



## Single Channel Light Sensors



Skye Instruments Ltd.,  
21 Ddole Enterprise Park,  
Llandrindod Wells,  
Powys LD1 6DF UK  
Tel: +44 (0) 1597 824811

[skyemail@skyeinstruments.com](mailto:skyemail@skyeinstruments.com)

[www.skyeinstruments.com](http://www.skyeinstruments.com)

## 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.

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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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# Single Channel Light Sensors

## 1. INTRODUCTION

Skye Instruments' 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, three PAR or Photosynthetically Active Radiation sensors (PAR Quantum, PAR Special and PAR Energy), a total solar radiation Pyranometers plus Lux sensors for human or animal studies.

This manual covers the non-amplified output sensor versions, 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. LIGHT SENSORS FOR MEASURING FROM ANY LIGHT SOURCE**

- 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). They are calibrated for use with any natural or artificial light source.

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## 3. LIGHT SENSORS FOR TOTAL SOLAR RADIATION

- 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<sup>-2</sup> (greater than normal solar irradiance).

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## 4. POSITIONING OF ALL TYPES OF LIGHT SENSOR

For accurate positioning of the sensor Skye 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.

## 5. 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  $90^\circ$  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  $70^\circ$  are minimal and are less than 5% to an angle of  $80^\circ$ . The graph shows the actual response of the sensor as a percentage of the ideal response. At  $90^\circ$ , 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.

## 6. SENSOR MAINTENANCE

Light 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 a new calibration certificate issued.

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## 7. CONNECTIONS

### Wire Ended Sensors (no part number suffix)

Connection to obtain either mV or  $\mu\text{A}$  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.

### /I

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

### /D/I

These sensors have been fitted with a 5 pin plug for a Skye DataHog datalogger connection and wired for a differential voltage input socket, as shown below:

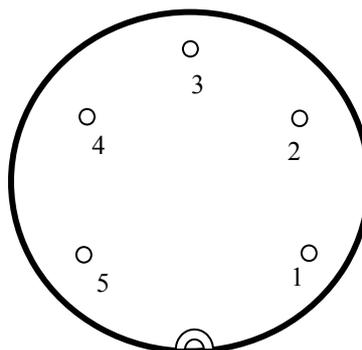
### /SS2

These sensors have been fitted with a 5 pin plug for a Skye SpectroSense2 meter connection and wired for a current input socket, as shown below:

Pin Number	/I	/D/I	/SS2
1	not connected	not connected	not connected
2	not connected	Blue (link to pin3)	Red
3	Red	Red	not connected
4	Blue	Green (link to pin5)	Blue
5	Green + screen	Screen	Green + screen

### Datahog, Display Meter and SpectroSense2 waterproof binder 5 pin plug

Outside pin view



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## **/LT**

These sensors are fitted with a grey cable that has the following temperature specifications;

Moving: -20°C to +80°C

Fixed: -40°C to +80°C

In the /LT version the standard wire colours are substituted as shown below.

### **/LT Cable Wire Colour:**

Brown

Yellow

Green

Pink

### **Standard Cable Wire Colour:**

Red

Blue

Green

Grey

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## 8. HISTORICAL VARIATIONS

**Sensors manufactured prior to February 2008** without a suffix will be fitted with a 2 core (red and blue) screened cable, where a green "tail" is fitted to the cable screen.

For a mV voltage output, the negative output is from both red and blue wires connected together, the positive output is from the green wire.

For a  $\mu$ A current output, the negative output is from the blue wire and the positive output from the green wire. The red wire is not used in this case.

**Sensors manufactured between February 2008 and September 2011** will have a part number containing the suffix "/S". This is simply a change in connection to include an uncommitted cable screen. All other specifications remain the same. All serial numbers above 40000 have uncommitted screens but no /S.

### **L**

E.g. SKL 310L. These sensors have been fitted with a Large Area Photodiode for increased sensitivity at low light levels. All other sensor specifications and wire connections remain the same. The sensitivity of the individual sensor is shown on the Calibration Certificate as usual.

### **LS**

These sensors have been fitted with a Large Area Photodiode plus a non cosine correcting diffuser for maximum sensitivity at low light levels. All other sensor specifications and wire connections remain the same. The sensitivity of the individual sensor is shown on the Calibration Certificate as usual.

### **/M4**

These sensors have an M4 threaded hole in the base to facilitate mounting.

### **/V**

These sensors have a voltage output only.

The red wire is the positive output and the blue wire is the ground / screen. All other specifications remain the same.

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## 9. SPECIFICATIONS

	<b>SKP 215</b>	<b>SKP 210</b>	<b>SKE 510</b>	<b>SKL 310</b>	<b>SKS 1110</b>
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 $\text{W m}^{-2}$	0-500 klx	0-5000 $\text{W m}^{-2}$
Sensor Passband	PAR 400 - 700 nm	PAR 400 - 700 nm	PAR 400 - 700 nm	CIE photopic Curve V( $\lambda$ )	350 - 1100 nm
Internal resistance - voltage output	c.300 $\Omega$	c.1000 $\Omega$	c.130 $\Omega$	c.650 $\Omega$	c.200 $\Omega$
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°.

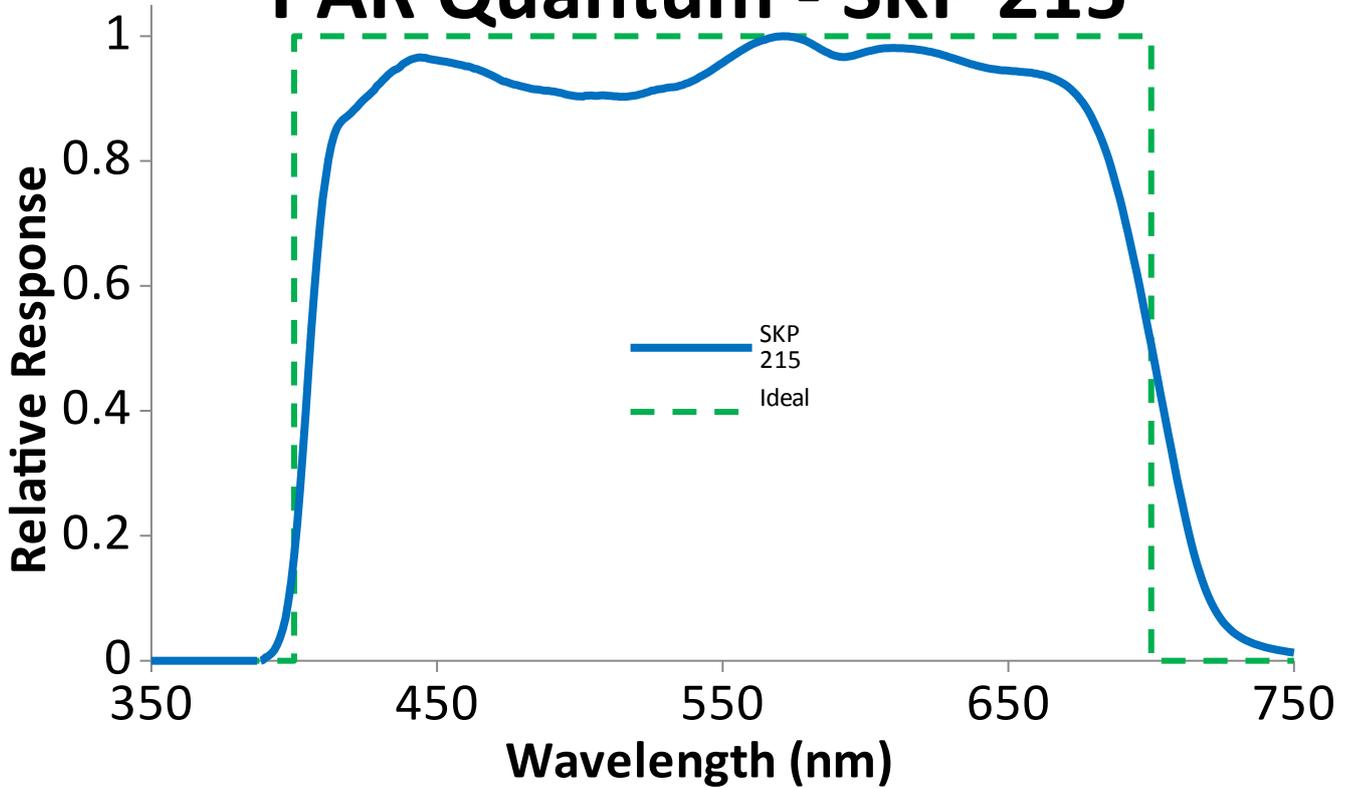
(6) Maximum change in one year. Calibration check recommended at least every two years. Experience has shown that changes are typically much less than figures quoted.

(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.

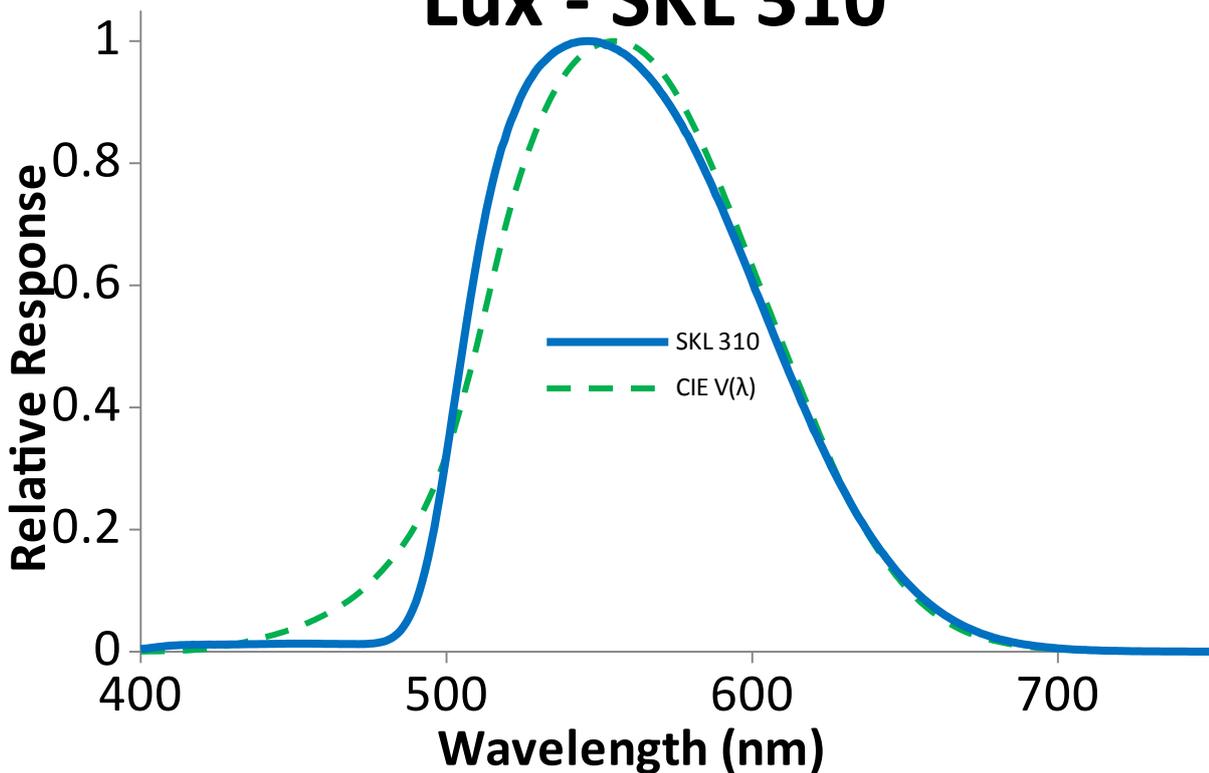
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## APPENDIX 1 – RESPONSE CURVES

### PAR Quantum - SKP 215

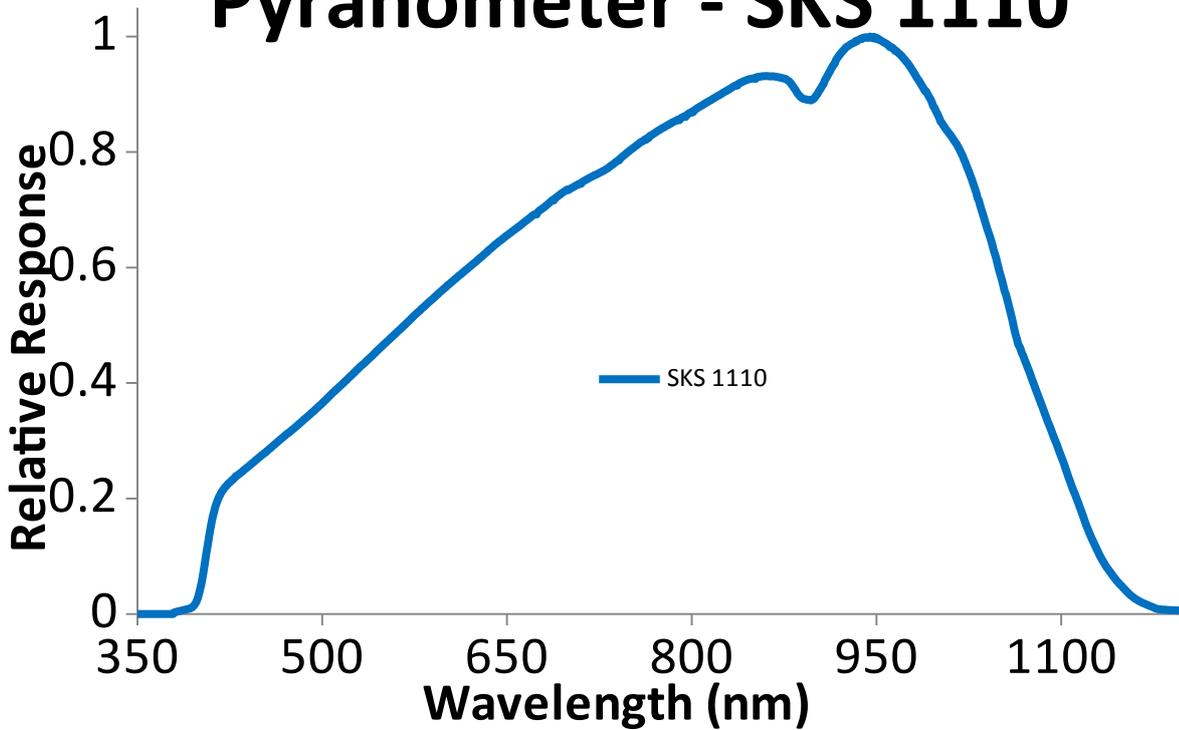


### Lux - SKL 310

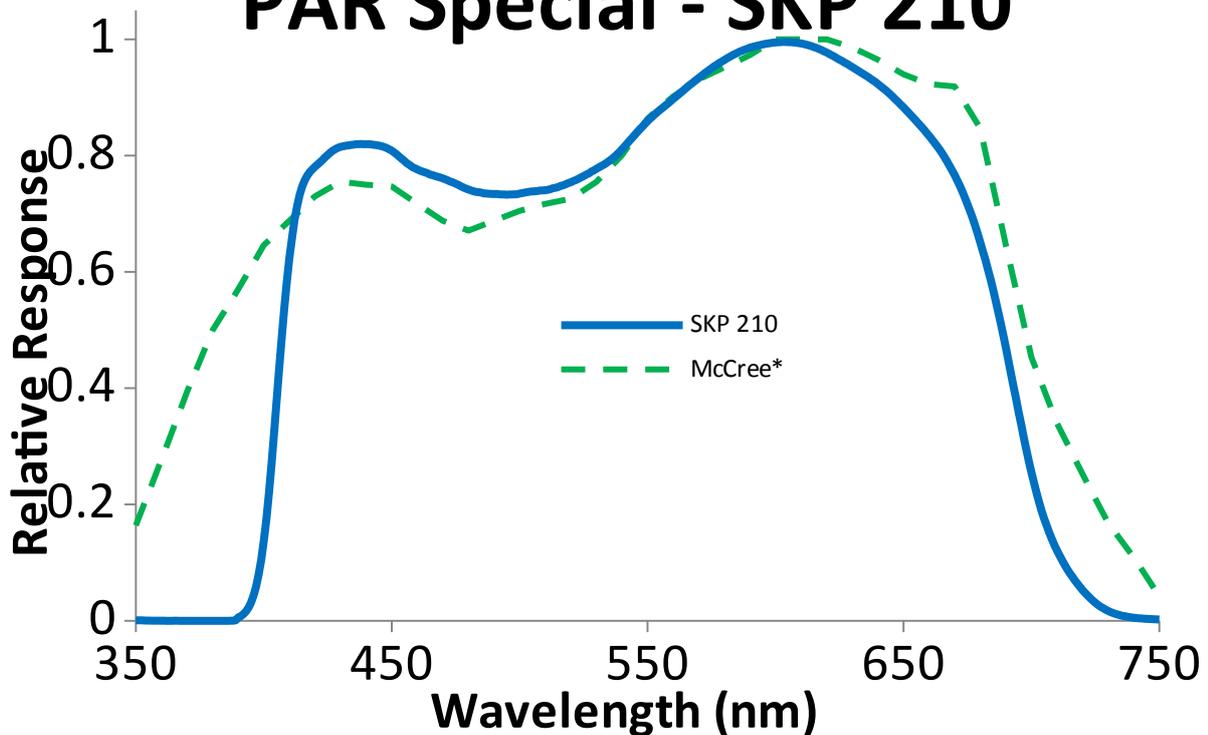


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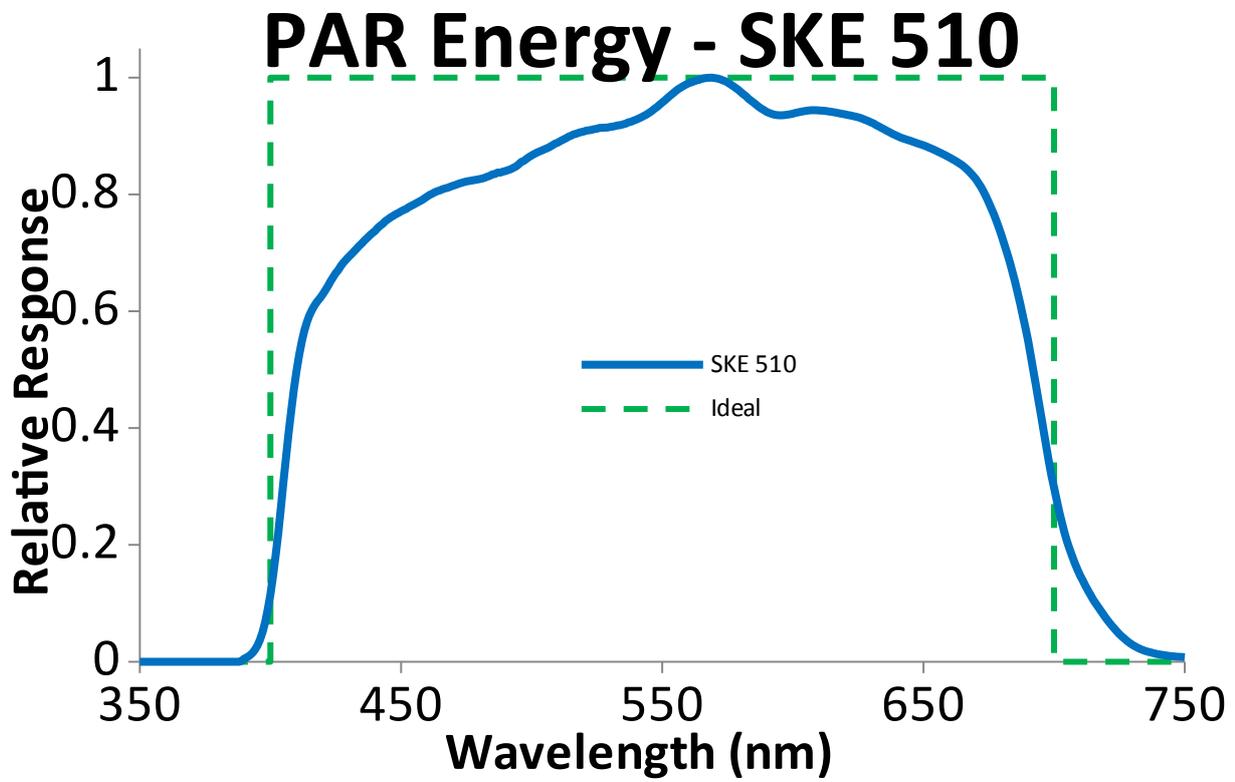
## Pyranometer - SKS 1110



## PAR Special - SKP 210



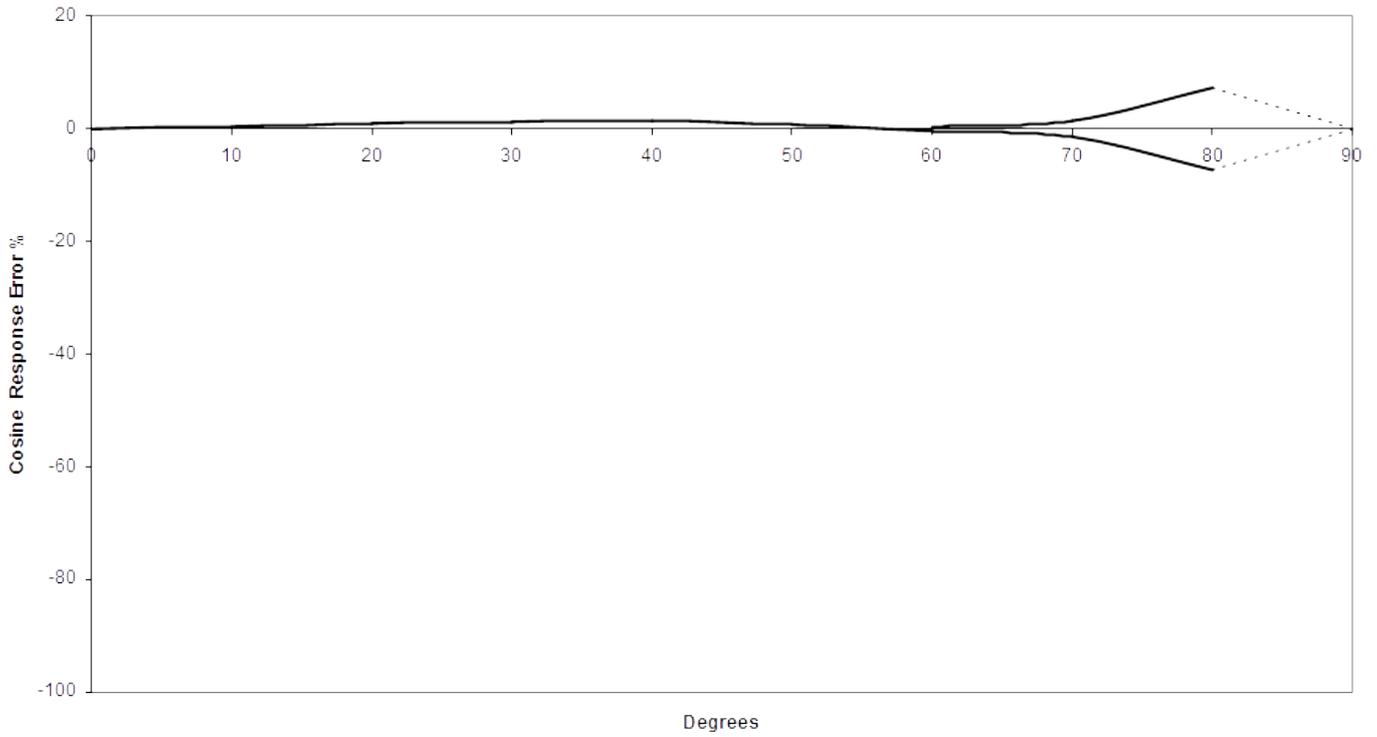
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## APPENDIX 2 – COSINE CORRECTION

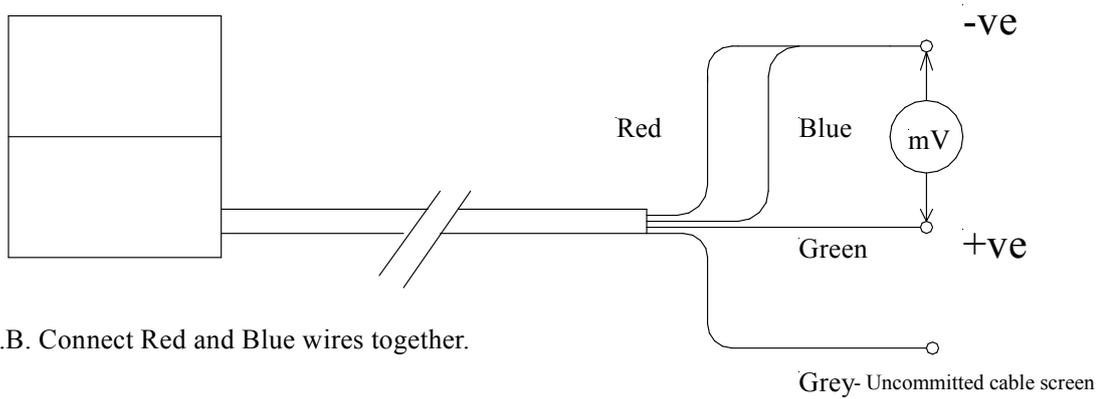
Typical Cosine Response Error Window



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## APPENDIX 3 - WIRE CONNECTIONS

### VOLTAGE OUTPUT



### CURRENT OUTPUT

