

OWNER'S MANUAL

ULTRAVIOLET METER

Model JMU-100 and JMU-200



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DECLARATION OF CONFORMITY

CE and ROHS Certificate of Compliance

We Declare under our sole responsibility that the products:

Models: JMU-100, JMU-200
Type: Ultraviolet Meter

are in conformity with the following standards and relevant EC directives:

Emissions: EN 61326-1:2013
Immunity: EN 61326-1:2013
Safety: EN 61010-1:2010

EU directive 2004/108/EC, EMC
EU directive 2002/95/EC, RoHS (Restriction of Hazardous Substances)
EU directive 2011/65/EU, RoHS2

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 Instruments does not specifically run any analysis on our raw materials or end product 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.

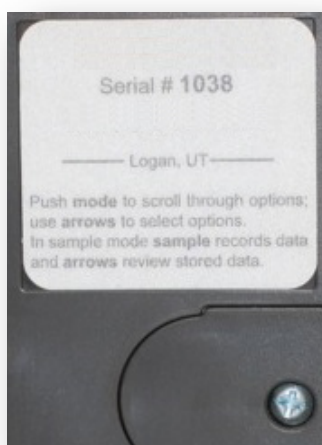
Most UV sensors designed for sunlight measurements are sensitive to UV radiation in the UV-A and UV-B ranges. Instruments JMU series meters detect UV radiation from 250 to 400 nm and are calibrated in photon flux units of micromoles per square meter per second ($\mu\text{mol m}^{-2} \text{s}^{-1}$). 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 meters include incoming UV radiation measurement in outdoor environments or in laboratory use with artificial light sources (e.g., germicidal lamps).

JMU series UV meters consist of a handheld meter and a dedicated sensor that is integrated into the top of the meter housing (JMU-100) or connected by cable to an anodized aluminum housing (JMU-200). Integrated and separate sensors consist of a photodiode and filter, and are potted solid with no internal air space. JMU series meters provide a realtime photon flux or energy flux (menu selectable) reading on the LCD display that determines the UV radiation incident on a planar surface (does not have to be horizontal), where the radiation emanates from all angles of a hemisphere. JMU series meters include manual and automatic data logging features for making spot check measurements or calculating integrated daily total values.

SENSOR MODELS

JMU series UV meters covered in this manual are self-contained and come complete with handheld meter and sensor.



Sensor model number and serial number are located on a label on the backside of the handheld meter.

SPECIFICATIONS

Calibration Uncertainty: $\pm 10\%$ (see Calibration Traceability below)

Measurement Repeatability: $< 1\%$

Non-stability (Long-term Drift): $< 3\%$ per year

Non-linearity: $< 1\%$ (up to $300\ \mu\text{mol m}^{-2}\text{s}^{-1}$)

Response Time: $< 1\text{ ms}$

Field of View: 180°

Spectral Range: 250 nm to 400 nm (see Spectral Response below)

Directional (Cosine) Response: $\pm 10\%$ at 75° zenith angle

Temperature Response: approximately 0.1% per C

Operating Environment: 0 to 50 C

$< 90\%$ non-condensing relative humidity up to 30 C

$< 70\%$ non-condensing relative humidity from 30 to 50 C

Meter Dimensions: 12.6 cm length, 7.0 cm width, 2.4 cm height

Sensor Dimensions: JMU-200: 2.4 cm diameter and 2.8 cm height

Mass: JMU-100: 150 g

JMU-200: 180 g

Cable: 2 m of shielded, twisted-pair wire.

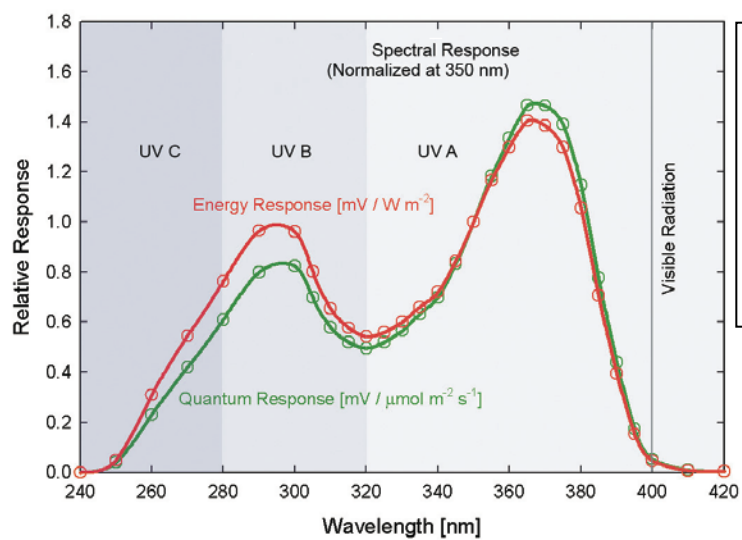
Additional cable available

Santoprene rubber jacket (high water resistance, high UV stability, flexibility in cold conditions)

Calibration Traceability:

JMU series UV meters are calibrated through side-by-side comparison to the mean of four model NSU-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 model NPS-200 spectroradiometer under sunlight (clear sky conditions) in Logan, Utah. The NPS-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 JMU series meters. 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

JMU series meters are designed for spot-check measurements, and calculation of integrated daily totals (total number of photons incident on a planar surface over the course of a day) through the built-in logging feature. To accurately measure UV radiation incident on a horizontal surface, the sensor must be level. For this purpose, each JMU model comes with a different option for mounting the sensor to a horizontal plane.



The AL-210 leveling plate is recommended for use with the JMU-100.



The AL-100 leveling plate is recommended for use with the JMU-200. To facilitate mounting to a cross arm, the AM-110 mounting bracket is recommended for use with the AL-100.

In addition to leveling, all sensors should also be mounted such that obstructions (e.g., weather station tripod/tower or other instrumentation) do not shade the sensor.

OPERATION AND MEASUREMENT

JMU series quantummeters are designed with a usefriendly interface allowing quick and easy measurements.



To power the meter, slide the included battery (CR2320) into the battery holder, after removing the battery door from the meter's back panel. The positive side (designated by a "+" sign) should be facing out from the meter circuit board.



Press the power button to activate the LCD display. After two minutes of non-activity the meter will revert to sleep mode and the display will shut off to conserve battery life.



Press the mode button to access the main menu, where the appropriate unit (photon flux or energy flux) and manual or automatic logging are selected, and where the meter can be reset.



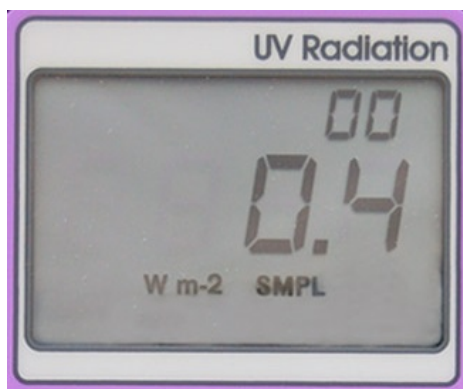
Press the sample button to log a reading while taking manual measurements.



Press the up button to make selections in the main menu. This button is also used to view and scroll through the logged measurements on the LCD display.



Press the down button to make selections in the main menu. This button is also used to view and scroll through the logged measurements on the LCD display.



The LCD display consists of the total number of logged measurements in the upper right hand corner, the real-time UV measurement in the center, and the selected menu options along the bottom.

Units: To choose between units of energy flux (W m^{-2}) or photon flux ($\mu\text{mol m}^{-2} \text{s}^{-1}$), push the mode button once and use the up/down buttons to make the appropriate selection. Once the desired mode is blinking, press the mode button three more times to exit the menu.

Logging: To choose between manual or automatic logging, push the mode button twice and use the up/down buttons to make the appropriate selection (SMPL or LOG). Once the desired mode is blinking,

press the mode button two more times to exit the menu. When in SMPL mode press the sample button to record up to 99 manual measurements (a counter in the upper right hand corner of the LCD display indicates the total number of saved measurements). When in LOG mode the meter will power on/off to make a measurement every 30 seconds. Every 30 minutes the meter will average the sixty 30 second measurements and record the averaged value to memory. The meter can store up to 99 averages and will start to overwrite the oldest measurement once there are 99 measurements. Every 48 averaged measurements (making a 24 hour period), the meter will also store an integrated daily total in moles per meter squared per day ($\text{mol m}^{-2} \text{d}^{-1}$).

Reset: To reset the meter, in either SMPL or LOG mode, push the mode button three times (RUN should be blinking), then while pressing the down button, press the mode button once. This will erase all of the saved measurements in memory, but only for the selected mode. That is, performing a reset when in SMPL mode will only erase the manual measurements and performing a reset when in LOG mode will only erase the automatic measurements.

Review/Download Data: Each of the logged measurements in either SMPL or LOG mode can be reviewed on the LCD display by pressing the up/down buttons. To exit and return to the real-time readings, press the sample button. Note that the integrated daily total values are not accessible through the LCD and can only be viewed by downloading to a computer.

(SMPL) 99 Sample Measurements	(LOG) 99 Log Measurements	(LOG) 99 Daily Total Measurements
Viewable on meter LCD & downloadable		Downloadable Only

UV-B Measurements and Spectral Errors:

JMU series meters 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 JMU series meters cannot be used to selectively measure UV-B radiation. The JMU series 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 JMU series meters provide 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 MU series meters are 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 J M U series UV meters

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

MAINTENANCE AND RECALIBRATION

Moisture or debris on the sensor is a common cause of low readings. The sensor has a domed-shaped housing for improved self-cleaning from rainfall, but materials can accumulate on the photo-sensitive area (e.g., dust during periods of low rainfall, salt deposits from evaporation of sea spray or sprinkler irrigation water) and partially block the optical path. 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 soft cloth or cotton swab. **Never use an abrasive material or cleaner on the sensor.**

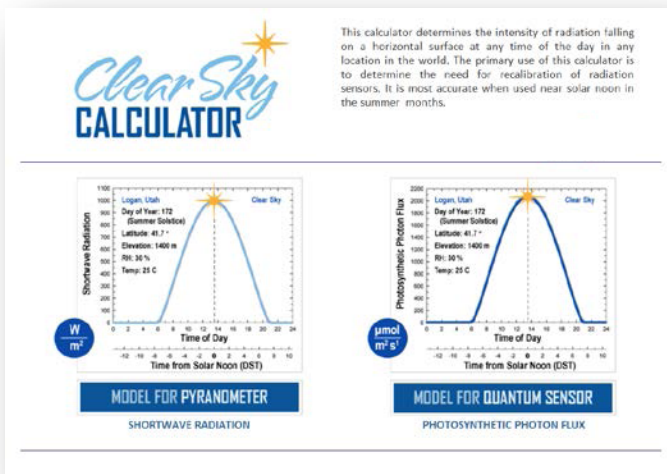
The Clear Sky Calculator (www.clearskycalculator.com) determines total shortwave radiation or photosynthetic photon flux (PPF) incident on a horizontal surface at any time of day at any location in the world. It is most accurate when used near solar noon in spring and summer months, where accuracy over multiple clear and unpolluted days is estimated to be $\pm 4\%$ in all climates and locations around the world.

Although the Clear Sky Calculator does not specifically report an estimated value for UV radiation, it can still be used to help determine the need for UV sensor recalibration by approximating the ratio of UV to total shortwave or the ratio of UV to PPF. However, due to continuous changes in atmospheric conditions and their effect on UV radiation, the comparison of the UV sensor to the Clear Sky Calculator should only be made in the summer months near solar noon, and under completely clear skies.

To calculate a reference value of UV radiation in units of energy flux (W m^{-2}), input site conditions into the calculator to determine the estimated total shortwave radiation. Then multiply the estimated total shortwave value by an approximated ratio value between 0.045 and 0.050 to convert the total shortwave radiation to total UV radiation.

To calculate a reference value of UV radiation in units of photon flux ($\mu\text{mol m}^{-2} \text{s}^{-1}$), input site conditions into the calculator to determine the estimated PPF. Then multiply the estimated PPF by an approximated ratio value between 0.070 and 0.075 to convert the PPF to total UV radiation.

If UV sensor measurements over multiple days near solar noon are consistently different than calculated values (by more than 10 %), the sensor should be cleaned and releveled. If measurements are still different after a second test, email to discuss test results and possible return of sensor(s).



Homepage of the Clear Sky Calculator. Two calculators are available: One for pyranometers (total shortwave radiation) and one for quantum sensors (photosynthetic photon flux).

Clear Sky CALCULATOR FOR PYRANOMETERS

- For best accuracy, comparison should be made on clear, non-polluted, summer days within one hour of solar noon.
- Enter input parameters in the blue cells at right. Definitions are shown below.
- Sensor must be level and perfectly clean. Enter your measured solar radiation in the blue "Measured Shortwave" cell at far right.
- Difference between the model and your sensor is shown in the yellow "DIFFERENCE FROM MODEL" cell at right.
- Run the model on replicate days. Contact Apogee for recalibration if the measured value is more than 5 % different than the estimated value. You will be contacted within two business days.

For a discussion on model accuracy and sensitivity of input parameters, [CLICK HERE](#).

INPUT AND OUTPUT DEFINITIONS

Latitude = latitude of the measurement site [degrees]; for southern hemisphere, insert as a negative number; info may be obtained from <http://touchmap.com/latlong.html>

Longitude = longitude of the measurement site [degrees]; expressed as positive degrees west of the standard meridian in Greenwich, England (e.g. 74° for New York, 260° for Bangkok, Thailand, and 358° for Paris, France).

Input Parameters for Estimating Solar Radiation:

Latitude = 41.7°
 Longitude = 111.8°
 Longitude_{ref} = 105°
 Elevation = 1400 m
 Day of Year = 172
 Time of Day = 12.9 (5 min = 0.1 hr)
 Daylight Savings = 1 hr
 Air Temperature = 25 °C
 Relative Humidity = 30 %

Output from Model:

Model Estimated Shortwave = 987 W m⁻²
 Measured Shortwave = 970 W m⁻²
 DIFFERENCE FROM MODEL = -1.7 %

CONTACT APOGEE FOR RECALIBRATION

Name: _____
 E-mail: _____
 Phone: _____
 Serial #: _____
 Comments: _____

Please include all requested information.
[SEND INFO TO APOGEE](#)

[RECALCULATE MODEL](#)

Clear Sky Calculator for pyranometers. Site data are input in blue cells in middle of page and an estimate of total shortwave radiation is returned on right-hand side of page.

TROUBLESHOOTING AND CUSTOMER SUPPORT

Verify Functionality:

Pressing the power button should activate the LCD and provide a real-time UV measurement. Direct the sensor head toward the sun and verify the UV reading responds. Blocking all radiation from the sensor should force the UV reading to zero.

Battery Life:

When the meter is maintained properly the coin cell battery (CR2320) should last for many months, even after continuous use. The low battery indicator will appear in the upper left hand corner of the LCD display when the battery voltage drops below 2.8 V DC. The meter will still function correctly for some time, but once the battery is drained the pushbuttons will no longer respond and any logged measurements will be lost.

Pressing the power button to turn off the meter will actually put it in sleep mode, where there is still a slight amount of current draw. This is necessary to maintain the logged measurements in memory. Therefore, it is recommended to remove the battery when storing the meter for many months at a time, in order to preserve battery life.

Master Reset:

If a meter ever becomes non-responsive or experiences anomalies, such as a low battery indicator even after replacing the old battery, a master reset can be performed that may correct the problem. Note that a master reset will erase all logged measurements from memory.

First press the power button so that the LCD display is activated. While still powered, slide the battery out of the holder, which will cause the LCD display to fade out. After a few seconds, slide the battery back into the holder. The LCD display will flash all segments and then show a revision number (e.g. "R1.0"). This indicates the master reset was performed and the display should return to normal.

Error Codes and Fixes:

Error codes will appear in place of the real time reading on the LCD display and will continue to flash until the problem is corrected. Contact if the following fixes do not rectify the problem.

Err 1: battery voltage out of range. **Fix:** replace CR2320 battery and perform master reset.

Err 2: sensor voltage out of range. **Fix:** perform master reset.

Err 3: not calibrated. **Fix:** perform master reset.

Err 4: CPU voltage below minimum. **Fix:** replace CR2320 battery and perform master reset.

Modifying Cable Length:

Although it is possible to splice additional cable to the separate sensor of the JMU-200, note that the cable wires are soldered directly into the circuit board of the meter. Care should be taken to remove the back panel of the meter in order to access the board and splice on the additional cable, otherwise two splices would need to be made between the meter and sensor head.

WARRANTY POLICY

What is Covered

All products manufactured 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 (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.