

# apogee

## INSTRUMENTS

### OWNER'S MANUAL

## ULTRAVIOLET-A SENSOR

Models SU-200  
(including SS models)



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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-200  
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

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 Apogee Instruments from the raw material suppliers, the products manufactured by Apogee Instruments do not contain, as intentional additives, any of the restricted materials including cadmium, hexavalent chromium, lead, mercury, polybrominated biphenyls (PBB), polybrominated diphenyls (PBDE).

Further note that Apogee Instruments does not specifically analyze raw materials or end products for the presence of these substances, but relies on the information provided by the material suppliers.

Signed for and on behalf of:  
Apogee Instruments, December 2018



Bruce Bugbee  
President  
Apogee Instruments, Inc.

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## 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 many artificial UV light sources available that output a select wavelength range or offer a broadband UV radiation source.

Most UV sensors designed for sunlight measurements are sensitive to UV radiation in the UV-A and UV-B ranges. Apogee Instruments SU-200 series UV-A sensors detect UV radiation from 315 to 400 nm and are calibrated in energy flux units of watts per square meter ( $\text{W m}^{-2}$ , equal to Joules per second per square meter). The output can also be expressed in photon flux units of micromoles per square meter per second ( $\mu\text{mol m}^{-2} \text{s}^{-1}$ ).

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. Sensors are potted solid with no internal air space and are designed for 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 unamplified model SU-200 UV-A sensor. Additional models are covered in their respective manuals.

Model	Signal
SU-200	Self-powered
SU-202	0- 2.5 V
SU-205	0- 5 V



Sensor model number and serial number are located on the cable end of the sensor between the sensor itself and the cable connector. If you need the manufacturing date of your sensor, please contact Apogee Instruments with the serial number of your sensor.

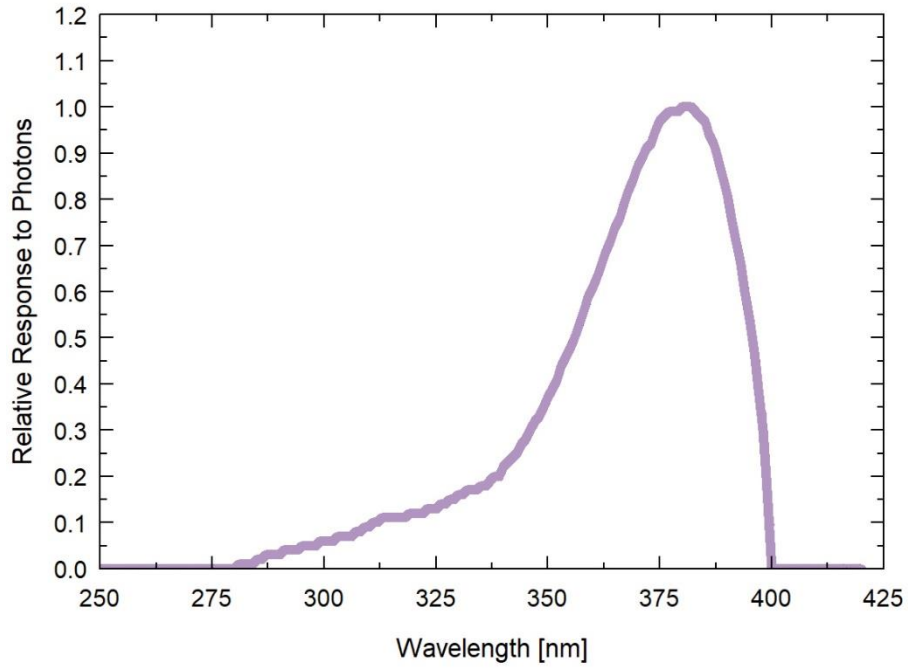
## SPECIFICATIONS

SU-200-SS	
Output (sensitivity)	0.01 mV per W m <sup>-2</sup>
Calibration Factor (reciprocal of sensitivity)	100 W m <sup>-2</sup> per mV
Calibration Uncertainty	± 5 %
Output Range	0 to 1 mV
Measurement Range	0 to 100 W m <sup>-2</sup>
Measurement Repeatability	Less than 0.5 %
Non-stability (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	310 to 400 nm (wavelengths where response is greater than 10 % of maximum; see Spectral Response below)
Directional (Cosine) Response	± 2 % at 45°, ± 5 % at 75°
Temperature Response	Less than 0.1 % per C
Operating Environment	-40 to 70 C; 0 to 100 % relative humidity
Dimension	24 mm diameter, 37 mm height
Mass	100 g (with 5 m of lead wire)
Cable	5 m of shielded, twisted-pair wire; TPR jacket (high water resistance, high UV stability, flexibility in cold conditions); pigtail lead wires; stainless steel (316), M8 connector located 25 cm from sensor head

### 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).

### Spectral Response



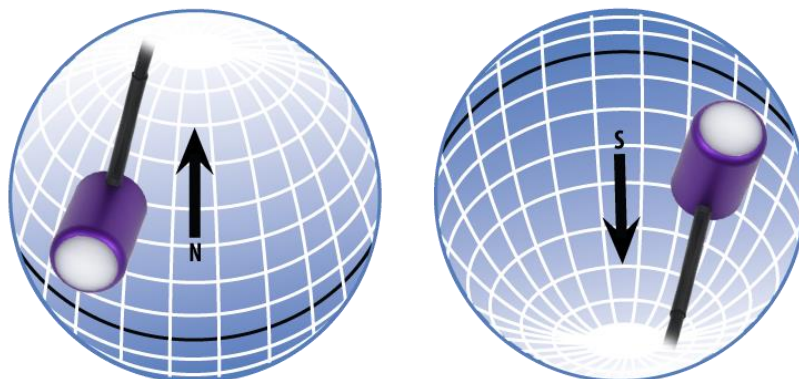
Spectral response estimate of Apogee SU-200 UV-A sensors. Spectral response was modeled from sensitivity of the photodetector and transmittance of the diffuser.

## 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.



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 green cap should be removed from the sensor.** The green cap can be used as a protective covering for the sensor when it is not in use.



## CABLE CONNECTORS

Apogee started offering in-line cable connectors on some bare-lead sensors in March 2018 to simplify the process of removing sensors from weather stations for calibration (the entire cable does **not** have to be removed from the station and shipped with the sensor).

The ruggedized M8 connectors are rated IP68, made of corrosion-resistant marine-grade stainless-steel, and designed for extended use in harsh environmental conditions.

### Instructions

**Pins and Wiring Colors:** All Apogee connectors have six pins, but not all pins are used for every sensor. There may also be unused wire colors inside the cable. To simplify datalogger connection, we remove the unused pigtail lead colors at the datalogger end of the cable.

If you ever need a replacement cable, please contact us directly to ensure ordering the proper pigtail configuration.

**Alignment:** When reconnecting your sensor, arrows on the connector jacket and an aligning notch ensure proper orientation.

**Disconnection for extended periods:** When disconnecting the sensor for an extended period of time from a station, protect the remaining half of the connector still on the station from water and dirt with electrical tape or other method.

**Tightening:** Connectors are designed to be firmly finger-tightened only. There is an O-ring inside the connector that can be overly compressed if a wrench is used. Pay attention to thread alignment to avoid cross-threading. When fully tightened, 1-2 threads may still be visible.



In-line cable connectors are installed 30 cm from the head  
(pyranometer pictured)



A reference notch inside the connector ensures proper alignment before tightening.



When sending sensors in for calibration, only send the short end of the cable and half the connector.

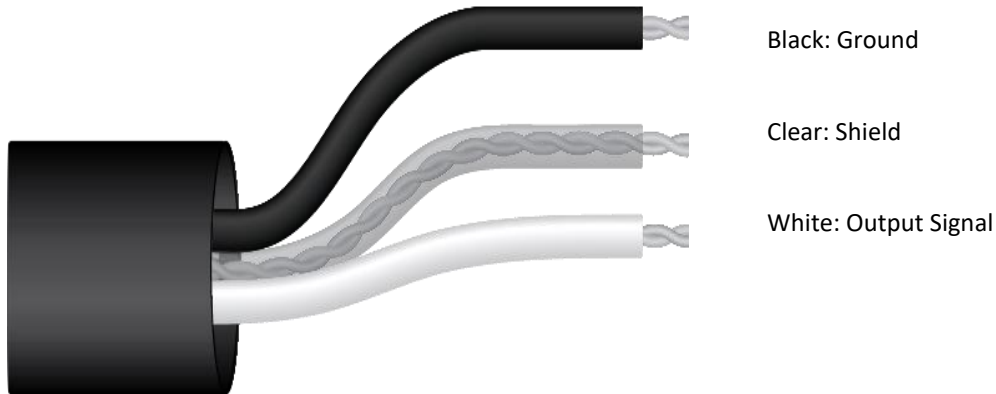


Finger-tighten firmly

## OPERATION AND MEASUREMENT

Connect the sensor to a measurement device (meter, datalogger, controller) capable of measuring and displaying or recording a millivolt signal (an input measurement range of approximately 0-1 mV is required to cover the entire range of UV-A from the sun). In order to maximize measurement resolution and signal-to-noise ratio, the input range of the measurement device should closely match the output range of the UV sensor. **DO NOT connect the sensor to a power source. The sensor is self-powered and applying voltage will damage the sensor.**

### Wiring for SU-200



## Sensor Calibration

The SU-200 has a standard UV calibration factor of exactly:

$$100 \text{ W m}^{-2} \text{ per mV}$$

Multiply this calibration factor by the measured mV signal to convert sensor output to UV-A in units of  $\text{W m}^{-2}$ :

$$\text{Calibration Factor (100 W m}^{-2} \text{ per mV)} * \text{Sensor Output Signal (mV)} = \text{UV-A (W m}^{-2}\text{)}$$

$$100 \quad * \quad 0.6 \quad = \quad 60$$



Example of UV-A measurement with an Apogee UV-A sensor. Full sunlight yields UV-A radiation on a horizontal plane at the Earth's surface of approximately  $60 \text{ W m}^{-2}$ . This yields an output signal of 0.6 mV. The signal is converted to UV-A radiation by multiplying by the calibration factor of  $100 \text{ W m}^{-2}$  per mV.

Sensor Output

0.6 mV

## UV-A Measurements and Spectral Errors

Apogee Instruments model SU-200 UV-A sensors measure ultraviolet radiation between 310 and 400 nm in Watts per square meter per second. 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 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.

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## 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 upward-looking sensor and in the apertures of the downward-looking sensor can block the optical path in three common ways:

1. Moisture or debris on the diffuser (upward-looking) or in the apertures (downward-looking).
2. Dust during periods of low rainfall.
3. Salt deposit accumulation from evaporation of sea spray or sprinkler irrigation water.

Apogee Instruments upward-looking 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. **Salt deposits cannot be removed with solvents such as alcohol or acetone.** Use only gentle pressure when cleaning the diffuser with a cotton swab or soft cloth, to avoid scratching the outer surface. The solvent should be allowed to do the cleaning, not mechanical force. **Never use an abrasive material or cleaner on the diffuser.**

It is recommended that two-band 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/>).

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## TROUBLESHOOTING AND CUSTOMER SUPPORT

### Independent Verification of Functionality

Apogee SU-200 sensors are self-powered devices and output a voltage signal proportional to incident UV-A radiation. A quick and easy check of sensor functionality can be determined using a voltmeter with millivolt resolution. Connect the positive lead of the voltmeter to the white wire from the sensor and the negative lead (or common) to the black wire from the sensor. Direct the sensor head toward the sun and verify the sensor provides a signal. Blocking all UV radiation from the sensor should force the sensor signal to zero.

### Compatible Measurement Devices (Dataloggers/Controllers/Meters)

SU-200 UV-A sensors are calibrated with a standard calibration factor of  $100 \text{ W m}^{-2}$  per mV, yielding a sensitivity of  $0.01 \text{ mV per W m}^{-2}$ . Thus, a compatible measurement device (e.g., datalogger or controller) should have resolution of at least  $0.01 \text{ mV}$  to provide a measurement resolution of  $1 \text{ W m}^{-2}$ .

An example datalogger program for Campbell Scientific dataloggers can be found on the Apogee webpage at <http://www.apogeeinstruments.com/content/UV-Sensor.CR1>.

### Zero Offset Error

With the use of certain dataloggers it is possible to measure a non-zero voltage (zero offset) when the sensor output should be zero (no photons incident on diffuser). This offset can be corrected by applying the necessary correction offset in the datalogger program. To test if a zero offset exists, connect the sensor to the datalogger in question, cover the sensor head completely with a thick black cloth to block all photons, and allow the reading to stabilize. If an offset exists, connect the sensor lead wires to a DC power supply and an independent measurement instrument, such as a voltmeter, cover the sensor head completely to block all photons, and allow the reading to stabilize. If the offset still exists, contact Apogee customer support to recalibrate the sensor. If the offset does not exist, program the datalogger to take into account the offset attributed by the datalogger in question.

### Cable Length

When the sensor is connected to a measurement device with high input impedance, sensor output signals are not changed by shortening the cable or splicing on additional cable in the field. Tests have shown that if the input impedance of the measurements device is greater than 1 mega-ohm there is negligible effect on the calibration, even after adding up to 100 m of cable. All Apogee sensors use shielded, twisted pair cable to minimize electromagnetic interference. For best measurements, the shield wire must be connected to an earth ground. This is particularly important when using the sensor with long lead lengths in electromagnetically noisy environments.

### Modifying Cable Length

See Apogee webpage for details on how to extend sensor cable length: (<http://www.apogeeinstruments.com/how-to-make-a-weatherproof-cable-splice/>).

**Unit Conversion**

SU-200 series UV-A sensors are calibrated in energy flux units of  $\text{W m}^{-2}$ . It is possible to convert the energy flux value to photon flux units of  $\mu\text{mol m}^{-2} \text{s}^{-1}$ . Examples of this conversion can be found in the Knowledge Base of the Apogee website <http://www.apogeeinstruments.com/knowledge-base/> (scroll down to UV Sensors section).

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## 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 either at our factory or by an authorized distributor.

Products not manufactured by Apogee (spectroradiometers, chlorophyll content meters) 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 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 We Will Do**

At no charge we 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 calling (435) 792-4700 or by submitting an online RMA form at [www.apogeeinstruments.com/tech-support-recalibration-repairs/](http://www.apogeeinstruments.com/tech-support-recalibration-repairs/). We will use your RMA number for tracking of the service item.
2. 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.
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.
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.

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

### 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 wages, loss of time, loss of sales, accrual 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 be 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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