

# QUANTUM RADIOMETER

## MODEL Q201

### HANDBOOK

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A	26/01/01	New Issue
B	09/08/05	First Update

## 1 INTRODUCTION

The Macam portable digital Quantum radiometers model Q201 is a versatile direct reading instrument designed specifically for measuring photosynthetic active radiation (PAR 400 and 700nm) in units of  $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  (micro Einstein. $\text{m}^{-2}\cdot\text{s}^{-1}$ ).

The radiometer comprises of a Q201X handheld display unit with Lithium battery, SD221Q Cos detector and integral amplifier, with interconnecting cable. The meter also includes a calibration certificate and CC-2 carrying case.

The Q201 may be used in applications such as Agriculture, Horticulture, Plant Growth studies, Biology, Liminology (with under water detectors).

**2 SPECIFICATION:**

DISPLAY UNIT	Q201X	
Controller:	80C51 based 8bit micro-processor with a 3.6864MHz clock.	
Memory	On board non volatile RAM for calibration factors and set-up parameters.	
Key Operation	3 switch key board.	
Power Switch	Microprocessor reset at switch on.	
Integration Time	0.33s	
Conversion Scale	17 bit	
Accuracy:	Measurement accuracy $\pm 1$ digit with a linearity error of $<1\%$ .	
Display:	4½ digit lcd display. Character height 10mm.	
Power Supply:	9 volt 1200mAh, PP3 Lithium Manganese.	
Power Consumption:	Shut down mode	$<5\mu\text{A}$
	Operating	10 - 20mA
Battery Life	~ 50 hours without backlight use	
Range:	PAR	
	Full scale decade measuring from*:	
	0 to 1999.9 $\mu\text{mol.m}^{-2}.\text{s}^{-1}$	
	Resolution 0.1 $\mu\text{mol.m}^{-2}.\text{s}^{-1}$ .	
	* Other ranges available on request.	
Calibration	Absolute calibration accuracy $\pm 7.5\%$ traceable to NPL standards.	

**2 SPECIFICATION (continued):**

## Front Panel Controls:

ZERO Initiates a zero or background measurement.

*HOLD/RUN* Display is held at present reading until HOLD button is pressed again. Select to run or hold.

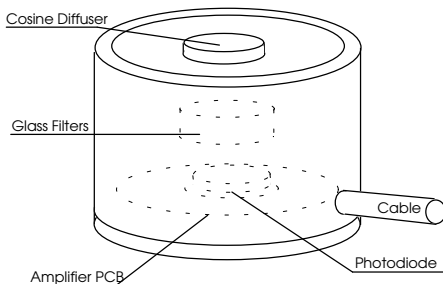
⓪ Power on / off button

Connectors: 4 pin mini DIN type detector connector.

Temperature Range: 0 to 40°C. 80% RH.

Dimensions: 150 x 80 x 45mm.  
High impact polystyrene.

Weight: approx. 270g

**2 SPECIFICATION (continued):****SD221Q Cos DETECTOR**

The SD221Q Cos quantum detector comprises of an aluminium housing, photodiode, PAR filter and PCB assembly.

Detector: 15mm<sup>2</sup> High stability silicon photodiode.

Spectral Response: Refer figure 1.

Angular Response: Accurately cosine corrected to Lambert's Cosine Law. Maximum error is less than  $\pm 5\%$  from true response to  $70^\circ$  from normal incidence, reference section 5.

Temperature Coefficient:  $<0.3\ \%/^\circ\text{C}$

Amplifier Gain  $5 \times 10^4\ \text{V/A}$

Current to Frequency 0 - 0.5Mhz

Linearity Error:  $<1\%$  across range

Temperature Range: Operation:  $-10$  to  $+60^\circ\text{C}$   
Storage:  $-20$  to  $+70^\circ\text{C}$

Detector Housing: Black anodised aluminium alloy housing.

Cable: 1 metre cable to 4 pin mini DIN type connector

Weight: approx. 140g

**2 SPECIFICATION (continued):**

SD221Q Cos Detector  
Typical Spectral response

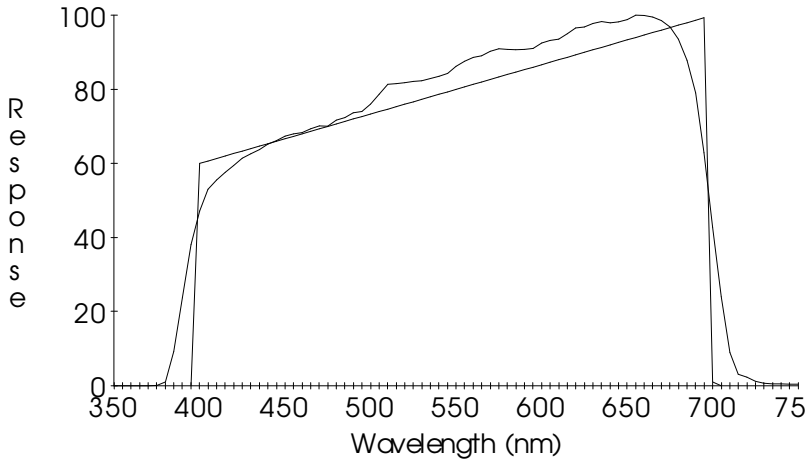


Figure 1

### 3 OPERATION

#### SETTING UP

- 1) With the unit OFF, plug the detector 4 way connector into the socket on the top of the display unit.
- 2) Press and release the power switch on the Q201 display key pad. The microcontroller will initiate, the display momentarily showing:-



The radiometer display will now change to show the PAR value. A typical display is shown below.



- 3) It is recommended that the radiometer amplifier is nulled periodically. Place the cover over the detector. Press and release the *ZERO* switch, the display will momentarily show:-



- 4) The micro controller will now measure the amplifier offset and store this value in the non volatile memory. All subsequent measurements will first have this offset subtracted before displaying the measurement. At the end of the sequence the display will show:-



- 5) Remove the light cover from the detector. The equipment is now ready for use.
- 6) At any time the measurement process can be halted by pressing the HOLD/RUN button. Pressing the button once again will resume the measurement process.

#### 4 PAR MEASUREMENTS

The Q201 radiometer measures the number of quanta (photons) of light between 400nm and 700nm incident on the diffuser input to the detector, per second. Measurement units are  $\mu\text{mol.m}^{-2}.\text{s}^{-1}$  (equivalent to  $\mu\text{Einstein.m}^{-2}.\text{s}^{-1}$ ). Conversion to number of photons  $1 \mu\text{mol.m}^{-2}.\text{s}^{-1} = 6.02 \times 10^{17} \text{ quanta.m}^{-2}.\text{s}^{-1}$

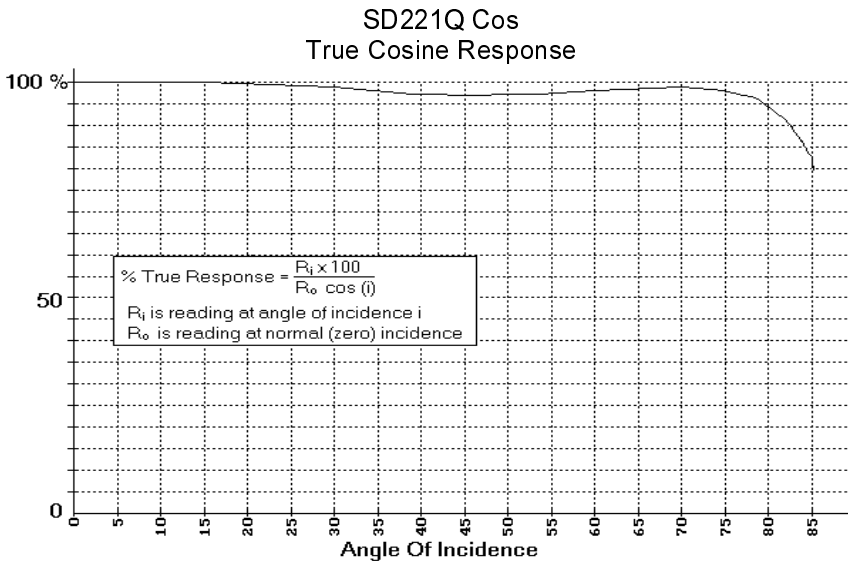
For most applications the measurement plane is horizontal and a cosine corrected diffuser is fitted to the front of the detector assembly. If the working surface is not horizontal then placing the detector on or parallel to the worktop is a more representative measurement of irradiance.

Note that all the light sources in the hemisphere above the detector will contribute to the measurement. The sources may be obvious, lamps or windows or even walls or other reflecting surfaces. Take care not to shadow the detector during all measurements.

**5 COSINE ANGULAR RESPONSE**

Quantum irradiance is a measurement of the amount of light incident on a unit area ( $\mu\text{mol.m}^{-2}.\text{s}^{-1}$ ). Any detector will measure this reliably when measuring a beam of light perpendicular to the detectors surface, however, when measuring scattered light or light from an extended source the sensor must have an accurate response over its 180° field of view. More importantly, this response should be proportional to the cosine of the angle of light incident on the detector. This comes from the fact that the projected area of any surface at an angle of  $i$  is proportional to  $\cos(i)$ .

To ensure that the integration of light from all angles is correct, the cosine diffuser matches the angular response so that response of the detector decreases with  $\cos(i)$  as the angle between the source and detector increases from 0 to 90°.



Macam's cosine diffusers are corrected to match the cosine response to within  $\pm 5\%$  up to angles of 70°. This ensures that the meter correctly reads illuminance or visible light flux density whether it is measuring light from an extended or a point source.

## **6 CALIBRATION DESCRIPTION**

Macam Photometrics hold a number of tungsten halogen and deuterium lamps and a silicon photodiode which are routinely calibrated by the National Physics Laboratory in the UK.

PAR Calibration is carried out using a solar simulated uniform source and Macam Spectroradiometer.

During manufacture each detector has its spectral response measured. Changes are made to the filter glasses if the peak wavelength or filter bandwidth exceed the specification limits. A graph of the final filter/detector response is provided. The data on a disk (IBM PC format) is also available on request for importing to a spreadsheet.

As with all measuring equipment a routine calibration is recommended, typically annually, but with frequent use by a number of different users a shorter recalibration period may be necessary.

## **7 CARE AND MAINTENANCE**

- 1) The Q201 display unit can be cleaned using a moist cloth with detergent. Do not use solvent or alcohol to clean surfaces.
- 2) The diffuser on the detector should be kept clean at all times.
- 3) The radiometer is a precision instrument, protect from shocks.
- 4) Avoid supporting the detector by the multi core cable.

## **8 OPTIONAL ACCESSORIES**

The following items are available from Macam:

Levelling Plate (Three adjustable feet and built in spirit bubble)  
Waterproof Cosine and  $4\pi$  detectors  
Extension cable

### 9 BLOCK DIAGRAM

