apogee
INSTRUMENTS

OWNER'S MANUAL

ULTRAVIOLET SENSOR

Model JSU-100

(including SS model)

TABLE OF CONTENTS

CERTIFICATE OF COMPLIANCE

EU Declaration of Conformity

for the following product(s):

Models: JSU-100
Type: Ultraviolet 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 us from our raw material suppliers, the products manufactured by us 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 run any analysis on our raw materials or end products for the presence of these substances, but rely on the information provided to us by our material suppliers.

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 the 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 JSU-100 UV sensors detect UV radiation from 250 to 400 nm and are calibrated in photon flux units of micromoles per square meter per second (µmol m^{-2} s^{-1}). The output can also be expressed in energy flux units of watts per square meter (W m^{-2}, equal to Joules per second per square meter).

Typical applications of UV sensors include incoming UV radiation measurement in outdoor environments (not recommended for continuous outdoor deployment) or in laboratory use with artificial light sources (e.g., germicidal lamps).

Apogee Instruments JSU-100 UV sensors consist of a 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 radiation measurement in indoor or outdoor environments. The JSU-100 outputs an analog voltage that is directly proportional to UV radiation incident on a planar surface (does not have to be horizontal), where the radiation emanates from all angles of a hemisphere.

SENSOR MODELS

The JSU-100 UV sensor is the only stand-alone UV sensor offered by Apogee Instruments. Additional models are covered in their respective manuals.

Model	Signal
JSU-100	**Self-powered**
JSU-420	USB

Sensor model number and serial number are located near the pigtail leads on the sensor cable. If you need the manufacturing date of your sensor, please contact Apogee Instruments with the serial number of your sensor.

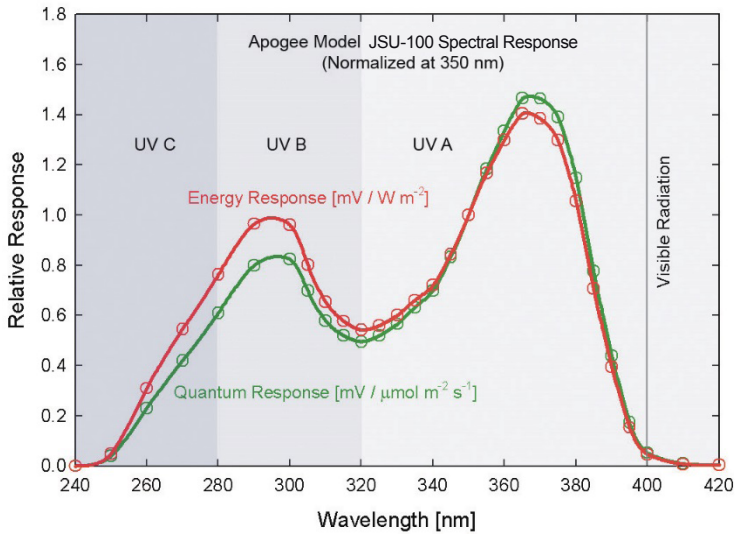
SPECIFICATIONS

	JSU-100
Sensitivity	0.20 mV per µmol m^{-2} s^{-1}; 0.61 mV per W m^{-2}
Calibration Factor (reciprocal of sensitivity)	5.0 µmol m^{-2} s^{-1} per mV; 1.65 W m^{-2} per mV
Calibration Uncertainty	± 10 % (see Calibration Traceability below)
Measurement Repeatability	less than 1 %
Non-stability (Long-term Drift)	less than 3 % per year
Non-linearity	less than 1 % (up to 300 µmol m^{-2} s^{-1})
Response Time	less than 1 ms
Field of View	180°
Spectral Range	250 nm to 400 nm (see Spectral Response below)
Directional (Cosine) Response	± 10 % at 75° zenith angle
Temperature Response	Approximately 0.1 % per C
Operating Environment	-40 to 70 C; 0 to 100 % relative humidity
Dimension	24 mm diameter; 28 mm height
Mass	75 g (with 5 m of lead wire)
Cable	5 m of two conductor, shielded, twisted-pair wire; additional cable available in multiples of 5 m; santoprene rubber jacket (high water resistance, high UV stability, flexibility in cold conditions); pigtail lead wires

Calibration Traceability

Apogee JSU-100 UV sensors are calibrated through side-by-side comparison to the mean of four Apogee model JSU-100 transfer standard UV sensors under high intensity discharge metal halide lamps. The transfer standard UV sensors are calibrated through side-by-side comparison to an Apogee model PS-200 spectroradiometer under sunlight (clear sky conditions) in Logan, Utah. The PS-200 is calibrated with a LI-COR model 1800-02 Optical Radiation Calibrator using a 200 W quartz halogen lamp. The 1800-02 and quartz halogen lamp are traceable to the National Institute of Standards and Technology (NIST).

Spectral Response



Spectral response estimate of Apogee JSU-100 UV sensors. Spectral response measurements were made at 10 nm increments across a wavelength range of 200 to 450 nm in a monochromator with an attached electric light source. Measured spectral data were normalized at 350 nm.

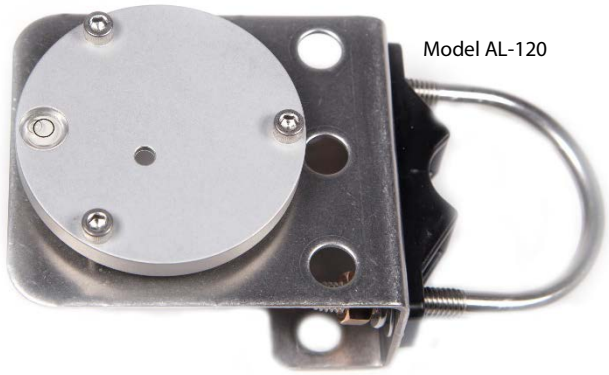
DEPLOYMENT AND INSTALLATION

Mount the sensor to a solid surface with the nylon mounting screw provided. To accurately measure PPFD 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

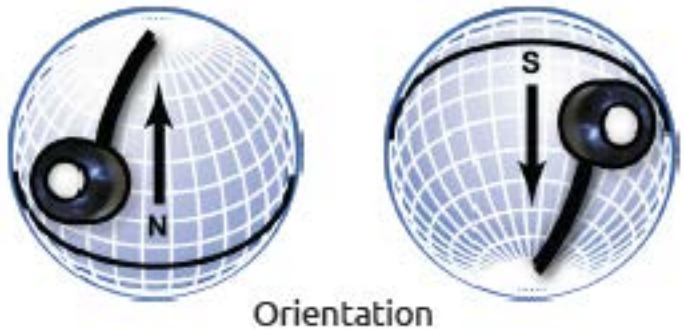
Model AL-100

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.



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 by not requiring the full cable to be uninstalled back to the data logger.

The ruggedized M8 connectors are rated IP67, made of corrosion-resistant marine-grade stainless-steel, and designed for extended use in harsh environmental conditions.

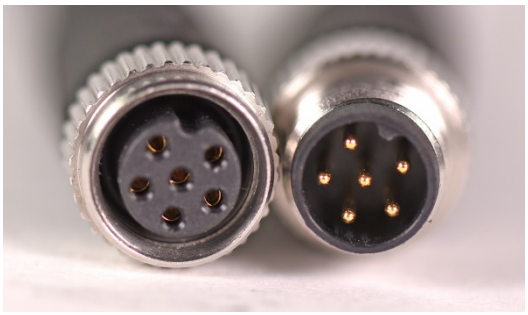
Inline cable connectors are installed 30 cm from the head (pyranometer pictured)

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 data logger connection, we remove the unused pigtail lead colors at the data logger 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.



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

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.

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

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.

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 0-40 mV is required to cover the entire range of UV 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.**

VERY IMPORTANT: Apogee changed all wiring colors of our bare-lead sensors in March 2018 in conjunction with the release of inline cable connectors on some sensors. To ensure proper connection to your data device, please note your serial number or if your sensor has a stainless-steel connector 30 cm from the sensor head then use the appropriate wiring configuration below.

Wiring for JSU-100 Serial Numbers range 0-2481

Red: Positive (signal from sensor)

Black: Negative (signal from sensor)

Clear: Shield/Ground

Wiring for JSU-100 Serial Numbers 2482 and above or with a cable connector

Black: Negative (signal from sensor)

Clear: Shield/Ground

White: Positive (signal from sensor)

Sensor Calibration

The JSU-100 has a standard UV calibration factor of exactly:

5.0 µmol m^{-2} s^{-1} per mV

Multiply this calibration factor by the measured mV signal to convert sensor output to UV in units of µmol m^{-2} s^{-1}:

Calibration Factor (5.0 µmol m^{-2} s^{-1} per mV) * Sensor Output Signal (mV) = UV (µmol m^{-2} s^{-1})

5.0 * 35 = 175

Sensor Output

35 mV

Example of UV measurement with an Apogee UV sensor. Full sunlight yields UV radiation on a horizontal plane at the Earth's surface of approximately 175 µmol m^{-2} s^{-1}. This yields an output signal of 35 mV. The signal is converted to UV radiation by multiplying by the calibration factor of 5.0 µmol m^{-2} s^{-1} per mV.

UV-B Measurements and Spectral Errors

Apogee Instruments model JSU-100 UV Sensors measure ultraviolet radiation between 250 and 400 nm in micromoles of photons per square meter per second. Although the UV radiation between 280 and 315 nm (UV-B) is critically important in photochemical and photobiological reactions, less than 3 % of the UV photons are in this range. Because only a small fraction of the photons are in the UV-B range, the JSU-100 cannot be used to selectively measure UV-B radiation. The JSU-100 is sensitive to UV-B radiation, but it is included with the UV-A radiation to provide a total measurement of UV radiation.

In addition to naturally occurring UV radiation from the sun, there are many electric light sources that emit UV radiation (e.g., cool white fluorescent, metal halide, mercury arc, and germicidal lamps). Although the relative wavelengths of UV radiation differ among sunlight and electric lights, the error estimates shown in the table below indicate that the JSU-100 provides reasonable estimates of UV radiation coming from electric lamps (table provides spectral error estimates for UV radiation measurements from radiation sources other than clear sky solar radiation). For common lamps, the error is less than 10 %. The JSU-100 is particularly useful for determining the UV filtering capacity of the transparent plastic and glass barriers that are commonly used below electric lamps.

Spectral Errors for UV Radiation Measurements with Apogee JSU-100 UV Sensors

Radiation Source (Error Calculated Relative to Sun, Clear Sky)	Error [%]
Sun (Clear Sky)	0.0
Sun (Cloudy Sky)	< 0.5
Reflected from Grass Canopy	< 0.5
Reflected from Deciduous Canopy	< 0.5
Reflected from Conifer Canopy	< 0.5
Reflected from Agricultural Soil	< 0.5
Reflected from Forest Soil	< 0.5
Reflected from Desert Soil	< 0.5
Reflected from Water	< 0.5
Reflected from Ice	< 0.5
Reflected from Snow	< 0.5
Cool White Fluorescent (T5)	9.0
Metal Halide	2.8
High Pressure Sodium	-1.7
Incandescent	-3.3
Mercury Arc	17.8