet an applications performance and lifetime requirements.

Table 3-5 below provides information on the estimated operating hours (“On” time) which can be expected depending on the exact configuration of your unit. This information assumes that was operated within specified water temperature and ambient temperature conditions (as described in [Section 1e](#)). This information applies to all versions/base models of the PearlAqua Micro.

Table 3-5: Lamp Operating Lifetime Information (All Models)

Configuration	Estimated Lamp Lifetime (until L70)
PAQ-xxx-410	>20,000
PAQ-xxx-430	10,000
PAQ-xxx-450	8,000
PAQ-xxx-470	2,000-4,000

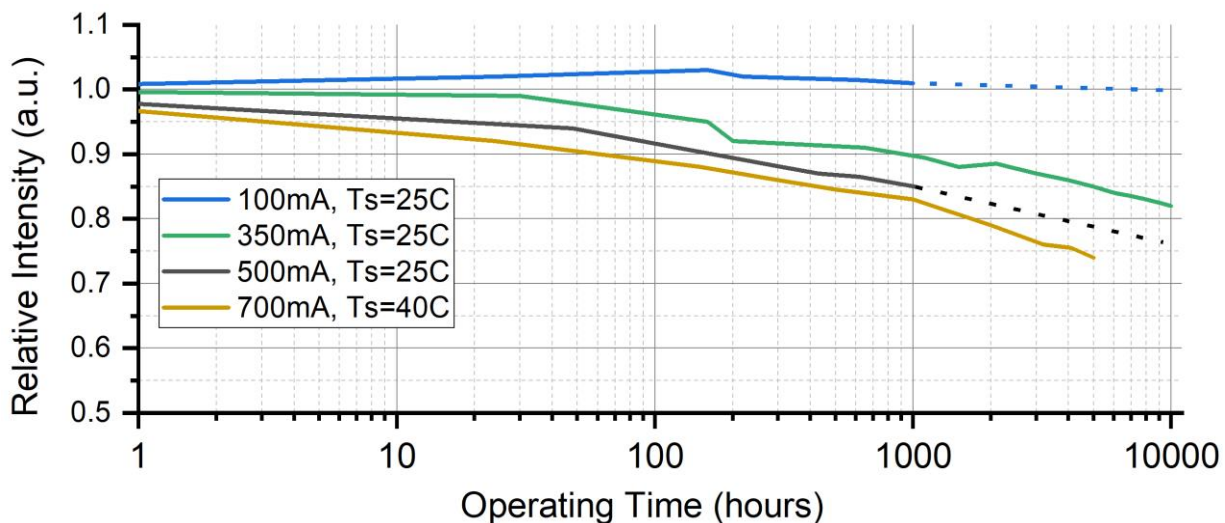


Figure 3-3: Graph of UV-LED lifetime with varied drive current

d. PearlAqua Micro Models 3B and 6B

Overview

- [Disinfection Performance \(Flow Ratings\)](#)
- [Mechanical/Hydraulic Data](#)
- [Electrical Specifications](#)
- [Thermistor](#)
- [LED Status Signal in the 3B and 6B](#)

Disinfection Performance of the Micro 3B and 6B

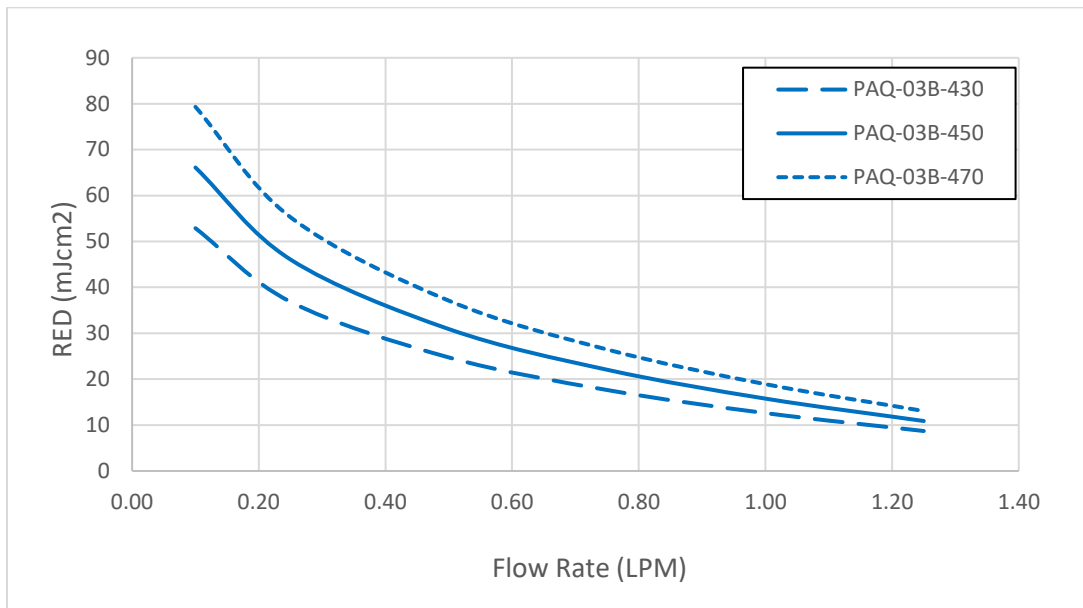


Figure 3-4: Graph of UV Dose vs Flow in the Micro 3B

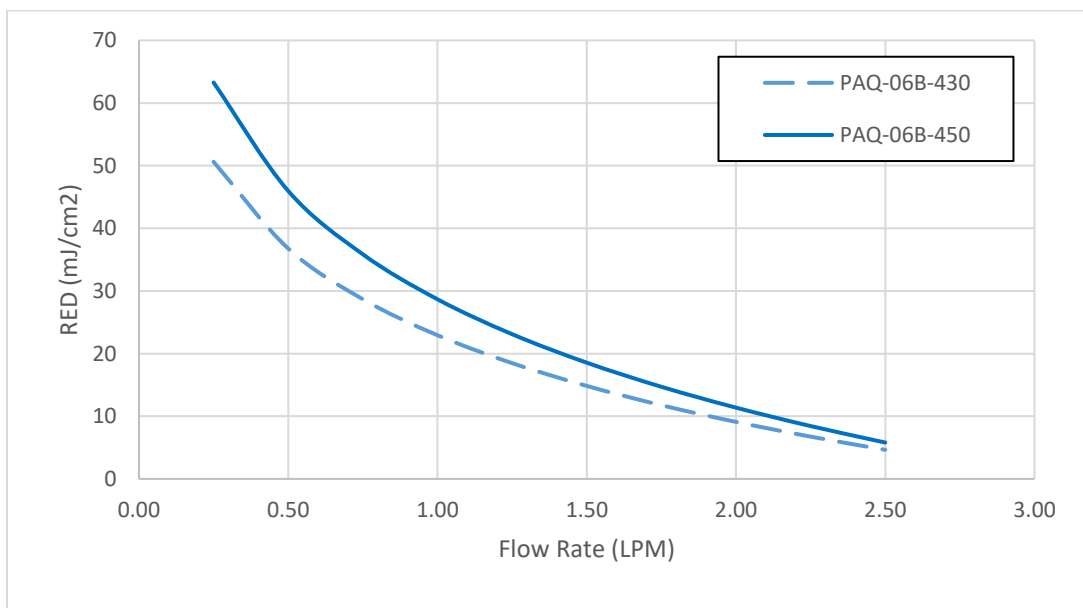


Figure 3-5: Graph of UV Dose vs Flow in the Micro 6B

Mechanical/Hydraulic Specifications

This section provides mechanical and hydraulic data for 3B and 6B units.

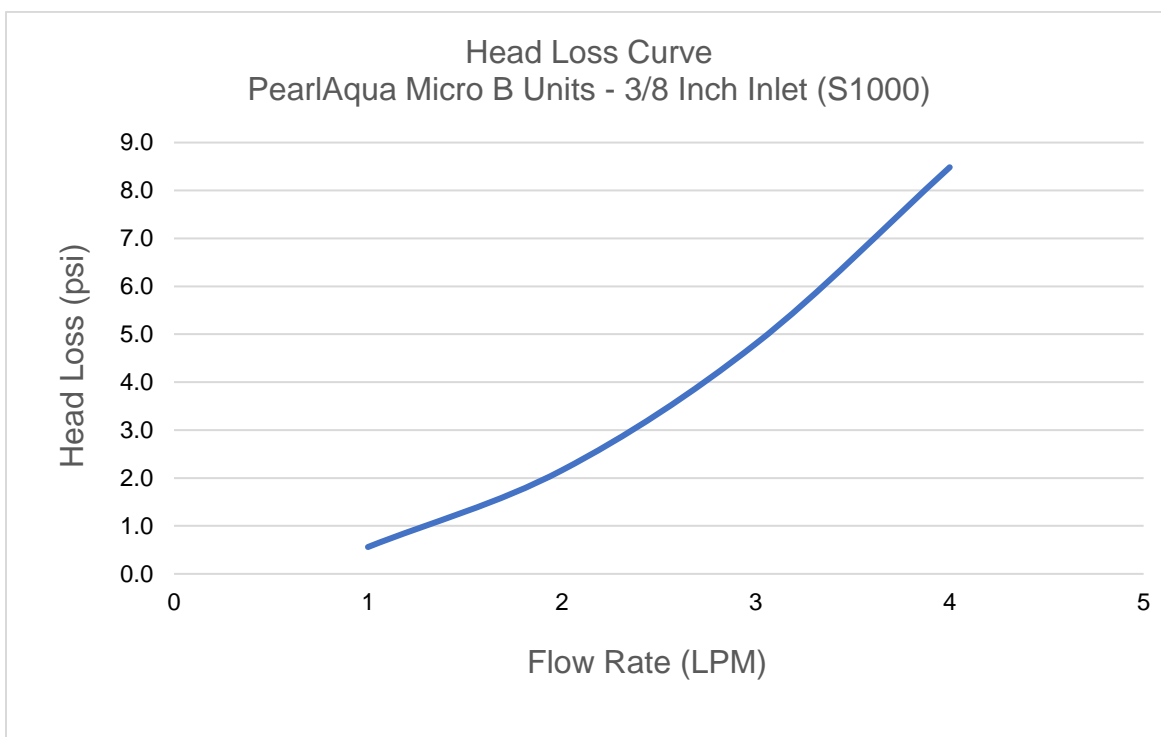


Figure 3-6: Head Loss in 'B' units, 3/8 Inch Inlet and Outlet, Vertical Orientation, flat side down

Table 3-6: “B-sized” PearlAqua Micro Mechanical Specifications

	<u>Min</u>	<u>Recommended/Typical</u>	<u>Max</u>	<u>Units</u>
Operating Pressure	-	-	8.3 (120)	Bar (psi)
Ambient Air Temperature (while unit is powered)	-	≤25 (77)	80 (176)	°C (°F)
Water Temperature (while unit is powered)	>0 (>32)	≤20 (68)	50 (122)	°C (°F)
Weight	77 (2.7)			g (oz)
Total Internal Volume (S1000 Enclosure)	17			cc (mL)
Environmental Protection	IP68			-

Electrical Specifications

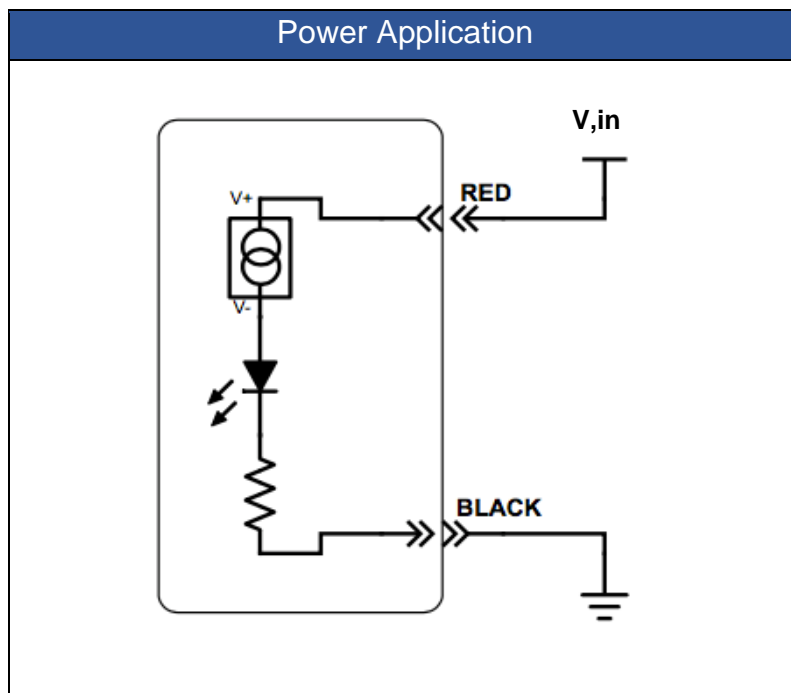


Figure 3-7: Power Application scheme for all Micro units.

To determine if your unit is a 12V or 24V input device, please refer to your unit's [Safety Label](#) or refer to [Section 3a](#) to read your product's full model number.

Table 3-7: PearlAqua Micro 3B Electrical Specifications for 12V Devices

	PAQ-03B-430			PAQ-03B-450			PAQ-03B-470			Units
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Voltage for 12V devices	11.4	12	14	11.4	12	14	11.4	12	14	Vdc
Current Draw	130	190	275	185	270	390	255	380	545	mA
Power Draw	1.8	2.3	3.1	2.5	3.2	4.4	3.6	4.5	6.2	W
Standard Electrical Connection	4-Core Cable; 150mm (6") length									
	PAQ-03B-431			PAQ-03B-451			PAQ-03B-471			Units
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Voltage for 12V devices	11.4	12	14	11.4	12	14	11.4	12	14	Vdc
Current Draw	220	310	420	315	440	600	440	620	840	mA
Power Draw	3.1	3.7	4.8	4.4	5.3	6.9	6.2	7.4	9.6	W
Standard Electrical Connection	4-Core Cable; 150mm (6") length									

*Estimated values; subject to change.

Table 3-8: PearlAqua Micro 3B Electrical Specifications for 24V Devices

	PAQ-03B-430			PAQ-03B-450			PAQ-03B-470			Units
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Voltage for 24V devices	21.6	24	26.4	21.6	24	26.4	21.6	24	26.4	Vdc
Current Draw	70	95	145	95	135	205	135	190	290	mA
Power Draw	1.8	2.3	3.1	2.5	3.2	4.4	3.6	4.5	6.2	W
Standard Electrical Connection	4-Core Cable; 150mm (6") length									
	PAQ-03B-431			PAQ-03B-451			PAQ-03B-471			Units
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Voltage for 24V devices	21.6	24	26.4	21.6	24	26.4	21.6	24	26.4	Vdc
Current Draw	120	155	220	165	220	320	235	310	445	mA
Power Draw	3.1	3.7	4.8	4.4	5.3	6.9	6.2	7.4	9.6	W
Standard Electrical Connection	4-Core Cable; 150mm (6") length									

*Estimated values; subject to change.

Micro 6B Units

Table 3-9: PearlAqua Micro 6B Electrical Specifications for 12V Devices

	<u>PAQ-06B-430</u>			<u>PAQ-06B-450</u>			<u>Units</u>
	<u>Min</u>	<u>Typ</u>	<u>Max</u>	<u>Min</u>	<u>Typ</u>	<u>Max</u>	
Input Voltage for 12V devices	11.4	12	14	11.4	12	14	Vdc
Current Draw	255	375	545	370	540	780	mA
Power Draw	3.6	4.5	6.2	5.2	6.5	8.9	W
Standard Electrical Connection	4-Core Cable; 150mm (6") length						

*Estimated values; subject to change.

Table 3-10: PearlAqua Micro 6B Electrical Specifications for 24V Devices

	<u>PAQ-06B-430</u>			<u>PAQ-06B-450</u>			<u>PAQ-06B-470</u>			<u>Units</u>
	<u>Min</u>	<u>Typ</u>	<u>Max</u>	<u>Min</u>	<u>Typ</u>	<u>Max</u>	<u>Min</u>	<u>Typ</u>	<u>Max</u>	
Input Voltage for 24V devices	21.6	24	26.4	21.6	24	26.4	21.6	24	26.4	Vdc
Current Draw	135	190	290	200	270	410	270	380	575	A
Power Draw	3.6	4.5	6.2	5.2	6.5	8.9	7.2	9.1	12.4	W
Standard Electrical Connection	4-Core Cable; 150mm (6") length									

*Estimated values; subject to change.

Fuse Rating Requirements

For applications involving an in-line fuse, it is recommended to size the fuse 20% above a unit's Typical Current Draw. See the table and column above relevant to your model number.

$$\text{Fuse Rating (A)} = 1.20 \times \frac{\text{Typical Power Draw (W)}}{\text{Typical Input Voltage (V dc)}}$$

Thermistor (Temperature Sensing)

This feature can be used to prevent over-heating of the PearlAqua Micro unit's electronics which could damage the unit and reduce lamp lifetime.

For information on using the Temperature Sensing feature, please refer to [Section 3f](#).

LED Status Signal in the 3B and 6B

Some models of the 3B and 6B come with an LED Status signal (sometimes referred to as LED Health). This is a digital signal which can be used to confirm the UV-LEDs in your Micro unit are powered.

Measurement Method A in **Figure 3-7** below is a basic measurement method designed for use with handheld multi-meters.

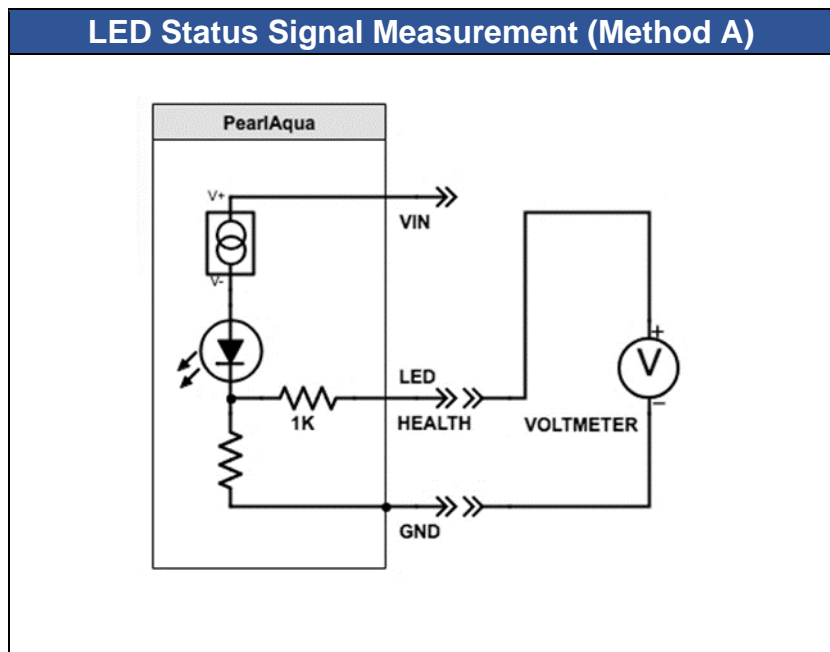


Figure 3-7: LED Status (LED Health) Signal Measurement (Method A)

Measurement Method B in **Figure 3-8** below is a more general method intended for use with an Operational Amplifier (OP-AMP) providing impedance exceeding 100k Ohms. This method is most useful when using a PLC or other data acquisition (DAQ) module to read and interpret the signal.

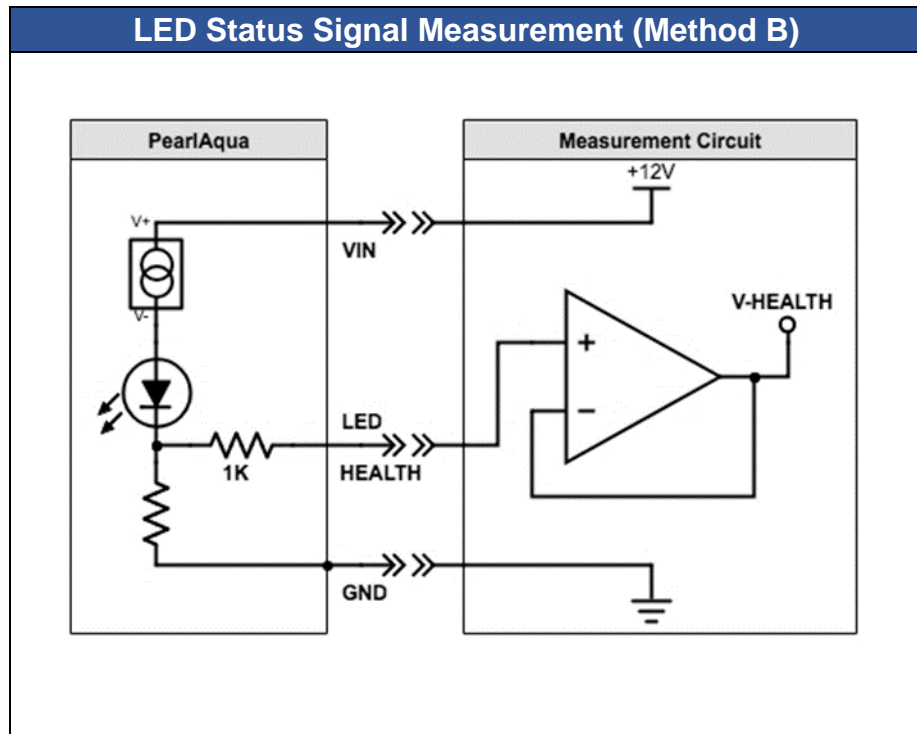


Figure 3-8: LED Status (LED Health) signal Measurement (Method B)

The color of wire for the LED Status (LED Health) connection and the value of signals for will vary slightly depending on the exact configuration of your PearlAqua Micro. Review **Table 3-11** below to find the values for your configuration.

Table 3-11: LED Status Signal values for Micro 3B and 6B units

Model Number	LED Health Wire Color	Signal when UV-LEDs are OFF			Signal when UV-LEDs are ON			<u>Units</u>
		<u>Min</u>	<u>Typ</u>	<u>Max</u>	<u>Min</u>	<u>Typ</u>	<u>Max</u>	
PAQ-03B-x3x-xC0-2xxx-xxxxx		-	0	-	40	50	60	mV dc
PAQ-03B-x5x-xC0-2xxx-xxxxx		-	0	-	70	80	90	
PAQ-06B-x3x-xC0-2xxx-xxxxx		-	0	-	90	100	120	
PAQ-06B-x5x-xC0-2xxx-xxxxx		-	0	-	130	150	170	

e. **PearlAqua Micro Models 3C and 6C**

Overview

- [Disinfection Performance \(Flow Ratings\)](#)
- [Mechanical/Hydraulic Specifications](#)
- [Electrical Specifications](#)
- [Thermistor](#)

Disinfection Performance of the Micro 3C and 6C

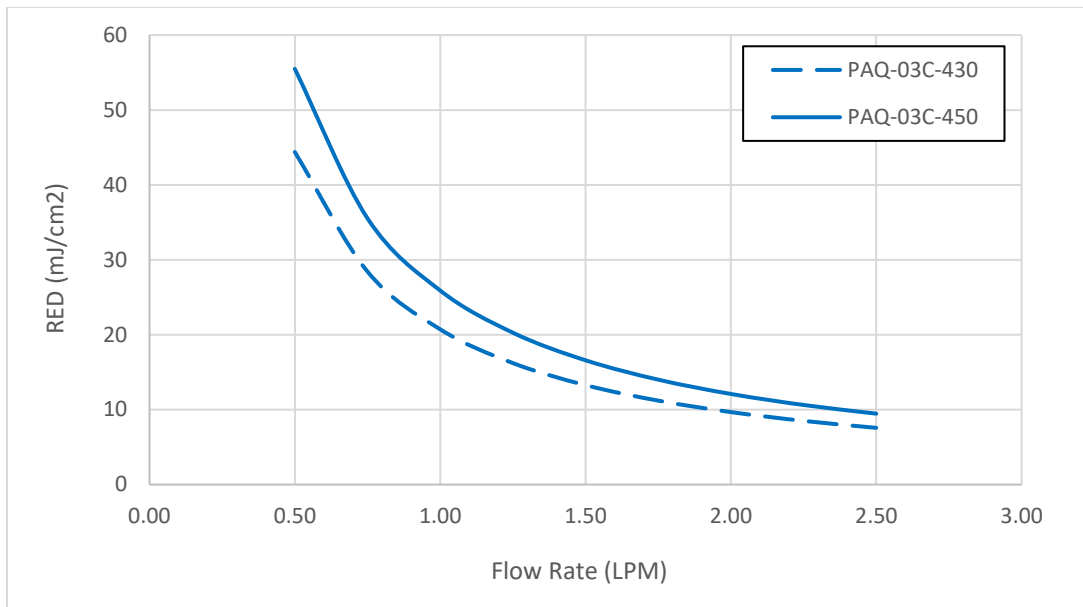


Figure 3-9: Graph of UV Dose versus Flow in the Micro 3C

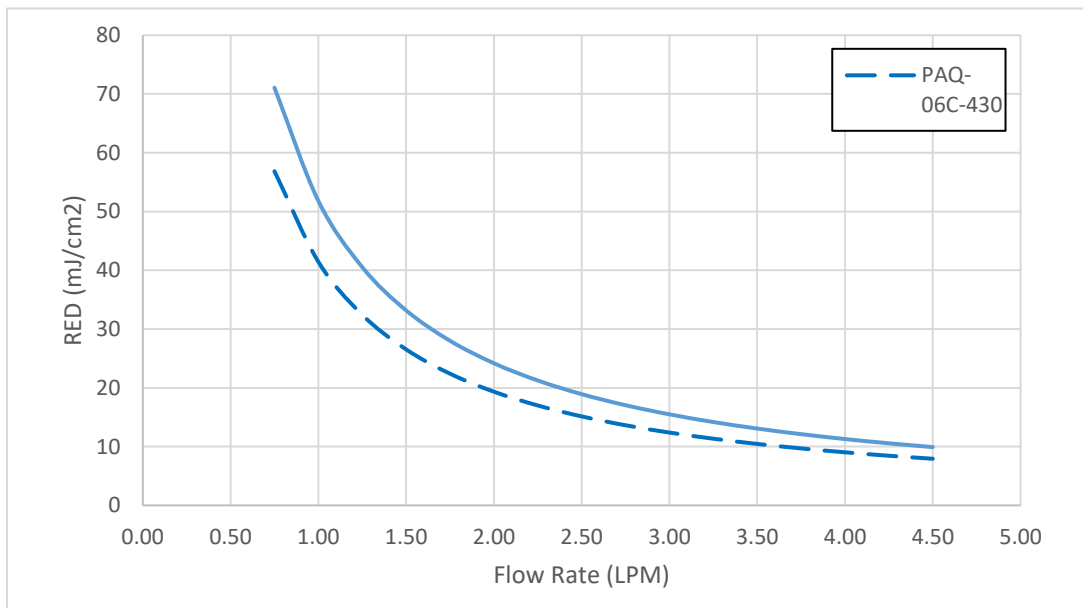


Figure 3-10: Graph of UV Dose versus Flow in the Micro 6C

Mechanical/Hydraulic Specifications

This section provides mechanical and hydraulic data for 3C and 6C units.

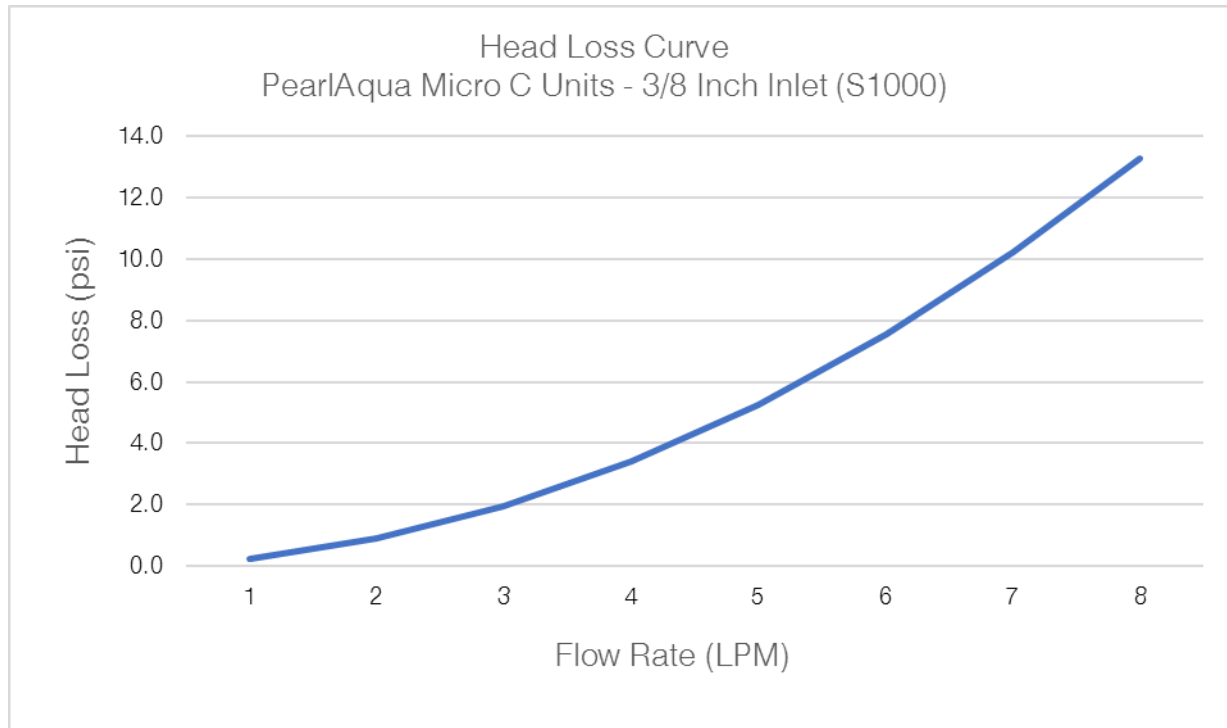


Figure 3-11: Graph of head loss in ‘C’ units, 3/8 Inch Inlet and Outlet, Vertical Orientation, flat-side down

Table 3-12: “C-sized” PearlAqua Micro Mechanical Specifications

	<u>Min</u>	<u>Recommended/Typical</u>	<u>Max</u>	<u>Units</u>
Operating Pressure	-	-	8.3 (120)	Bar (psi)
Ambient Air Temperature (while unit is powered)	-	≤25 (77)	80 (176)	°C (°F)
Water Temperature (while unit is powered)	>0 (>32)	≤20 (68)	45	°C (°F)
Weight	162 (5.7)			g (oz)
Total Internal Volume (S1000 Enclosure)	47			cc (mL)
Environmental Protection	IP68			-

Electrical Specifications

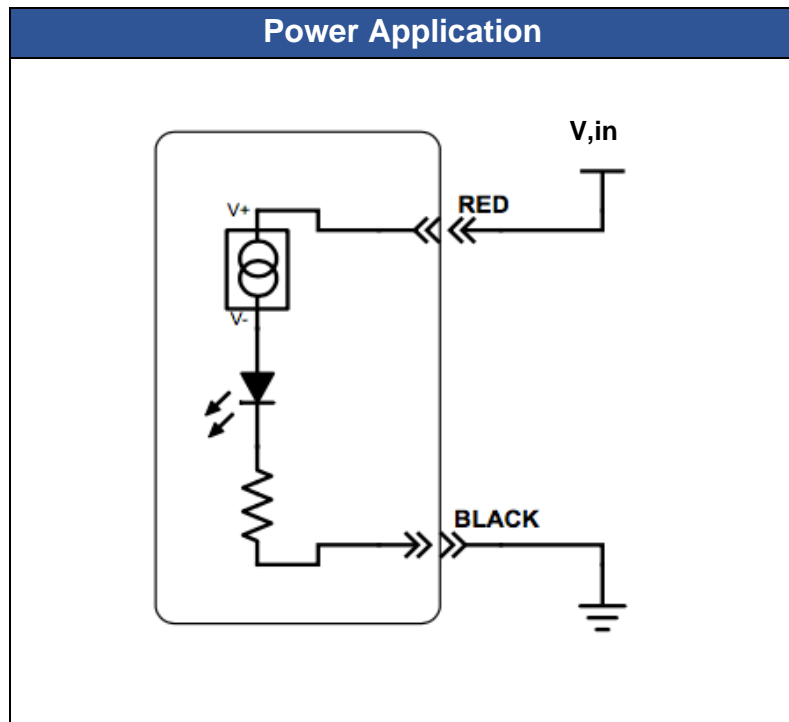


Figure 3-12: Power Application scheme for all Micro units

To determine if your unit is a 12V or 24V device, please refer to your unit's [Safety Label](#) or refer to [Section 3a](#) to read your product's full model number.

Table 3-13: PearlAqua Micro 3C Electrical Specifications

	<u>PAQ-03C-430</u>			<u>PAQ-03C-450</u>			<u>PAQ-03C-470</u>			<u>Units</u>
	<u>Min</u>	<u>Typ</u>	<u>Max</u>	<u>Min</u>	<u>Typ</u>	<u>Max</u>	<u>Min</u>	<u>Typ</u>	<u>Max</u>	
Input Voltage for 12V devices	11.4	12	14	11.4	12	14	11.4	12	14	Vdc
Current Draw	130	190	275	185	270	390	255	380	545	mA
Power Draw	1.8	2.3	3.1	2.5	3.2	4.4	3.6	4.5	6.2	W
Standard Electrical Connection	4-Core Cable; 150mm (6") length									
	<u>PAQ-03C-431</u>			<u>PAQ-03C-451</u>			<u>PAQ-03C-471</u>			<u>Units</u>
	<u>Min</u>	<u>Typ</u>	<u>Max</u>	<u>Min</u>	<u>Typ</u>	<u>Max</u>	<u>Min</u>	<u>Typ</u>	<u>Max</u>	
Input Voltage for 12V devices	11.4	12	14	11.4	12	14	11.4	12	14	Vdc
Current Draw	220	310	420	315	440	600	440	620	840	mA
Power Draw	3.1	3.7	4.8	4.4	5.3	6.9	6.2	7.4	9.6	W
Standard Electrical Connection	4-Core Cable; 150mm (6") length									

*Estimated values; subject to change

Micro 6C Units

Table 3-14: PearlAqua Micro 6C Electrical Specifications

	<u>PAQ-06C-430</u>			<u>PAQ-06C-450</u>			<u>Units</u>
	<u>Min</u>	<u>Typ</u>	<u>Max</u>	<u>Min</u>	<u>Typ</u>	<u>Max</u>	
Input Voltage for 12V devices	11.4	12	14	11.4	12	14	Vdc
Current Draw	255	375	545	370	540	780	mA
Power Draw	3.6	4.5	6.2	5.2	6.5	8.9	W
Standard Electrical Connection	4-Core Cable; 150mm (6") length						

*Estimated values; subject to change

For applications involving an in-line fuse, it is recommended to size the fuse 20% above a unit's Typical Current Draw. See the table relevant to your model number.

$$\text{Fuse Rating (A)} = 1.20 \times \frac{\text{Typical Power Draw (W)}}{\text{Typical Input Voltage (V dc)}}$$

Thermistor (Temperature Sensing)

This feature can be used to prevent over-heating of the PearlAqua Micro unit's electronics which could damage the unit and reduce lamp lifetime.

For information on using the Temperature Sensing feature, please refer to [Section 3f](#).

f. **PearlAqua Micro Models 9C and 12C**

Overview

- [Disinfection Performance \(Flow Ratings\)](#)
- [Mechanical/Hydraulic Specifications](#)
- [Electrical Specifications](#)
- [Thermistor \(Temperature Sensing\)](#)
- [LED Status Signal in the 9C and 12C](#)
- [UV Intensity Sensing Option \(Photodiode\) in the 9C and 12C](#)

Disinfection Performance of the Micro 9C and 12C

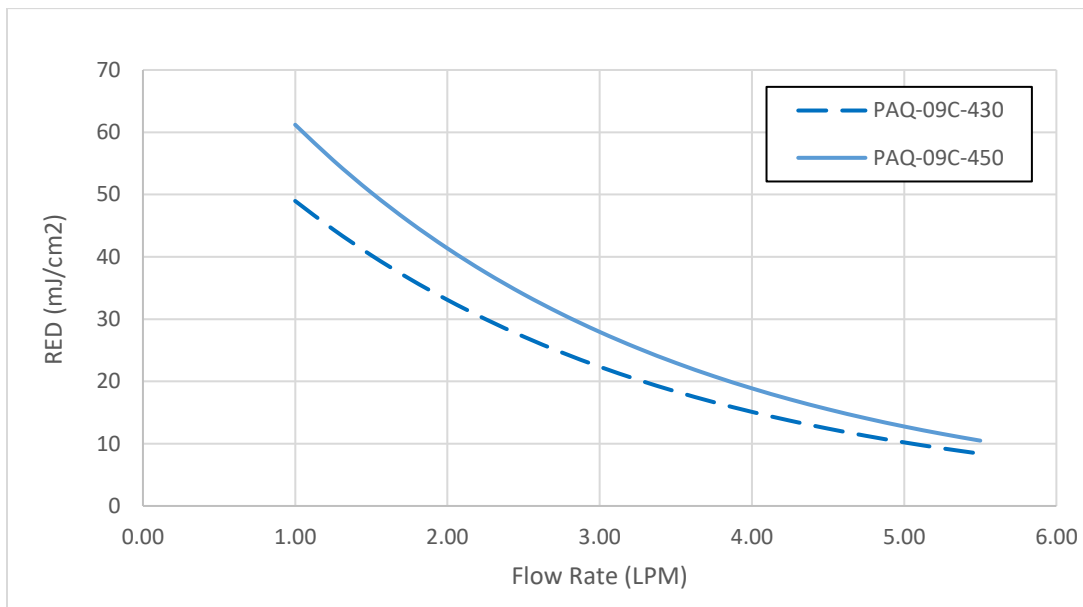


Figure 3-13: Graph of UV Dose vs Flow in the Micro 9C

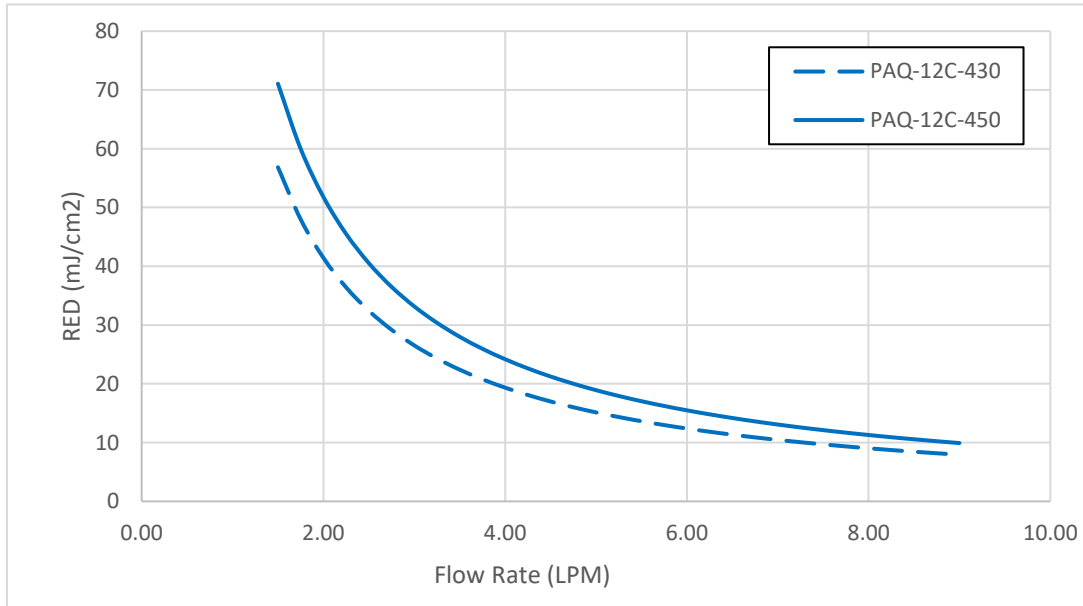


Figure 3-14: Graph of UV Dose vs Flow in the Micro 12C

Mechanical/Hydraulic Specifications

This section provides mechanical and hydraulic data for 9C and 12C units.

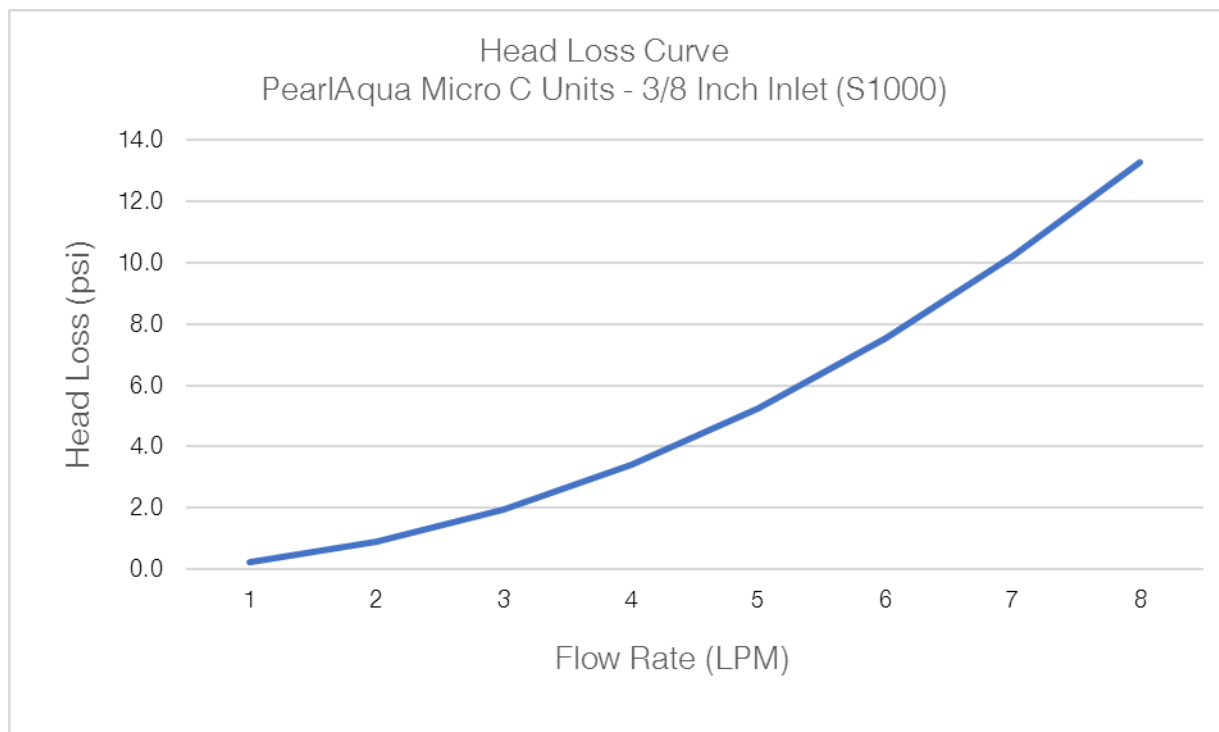


Figure 3-15: Graph of head loss in “C” units, 3/8 Inch Inlet and Outlet, Vertical Orientation, flat-side down

Table 3-15: “C-sized” PearlAqua Micro Mechanical Specifications

	<u>Min</u>	<u>Recommended/Typical</u>	<u>Max</u>	<u>Units</u>
Operating Pressure	-	-	8.3 (120)	Bar (psi)
Ambient Air Temperature (while unit is powered)	-	≤25 (77)	80 (176)	°C (°F)
Water Temperature (while unit is powered)	>0 (>32)	≤20 (68)	45	°C (°F)
Weight	162 (5.7)			g (oz)
Total Internal Volume (S1000 Enclosure)	47			cc (mL)
Environmental Protection	IP68			-

Electrical Specifications

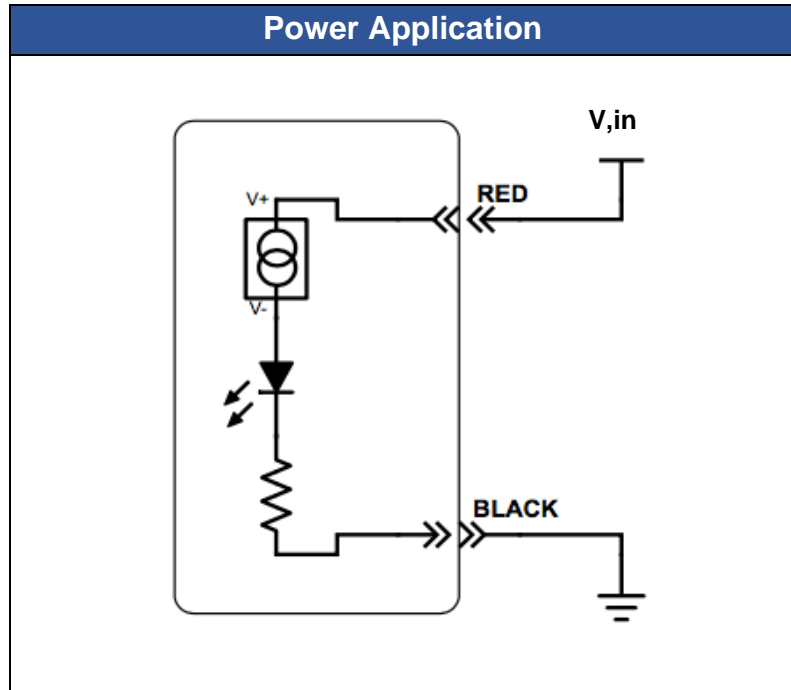


Figure 3-16: Power Application scheme for all Micro units

To determine if your unit is a 12V or 24V device, please refer to your unit's [Safety Label](#) or refer to [Section 3a](#) to read your product's full model number.

Table 3-16: PearlAqua Micro 9C Electrical Specifications

	<u>PAQ-09C-430</u>			<u>PAQ-09C-450</u>			<u>Units</u>
	<u>Min</u>	<u>Typ</u>	<u>Max</u>	<u>Min</u>	<u>Typ</u>	<u>Max</u>	
Input Voltage for 12V devices	11.4	12	14	11.4	12	14	Vdc
Current Draw	385	570	820	555	810	1170	mA
Power Draw	5.4	6.8	9.3	7.7	9.7	13.3	W
Standard Electrical Connection	4-Core Cable; 150mm (6") length						
	<u>PAQ-09C-431</u>			<u>PAQ-09C-451</u>			<u>Units</u>
	<u>Min</u>	<u>Typ</u>	<u>Max</u>	<u>Min</u>	<u>Typ</u>	<u>Max</u>	
Input Voltage for 12V devices	11.4	12	14	11.4	12	14	Vdc
Current Draw	480	690	965	685	980	1380	mA
Power Draw	6.7	8.2	11.0	9.6	11.8	15.7	W
Standard Electrical Connection	4-Core Cable; 150mm (6") length						

Micro 12C Units

Table 3-17: PearlAqua Micro 12C Electrical Specifications

	<u>PAQ-12C-430</u>			<u>PAQ-12C-450</u>			<u>Units</u>
	<u>Min</u>	<u>Typ</u>	<u>Max</u>	<u>Min</u>	<u>Typ</u>	<u>Max</u>	
Input Voltage for 12V devices	11.4	12	14	11.4	12	14	Vdc
Current Draw	515	755	1090	740	1080	1560	mA
Power Draw	7.2	9.1	12.4	10.3	12.9	17.7	W
Standard Electrical Connection	4-Core Cable; 150mm (6") length						

Fuse Rating Requirements

For applications involving an in-line fuse, it is recommended to size the fuse 20% above a unit's Typical Current Draw. See the table relevant to your model number.

$$\text{Fuse Rating (A)} = 1.20 \times \frac{\text{Typical Power Draw (W)}}{\text{Typical Input Voltage (V dc)}}$$

Thermistor (Temperature Sensing)

This feature can be used to prevent over-heating of the PearlAqua Micro unit's electronics which could damage the unit and reduce lamp lifetime.

For information on using the Temperature Sensing feature, please refer to [Section 3f](#).

LED Status Signal in the 9C and 12C

Many models of the 9C and 12C come with an LED Status signal (sometimes referred to as LED Health). This is a digital signal which can be used to confirm the UV-LEDs in your Micro unit are powered.

Measurement Method A in **Figure 3-17** below is a basic measurement method designed for use with handheld multi-meters.

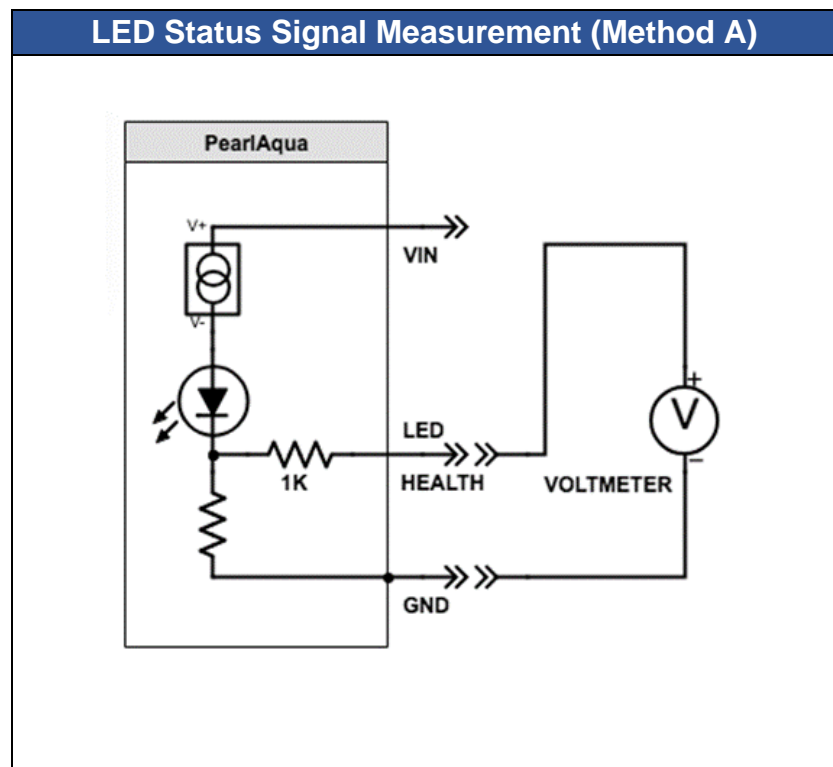


Figure 3-17: LED Status (LED Health) signal Measurement (Method A)

Measurement Method B in **Figure 3-18** below is a more general method intended for use with an Operational Amplifier (OP-AMP) providing impedance exceeding 100k Ohms. This method is most useful when using a PLC or other data acquisition (DAQ) module to read and interpret the signal.

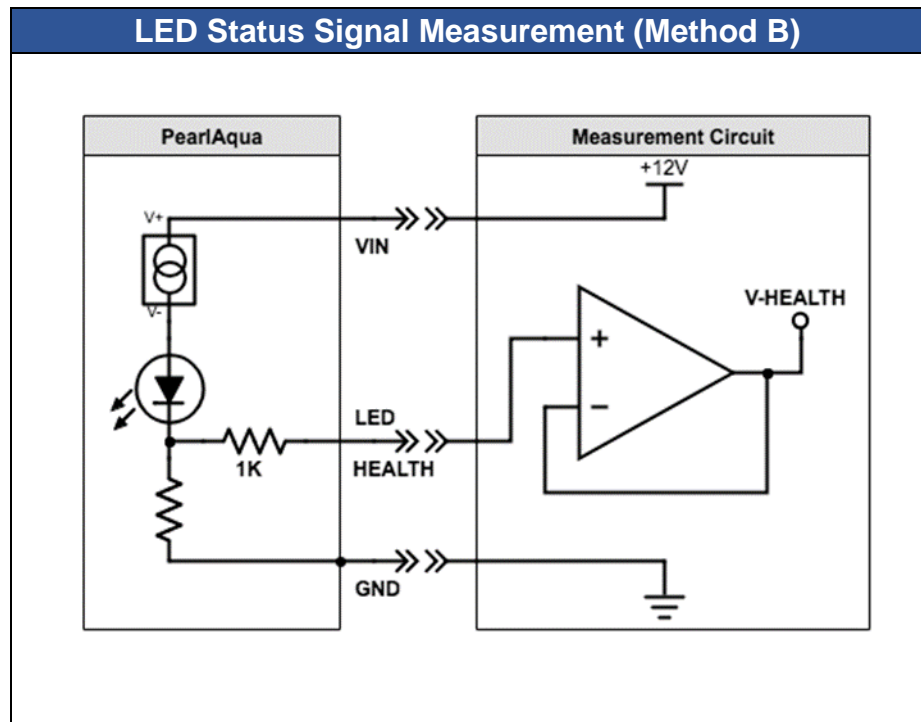


Figure 3-18: LED Status (LED Health) signal Measurement (Method B)

The value of signal for will vary depending on the exact configuration of your PearlAqua Micro. Review **Table 3-18** below.

Table 3-18: LED Status Signal values for Micro 9C and 12C units

Model Number	LED Health Wire Color	Signal when UV-LEDs are OFF			Signal when UV-LEDs are ON			<u>Units</u>
		<u>Min</u>	<u>Typ</u>	<u>Max</u>	<u>Min</u>	<u>Typ</u>	<u>Max</u>	
PAQ-09C-xxx-xC0-1x4x-xxxxx	YELLOW	-	0	-	-	0.2	0.22	V dc
PAQ-09C-xxx-xH0-1x4x-xxxxx		-	0	-	-	10	-	
PAQ-12C-xxx-xC0-1x4x-xxxxx	YELLOW	-	0	-	-	0.2	0.22	V dc
PAQ-12C-xxx-xH0-1x4x-xxxxx		-	0	-	-	10	-	

UV Intensity Sensing Option (Photodiode) in the 9C and 12C

This section provides guidance on using the UV Intensity (UVI) sensor feature which is available as an option on Micro 9C and 12C units.

The UVI sensor (also known as a 'Photodiode') produces an output signal in the form of a constant-current-sink that varies proportionally to the intensity of incident UV light on the sensor component. The intensity of UV light is a function of factors influencing disinfection including but not limited to:

- Power output of the UV-LEDs
- UV-Transmittance (UV-T) of the liquid
- State of the reactor interior i.e. presence of fouling, deposits, etc.

Because of these relationships, the UVI signal can be used to make observations about the performance of the Micro unit as a whole.

The UVI signal relationship with interior reactor conditions and disinfection performance is complex. Analysis of the UVI Sensor signal needs to be carried out relative to UVI signals acquired under known conditions in-situ, ideally on a module-to-module basis.

Method of Measurement and Signal Range

The voltage across a series 470 Ohm resistor is measured to deduce the value of the UVI sensor signal. See **Figure 3-19**: Scheme for measuring the UV Intensity signal below.

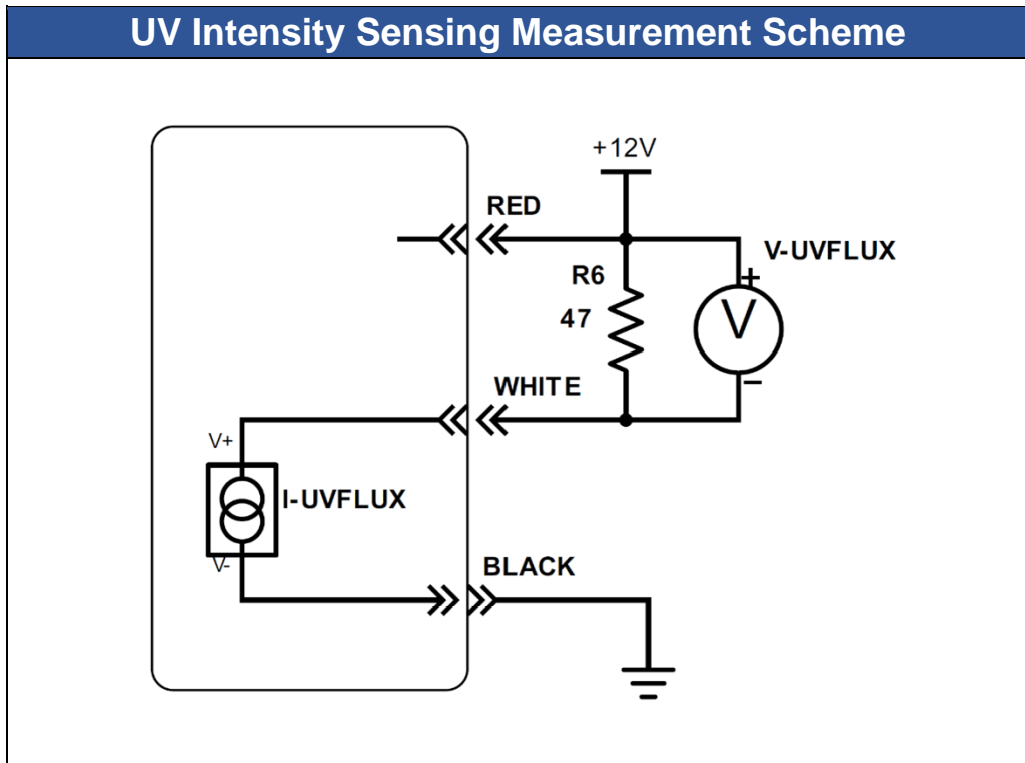


Figure 3-19: Scheme for measuring the UV Intensity signal

Note: Proper sensing wire may be white or yellow. See [table 2-1](#)

The value of the UVI signal will vary based on the UV intensity detected by the sensor, the specific configuration, water quality, and more. It is important to analyze the values of the UV-Sensor signal in-situ with conditions closely comparable to what will be expected in final operation. A typical value may be on the order of 20mA, but can vary greatly.

UVI Signal Interpretation Example – Change in UV-Transmittance

The interaction between reactor condition (LED output power, liquid UV-T, and state of reactor interior) and the UVI signal is complicated. In general, UVI signals must be interpreted relative to a signal measured in known conditions.

As an example, below in **Figure 3-20** is a graph showing the relationship between the UVI signal in a PearlAqua Micro 12C-350 or 12C-450 unit as a function of liquid UV-T. The signal is normalized relative to ~98.4 % UVT. 100% UVT is assumed to correspond to fresh distilled water.

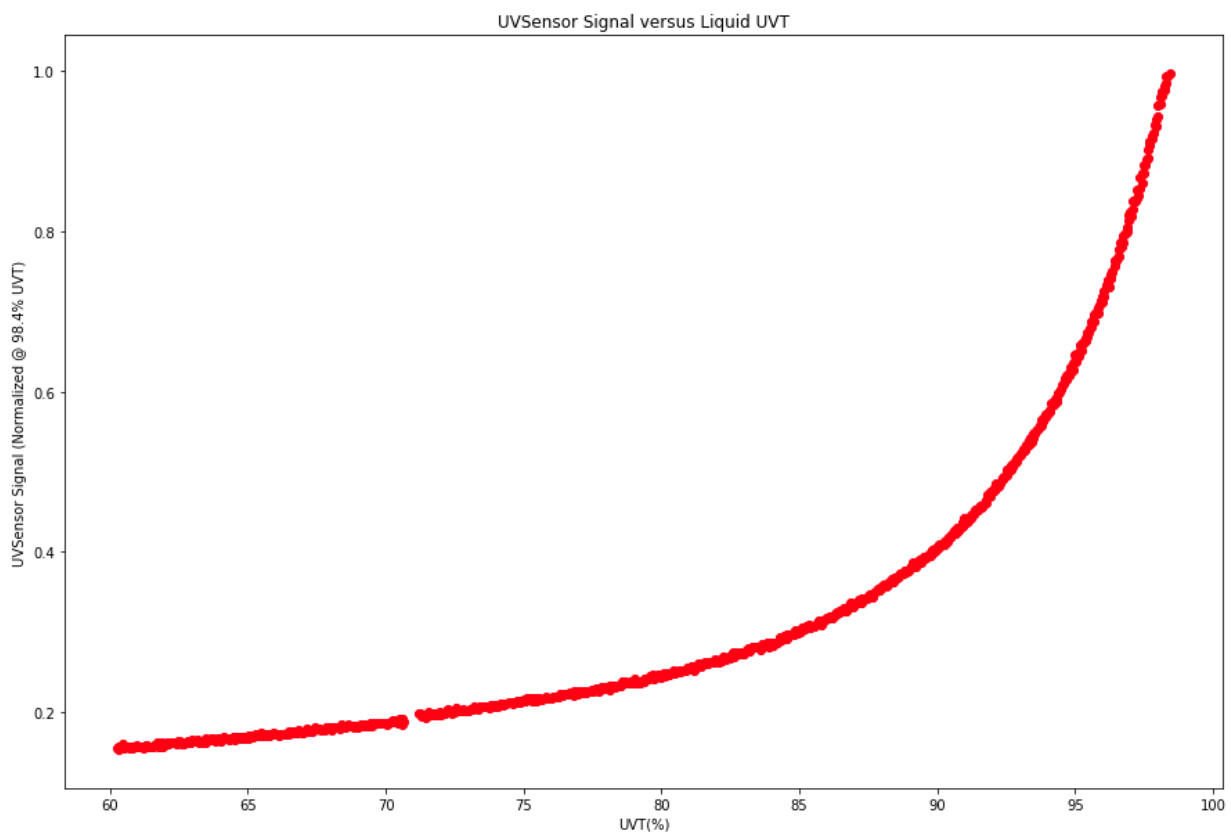


Figure 3-20: Relationship between UVI signal and liquid UV-T, normalized to 98.4% UV-T, in a PAQ-12C-350

g. Thermistor (All Models)

This section provides design guidance for integrating, reading and parsing signals from any thermistor-equipped PearlAqua Micro device. This information can be used to prevent over-heating of the PearlAqua Micro’s electronics which could damage the unit and reduce lamp lifetime.

A thermistor is a class of resistor that features a large and well-defined temperature coefficient. By measuring the resistance of the thermistor element, the device temperature can be deduced.

There are two methods to measure the thermistor depending on the model number of your PearlAqua Micro.

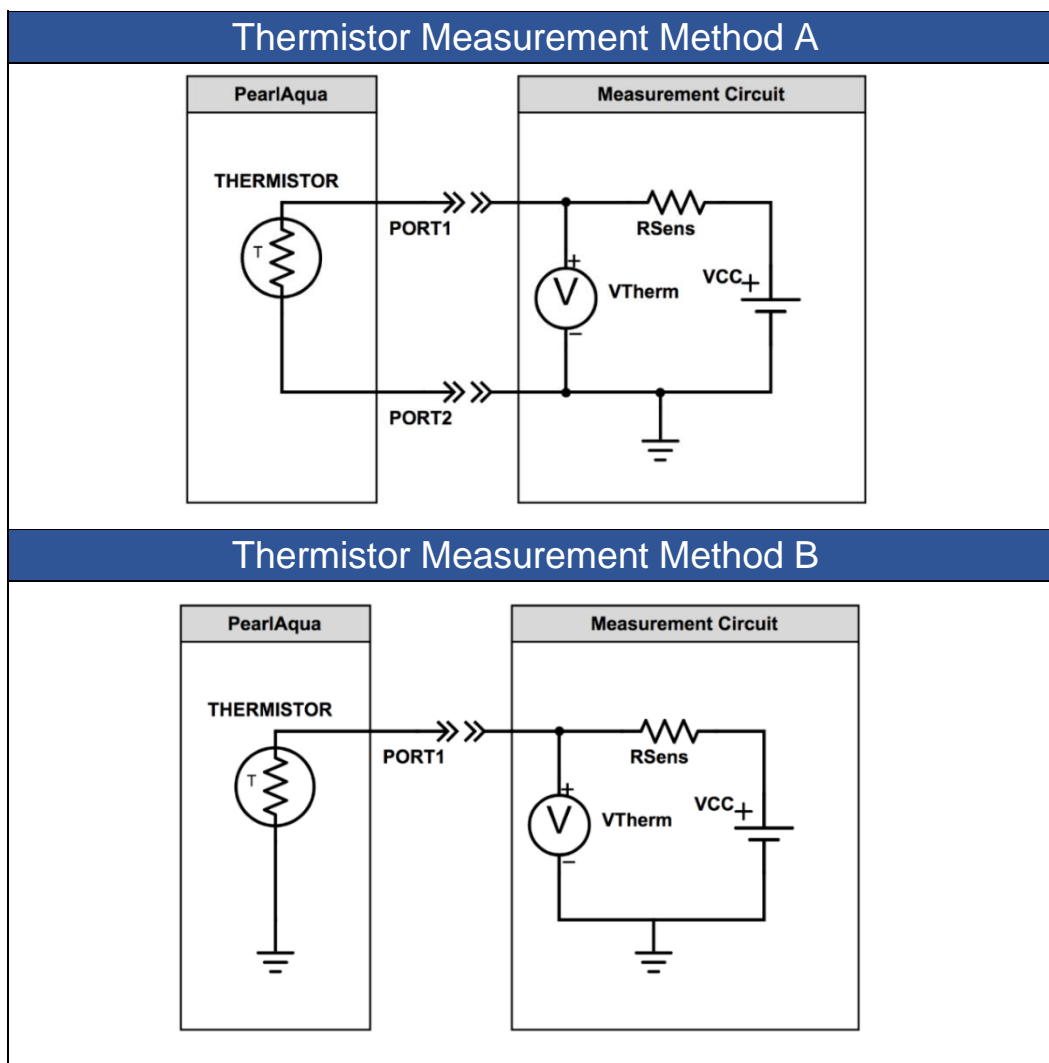


Figure 3-21: Methods A & B to measure the thermistor signal for unit temperature monitoring

To find the values relevant to a specific product, find the table below which corresponds to your model number.

- **Table 3-20** is compatible with model-numbers "PAQ-xxx-xxx-**T00-1**xxx-xxxxx".
- **Table 3-21** is compatible with model-numbers "PAQ-xxx-xxx-**TC0-1**xxx-xxxxx", "PAQ-xxx-xxx-**TH0-1**xxx-xxxxx" and "PAQ-xxx-xxx-**T0S-1**xxx-xxxxx".
- **Table 3-22** is compatible with model-numbers "PAQ-xxx-xxx-**T00-2**xxx-xxxxx".
- **Table 3-23** is compatible with model-numbers "PAQ-xxx-xxx-**TC0-2**xxx-xxxxx", "PAQ-xxx-xxx-**TH0-2**xxx-xxxxx", and "PAQ-xxx-xxx-**T0S-2**xxx-xxxxx".

All tables provide values for measurement with a 10k Ohm resistor ("RSens" in measurement Method A or Method B). When data is provided, a 47k Ohm may also be used (Option 2 when shown).

In most situations, **it is recommended the thermistor signal be kept no hotter than 55°C as described in Table 3-19 below**. Failure to keep the temperature below this value may shorten time until end-of-lamp-life and/or damage the unit.

Table 3-19: On-board Thermistor Specifications

Specification	Min	Recommended/Typical	Max	Unit
Thermistor Signal Temp Value	-	20	55	°C (°F)
Thermistor B25/50		3380		K
Thermistor B25/85		3435		K
Thermistor R @ 25C		10		kohm

Table 3-20: Thermistor values, Table 1

PAQ-xxx-xxx-T00-1xxx-xxx00					
Use Thermistor Measurement Method A					
PORT1	PORT2	VCC (Vdc)	RSens (ohm)	VTherm (Vdc)	Temperature (°C)
GREEN	YELLOW	12	10K	6	25
				5.4	30
				4.9	35
				4.4	40
				3.9	45
				3.5	50
				3.1	55
				2.8	60
				2.5	65
				2.2	70
				2	75
				1.8	80

Table 3-21: Thermistor values, Table 2

PAQ-xxx-xxx-TC0-1xxx-xxx00 PAQ-xxx-xxx-TH0-1xxx-xxx00 PAQ-xxx-xxx-T0S-1xxx-xxx00					
Use Thermistor Measurement Method B					
PORT1		VCC (volt)	RSens (ohm)	VTherm (Vdc)	Temperature (°C)
GREEN		12	10K	6	25
				5.4	30
				4.9	35
				4.4	40
				3.9	45
				3.5	50
				3.1	55
				2.8	60
				2.5	65
				2.2	70
				2	75
				1.8	80

Table 3-22: Thermistor values, Table 3

PAQ-xxx-xxx-T00-2xxx-xxx00					
Use Thermistor Measurement Method A					
Option 1 – 10k Ohm resistor (RSense)					
<u>PORT1</u>	<u>PORT2</u>	<u>VCC (volt)</u>	<u>RSens (ohm)</u>	<u>VTherm (volt)</u>	<u>Temperature (C)</u>
GREEN	BLACK	24	10K	12	25
				10.9	30
				9.8	35
				8.8	40
				7.9	45
				7.1	50
				6.3	55
				5.6	60
				5	65
				4.4	70
				3.9	75
				3.5	80
Option 2 – 47k Ohm Resistor (RSense)					
<u>PORT1</u>	<u>PORT2</u>	<u>VCC (volt)</u>	<u>RSens (ohm)</u>	<u>VTherm (volt)</u>	<u>Temperature (C)</u>
GREEN	BLACK	24	47K	4.2	25
				3.6	30
				3.1	35
				2.6	40
				2.3	45
				2	50
				1.7	55
				1.5	60
				1.3	65
				1.1	70
				1	75
				0.8	80

Table 3-23: Thermistor values, Table 4

PAQ-xxx-xxx-TC0-2xxx-xxx00 PAQ-xxx-xxx-TH0-2xxx-xxx00 PAQ-xxx-xxx-T0S-2xxx-xxx00					
Use Thermistor Measurement Method B					
Option 1 – 10k Ohm resistor (RSense)					
<u>PORT1</u>		<u>VCC (volt)</u>	<u>RSens (ohm)</u>	<u>VTherm (volt)</u>	<u>Temperature (C)</u>
GREEN		24	10K	12	25
				10.9	30
				9.8	35
				8.8	40
				7.9	45
				7.1	50
				6.3	55
				5.6	60
				5	65
				4.4	70
				3.9	75
				3.5	80
Option 2 – 47k Ohm Resistor (RSense)					
<u>PORT1</u>		<u>VCC (volt)</u>	<u>RSens (ohm)</u>	<u>VTherm (volt)</u>	<u>Temperature (C)</u>
GREEN		24	47K	4.2	25
				3.6	30
				3.1	35
				2.6	40
				2.3	45
				2	50
				1.7	55
				1.5	60
				1.3	65
				1.1	70
				1	75
				0.8	80

h. Pulsed Operation without Flow

In some cases, it may be beneficial to power your Micro unit temporarily (i.e. pulse) during long periods without water flow. Pulsing the power can be done to prevent retrograde contamination and biofilm growth within the Micro unit in these situations.

Pulsing a unit without water flow outside of the specifications described herein may damage your unit and void any warranty.

Pulsing should only be done for very short periods of time on the order of seconds. If using the thermistor, the temperature reading should **be kept no hotter than 55°C** as described in **Table 3-19** in [Section 3f](#).

For additional guidance in performing this operation, please contact Aquisense.

i. **Flow Sensor Package**

In situations where integrating power to the Micro unit with water flow is not readily possible, AqiSense offers a Flow Sensor package which allows for this functionality. It includes an off-the-shelf flow sensor, mounting bracket, and interface board with external indicator lights.

Note: This option requires a power supply. Compatible with the same power supply described in **Table 2-3: Specifications of AqiSense power supply offering**. Sold separately.



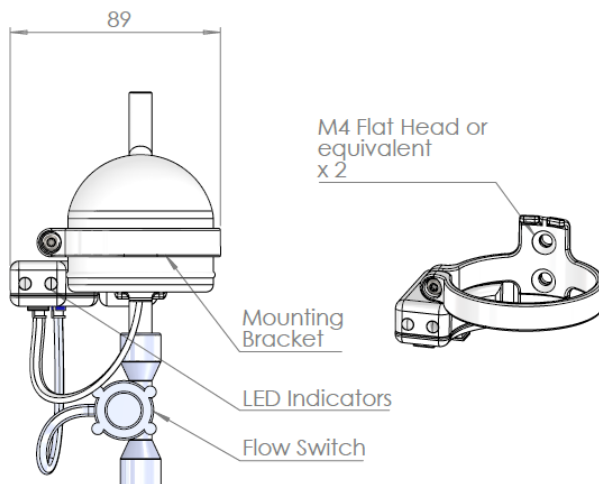
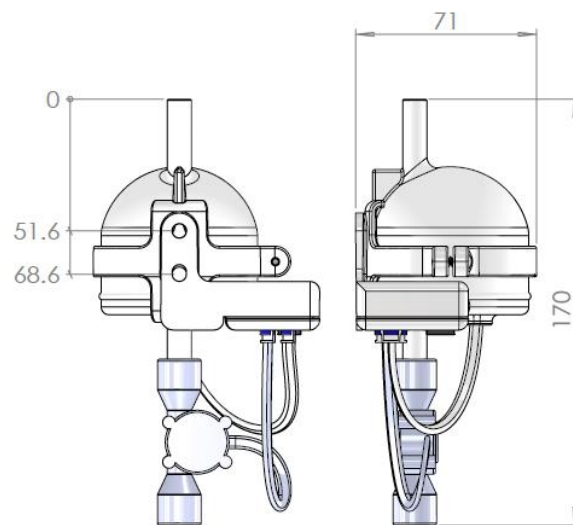
Figure 3-22: Flow Sensor Package with External Indicators

Table 3-24: Flow Switch Indicator Light Interpretation

Indicator Color		Function
Green		Power is applied to unit
Blue		UV-C LEDs are active

Table 3-25: FL-308 Flow Sensor Specifications

Specification	Value	Unit
Minimum actuation flow	0.3	LPM
Inlet/outlet water connection	3/8" (OD)	Inches
Weight [g]	38.3	g
Max operating pressure	8	Bar
Fluid temperature	≤ 80	°C
Dimensions	60 x 28.4 x 36.4	mm
Electrical connection	XHP-3	
Compliance	RoHS	



UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH = 1.5 μ (RMS) OR BETTER TOOL RADIUS = 0.4 OR 0.8 DEBURR ALL EDGES	ANGLES ± 1.0° X. ± 1.0 X.X ± 0.25 X.XX ± 0.10 X.XXX ± 0.05
THIRD ANGLE PROJECTION	
 Denotes incoming inspection dimension	 ASME Y14.5 2009

4. Troubleshooting

Table 4-1: Troubleshooting, Potential issues and Solutions

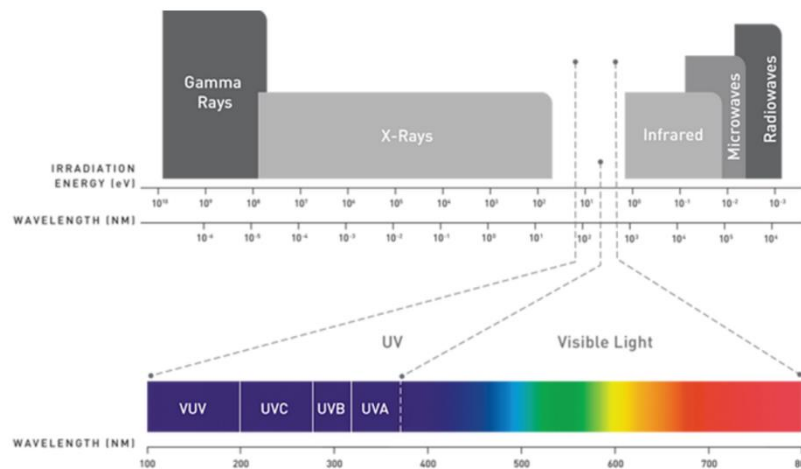
Issue	Possible Cause	Possible Solution(s)
Unit does not power on	Unsecure power connections	Verify all electrical connections are secure
	Low voltage or low current condition	See Electrical Specifications for your model number to verify recommended voltage/current requirements
Unit shuts down intermittently	Unit is overheating	Do not operate unit without water flow. Check air and water temp. If equipped, see Section 3f to monitor unit temperature with the thermistor feature.
Unit is leaking	Unsecure plumbing connections	Verify connections are secure, use recommended tubing material i.e. polyethylene or nylon
	Improper connector sizing	Ensure connector size matches your unit's plumbing Inlet/Outlet. Check metric vs Imperial units.
High pathogen counts	Low UV-Transmittance or other water quality issue	See Section 1c on Water Chemistry specifications. Add pre-treatment steps as required.
	Bacteria from other portion of water system after UV i.e. tubing, connectors	Use new, clean tubing and connections. Flush system with hot water.
	Air bubbles trapped in unit	See Section 2b on plumbing installation. Adjust orientation, flow, and system as applicable.
	High flow rate	Refer to the Disinfection Performance specifications for your model of PearlAqua Micro
	Lamp has reached end of life	Contact Aquisense for replacement
	Biofilm growth or retrograde contamination within unit	Ensure unit is being used regularly. If unit might have long periods without normal usage, see Section 3h about pulsing the unit. Consult Aquisense for details.

If issues continue after careful review of this O&M manual and troubleshooting, contact Aquisense for assistance.

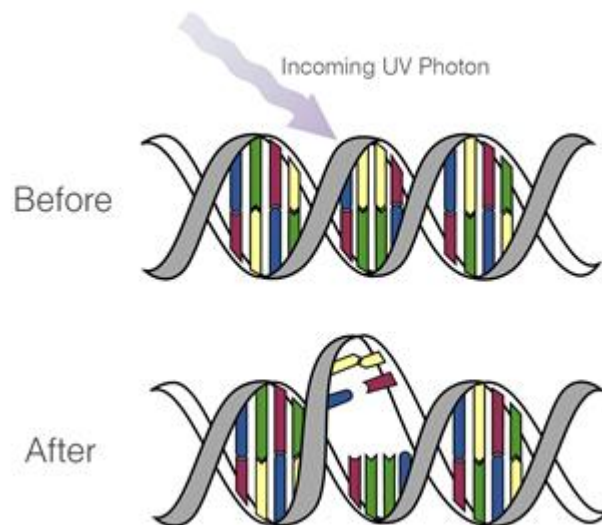
5. Application Examples/Theory

UV-C Water Disinfection

Ultraviolet (UV) water disinfection technology has become an increasingly popular tool in water treatment over the past three decades, due in part to its ability to provide treatment without the use of harmful chemicals. UV represents wavelengths that fall between visible light and x-ray on the electromagnetic spectrum.



The UV range can be further divided into UV-A, UV-B, UV-C, and Vacuum-UV. The UV-C portion represents wavelengths from 200 nm - 280 nm, which is the wavelength range used in our LED disinfection products. UV-C photons penetrate cells and damage the nucleic acid, rendering them incapable of reproduction, or microbiologically inactive.





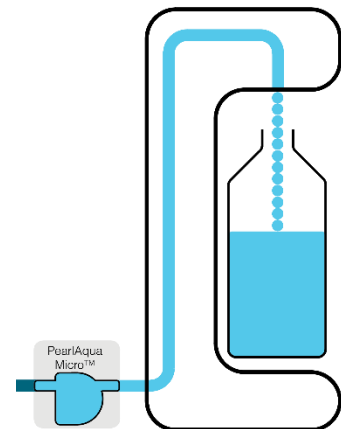
A light-emitting diode (LED) is a semiconductor light source. It is a p–n junction diode, which emits light (or photons) when activated. The PearlAqua Micro utilizes small, state-of-the-art, UV-C LEDs, which emit photons in the UV range, to provide pathogen reduction without the use of harmful chemicals or heavy metals. Use of LEDs allows the PearlAqua Micro to achieve full intensity power upon start-up, withstand unlimited power cycles without impacting device life, and eliminate expensive disposal processes.

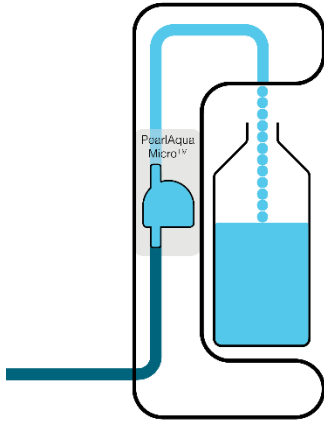
Where to Install UV-C LEDs

Ultraviolet LEDs are gaining interest in water dispensing applications, to provide enhanced disinfection. While this digital technology boasts several unique benefits (i.e. instant on, small footprint, long replacement intervals), exploiting these attributes takes expertise, experience and engineering know-how. Aquisense Technologies offers added insight as we have been designing for these solutions for years. Below are a few installation concepts to keep in mind when designing for the integration of the world's smallest UV disinfection system, the PearlAqua Micro™.

Inlet Disinfection

This method leaves the disinfection outside the device or process, leaving an opening for bacteria growth at any point in the system. The UV LED system is easier to replace but with lamp lifetimes of up to 10,000 hours, the need to replace is less frequent when compared to conventional mercury lamps. For example, 5,000 hours 'on' time at 2 LPM equals 600,000 liters of water served to clients. Inlet disinfection can also make installations easier as there is no need for a system redesign or remodeling of the original product. However, installing the UV LED system at the inlet can make for a more cumbersome system as your components are now outside and more likely to be damaged or disconnected.



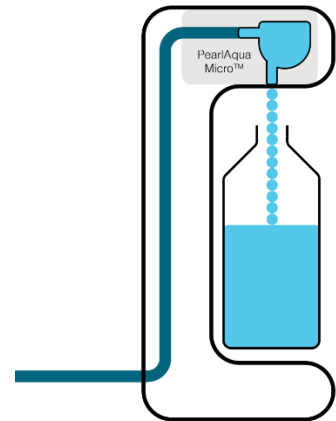


In-Process Disinfection

Installing a PearlAqua Micro offers added benefits as your product is now intact with no parts or components outside the system. This type of installation is closer to point of use as the amount of contamination possible from the point of use to the disinfection point has been diminished. One drawback is this type of installation does not prevent retro contamination, or bacteria growing up the pipeline from the point of use.

Point-of-Consumption Disinfection

Point of consumption or point of use disinfection offers the most protection for contamination in a product or system. By installing a UV-C LED system at the point of consumption two major benefits are offered – retrograde protection and last mile protection. Retrograde contamination, as mentioned before happens when bacteria from the outlet contaminates the system by growing up the pipeline into the system. Retrograde protection offers disinfection at the outlet, so growth is prevented. One manufacturer who uses our product also improves on this concept by switching on the UV LEDs to periodically disinfect the outlet even when not in use. Last mile protection offers disinfection from pathogens that might be growing at any point prior to the outlet. Point of use protection allows the manufacturer an assurance of disinfection for the end user of their product.



Each application has different needs and reasons for disinfection. Any of these options are suitable depending on the internal space available, the need for replacement, and the level of disinfection. The PearlAqua Micro provides flexible options for any need.

6. Warranty

General Statement of Warranty

The warranty period is 24 months from date of warranty registration, covering all failures due to material and product assembly. The owner must register the product at ast1.aquisense.com/registration for the warranty to be in place. The only exception to this practice will be large volume Original Equipment Manufacturer (OEM) purchases where warranty registration and conditions will be outlined in a separate document specific to the OEM.

This warranty shall not apply to any failure or defect which results from the Equipment not being operated and maintained in strict accordance with instructions specified in the Aquisense Operations manual or defect which results from mishandling, misuse, neglect, improper storage, improper operation of the Equipment with other equipment furnished by the Owner or by other third parties or from defects in designs or specifications furnished by, or on behalf of, the Owner by a person other than Aquisense. In addition, this warranty shall not apply to Equipment that has been altered or repaired by anyone except Aquisense, their Authorized representative, or personnel acting under specific instructions from Aquisense.

The Owner must notify Aquisense in writing at info@aquisense.com within 5 days of the date of any Equipment failure. This notification shall include a description of the problem, details of the product name (e.g. PearlAqua Micro), model number (e.g. 3B) and serial number - all found on the product safety label or power and signal cable.

The Owner will fully cooperate with Aquisense in attempting to diagnose and resolve the problem by way of telephone/web support. If the problem can be diagnosed by telephone/web support and a replacement unit is required, Aquisense will either, at Aquisense expense, ship a repaired, reworked or new part to the Owner. If the problem is not attributable to a breach of this warranty, Aquisense reserves the right to invoice the Owner for this service.

This warranty is in lieu of all other warranties whether written, oral, implied or statutory. Without limitation, no warranty of merchantability or fitness for a particular purpose shall apply to the Equipment.

Operating Hours

Unlike mercury vapour UV-C lamps, the lifetime of UV-C LEDs is not affected by on/off cycles. However, like all light sources, LEDs are subject to aging over time. Within the PearlAqua Micro platform, Aquisense Technologies have engineered an integrated UV-C LED lamp module (UVinaire) that contains: power regulation, temperature management, temperature monitoring, and intensity monitoring (optional). When operated in accordance with Aquisense instructions, it is expected that the UVinaire lifetime will be up to 10,000 operational hours ("On" time) depending on configuration.

Limitations of Warranty

This warranty:

- Relates only to faults in material and assembly. It does not cover any form of breakage from mis-handling or mis-operation
- Applies where operating conditions are kept in accordance with Aquisense instructions
- Is limited to 24 months after the date of delivery
- Excludes transport costs for the return of parts
- Aquisense will not be responsible for any damages, consequential or otherwise

Return of Product

In all warranty cases, contact info@aquisense.com with details of the product name (e.g. PearlAqua Micro), model number (e.g. PAQ-03B-450...) and serial number - all found on the product's power and signal cable.

Disposal of Product

As part of our commitment to the environment, all used or failed product returned to Aquisense facilities will be properly recycled at no charge.

7. Legal

Terms for Product Usage

In using AquiSense UV-LED products and components, on behalf of the Company, using this document and the PearlAqua Micro product agrees to follow the items listed below. In this document, "UV LED" means any LEDs that emit ultraviolet light with a peak wavelength shorter than 400nm.

1. Do not look directly into the UV LEDs during operation. The UV LEDs radiate intense ultraviolet light (hereinafter referred to as "UV light") which can be harmful to the eyes, even during a brief period of exposure. UV light is not visible to human eye, so individuals exposed to the UV light may not notice it.
2. Always wear UV protective eyewear when operating the UV LEDs.
3. UV light can cause skin damage, up to and including, skin cancer. Always wear protective clothing to prevent UV LED exposure to skin.
4. Always instruct and warn all intended users of proper handling of the UV LEDs and all potential hazards. Always provide proper instructions, labels, and warnings to the customers and users of products containing UV LEDs in accordance, at minimum, with the standards set forth by the International Electrotechnical Commission (IEC). All UV LED should be used in such a way as to ensure that no direct exposure to the UV light on the human eyes is experienced.
5. Always keep the products containing UV LEDs out of the reach of children and other untrained persons.
6. Always adhere to safety instructions and warnings, including any and all instructions set forth in the Product Specifications.
7. As applicable, user must provide adequate thermal management, electrical power, and safe mechanical integration.
8. If products and components are used outside the specified/recommended manner, the user accepts all risk for all damages or ineffective performance.

All relevant officers and employees at our Company have reviewed and understand all the safety instructions and warnings in connection with the purchase and use for AquiSense UV-LED products and components, and further agree not to hold AquiSense Technologies LLC and its partners, including but not limited to, Nikkiso America and Nikkiso Giken, responsible for any damage or injury caused by the use, misuse, or mishandling of any AquiSense UV-LED product or component.

8. Revision/Change Log

O&M Manual Version 06.2020

- Features an updated, more complete layout with new sections and additional information
- New executive summary
- More information on available enclosures, connections, etc.
- Detail on reading and using the product model number
- Additional instructions for product options
- Troubleshooting section added

O&M Manual Version 10.2020

- Moved Executive Summary; now after Table of Contents and Figure/Table Lists
- Added 'Hardness' and 'Iron' to Water Chemistry table (Table 1-1)
- Updated Regulatory Compliance Summary (Table 1-2)
- Updates throughout manual to reflect change in 'standard' UV-C LED option
 - Performance Graphs updated (Figures 3-4, 3-5, 3-9, 3-10, 3-13, 3-14)
 - Tables 3-7, 3-8, 3-9, 3-10, 3-13, 3-14, 3-16, 3-17
- Updated photos of connector options in Section 2c
- Minor updates to model number examples to reflect current standard options (Tables 3-1 through 3-4)
- Section on Packaging removed
- Section on Gen 1 Flow Sensor Package removed
- New 'Legal' section with conditions of usage
- Updates to Flow Sensor Package Information
 - Addition of information on Indicator Lights (Table 3-24)
 - More background information on Flow Sensor Package
- Aesthetic updates/typo corrections to Tables 1-3, 2-1, 3-9, 3-10, 3-18
- Aesthetic updates/typo corrections to Tables 3-20 through 3-23 (Thermistor)

9. Notes/Custom Specifications