apogee

INSTRUMENTS

OWNER'S MANUAL

QUANTUM METER

Models MQ-100, MQ-200, and MQ-300 Series



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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: MQ-100, MQ-200, MQ-301, MQ-303, MQ-306
Type: Quantum Meter

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.

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



Bruce Bugbee
President
Apogee Instruments, Inc.

INTRODUCTION

Radiation that drives photosynthesis is called photosynthetically active radiation (PAR) and is typically defined as total radiation across a range of 400 to 700 nm. PAR is often expressed as photosynthetic photon flux density (PPFD): photon flux in units of micromoles per square meter per second (µmol m^{-2} s^{-1}, equal to microEinsteins per square meter per second) summed from 400 to 700 nm (total number of photons from 400 to 700 nm). While Einsteins and micromoles are equal (one Einstein = one mole of photons), the Einstein is not an SI unit, so expressing PPFD as µmol m^{-2} s^{-1} is preferred.

The acronym PPF is also widely used and refers to the photosynthetic photon flux. The acronyms PPF and PPFD refer to the same parameter. The two terms have co-evolved because there is not a universal definition of the term "flux". Some physicists define flux as per unit area per unit time. Others define flux only as per unit time. We have used PPFD in this manual because we feel that it is better to be more complete and possibly redundant.

Sensors that measure PPFD are often called quantum sensors due to the quantized nature of radiation. A quantum refers to the minimum quantity of radiation, one photon, involved in physical interactions (e.g., absorption by photosynthetic pigments). In other words, one photon is a single quantum of radiation.

Typical applications of quantum sensors include incoming PPFD measurement over plant canopies in outdoor environments or in greenhouses and growth chambers, and reflected or under-canopy (transmitted) PPFD measurement in the same environments.

Apogee Instruments MQ series quantum meters consist of a handheld meter and a dedicated quantum sensor that is integrated into the top of the meter housing (MQ-100) or connected by cable to an anodized aluminum housing (MQ-200 and MQ-300 series). Integrated and separate sensors consist of a cast acrylic diffuser (filter), photodiode, and are potted solid with no internal air space. MQ series quantum meters provide a real-time PPFD reading on the LCD display and offer measurements for both sunlight and electric light calibrations (menu selectable) that determine the radiation incident on a planar surface (does not have to be horizontal), where the radiation emanates from all angles of a hemisphere. MQ series quantum meters include manual and automatic data logging features for making spot-check measurements or calculating daily light integral (DLI).

SENSOR MODELS

Apogee MQ series quantum meters covered in this manual are self-contained and come complete with handheld meter and sensor.

Line quantum meters, MQ-300 series, provide spatially averaged PPFD measurements. All sensors along the length of the line are connected in parallel, and as a result, Apogee line quantum meters display PPFD values that are averaged from the location of the individual sensors.



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



MQ-100:
Meter w/ integral sensor



MQ-200:
Meter w/ separate sensor



MQ-300 Series:
Meter w/ separate line sensor

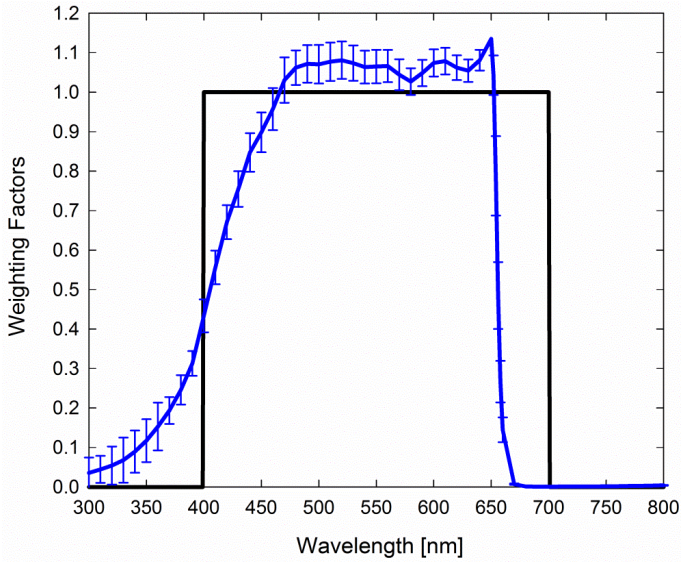
SPECIFICATIONS

	MQ-100	MQ-200	MQ-301	MQ-303/306
Calibration Uncertainty	± 5 % (see calibration Traceability below)			
Measurement Repeatability	Less than 1 %			
Long-term Drift (Non-stability)	Less than 2 % per year			
Non-linearity	Less than 1 % (up to 3000 µmol m^{-2} s^{-1})			
Response Time	Less than 1 ms			
Field of View	180º			
Spectral Range	410 to 655 nm (wavelengths where response is greater than 50 % of maximum; see Spectral Response below)			
Directional (Cosine) Response	± 5 % at 75º zenith angle (see Cosine Response below)			
Temperature Response	0.06 ± 0.06 % per C (see Temperature Response below)			
Operating Environment	0 to 50 C; less than 90 % non-condensing relative humidity up to 30 C; less than 70 % non-condensing relative humidity from 30 to 50 C; separate sensors can be submerged in water up to depths of 30 m			
Meter Dimensions	126 mm length; 70 mm width; 24 mm height			
Sensor Dimensions	Integrated w/ Meter	24 mm diameter; 28 mm height	70 mm length; 15 mm width; 15 mm height	50 mm length; 15 mm width; 15 mm height
Mass	150 g	180 g	380 g	300 g
Cable	2 m of two conductor, shielded, twisted-pair wire; TPR jacket (high water resistance, high UV stability, flexibility in cold conditions)			

Calibration Traceability

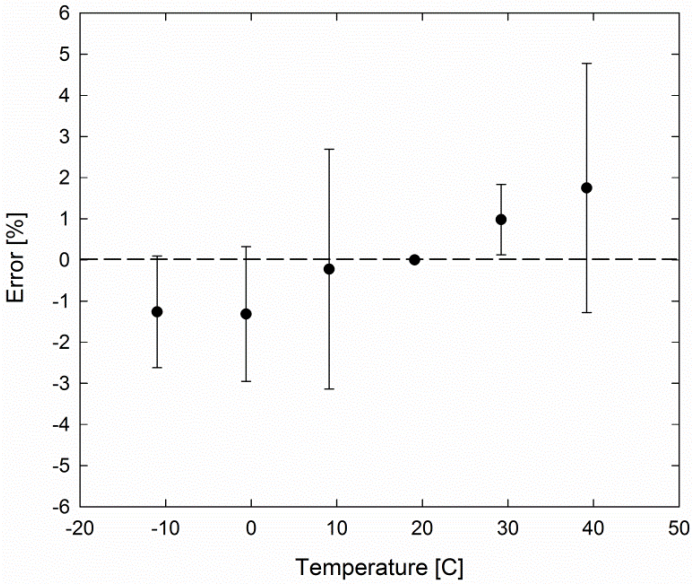
Apogee MQ series quantum meters are calibrated through side-by-side comparison to the mean of four transfer standard quantum sensors under a reference lamp. The reference quantum sensors are recalibrated with a 200 W quartz halogen lamp traceable to the National Institute of Standards and Technology (NIST).

Spectral Response



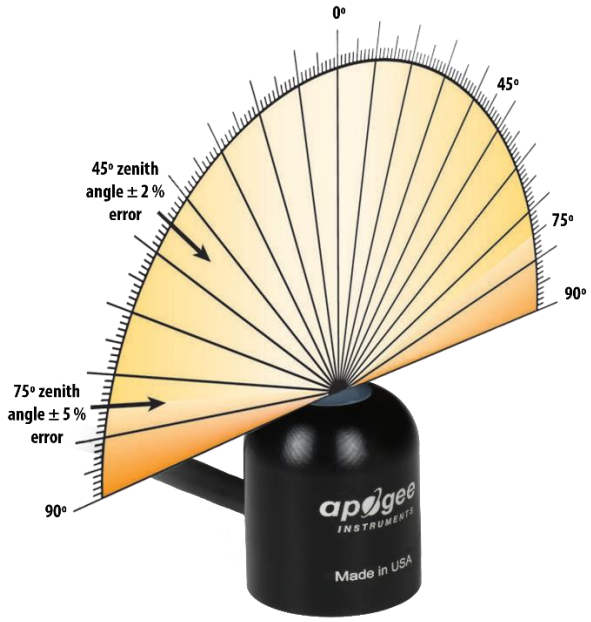
Mean spectral response of six SQ series quantum sensors (***error bars represent two standard deviations above and below mean***) compared to PPFD weighting function. Spectral response measurements were made at 10 nm increments across a wavelength range of 300 to 800 nm in a monochromator with an attached electric light source. Measured spectral data from each quantum sensor were normalized by the measured spectral response of the monochromator/electric light combination, which was measured with a spectroradiometer.

Temperature Response

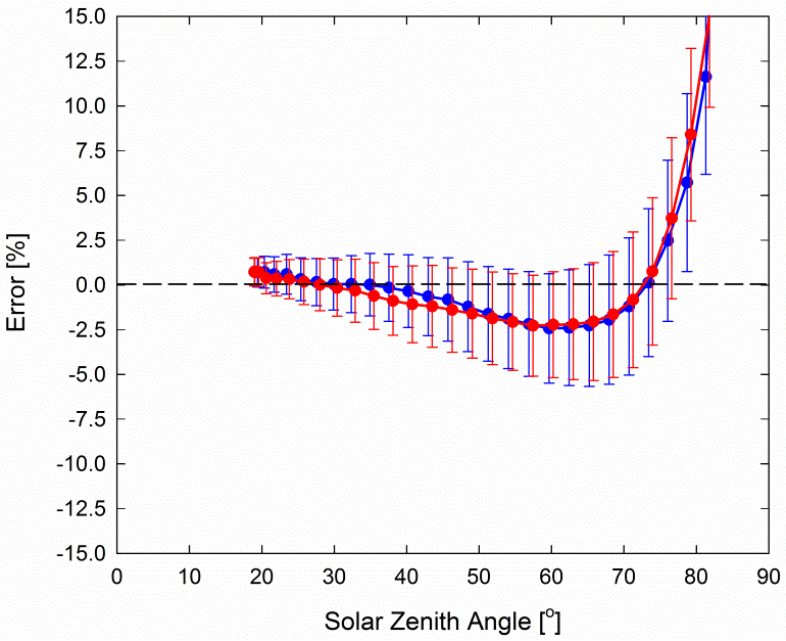


Mean temperature response of eight SQ series quantum sensors (***errors bars represent two standard deviations above and below mean***). Temperature response measurements were made at 10 C intervals across a temperature range of approximately -10 to 40 C in a temperature controlled chamber under a fixed, broad spectrum, electric lamp. At each temperature set point, a spectroradiometer was used to measure light intensity from the lamp and all quantum sensors were compared to the spectroradiometer. The spectroradiometer was mounted external to the temperature control chamber and remained at room temperature during the experiment.

Cosine Response



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



Mean cosine response of twenty-three SQ series quantum sensors (***error bars represent two standard deviations above and below mean***). Cosine response measurements were made by direct side-by-side comparison to the mean of four reference thermopile pyranometers, with solar zenith angle-dependent factors applied to convert total shortwave radiation to PPFD. Blue points represent the AM response and red points represent the PM response.

DEPLOYMENT AND INSTALLATION

Apogee MQ series quantum meters are designed for spot-check measurements, and calculation of daily light integral (DLI; total number of photons incident on a planar surface over the course of a day) through the built-in logging feature. To accurately measure PFFD incident on a horizontal surface, the sensor must be level. For this purpose, each MQ 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 MQ-100.



The AL-100 leveling plate is recommended for use with the MQ-200. To facilitate mounting to a cross arm, the AL-120 mounting bracket is recommended.

MQ-300 series line quantum sensors are leveled using the built-in bubble level located in the handle of the sensor. 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

MQ series quantum meters are designed with a user-friendly 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.



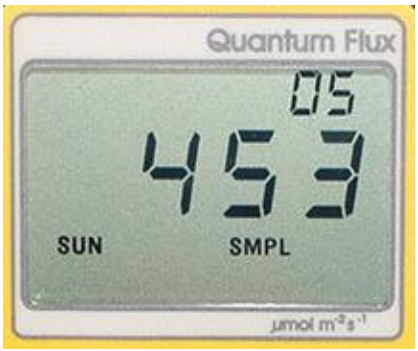
Press the mode button to access the main menu, where the appropriate calibration (sunlight or electric light) and manual or automatic logging are selected, and where the meter can be reset.



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 PPFD value in the center, and the selected menu options along the bottom.

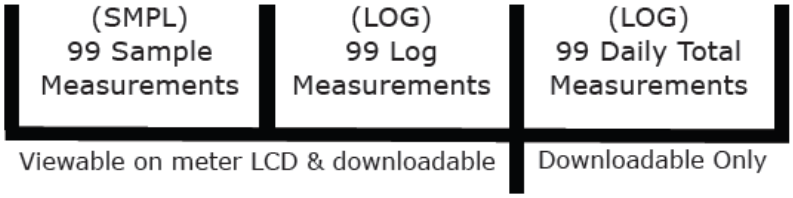
Calibration: To choose between sunlight and electric light calibration, push the mode button once and use the up/down buttons to make the appropriate selection (SUN or ELEC). Once the desired mode is blinking, press the mode button three more times to exit the menu.

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 (mol m^{-2} 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.

Downloading the stored measurements will require the AC-100 communication cable and software (sold separately). The meter outputs data using the UART protocol and requires the AC-100 to convert from UART to USB, so standard USB cables will not work. Set up instructions and software can be downloaded from the Apogee website (http://www.apogeeinstruments.com/ac-100-communcation-cable/).



Spectral Errors and Yield Photon Flux Measurements

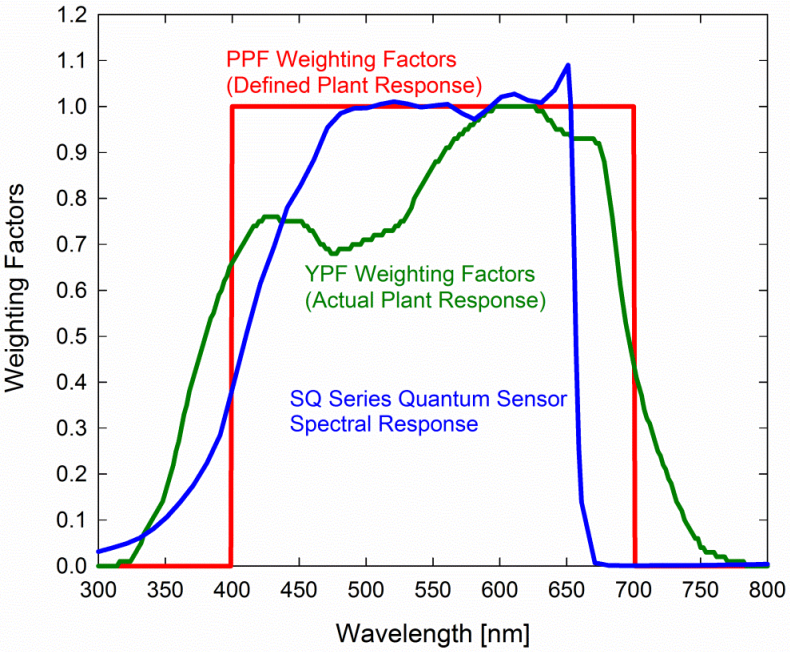
Apogee quantum meters are calibrated to measure PPFD for either sunlight or electric light (menu selectable). The difference between the calibrations is 12 %. A sensor calibrated for electric lights (calibration source is T5 cool white fluorescent lamps) will read approximately 12 % low in sunlight.

In addition to PPFD measurements, Apogee MQ series quantum meters can also be used to measure yield photon flux density (YPF): photon flux weighted according to the plant photosynthetic action spectrum (McCree, 1972) and summed. YPFD is also expressed in units of µmol m^{-2} s^{-1}, and is similar to PPFD, but is typically more closely correlated to photosynthesis than PPFD. PPFD is usually measured and reported because the PPFD spectral weighting function (equal weight given to all photons between 400 and 700 nm; no weight given to photons outside this range) is easier to define and measure, and as a result, PPFD is widely accepted. The conversion factor to calculate YPFD from the PPFD measurements displayed on the LCD is 0.90 and 0.89 for sunlight and electric light measurements, respectively.

The weighting functions for PPFD and YPFD are shown in the graph below, along with the spectral response of Apogee quantum sensors. The closer the spectral response matches the defined PPFD or YPFD spectral weighting functions, the smaller spectral errors will be. The table below provides spectral error estimates for PPFD and YPFD measurements from light sources different than the calibration source. The method of Federer and Tanner (1966) was used to determine spectral errors based on the PPFD and YPFD spectral weighting functions, measured sensor spectral response, and radiation source spectral outputs (measured with a spectroradiometer). This method calculates spectral error and does not consider calibration, cosine, and temperature errors.

Federer, C. A., and C. B. Tanner, 1966. Sensors for measuring light available for photosynthesis. Ecology 47:654-657.

McCree, K. J., 1972. The action spectrum, absorptance and quantum yield of photosynthesis in crop plants. Agricultural Meteorology 9:191-216.



Radiation weighting factors for PPFD (defined plant response to radiation), YPFD (measured plant response to radiation), and Apogee quantum sensors (sensor sensitivity to different wavelengths of radiation).

Spectral Errors for PPFD and YPFD Measurements with Apogee MQ Series Quantum Meters

Radiation Source (Error Calculated Relative to Sun, Clear Sky)	**PPFD Error [%]**	**YPFD Error [%]**
Sun (Clear Sky)	0.0	0.0
Sun (Cloudy Sky)	1.4	1.6
Reflected from Grass Canopy	5.7	-6.3
Reflected from Deciduous Canopy	4.9	-7.0
Reflected from Conifer Canopy	5.5	-6.8
Transmitted below Grass Canopy	6.4	-4.5
Transmitted below Deciduous Canopy	6.8	-5.4
Transmitted below Conifer Canopy	5.3	2.6
Radiation Source (Error Calculated Relative to Cool White Fluorescent, T5)		
Cool White Fluorescent (T5)	0.0	0.0
Cool White Fluorescent (T8)	-0.3	-1.2
Cool White Fluorescent (T12)	-1.4	-2.0
Compact Fluorescent	-0.5	-5.3
Metal Halide	-3.7	-3.7
Ceramic Metal Halide	-6.0	-6.4
High Pressure Sodium	0.8	-7.2
Blue LED (448 nm peak, 20 nm full-width half-maximum)	-12.7	8.0
Green LED (524 nm peak, 30 nm full-width half-maximum)	8.0	26.2
Red LED (635 nm peak, 20 nm full-width half-maximum)	4.8	-6.2
Red, Blue LED Mixture (85 % Red, 15 % Blue)	2.4	-4.4
Red, Green, Blue LED Mixture (72 % Red, 16 % Green, 12 % Blue)	3.4	0.2
Cool White Fluorescent LED	-4.6	-0.6
Neutral White Fluorescent LED	-6.7	-5.2
Warm White Fluorescent LED	-10.9	-13.0

Quantum sensors can be a very practical means of measuring PPFD and YPFD from multiple radiation sources, but spectral errors must be considered. The spectral errors in the table above can be used as correction factors for individual radiation sources.

Underwater Measurements and Immersion Effect

When a quantum sensor that was calibrated in air is used to make underwater measurements, the sensor reads low. This phenomenon is called the immersion effect and happens because the refractive index of water (1.33) is greater than air (1.00). The higher refractive index of water causes more light to be backscattered (or reflected) out of the sensor in water than in air (Smith,1969; Tyler and Smith,1970). As more light is reflected, less light is transmitted through the diffuser to the detector, which causes the sensor to read low. Without correcting for this effect, underwater measurements are only relative, which makes it difficult to compare light in different environments.

The original quantum sensors covered in this manual have an immersion effect correction factor of 1.08. If you wish to use your meter to make measurements underwater, simply multiply the measured number by the immersion effect (1.08).

When making underwater measurements, only the sensor and cable can go in the water. The handheld meter is not waterproof and must not get wet. If the meter might get wet from splashing, we recommend placing it in a plastic bag or other container to help protect it from accidentally getting wet.

Further information on underwater measurements and the immersion effect can be found at http://www.apogeeinstruments.com/underwater-par-measurements/.

MAINTENANCE AND RECALIBRATION

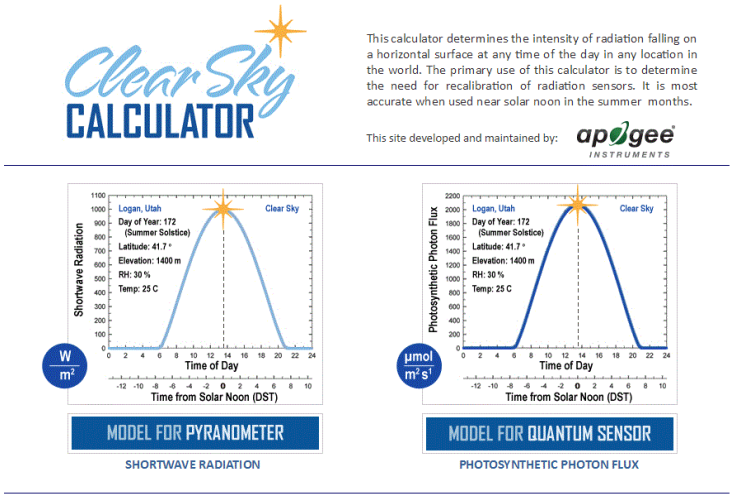
Moisture or debris on the diffuser is a common cause of low readings. The sensor has a domed diffuser and housing for improved self-cleaning from rainfall, but materials can accumulate on the diffuser (e.g., dust during periods of low rainfall, salt deposits from evaporation of sea spray or sprinkler 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 diffuser.**

The Clear Sky Calculator (www.clearskycalculator.com) can be used to determine the need for quantum meter recalibration. It determines PPFD 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 ± 4 % in all climates and locations around the world. For best accuracy, the sky must be completely clear, as reflected radiation from clouds causes incoming radiation to increase above the value predicted by the clear sky calculator. Measured values of PPFD can exceed values predicted by the Clear Sky Calculator due to reflection from the sides and edges of clouds. This reflection increases the incoming radiation. The influence of high clouds typically shows up as spikes above clear sky values, not a constant offset greater than clear sky values.

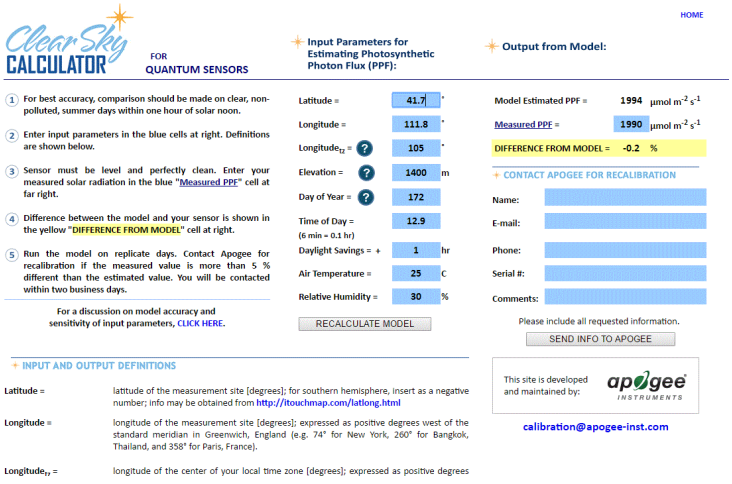
To determine recalibration need, input site conditions into the calculator and compare PPFD measurements to calculated PPFD values for a clear sky. If sensor PPFD measurements over multiple days near solar noon are consistently different than calculated values (by more than 6 %), the sensor should be cleaned and re-leveled. If PPFD measurements are still different after a second test, email calibration@apogeeinstruments.com to discuss test results and possible return of meter(s) for recalibration.

Steps to Replace a Handheld Meter Battery

1. Use a phillips head screw driver to remove the screw from the battery cover.
2. Remove the battery cover by slightly lifting and sliding the outer edge of the cover away from the meter.
3. Use your thumb to slide the battery out of the battery holder.
    a. If the battery is difficult to move, turn the meter on its side so that the opening for the batter is facing downward and tap the meter downward against an open palm to dislodge the battery enough that it can be removed as described in step 3.
4. To place the battery back in, simply slide it back into the battery holder with the flat side of the battery facing up.



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



Clear Sky Calculator for quantum sensors. Site data are input in blue cells in middle of page and an estimate of PPFD 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 PPFD reading. Direct the sensor head toward a light source and verify the PPFD reading responds. Increase and decrease the distance from the sensor to the light source to verify that the reading changes proportionally (decreasing PPFD with increasing distance and increasing PPFD with decreasing distance). Blocking all radiation from the sensor should force the PPFD 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.

Low-Battery Error after Battery Replacement

A master reset will usually correct this error, please see the master reset section for details and cautions. If a master reset does not remove the low battery indicator, please double check that the voltage of your new batter is above 2.8 V, this is the threshold for the indicator to turn on.

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.

Step 1: press the power button so that the LCD display is activated.

Step 2: Slide the battery out of the holder, which will cause the LCD display to fade out.

Step 3: 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 Apogee 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 appropriate MQ model, 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. See Apogee webpage for further details on how to extend sensor cable length: (http://www.apogeeinstruments.com/how-to-make-a-weatherproof-cable-splice/).

Unit Conversion Charts

Apogee MQ series quantum sensors are calibrated to measure PPFD in units of µmol m^{-2} s^{-1}. Units other than photon flux density (e.g., energy flux density, illuminance) may be required for certain applications. It is possible to convert the PPFD value from a quantum sensor to other units, but it requires spectral output of the radiation source of interest. Conversion factors for common radiation sources can be found on the Unit Conversions page in the Support Center on the Apogee website (http://www.apogeeinstruments.com/unit-conversions/). A spreadsheet to convert PPFD to energy flux density or illuminance is also provided on the Unit Conversions page in the Support Center on the Apogee website (http://www.apogeeinstruments.com/content/PPFD-to-Illuminance-Calculator.xls).

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/. 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, 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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