apogee
INSTRUMENTS

OWNER'S MANUAL

USB ULTRAVIOLET-A SENSOR

Model SU-220

Rev: 31-Mar-2022

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CERTIFICATE OF COMPLIANCE

EU Declaration of Conformity

This declaration of conformity is issued under the sole responsibility of the manufacturer:

Apogee Instruments, Inc.
721 W 1800 N
Logan, Utah 84321
USA

for the following product(s):

Models: SU-220
Type: Ultraviolet-A Sensor

The object of the declaration described above is in conformity with the relevant Union harmonization legislation:

2014/30/EU	Electromagnetic Compatibility (EMC) Directive
2011/65/EU	Restriction of Hazardous Substances (RoHS 2) Directive
2015/863/EU	Amending Annex II to Directive 2011/65/EU (RoHS 3)

Standards referenced during compliance assessment:

EN 61326-1:2013	Electrical equipment for measurement, control, and laboratory use – EMC requirements
EN 50581:2012	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Please be advised that based on the information available to us from our raw material suppliers, the products manufactured by us do not contain, as intentional additives, any of the restricted materials including lead (see note below), mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB), polybrominated diphenyls (PBDE), bis (2-ethylhexyl) phthalate (DEHP), butyl benzyl phthalate (BBP), dibutyl phthalate (DBP), and diisobutyl phthalate (DIBP). However, please note that articles containing greater than 0.1 % lead concentration are RoHS 3 compliant using exemption 6c.

Further note that Apogee Instruments does not specifically run any analysis on our raw materials or end products for the presence of these substances, but we rely on the information provided to us by our material suppliers.

Signed for and on behalf of:
Apogee Instruments, March 2022

Bruce Bugbee
President
Apogee Instruments, Inc.

INTRODUCTION

Ultraviolet (UV) radiation constitutes a portion of the electromagnetic spectrum from 100 to 400 nm and is further subdivided into three wavelength ranges: UV-A (315 to 400 nm), UV-B (280 to 315 nm), and UV-C (100 to 280 nm). Much of the UV-B and all of the UV-C wavelengths from the sun are absorbed by Earth's atmosphere. There are also multiple artificial UV light sources available.

Most UV sensors designed for sunlight measurements are sensitive to UV radiation in the UV-A or UV-B ranges. Apogee Instruments SU-200 series UV-A sensors detect UV radiation from 300 to 400 nm and are calibrated in energy flux density units of watts per square meter (W m^{-2}, equal to Joules per second per square meter). The output can also be expressed in photon flux density units of micromoles per square meter per second (µmol m^{-2} s^{-1}).

Typical applications of UV sensors include incoming UV radiation measurement in outdoor environments or in laboratory use with artificial light sources (e.g., germicidal lamps).

Apogee Instruments SU-200 series UV-A sensors consist of a cast acrylic diffuser, photodiode, and signal processing circuitry mounted in an anodized aluminum housing and a cable to connect the sensor to a measurement device. SU-200 sensors are designed for continuous UV-A radiation measurement in indoor or outdoor environments. The SU-200 series outputs an analog voltage that is directly proportional to UV-A radiation incident on a planar surface (does not have to be horizontal) where the radiation emanates from all angles of a hemisphere.

SENSOR MODELS

This manual covers the USB model SU-220 UV-A sensor (listed below in bold). Additional models are covered in their respective manuals.

Model	Signal
SU-200	0-10 mV
SU-202	0- 2.5 V
SU-205	0- 5 V
SU-220	**USB**

A sensor's model number and serial number are located on the bottom of the sensor. If you need the manufacturing date of your sensor, please contact Apogee Instruments with the serial number of your sensor.

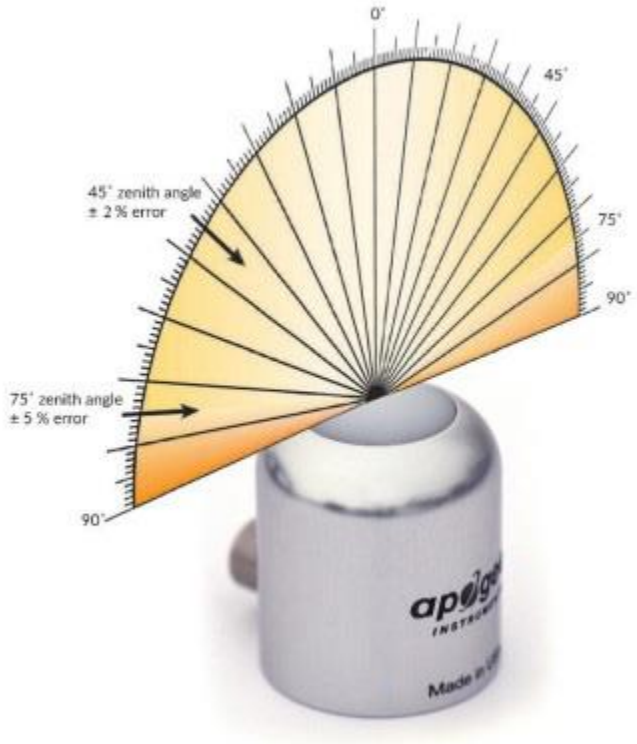
SPECIFICATIONS

	SU-220
Resolution	0.1 µmol m^{-2} s^{-1}
Calibration Factor	Custom for each sensor and stored in the firmware
Calibration Uncertainty	± 10 %
Measurement Range	0 to 100 W m^{-2}
Measurement Repeatability	Less than 0.5 %
Long-term Drift	Less than 2 % per year
Non-linearity	Less than 1 %
Response Time	Less than 1 ms
Field of View	180°
Spectral Range	300 to 400 nm (wavelengths where response is greater than 10 % of maximum; see Spectral Response below)
Directional (Cosine) Response	± 2 % at 45°, ± 5 % at 70°
Temperature Response	Less than 0.1 % per C
Operating Environment	-30 to 85 C; 0 to 100 % relative humidity
Dimension	30.5 mm diameter, 37 mm height
Mass (5 m of cable)	140 g
USB Cable	4.5 m (15 ft)
Current Draw (when Logging)	61 mA

Calibration Traceability

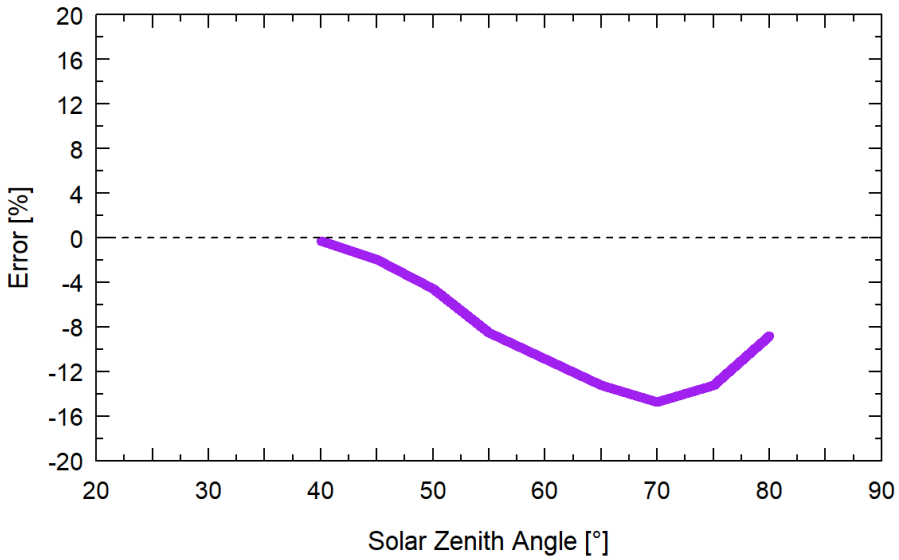
Apogee UV series sensors are calibrated through side-by-side comparison to the mean of four transfer standard UV sensors under UV-enhanced T5 fluorescent tubes. The transfer standard UV sensors are calibrated through side-by-side comparison to an Apogee model PS-300 spectroradiometer under sunlight (clear sky conditions) in Logan, Utah. The PS-300 is calibrated with a quartz halogen lamp traceable to the National Institute of Standards and Technology (NIST).

Cosine Response



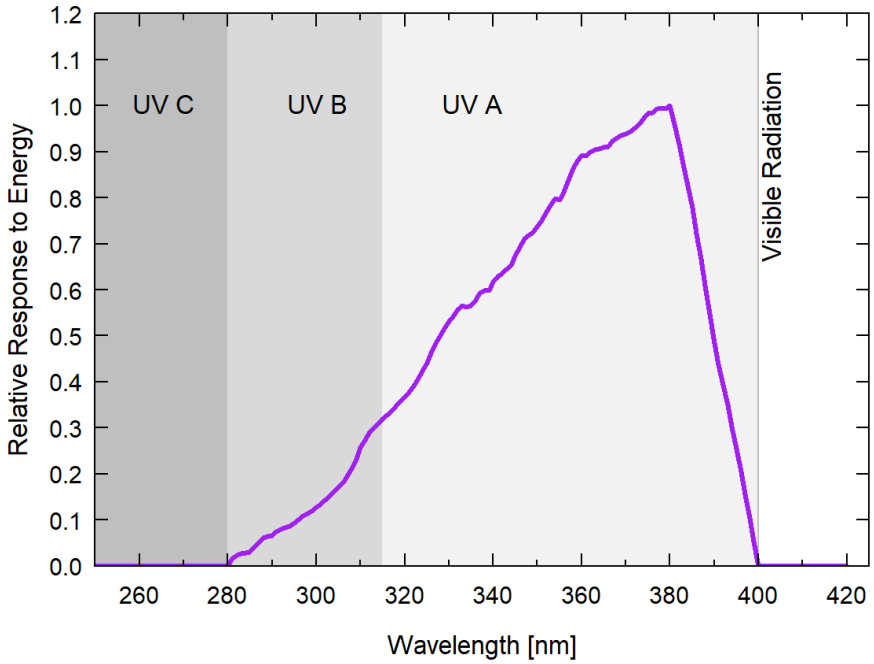
Directional, or cosine, response is defined as the measurement error at a specific angle of radiation incidence. Directional error for Apogee SU-200 series UV-A sensors is approximately ± 2 % and ± 5 % at solar zenith angles of 45° and 75°, respectively.

Cosine Response Graph



Mean cosine response of four Apogee UV-A sensors. Cosine response was calculated as the relative difference of UV-A sensors from the mean of replicate reference UV-A sensors deployed outdoors. These data are the average of the AM and PM response.

Spectral Response



Spectral response estimate of Apogee SU-200 UV-A sensors. Spectral response was modeled from sensitivity of the photodetector and transmittance of the diffuser.

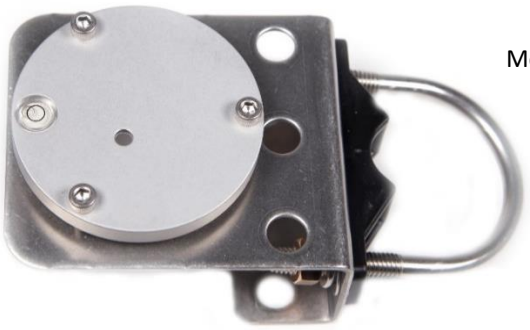
DEPLOYMENT AND INSTALLATION

Mount the sensor to a solid surface with the nylon mounting screw provided. To accurately measure UV-A incident on a horizontal surface, the sensor must be level. An Apogee Instruments model AL-100 Leveling Plate is recommended to level the sensor when used on a flat surface or being mounted to surfaces such as wood. To facilitate mounting on a mast or pipe, the Apogee Instruments model AL-120 Solar Mounting Bracket with Leveling Plate is recommended.

Nylon Screw: 10-32x3/8

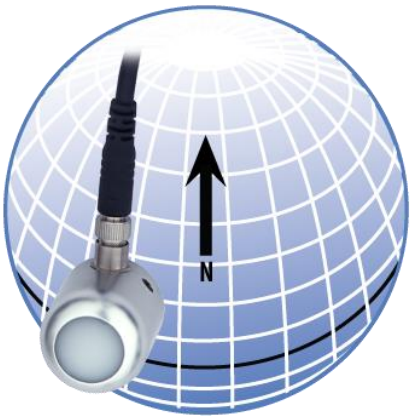
Model AL-100

Nylon Screw: 10-32x3/8



Model AL-120

To minimize azimuth error, the sensor should be mounted with the cable pointing toward true north in the northern hemisphere or true south in the southern hemisphere. Azimuth error is typically less than 1 %, but it is easy to minimize by proper cable orientation.

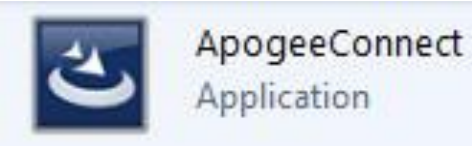


In addition to orienting the cable to point toward the nearest pole, the sensor should also be mounted such that obstructions (e.g., weather station tripod/tower or other instrumentation) do not shade the sensor. **Once mounted, the black cap should be removed from the sensor.** The black cap can be used as a protective covering for the sensor when it is not in use.

SOFTWARE INSTALLATION

The most recent version of ApogeeConnect software can be downloaded at http://www.apogeeinstruments.com/downloads/.

Installing the software on a PC (Windows compatible, XP and later)



1. Double click on the installer package:
2. On the 'Welcome' screen, please click 'Next' to continue.
3. Select the radio button next to "I Agree" to the UELA… and click 'Next' to continue.
4. On the 'Ready to Install the Program' screen, click 'Install' to continue.
5. Click 'Finish' to complete the installation. There are shortcuts on your desktop and in your start bar.

Installing the software on a Mac (Mac compatible, 10.10 and later)

1. Double click on the installer package
2. On the 'Introduction' screen, please click 'Continue' to proceed.
3. Select 'Continue' on the 'Read Me' screen to continue, this screen contains a history of updates made to the ApogeeConnect software versions.
4. Select 'Continue' on the 'License' screen to receive a prompt to agree to the terms of the software license agreement. Click 'Agree' to continue once you receive the prompt.
5. On the 'Installation Type' screen, click 'Install' to install the software. You can change the location the software installs to by clicking 'Change Install Location…'. *Note: You may be prompted for an administrator password at this time. If you are, proceed by entering your respective password and clicking 'Install Software'.
6. Once you receive the message "The installation was successful." on the 'Summary' screen click 'Close'. Your software is now ready to be used.

OPERATION AND MEASUREMENT

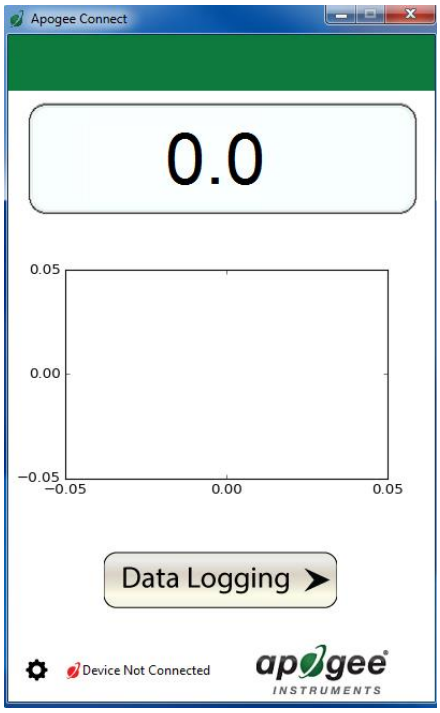
UV-A Measurements and Spectral Errors

Apogee Instruments model SU-200 UV-A sensors are calibrated to measure ultraviolet radiation from the sun between 315 and 400 nm in Watts per square meter. In addition to naturally occurring UV-A radiation from the sun, there are many electric light sources that emit UV-A radiation (e.g., cool white fluorescent, metal halide, mercury arc, and germicidal lamps). Although the relative wavelengths of UV-A radiation differ among sunlight and electric lights, the error estimates shown in the table below indicate the SU-200 provides reasonable estimates of UV-A radiation coming from electric lamps (table provides spectral error estimates for UV-A radiation measurements from radiation sources other than clear sky solar radiation). For most common lamps, the error is less than 10 %. The SU-200 is particularly useful for determining the UV-A filtering capacity of the transparent plastic and glass barriers that are commonly used below electric lamps.

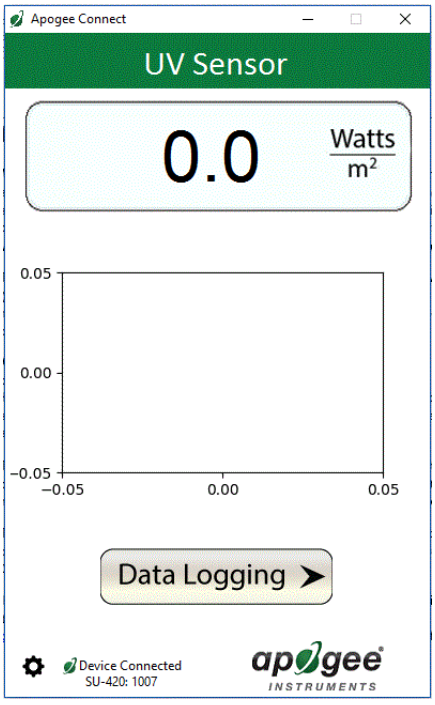
Radiation Source (Error Calculated Relative to Sun, Clear Sky)	Expected EFD Error [%]	Expected PFD Error [%]
Clear Sky	0.0	0.0
Overcast	0.0	-1.1
Direct Normal	-0.2	-1.0
Diffused Blue Light	0.3	1.4
CWF T5	8.2	9.2
Metal Halide	1.2	-1.2
Quartz Halogen	-2.3	-3.8
Mercury Arc	16.2	16.9
T12 Fluorescent UV-A Enhanced	12.2	15.2
UV-A LED (365 nm Peak)	37.4	35.3
UV-A LED (386 nm Peak)	1.8	-3.9
UV-A LED (395 nm Peak)	-36.9	-41.2

WINDOWS SOFTWARE

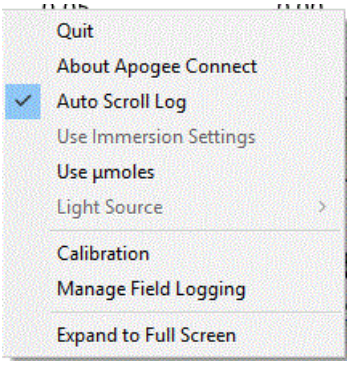
When the SU-220 sensor is not plugged into the USB port, the software will display a message in the lower left corner, “Device Not Connected,” indicating it cannot establish communication with the sensor.



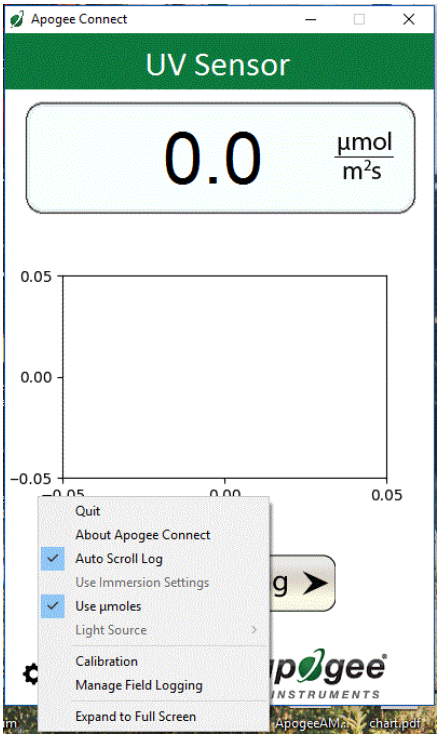
Plug the sensor into a USB port and allow some time for the sensor to automatically establish communication with the software. Once established, the message in the lower left corner will display “Device Connected SN: ####” and real-time shortwave radiation readings will update on the screen. Moving the sensor closer to a light source should increase the readings, while blocking all light from the sensor should drop the reading to zero.



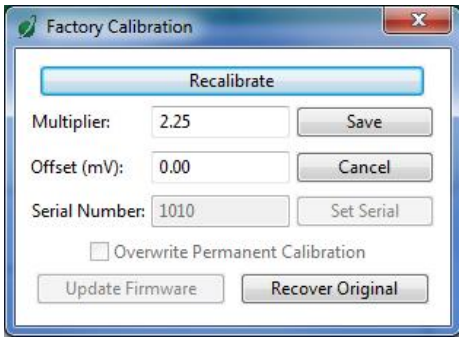
Click the '**Settings**' icon to display the software options. Note **'Light Source'** and '**Immersion Setting'** is not a setting for the SU-220.



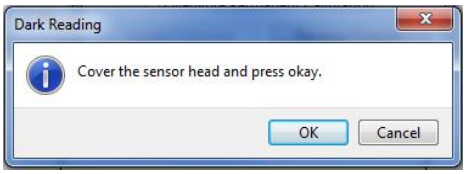
Clicking the **'Use µmoles'** setting option will change the units from W m^{-2} to µmol m^{-2} s^{-1}.



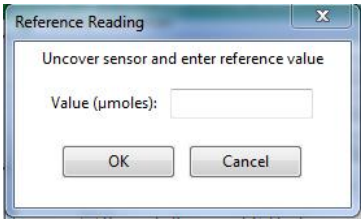
Clicking **'Calibration'** will display the factory calibrated multiplier and offset values. These values are saved in firmware and can be recovered by clicking the 'Recover Original' button. Deriving a new calibration multiplier and offset is accomplished by clicking the 'Recalibrate' button. This is applicable if users want to calibrate the sensor to their own specific light source. Note that a reference value of the light source is required to complete a recalibration.



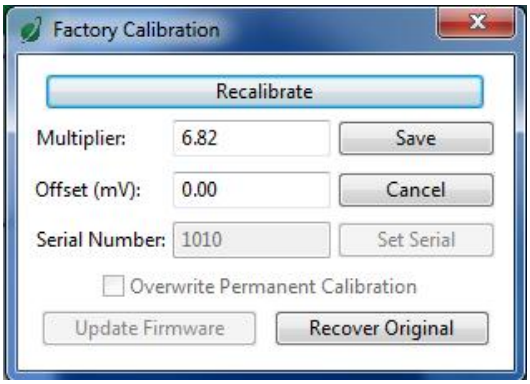
After clicking the ‘Recalibrate’ button the user will be prompted to cover the sensor. Place a dark cap over the sensor and wait for the real-time shortwave readiation reading to settle at zero. Click OK.



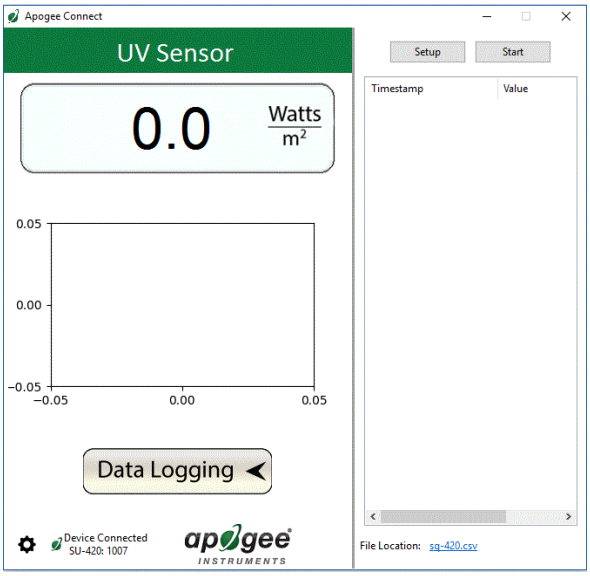
Uncover the sensor and wait for the shortwave radiation reading to settle ***before*** entering the reference value. Click OK.



The multiplier and offset values will automatically calculate and update in the appropriate field. Be sure to click ‘Save’ to retain the new multiplier and offset.

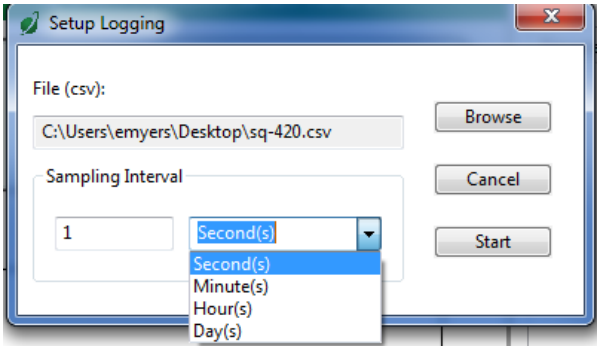


Clicking **‘Data Logging’** will allow the user to log interval measurements in a csv file while the software is open and communicating with the sensor.



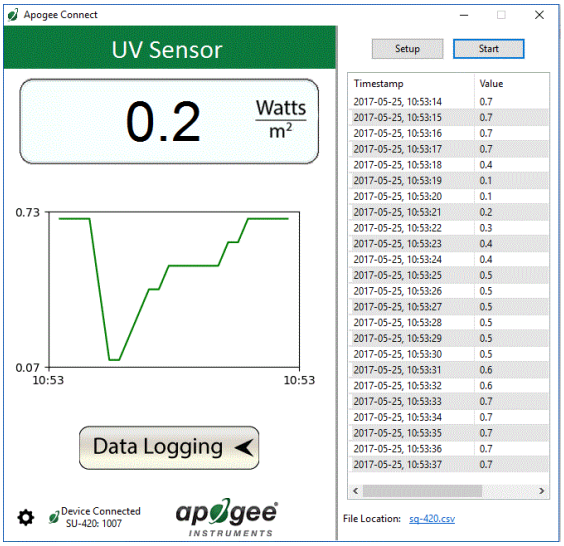
Click ‘Setup’ and the Setup Logging window appears. Click the ‘Browse’ button to create or select a csv file.

Select the desired sampling interval. Note that 1 second is the minimum interval allowed. Click ‘Start’.

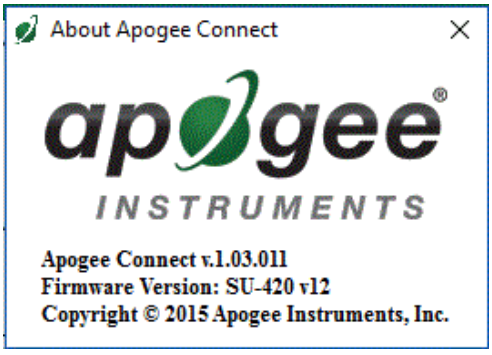


The data logging window will start to update at the specified sampling interval and display the Timestamp and Data Value. At the same time, data will be written to the csv file. Note that if the csv file is open in another program new data will not be saved to it.

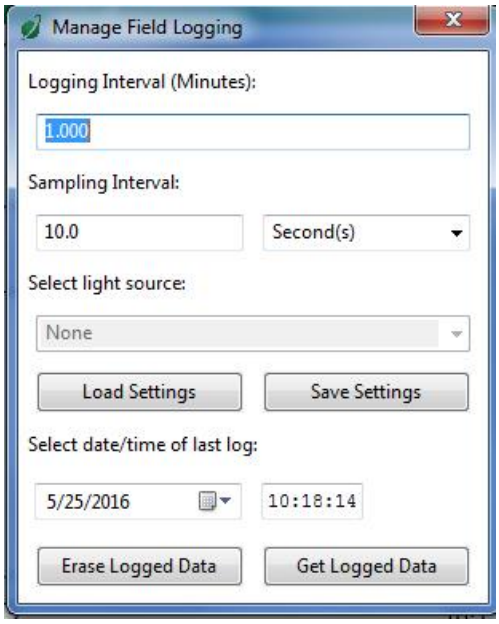
The data logging window can be closed without affecting logged data by clicking the ‘Exit’ button. The ‘Stop’ button must be clicked to end data logging.



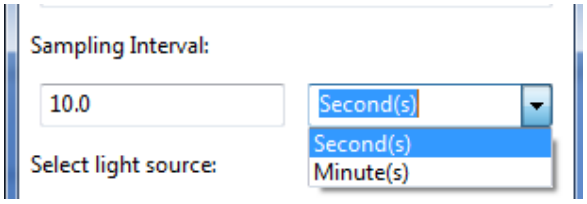
The about screen tells you the software and firmware versions. These can be used to help troubleshoot if problems arise.



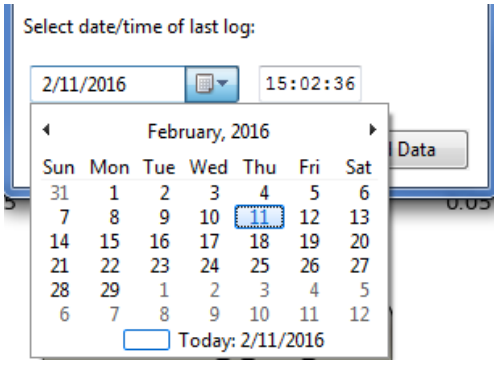
'Manage Field Logging' is used to setup the SU-220 for use in the field. When the SU-220 is supplied power from a USB power source it will log data which you can retrieve. Choose the interval that data is saved, as well as the interval that data is sampled and the light source used. The shortest sampling interval is 1 second. The longest sampling or logging interval is 1440 minutes (1 day). Click 'Load Settings' to see current settings and 'Save Settings' to save the settings you want to the sensor. Note: If you don't click save the sensor won't change the settings.



Set the sampling interval in minutes or seconds. The sampling interval is how often a measurement is taken and logging interval is how often the data is saved. The logged data is the average of the samples. The logging interval must be evenly divided by the sampling interval. For example, if the logging interval is 5 minutes and the sampling interval is 2 minutes it causes an error. But a sampling interval of 1 minute is acceptable.

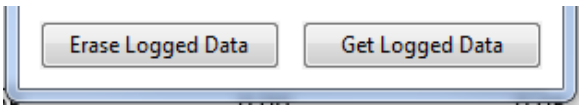


Before clicking 'Get Logged Data' it is important to set the time of the last logged data point. This is used to back calculate the timestamps for the remaining data points. If you just unplugged the sensor and plugged it into the computer, the preloaded day and time should be sufficient.



Click **'Get Logged Data'** to save the data to your computer. You will be asked where you want to save the data.

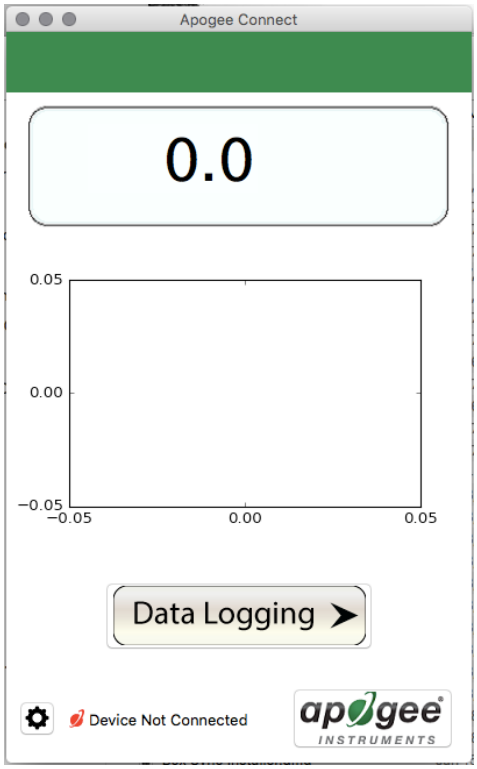
Click **'Erase Data'** to erase all the saved data. This can't be undone.



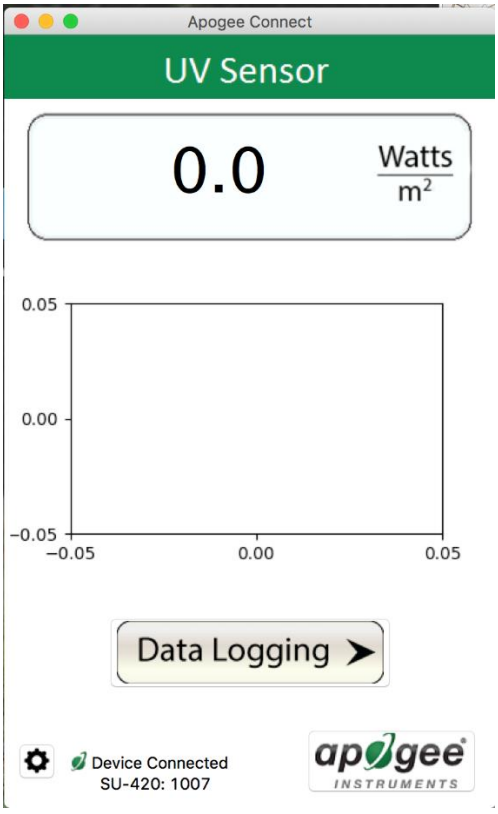
To use additional SU-220 devices, open additional ApogeeConnect software windows. The device serial number will display in the lower left-hand corner of the corresponding software window. Devices may be selected by serial number in the tool bar.

MAC SOFTWARE

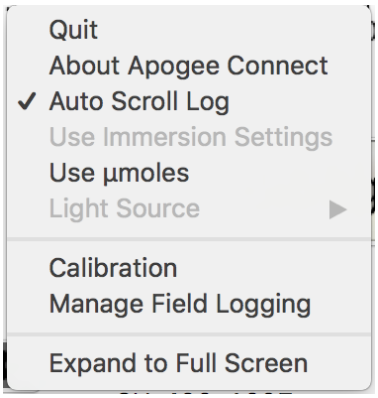
When the SU-220 sensor is not plugged into the USB port, the software will display a message in the lower left corner, “Device Not Connected,” indicating it cannot establish communication with the sensor.



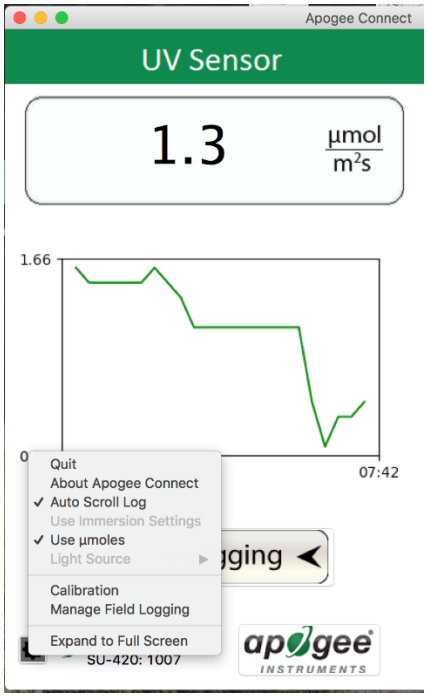
Plug the sensor into a USB port and allow some time for the sensor to automatically establish communication with the software. Once established, the message in the lower left corner will display “Device Connected Model: SN ####” and real-time shortwave radiation readings will update on the screen. Moving the sensor closer to a light source should increase the readings, while blocking all light from the sensor should drop the reading to zero.



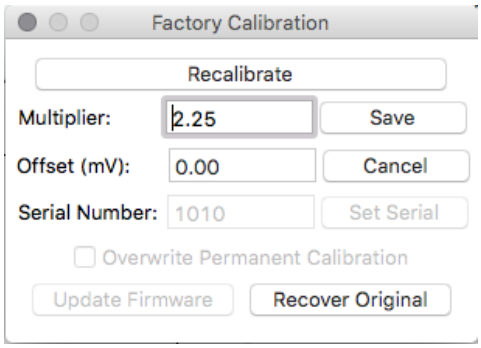
Click the **gear icon** to display the software options. Note **'Light Source' and 'Immersion Setting'** is not a setting option for the SU-220.



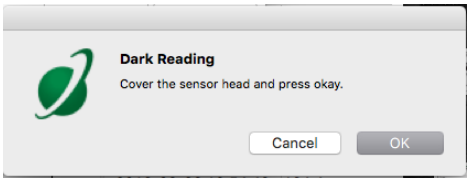
Clicking the **'Use µmoles'** setting option will change the units from W m^{-2} to µmol m^{-2} s^{-1}.



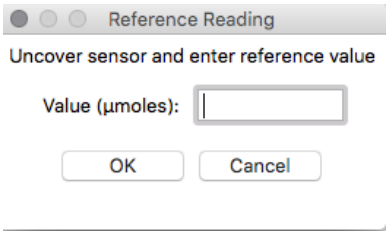
Clicking **'Calibration'** will display the factory calibrated multiplier and offset values. These values are saved in firmware and can be recovered by clicking the 'Recover Original' button. Deriving a new calibration multiplier and offset is accomplished by clicking the 'Recalibrate' button. This is applicable if users want to calibrate the sensor to their own specific light source. Note that a reference value of the light source is required to complete a recalibration.



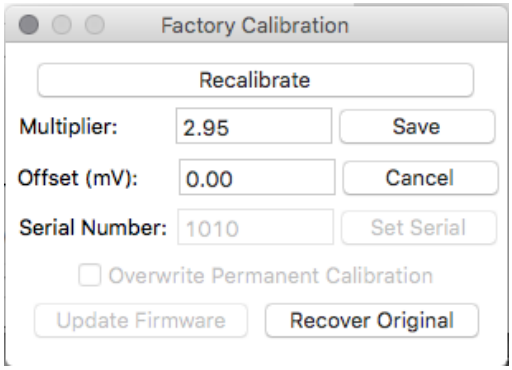
After clicking the 'Recalibrate' button the user will be prompted to cover the sensor. Place a dark cap over the sensor and wait for the real-time shortwave radiation reading to settle at zero. Click OK.



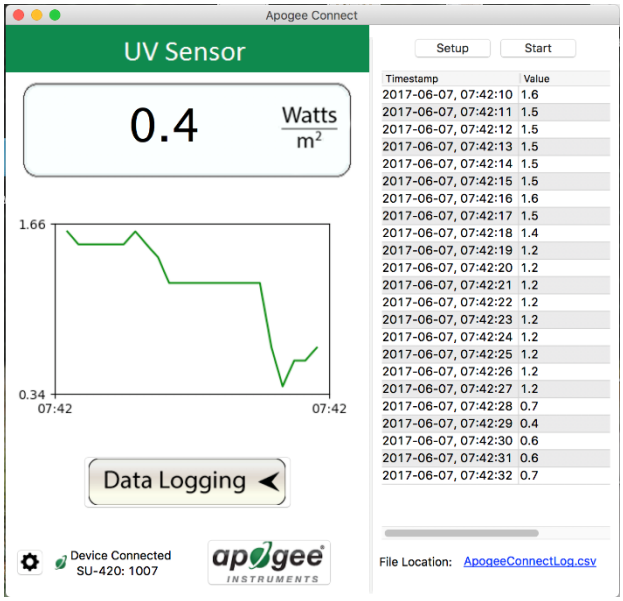
Uncover the sensor and wait for the shortwave radiation reading to settle ***before*** entering the reference value. Click OK.



The multiplier and offset values will automatically calculate and update in the appropriate field. Be sure to click 'Save' to retain the new multiplier and offset.

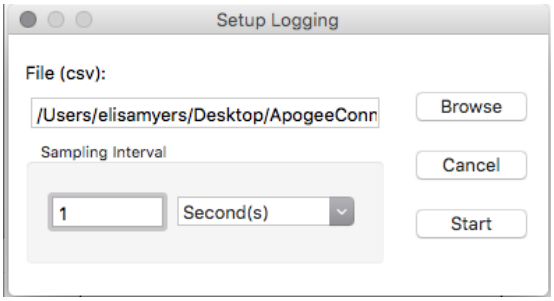


Clicking **'Data Logging'** will allow the user to log interval measurements in a csv file while the software is open and communicating with the sensor.



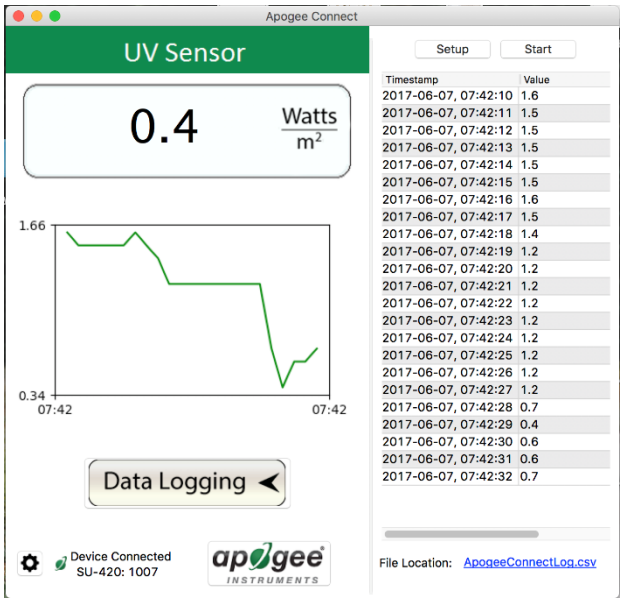
Click ‘Setup’ and the Setup Logging window appears. Click the ‘Browse button to create or select a csv file.

Select the desired sampling interval. Note that 1 second is the minimum interval allowed. Click ‘Start’.



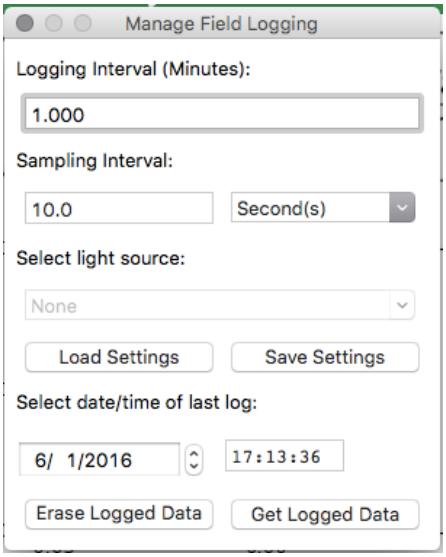
The data logging window will start to update at the specified sampling interval and display the Timestamp and Data Value. At the same time, data will be written to the csv file. Note that if the csv file is open in another program new data will not be saved to it.

The data logging window can be closed without affecting logged data by clicking the ‘Exit’ button. The ‘Stop’ button must be clicked to end data logging.

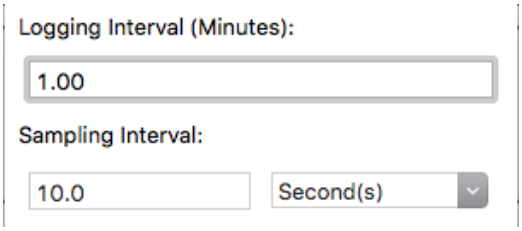


The about screen tells you the software and firmware versions. These can be used to help troubleshoot if problems arise.

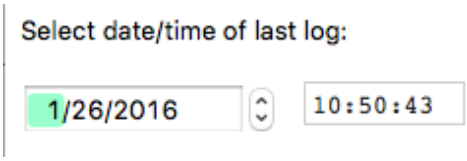
'**Manage Field Logging**' is used to setup the SU-220 for the use in the field. When the SU-220 is supplied power from a USB power source it will log data which you can retrieve. Choose the interval the data is saved, as well as the interval that data is sampled and the light source used. The shortest sampling interval is 1 second. The longest sampling or logging interval is 1440 minutes (1 day). Click 'Load Settings' to see current settings and 'Save Setting' to save the settings you want to the sensor. Note: If you don't click save the sensor won't change the settings.



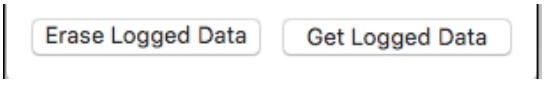
Set the sampling interval in minutes or seconds. The sampling interval is how often a measurement is taken and logging interval is how often the data is saved. The logged data is the average of the samples. The logging interval must be evenly divided by the sampling interval. For example, if the logging interval is 5 minutes and the sampling interval is 2 minutes it causes an error. But a sampling interval of 1 minute is acceptable.



Before clicking 'Get Logged Data' it is important to set the time of the last logged data point. This is used to back calculate the timestamps for the remaining data points. If you just unplugged the sensor and plugged it into the computer, the preloaded day and time should be sufficient.



Click '**Get Logged Data**' to save the data to your computer. You will be asked where you want to save the data.



Click '**Erase Data**' to erase all the save data. This can't be undone.

To use additional SU-220 devices, open additional ApogeeConnect software windows. The device serial number will display in the lower left-hand corner of the corresponding software window. Devices may be selected by serial number in the tool bar.

MAINTENANCE AND RECALIBRATION

Blocking of the optical path between the target and detector can cause low readings. Occasionally, accumulated materials on the diffuser of the SU-200 UV-A sensor can block the optical path in three common ways:

1. Moisture or debris build-up on the diffuser.
2. Dust during periods of low rainfall.
3. Salt deposit accumulation from evaporation of sea spray or sprinkler irrigation water.

SU-200 series sensors have a domed diffuser and housing for improved self-cleaning from rainfall, but active cleaning may be necessary. Dust or organic deposits are best removed using water, or window cleaner, and a soft cloth or cotton swab. Salt deposits should be dissolved with vinegar and removed with a cloth or cotton swab. **Never use solvents such as alcohol or acetone to clean the sensor.** Use only gentle pressure when cleaning the diffuser with a cotton swab or soft cloth, to avoid scratching the outer surface. The vinegar should be allowed to do the cleaning, not mechanical force. **Never use an abrasive material or cleaner on the diffuser**.

It is recommended that UV-A sensors be recalibrated every two years. See the Apogee webpage for details regarding return of sensors for recalibration (http://www.apogeeinstruments.com/tech-support-recalibration-repairs/).

TROUBLESHOOTING AND CUSTOMER SUPPORT

Cable Length

Fifteen feet is the maximum cable length that can be built into the sensor.

Modifying Cable Length

If you required a longer cable length an “active” USB extension cable is required. Please note, the connection between the cables must be made watertight prior to submersion.

Unit Conversion

SU-200 series UV-A sensors are calibrated in energy flux units of W m^{-2}. It is possible to convert the energy flux value to photon flux units of µmol m^{-2} s^{-1} using a conversion factor. Below is an example of how to convert energy flux units to photon flux.

1) Calculate the sensor output in units of J m^{-2} s^{-1}.

$$6\,mV * 10\,\frac{Wm^{-2}}{mV} = 60\frac{W}{m^2} = 60\frac{J}{m^2 s}$$

2) Multiply the energy flux units by the conversion factor. It’s important to note that each light source needs a specific conversion factor. The conversion factor used in the example equation is the sunlight conversion factor.

$$\frac{60\ {}^{J}/_{m^2 s}}{0.327\ {}^{J}/_{\mu mol}} = 183.5\ \frac{\mu mol}{m^2 s}$$

RETURN AND WARRANTY POLICY

RETURN POLICY

Apogee Instruments will accept returns within 30 days of purchase as long as the product is in new condition (to be determined by Apogee). Returns are subject to a 10 % restocking fee.

WARRANTY POLICY

What is Covered
All products manufactured by Apogee Instruments are warranted to be free from defects in materials and craftsmanship for a period of four (4) years from the date of shipment from our factory. To be considered for warranty coverage an item must be evaluated by Apogee.

Products not manufactured by Apogee (spectroradiometers, chlorophyll content meters, EE08-SS probes) are covered for a period of one (1) year.

What is Not Covered
The customer is responsible for all costs associated with the removal, reinstallation, and shipping of suspected warranty items to our factory.

The warranty does not cover equipment that has been damaged due to the following conditions:

1. Improper installation, use, or abuse.

2. Operation of the instrument outside of its specified operating range.

3. Natural occurrences such as lightning, fire, etc.

4. Unauthorized modification.

5. Improper or unauthorized repair.

Please note that nominal accuracy drift is normal over time. Routine recalibration of sensors/meters is considered part of proper maintenance and is not covered under warranty.

Who is Covered
This warranty covers the original purchaser of the product or other party who may own it during the warranty period.

What Apogee Will Do
At no charge Apogee will:

1. Either repair or replace (at our discretion) the item under warranty.

2. Ship the item back to the customer by the carrier of our choice.

Different or expedited shipping methods will be at the customer's expense.

How To Return An Item

1. Please do not send any products back to Apogee Instruments until you have received a Return Merchandise Authorization (RMA) number from our technical support department by submitting an online RMA form at www.apogeeinstruments.com/tech-support-recalibration-repairs/. We will use your RMA number for tracking of the service item. Call (435) 245-8012 or email techsupport@apogeeinstruments.com with questions.

2. For warranty evaluations, send all RMA sensors and meters back in the following condition: Clean the sensor's exterior and cord. Do not modify the sensors or wires, including splicing, cutting wire leads, etc. If a connector has been attached to the cable end, please include the mating connector – otherwise the sensor connector will be removed in order to complete the repair/recalibration. ***Note:*** *When sending back sensors for routine calibration that have Apogee's standard stainless-steel connectors, you only need to send the sensor with the 30 cm section of cable and one-half of the connector. We have mating connectors at our factory that can be used for calibrating the sensor.*

3. Please write the RMA number on the outside of the shipping container.

4. Return the item with freight pre-paid and fully insured to our factory address shown below. We are not responsible for any costs associated with the transportation of products across international borders.

Apogee Instruments, Inc.
721 West 1800 North Logan, UT
84321, USA

5. Upon receipt, Apogee Instruments will determine the cause of failure. If the product is found to be defective in terms of operation to the published specifications due to a failure of product materials or craftsmanship, Apogee Instruments will repair or replace the items free of charge. If it is determined that your product is not covered under warranty, you will be informed and given an estimated repair/replacement cost.

PRODUCTS BEYOND THE WARRANTY PERIOD

For issues with sensors beyond the warranty period, please contact Apogee at techsupport@apogeeinstruments.com to discuss repair or replacement options.

OTHER TERMS

The available remedy of defects under this warranty is for the repair or replacement of the original product, and Apogee Instruments is not responsible for any direct, indirect, incidental, or consequential damages, including but not limited to loss of income, loss of revenue, loss of profit, loss of data, loss of wages, loss of time, loss of sales, accruement of debts or expenses, injury to personal property, or injury to any person or any other type of damage or loss.

This limited warranty and any disputes arising out of or in connection with this limited warranty ("Disputes") shall be governed by the laws of the State of Utah, USA, excluding conflicts of law principles and excluding the Convention for the International Sale of Goods. The courts located in the State of Utah, USA, shall have exclusive jurisdiction over any Disputes.

This limited warranty gives you specific legal rights, and you may also have other rights, which vary from state to state and jurisdiction to jurisdiction, and which shall not be affected by this limited warranty. This warranty extends only to you and cannot by transferred or assigned. If any provision of this limited warranty is unlawful, void, or unenforceable, that provision shall be deemed severable and shall not affect any remaining provisions. In case of any inconsistency between the English and other versions of this limited warranty, the English version shall prevail.

This warranty cannot be changed, assumed, or amended by any other person or agreement

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