HOPLS
High Output Light Sensor

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

skyemail@skyeinstruments.com

www.skyeinstruments.com

Iss. 1.1

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:

Skye Instruments Ltd.

@SkyeInstruments

Skye.Instruments

SkyeInstrumentsVideo

Skye Instruments Ltd.

Click on the icons to browse to the sites, or search for the usernames below.

Have a Smartphone? Scan this QR code to access our website for more information about your product:

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 re-design.

If you have any queries, please do not hesitate to contact our technical team by any of the methods above.

CONTENTS

HOPL – High Output Light 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 HOPL High Output Light Sensors include a built in amplifier with a choice of outputs for compatibility with most dataloggers, data acquisition systems, controllers and PLCs. The outputs can be one of a range of voltages – please see your Calibration Certificate for the exact model and output range of your sensor. HOPL sensors are also available with a 4-20 mA output, these are covered in a separate manual.

This manual covers the 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 Pyranometer plus Lux sensors for human or animal studies. Skye also manufacture HOPL sensors for UVA, UVB & UVI, these three sensors are covered in a separate manual.

As with Skye's standard output range of single channel light sensors, HOPLs are fully waterproof and guaranteed submersible to 4m depth. They are ideal for monitoring light levels in all environments around the world.

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.

2. TYPES OF SENSOR & OPERATION

2.1 Light Sensor for measuring from any light source

SKL 2610 - PAR Special

SKL 2620 - PAR Quantum

SKL 2640 – PAR Energy Sensor

SKL 2633 - LUX 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 and may be left exposed to rain and used in humid climates. They are guaranteed for underwater use up to 4m depth.

Each sensor has been calibrated against a reference lamp, whose own calibration has been carried out at the National Physical Laboratory (N.P.L.). They are calibrated for use with any natural or artificial light source.

Linearity is excellent with a maximum of 1% deviation up to levels beyond 200,000 $\mu mol.m^{-2}.s^{-1}$ (greater than normal solar irradiance).

N.B. The maximum output for some sensors will be limited by the amplifier gain and output voltage limits.

2.2 LIGHT SENSORS FOR TOTAL SOLAR RADIATION

SKL 2650 – Silicon Cell Pyranometer

The pyranometer cosine corrected head contains a special high grade silicon photocell, sensitive to light between 350 and 1100nm. The exact response curve is shown on Appendix 1.

The sensor is completely sealed and can be left indefinitely in exposed conditions.

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 thermopile pyranometers,

to obtain accurate readings the sensor must be used in the same conditions as its calibration, i.e. under open sky only. The calibration of the SKL 26500 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 watts/sq.m (greater than normal solar irradiance).

N.B. The maximum output for some sensors will be limited by the amplifier gain and output voltage limits.

2.3 POSITIONING OF ALL TYPES OF 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.

2.4 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°, event 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.

2.5 SENSOR MAINTENANCE

HOPL High Output 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. The sensor cable should be secured to avoid movement damage or chafing in the wind if used in an outdoor location.

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. The calibration change, if any, since last calibration will also be shown on the certificate.

3. OUTPUTS

All Skye HOPL sensors contain an in built amplifier which requires a power supply between 5 and 15 volts DC. The power supply voltage must be at least 2 volts higher than the maximum output of the sensor. Current consumption is approximately 0.9 mA.

E.g.	**Sensor Output**	**Power Supply Required**
	0-1V, 0-2V, 0-3V	5-15V
	0-4V	6-15V
	0-5V	7-15V
	0-10V	12-15V

The current consumption of the sensors is very low, typically 1 mA, meaning that it can be powered from a logic high output of some computer cards and PLC's (check the specifications of the equipment first).

The output is linear with increasing light levels and will rise to a maximum value, usually well above the output levels specified on the Calibration Certificate. This is because the built-in amplifier will increase its output linearly with increasing light levels up to an output voltage about 2 volts less than its supply.

The precise scaling factor is given on the sensor's Calibration Booklet. Typical sensor outputs are as follows:

SENSOR	DESCRIPTION	SENSOR OUTPUT	WORKING RANGE	TYPICAL VALUE ON A SUMMER DAY
SKL 2610	PAR Special	0-1V	0-3,000 $\mu mol.m^{-2}.s^{-1}$	>2,000 $\mu mol.m^{-2}.s^{-1}$
SKL 2620	PAR Quantum	0-1V	0-3,000 $\mu mol.m^{-2}.s^{-1}$	>2,000 $\mu mol.m^{-2}.s^{-1}$
SKL 2633	Lux	0-1V	0-150,000 lux	>100,000 lux
SKL 2640	PAR Energy	0-1V	0-600 $watts.m^{-2}$	>500 $watts.m^{-2}$
SKL 2650	Pyranometer	0-1V	0-1,500 $watts.m^{-2}$	>1,100 $watts.m^{-2}$

The zero or darkness output voltage should ideally be zero millivolts. In practice, this is rarely the case and there is often a small offset of around 0.1 millivolts, positive or negative*. Even with a 1 volt output sensor this represents an error of only 0.01% and can be reasonably ignored. With most systems it will be below the minimum resolution of measurement anyway and thus will not be resolved for measurement, it will appear as zero. If desired and possible, the offset can be measured and subtracted or added to all measurements, since it is a constant offset.

Great care should be taken not to apply power to the output lead. The output will drive loads with impedance from infinity to around 1K ohms. The output will not be damaged by momentary shorting to the common, but should never, even momentarily be shorted to the supply.

* for units with outputs of 5 volts this may be up to 1 millivolt

4. CONNECTIONS

The sensor may be supplied wire ended for connection to the user's own equipment, or with a connector fitted for compatibility with Skye's own DataHog or MiniMet datalogger ranges, or SpectroSense2 meter range.

Sensors manufactured after February 2008 are fitted with a 4 core screened cable, with a fifth white wire fitted to the cable screen. Sensor connections are shown below

Wire Colour	Function
Red	Positive power supply to sensor (5-15 VDC)
Yellow	Sensor positive output
Green	Sensor negative output
Blue	Power supply ground
White	Cable screen (no connection to sensor)

Sensors manufactured before February 2008 are fitted with a 2 core screened cable, with a third green wire fitted to the cable screen. Sensor connections are shown below

Wire Colour	Function
Red	Positive power supply to sensor (5-15 VDC)
Blue	Sensor positive output
Green	Sensor negative output and power supply ground (Green wire is connected to cable screen)

HOPL – High Output Light Sensors

5. SPECIFICATIONS

	SKL 2610	SKL 2620	SKL 2633	SKL 2640	SKL 2650
Dimension	65mm (h) x 34mm (d)	65mm (h) x 34mm (d)	65mm (h) x 34mm (d)	65mm (h) x 34mm (d)	65mm (h) x 34mm (d)
Weight	200g (with 3m cable	200g (with 3m cable	200g (with 3m cable	200g (with 3m cable	200g (with 3m cable
Housing	Delrin & anodised aluminium	Delrin & anodised aluminium	Anodised aluminium	Delrin & anodised aluminium	Delrin & anodised aluminium
Cable	7-2-4C	7-2-4C	7-2-4C	7-2-4C	7-2-4C
Detector	Silicon photocell	Silicon photocell	Silicon photocell	Silicon photocell	Silicon photocell
Response	McCree	PAR Quantum	Lux	PAR Energy	300 – 3000nm
Sensitivity	Customer choice between 1 and 10 volts	Customer choice between 1 and 10 volts	Customer choice between 1 and 10 volts	Customer choice between 1 and 10 volts	Customer choice between 1 and 10 volts
Working Range	See individual datasheet	See individual datasheet	See individual datasheet	See individual datasheet	See individual datasheet
Linearity	<0.2%	<0.2%	<0.2%	<0.2%	<0.2%
Absolute calibration error	Typically 3%, but <5%	Typically 3%, but <5%	Typically 3%, but <5%	Typically 3%, but <5%	Typically 3%, but <5%
Azimuth error	<1%	<1%	<1%	<1%	<1%
Cosine error	3%	3%	3%	3%	3%
Temp. Co-efficient	± 0.1%/°C	± 0.1%/°C	± 0.1%/°C	± 0.1%/°C	± 0.1%/°C
Long term stability	± 2%	± 2%	± 2%	± 2%	± 2%
Response Time	50ms	50ms	50ms	50ms	50ms
Operating Range	-20°C to +70° C 0-100% RH	-20°C to +70° C 0-100% RH	-20°C to +70° C 0-100% RH	-20°C to +70° C 0-100% RH	-20°C to +70° C 0-100% RH
Power Supply Requirements	2 volts higher than full scale eg. Full scale of 5volts = Power Supply of min 7 volts	2 volts higher than full scale eg. Full scale of 5volts = Power Supply of min 7 volts	2 volts higher than full scale eg. Full scale of 5volts = Power Supply of min 7 volts	2 volts higher than full scale eg. Full scale of 5volts = Power Supply of min 7 volts	2 volts higher than full scale eg. Full scale of 5volts = Power Supply of min 7 volts

APPENDIX 1 – NON-STANDARD PART NUMBERS

HISTORICAL PART NUMBERS

SKL 2630

Lux response in a delrin housing

SKL 2630L.

Lux response but fitted with a Large Area Photodiode for increased sensitivity at low light levels in a delrin housing.

SKL 2632L.

Lux response with a Large Area Photodiode in an aluminium housing.

NON-STANDARD PART NUMBERS

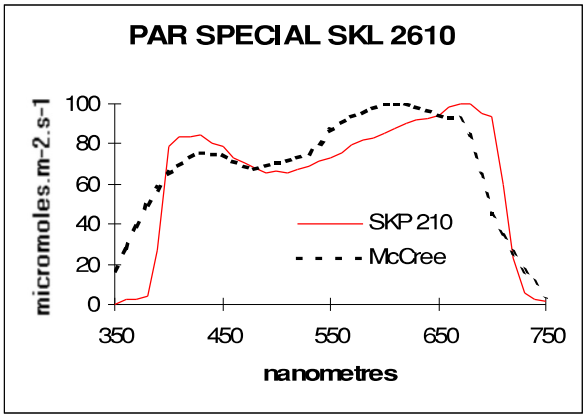
/LS

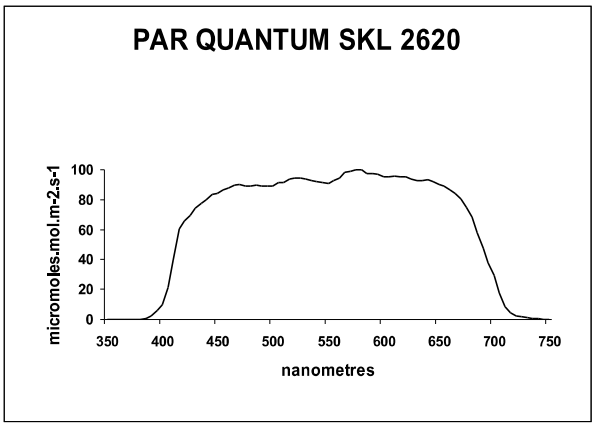
These sensors have been fitted with a Large Area Photodiode plus a non cosine correcting diffuser for maximum sensitivity at low light levels. All other sensor specifications and wire connections remain the same. The sensitivity of the individual sensor is shown on the Calibration Certificate as usual.

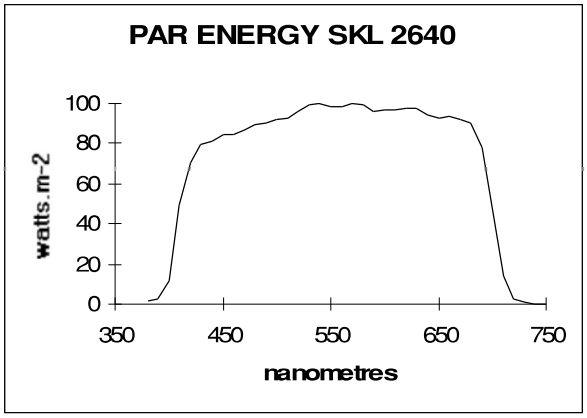
/LT

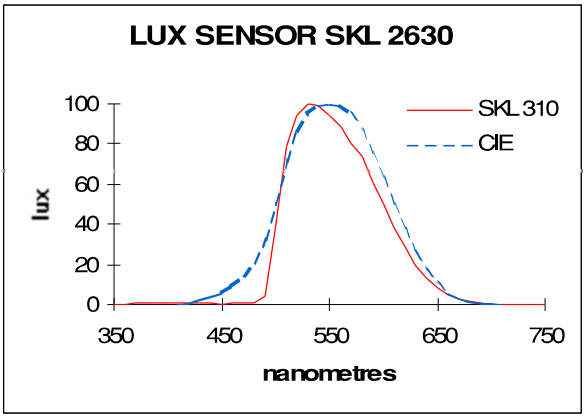
These sensors have been fitted with cable suitable for low temperatures. Whilst the special cable is rated for use at low temperatures, it is still advisable to avoid undue stress, movement, etc., of the cable when at low temperatures. A special modified levelling unit (SKM 2215) is available to give extra support to the cable and minimise unnecessary movement. Wire colours and connections may vary and are shown in the sensor's Calibration Booklet.

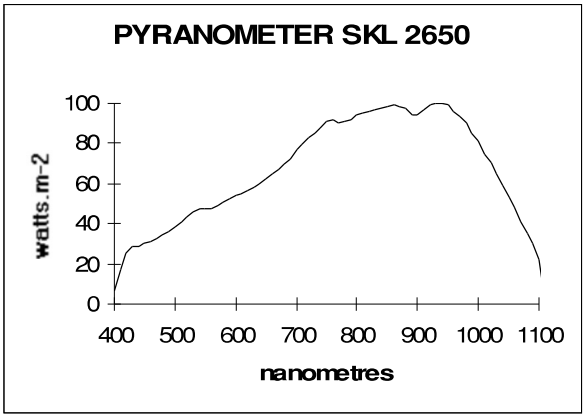
APPENDIX 2 - RESPONSE CURVES











APPENDIX 3 – COSINE RESPONSE