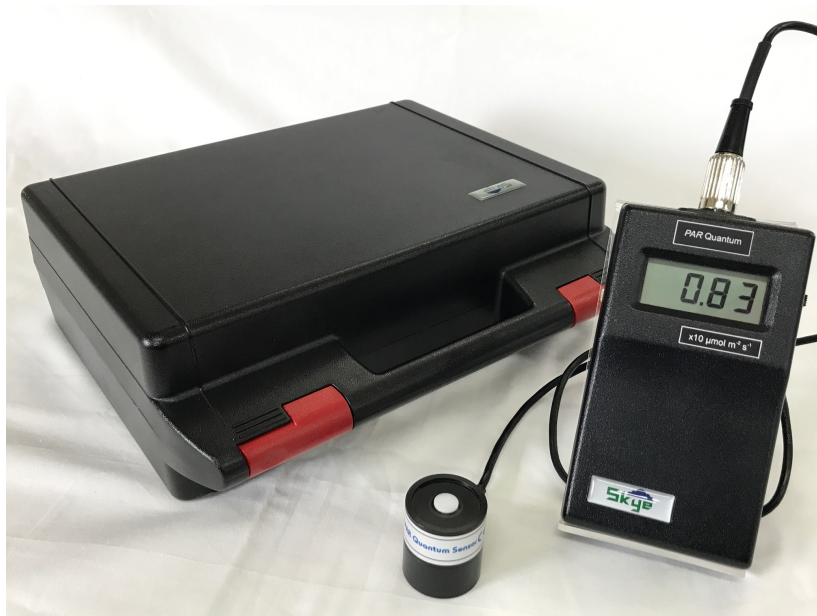




Display Meter for Single Channel Light Sensors



**SKP 210/200, SKP 215/200, SKE 510/500,
SKS 1110/1100, SKL 310/300,
SKP 210H/216Q-216ER**

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Skye Instruments Ltd.

Skye Instruments is based in the UK and we are very proud to be celebrating being in business since 1983. Our products are designed and built in the UK. We have a very wide product base and our sensors & systems are used for plant & crop research; micro-climate, global climate change studies; environmental monitoring and controlled environment installations.

Products include light sensors & systems, weather monitoring sensors, automatic weather stations, plant research systems, soil and water research systems.

Feel free to contact us via our e-mail, or any of the methods below. Please click on the icons to browse the sites, or search for the usernames.



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Please be aware that the information in this manual was correct at time of issue, and should be 100% relevant to the accompanying product. We take great pride in our ever-evolving range of products, which means that sometimes the product may change slightly due to a re-design. If you have any queries, please do not hesitate to contact our technical team by any of the methods above.

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Display Meter for Single Channel Sensors

1. INTRODUCTION

Skye Instruments Limited family of specialist light sensors include sensors to measure different parts of the ultra violet, visible and infra-red spectrum for a wide range of applications. All sensors use high quality photodiodes and spectral filters, and are individually calibrated to National Standards. Each is supplied with a traceable Calibration Certificate.

The single channel Light Sensors are fully waterproof to IP67 standards and are suitable for temporary immersion to 4m depth for up to 30 minutes. They are ideal for monitoring light levels in all environments around the world.

There are five types of sensor in this range, Photosynthetically Active Radiation sensors (PAR Quantum, PAR Special and PAR Energy), total Solar Radiation Pyranometer, and Lux sensor for human or animal studies.

This manual covers the non-amplified output sensor versions and the Display Meter, where the output signal comes direct from the sensor photodiode. Amplified versions and add on amplifiers are also available from Skye, please enquire for details.

These sensors are cosine corrected, which means that they accept incoming light according to Lambert's Cosine Law. Essentially this means that light is measured from the hemisphere directly above the sensor.

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2. WATERPROOF SENSORS

SKP 210 – PAR Special

SKP 215 – PAR Quantum

SKL 310 – LUX Sensor

SKE 510 – PAR Energy Sensor

These four sensors have cosine - corrected heads, each containing a semi conductor diode and filter system responding to light according to the response curves in Appendix 1.

They are all fully waterproof to IP67 standards and may be left exposed to rain and used in humid climates. They are suitable for temporary immersion to 4m depth for up to 30 minutes.

Each sensor has been calibrated against a reference lamp, whose own calibration has been carried out at the National Physical Laboratory (NPL).

SKS 1110 – Silicon Cell Pyranometer

The pyranometer cosine corrected head contains a special high grade silicon photocell, sensitive to light between 350 and 1100nm. The sensor is fully waterproof to IP67 standards and are suitable for temporary immersion to 4m depth for up to 30 minutes.

This sensor has been calibrated under open-sky conditions, against reference pyranometers and hence referred to the World Radiometric Reference. The calibration thus refers to Solar energy in the waveband 300nm to 3000nm, i.e. the acceptance band of thermopile pyranometers.

Because of the different spectral responses of the silicon photocell and the thermopiles, to obtain accurate readings the unit must be used in the same conditions as its calibration, i.e. under open sky only. The calibration of the SKS 1110 silicon cell pyranometer is not valid for measuring solar radiation inside glasshouses or polytunnels etc.

Different conditions of sun, cloud, etc., will slightly affect calibration, but absolute errors will always be within 5% and typically much better than 3%.

Linearity is excellent, with a maximum of 1% deviation up to levels of 3000 W m⁻² (greater than normal solar irradiance).

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3. POSITIONING OF ALL TYPES OF SENSORS

For accurate positioning of all of the sensors except the SKP 216ER and SKP 216Q, we would recommend the use of a levelling unit (SKM 221). Great care should be given to the placing of the sensor, in order to achieve accurate and repeatable results. Avoid objects, trees, etc., that will shade the sensor selectively, compared with the areas under study.

The SKP 216ER and SKP 216Q sensors have been designed to fit in a Hansatech Leaf Chamber. The full system comprises a large area sensor machined to match with the Hansatech Leaf Chamber, and a measuring unit giving direct readout of light levels at the leaf surface in $\mu\text{mol m}^{-2} \text{s}^{-1}$.

4. COSINE CORRECTION

Since the sensor is intended to measure light falling on a horizontal plane (i.e. the ground), it is designed to collect light from the whole hemisphere of sky above it. This is why light sensors are cosine corrected.

Light rays perpendicular to the sensor are fully measured, while those at 90° are not accepted (they pass parallel to the surface of the plane or the ground and never intercept it). Rays at intermediate angles are treated according to the cosine of their angle to the perpendicular. Imagine the sun overhead, you feel its rays strongest when directly overhead, and much weaker when the sun is near the horizon. The sensor measures light from the different angles in a similar way, stronger when overhead than at low angles.

The cosine response of the sensor is shown in Appendix 2. The cosine errors to angle of 70° are minimal and are less than 5% to an angle of 80° . The graph shows the actual response of the sensor as a percentage of the ideal response. At 90° , even the most insignificant acceptance of light represents an infinite error, and because of this, accurate plotting beyond 85% is not practical. Errors from such low angle light in nature are generally not material in most studies.

5. SENSOR MAINTENANCE

Sensors require very little maintenance apart from keeping the top light collecting surface (small white diffusing disc) clean and dust free. This can be done using a soft cloth dampened with de-ionised water. Take care not to scratch this surface as this may affect the sensor calibration.

Skye Instruments light sensors and meters are recommended to be calibrated every 2 Years. Please return to Skye where the sensor will be calibrated against the reference lamp and the meter adjusted accordingly.

6. CONNECTIONS

Connection to obtain either mV or microamp output is shown in Appendix 3. Please note that external voltages must not be applied to the sensor, the silicon photocell and precision resistive elements may be damaged by reverse voltage or excess current.

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7. THE DISPLAY METER

The SKP 200, SKL 300, SKS 1100 and SKE 500 display meters are normally supplied with and calibrated for their equivalent sensor heads. The relative response curves are shown in Appendix 1.

The serial numbers of the matching sensor and meter are shown on the reverse of the display meter.

The instrument is powered by a single PP3 battery, accessible by removing the cover located on the back of the unit. Alkaline Manganese or rechargeable NiCad types are recommended.

A "low" battery warning appears in the top left hand corner of the display, when the battery drops below 6 volts. The accuracy of the instrument is not impaired until the battery falls below 4 volts, at which point the display begins to fade. However, once the low battery indicator is on, there is only about 10% of the useful life of a dry cell remaining, and a NiCad battery will be harmed by further discharge. Remove exhausted batteries from the unit.

An on/off switch is provided. On older models (built before 2018) the unit is switched off automatically by unplugging the sensor from the meter.

The unit should be protected from extremes of temperature (e.g. when left in a car) as exposures below -10°C or above +70°C may cause damage to the Liquid Crystal Display. These display meters are splashproof only and should not be allowed to get wet.

All units are calibrated against standards traceable to the NPL, and subsequent recalibration every two years is recommended.

The measuring unit has three ranges, the table below details these. PLEASE NOTE - the reading displayed on the SKP 200 meter should be multiplied by 10.

Display Meters	Sensors	Scales	Units
SKP 200	SKP 210 SKP 215	0-200 0-2,000 0-20,000	$\mu\text{mols m}^{-2} \text{s}^{-1}$
SKL 300	SKL 310 SKL 315	0-2 0-20 0-200	klx
SKE 500	SKE 510 SKE 512	0-20 0-200 0-2,000	W m^{-2}
SKS 1100	SKS 1110	0-20 0-200 0-2,000	W m^{-2}
SKP 200H	SKP 216Q SKP 216ER	0-20 0-200 0-2000	$\mu\text{mols m}^{-2} \text{s}^{-1}$

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At all times the most sensitive range possible should be selected, the unit will not be damaged by accidental over-ranging.

The meter may require zero adjustment from time to time. This is easily accomplished by covering the top of the sensor completely to exclude all light. The scale should show '-000' with the zero sign showing intermittently. To achieve this, set the instrument to the most sensitive range, and using a small screwdriver adjust the potentiometer located just inside the small hole adjacent to the sensor plug and socket.

This adjustment will not affect full scale calibration.

Extreme conditions of temperature or humidity may cause a zero drift.

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8. DISPLAY METER OUTPUT SOCKET

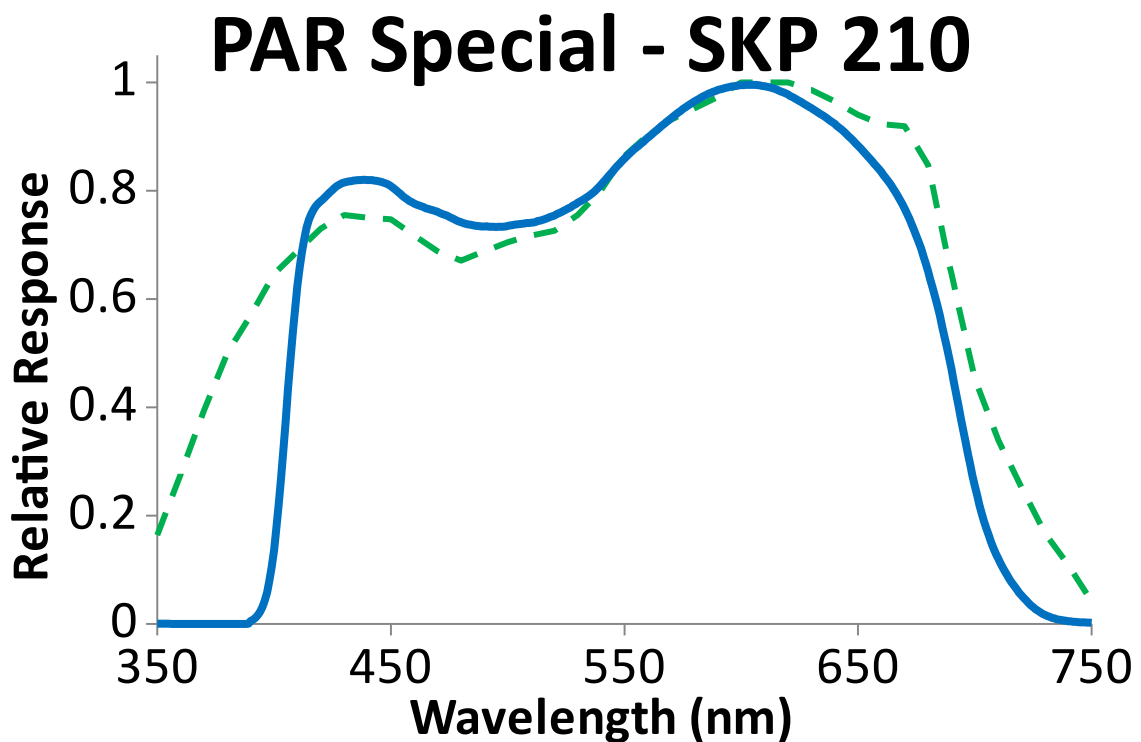
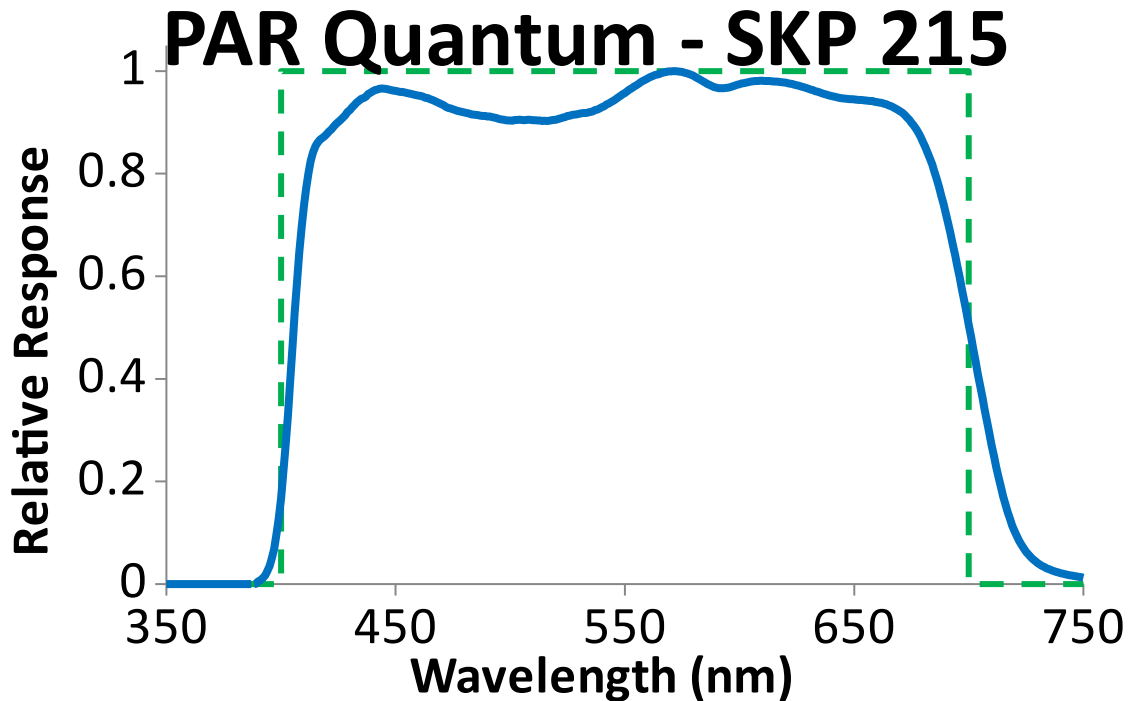
Meters with the part number SKP200H or a serial number below 47347 also have chart recorder output is from the unit. This is suitable only for feeding high impedance inputs, such as DVMs, Chart Recorders, Dataloggers, etc.

A suitable plug for connection is a 2.5mm 'Jack' (one is supplied with the unit), with the positive connection to the tip and the earth to the body of the plug.

The output is scaled with the display, being normally 0-2 V as with the display in three ranges. The chart recorder output however, unlike the display will exceed 2.0 V. For example, on the 0-2,000 $\mu\text{mols m}^{-2} \text{s}^{-1}$ range, 2.0 V at the recorder output corresponds with the display to 2000 $\mu\text{mols m}^{-2} \text{s}^{-1}$ but if the light input is increased without changing range then the recorder output will increase linearly at the same scale up to 3 volts (corresponding on this range to 3,000 $\mu\text{mols m}^{-2} \text{s}^{-1}$) even though the display is showing over-range. Thus the chart recorder output has three ranges - 0-30, 0-300 and 0-3,000 over the outputs 0-3000 mV.

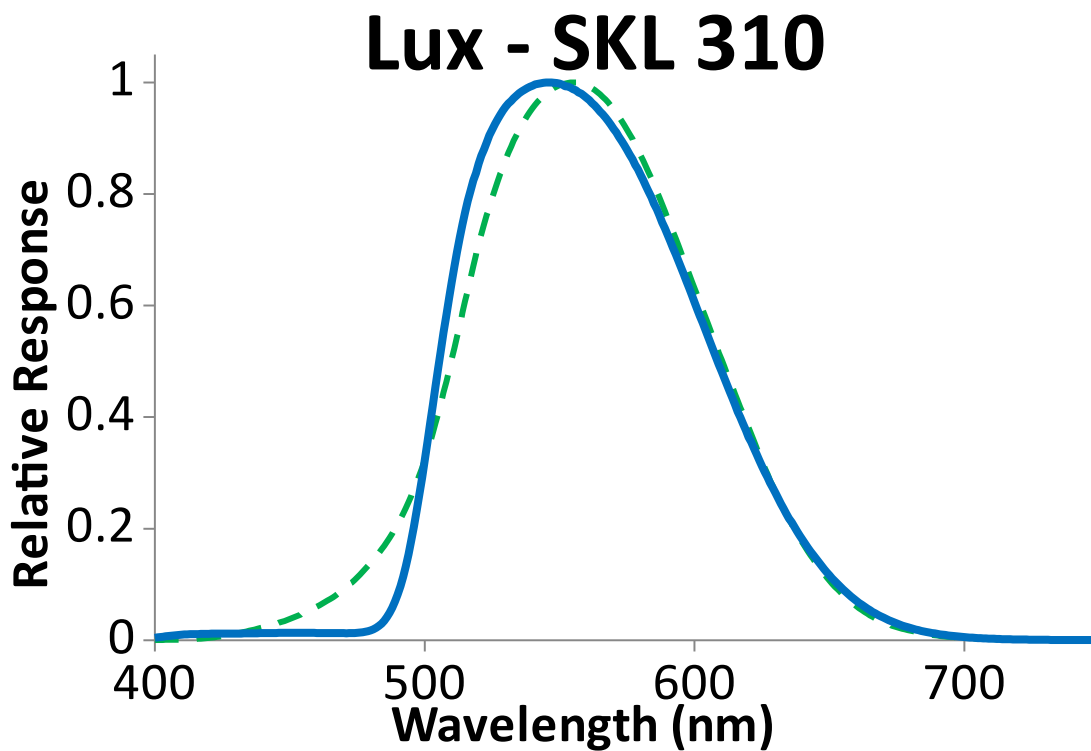
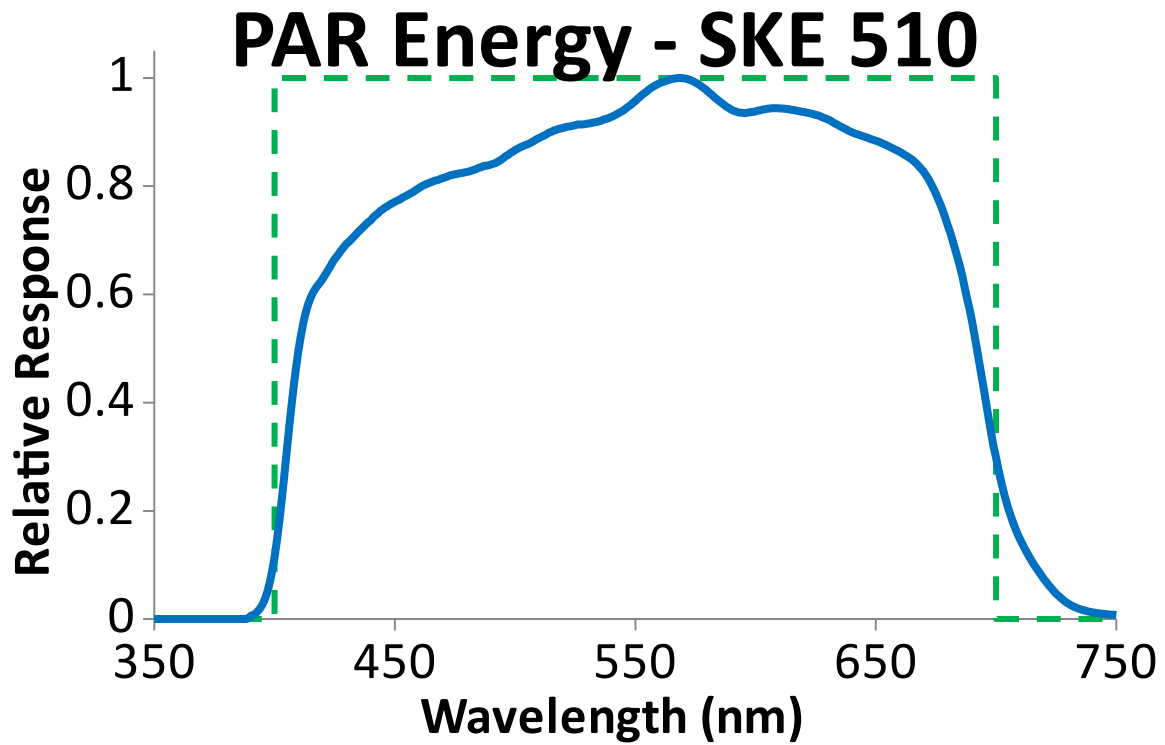
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APPENDIX 1 – SENSOR WAVELENGTH RESPONSE

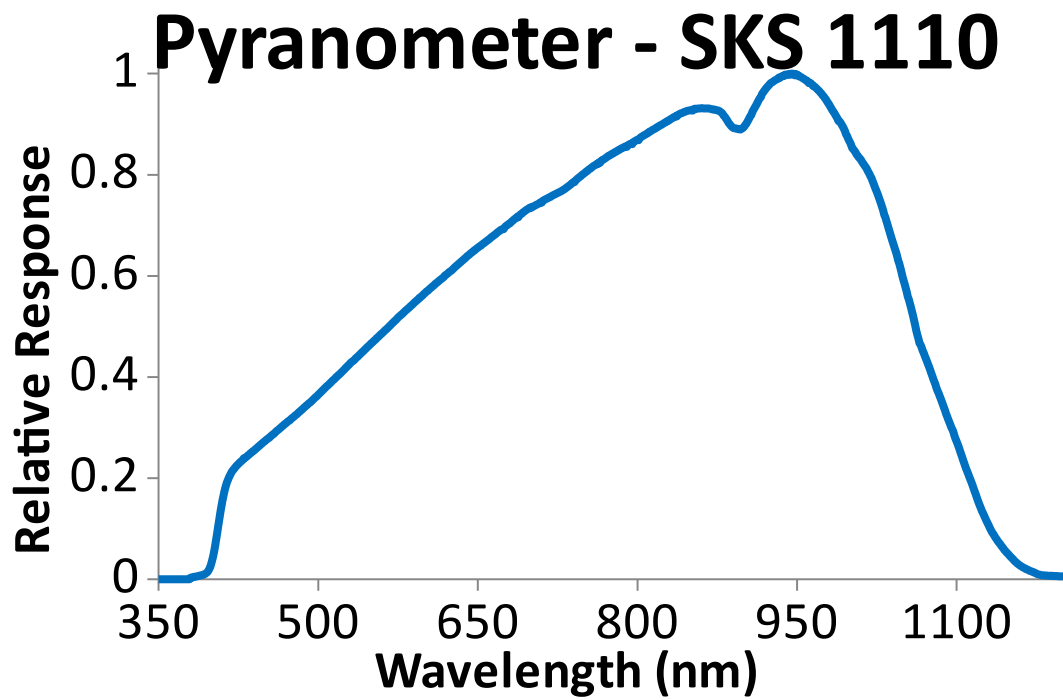


* KJ McCree. The action spectrum, absorbance and quantum yield of photosynthesis in crop plants. Agricultural Meteorology. 1971/72. Vol 9, pp 191-216.

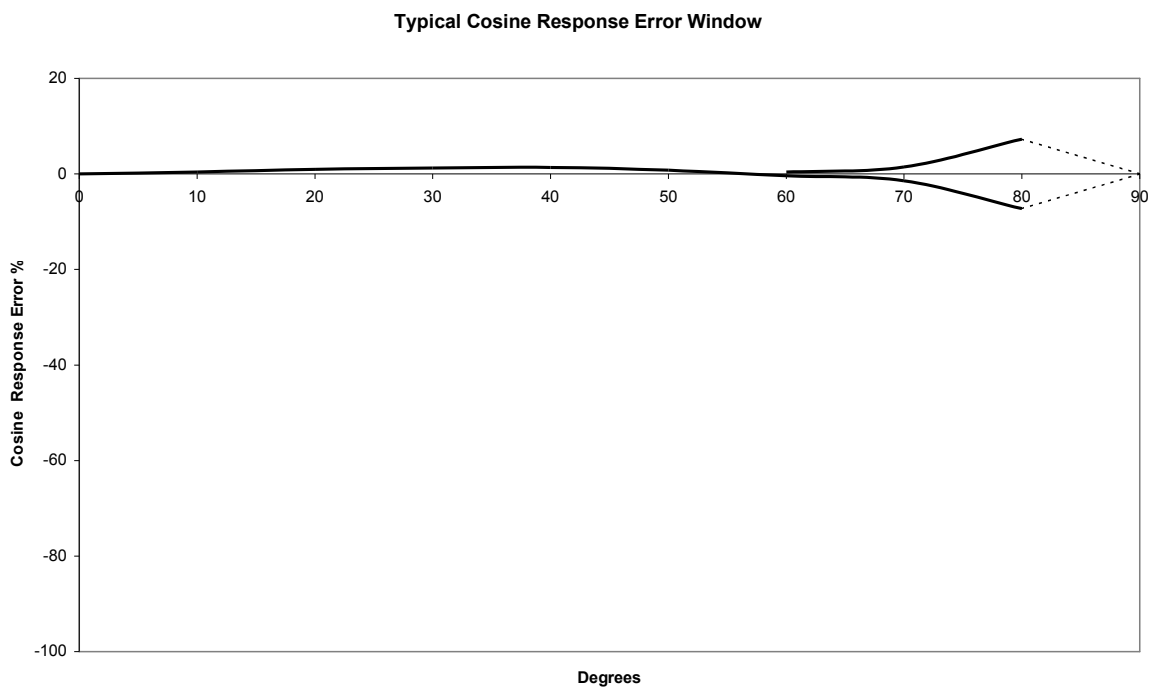
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APPENDIX 2 – COSINE CORRECTION



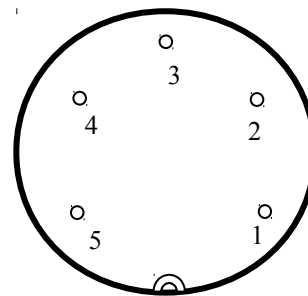
Display Meter for Single Channel Sensors

APPENDIX 3 – SENSOR CONNECTIONS

/I

These sensors have been fitted with a 5 pin plug for a Skye Display Meter (and DataHog datalogger) and wired for a current input socket of the Meter, as shown below:

Pin 1	not connected
Pin 2	not connected
Pin 3	Red
Pin 4	Blue
Pin 5	Green and cable screen



OUTSIDE PIN VIEW

STANDARD 6 PIN PLUG (PRE 2018)

If your sensor was manufactured before early 2018, you will have a 6 pin plug fitted. Please contact Skye for wiring details for this type of plug fitting.

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APPENDIX 4 – LIGHT SENSOR SPECIFICATIONS

	SKP 215	SKP 210	SKE 510	SKL 310	SKS 1110
Sensitivity - current (1)	0.015 $\mu\text{A}/\mu\text{mol m}^{-2}\text{s}^{-1}$	0.01 $\mu\text{A}/\mu\text{mol m}^{-2}\text{s}^{-1}$	0.1 $\mu\text{A}/\text{W m}^{-2}$	0.15 $\mu\text{A}/\text{klx}$	0.05 $\mu\text{A}/\text{W m}^{-2}$
Sensitivity - voltage	10 $\mu\text{V}/\mu\text{mol m}^{-2}\text{s}^{-1}$	10 $\mu\text{V}/\mu\text{mol m}^{-2}\text{s}^{-1}$	10 $\mu\text{V}/\text{W m}^{-2}$	100 $\mu\text{V}/\text{klx}$	10 $\mu\text{V}/\text{W m}^{-2}$
Working range (2)	0-50000 $\mu\text{mol m}^{-2}\text{s}^{-1}$	0-50000 $\mu\text{mol m}^{-2}\text{s}^{-1}$	0-5000 W m^{-2}	0-500 klx	0-5000 W m^{-2}
Sensor Passband	PAR 400 - 700 nm	PAR 400 - 700 nm	PAR 400 - 700 nm	CIE photopic Curve V(λ)	350 - 1100 nm
Internal resistance - voltage output	c.300 Ω	c.1000 Ω	c.130 Ω	c.650 Ω	c.200 Ω
Temperature Co-efficient	$\pm 0.1\%/^{\circ}\text{C}$				$\pm 0.2\%/^{\circ}\text{C}$
Linearity error over working range	<0.2%				
Absolute calibration error (3)	typ. <3% 5% max.				
Cosine error (4)	3%				
Azimuth error (5)	<1%				
Longterm stability (6)	$\pm 2\%$				
Response time - voltage output (7)	$\leq 10\text{ns}$				
Material	Acetal				
Dimensions	34mm diameter - 38mm height				
Cable	Screened 7-2-3C				
Detector	Si Photodiode				
Filters	Optical glass				

NOTES ON SPECIFICATIONS

(1) Current output varies from sensor to sensor. Each individual unit will have a slightly different output. A calibration certificate is supplied with each sensor.

(2) All Skye sensors will work at levels of irradiance well above that found in terrestrial sunlight conditions, room or growth chamber lighting.

(3) Main source of this error is uncertainty of calibration of Reference Lamp. Skye calibration standards are directly traceable to NPL standard references.

(4) Cosine error to 80° is typically 5% max. Figures shown are for normal use sources, e.g. sun plus sky, diffuse sun, growth chambers, etc.

(5) Measured at 45° elevation over 360°.

(6) Maximum change in one year. Calibration check recommended at least every two years. Experience has shown that changes are typically much less than figures quoted.

(7) Times are generally less than the figure quoted, which is in nanoseconds. They may be slightly increased if long leads are fitted, or those of a higher capacity cable.