2 – Channel Light Sensor

SKR 1800

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. 1.4

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

2 – Channel Light Sensor

1. INTRODUCTION

The SKR 1800 is a two channel sensor, with the ability to simultaneously detect and measure two separate bands of light that are chosen at the time of ordering by the purchaser. The wavelengths can be between 400 and 1050nm with bandwidths of set widths. The exact wavebands will be shown on the Calibration Certificate of each sensor for each of the four channels in each sensor.

The sensor may be used as either a cosine-corrected head or a narrow angle sensor, by the use of a removable diffuser. To remove the diffuser, grasp the black ring and twist whilst pulling it firmly off the top of the sensor, it should slide gently off of the top of the unit.

Sensors that are supplied in pairs will have normally have one sensor fitted with a cosine-corrected diffuser and one without. The sensor fitted with the cosine-corrected diffuser is usually mounted with the diffuser facing upwards for measuring the incident light. These sensors will have the suffix D after the part number. The sensor supplied without the cosine-corrected diffuser is normally mounted with the light collecting apertures facing downwards, for the measurement of reflected light. These sensors have the suffix ND after the part number.

The sensor may be used with a data logger (e.g. Skye DataHog2) or other readout devices (e.g. Skye SpectroSense 2+, Apollo, etc.), or alternatively with a third party display meter or logger.

The sensor output is a small (nA) current direct from the internal photodiode. No power supply is required. External amplifiers (voltage or current output), are available if required.

2 OPERATION

The sensor is machined from black Delrin acrylic material.

The optics and electronics are fully sealed and weatherproof. It is suitable for use in any orientation. It should be borne in mind, if continuous outside exposure is envisaged, that since the cosine diffuser is removable, it is possible for moisture to collect below it after a while, which may support the growth of algae, etc., and upset the light collection. Thus a periodic check should be made. Equally the recessed wells exposed when the diffuser is removed may fill with water. As long as this is optically clear then it will have little effect on the calibration, but again prolonged exposure may permit algal growth which must be removed. The sensor may be cleaned with moist soft tissues. Avoid the use of solvents.

The response of the sensor to light coming from different angles is clearly different depending on whether or not the diffuser is in place. Without the diffuser the response to light is from a 25° cone directly above the sensor. When the cosine diffuser is in place (be sure to twist it gently on to the rubber 'holding' ring), the collection of light depends on the cosine of the angle the ray of light makes to the axis down the length of the sensor.

Please see Appendix 1 for the narrow angle response and area of measurement for these sensors.

The sensor may be mounted to any flat surface using the M6 threaded hole in its base. It may be hand-held in many applications.

2.1 Sensor Maintenance

Light and Radiation Sensors require very little maintenance apart from cleaning. It is important keeping the light collecting surface clean and dust free.

For the white diffusing disc on cosine corrected Incident or Irradiance sensors, simply wipe clean with a soft cloth dampened with de-ionised water. Take care not to scratch this surface as this may affect the sensor calibration.

For the clear glass disc on the narrow angle Reflected light or Radiance sensors, simply wipe clean with a soft cloth dampened with de-ionised water. Take care not to scratch this surface as this may affect the sensor calibration.

For narrow angle Reflected light or Radiance sensors which have 2 or 4 deep columns, the glass at the bottom of the columns can be cleaned using a cotton ear bud dampened with de-ionised water. Take care not to scratch this surface as this may affect the sensor calibration. When installed permanently outdoors, especially in forestry areas, this should be done at regular periods to ensure it is kept clear of insects and their nests.

For all sensors, ensure the cable is not bent or curled up near the point where it exits the base of the sensor. The cable should not be tightly coiled at any point. These tips will help to increase the cable's lifetime. Skye Instruments light sensors and meters are recommended to be calibrated every 2 years. Please return to Skye for recalibration against the reference lamp and for a new calibration certificate to be issued.

3 OUTPUTS

The output from each channel is in the form of a current that is directly proportional to the amount of light falling on the sensor within the waveband of the filter for that channel. The output is linear over many decades of light level, extending well beyond natural ranges. In complete darkness the current will always be zero.

The calibration certificate will show the calibration values relevant to the model ordered. If you have purchased an SKR 1800, calibration values for use with and without a diffuser if provided. For the model SKR 1800D, only calibration values for the sensor with a diffuser is provided, and likewise for the SKR 1800ND, only calibration values for the sensor without a diffuser is provided.

When the cosine diffusing head is in place the Calibration Certificate shows the output current for a stated amount of light falling on the surface of the sensor. Since the output is quite linear with no offset, the zero and this stage define the output response of the sensor.

From February 2014 radiance sensors have been supplied with an absolute calibration figure. The values are given on the accompanying calibration certificate

Sensors supplied prior to February 2014

When the sensor was used without the diffuser, then a relative factor was given to relate one channel to another. Absolute calibration as done with the diffuser was not possible without the cosine correcting diffuser.

The currents coming from the channels being measured without the diffuser disc should be multiplied by the factors shown on the calibration certificate so that the sensor response can be quoted in relevant units.

Note though that this 'corrected' current is directly proportional to the level of light detected by the channel in its waveband. This factor has only corrected the relative sensitivity of the channels to light in terms of current produced for light intercepted.

If the outputs of the sensors channels are to be related in an attempt to gain knowledge of spectral distribution then the bandwidth of each channel should be taken into account.

The bandwidth shown on the calibration certificate is the range (around the centre wavelength) over which the sensitivity of the channel is greater than 50% of its peak. This is a common way of defining optical bands, and since the sensitivity of the SKR 1800 channels falls off very sharply beyond these 50% points this band definition includes most of the light detected. It is a consistent way of relating the widths of the channels.

Thus the currents (without the diffuser disc) or the number of μmol m^{-2} s^{-1} (with diffuser disc), detected by any channel, if divided by its bandwidth will then give a figure of or proportional to the light intensity per

nanometre.

Clearly this will be a mean of light detected in the waveband of the channel.

If a voltage output is needed to drive a logger or similar, then a resistor may be employed as a current to voltage converter. Appendix 2 shows how this may be accomplished.

The maximum value of resistor that should be used in this connection is 5 to 10 kohms. In general however the minimum value that can be used to give the desired mV output should be used. This will minimise the pickup of electrical interference. The output will be as follows :-

mV per light unit = mA per light unit x resistor (kohm)

When the sensor is used without the diffuser then the currents, or mV output from each channel should be multiplied by the relative factors shown on the calibration certificate. In this way the true ratios of the reflected or direct light levels detected by each channel will be determined. If a meter or output amplifier is employed then the reading or current conversion ratio of this must be taken into account.

It will be noticed that the ratio of channel sensitivities with and without the diffuser are slightly different. This arises as a result of different transmission of the diffuser at different wavelengths.

Any Skye Display Meter, SpectroSense2 meter, DataHog logger or external current amplifier that is built for the sensor or supplied with it will have the cosine diffuser calibration built in to it and will readout directly or have an output in direct engineering units, i.e.. the display will read in Mmol m^{-2} s^{-1} or the output is scaled at (usually) 10mV / Mmol m^{-2} s^{-1} or units appropriate to the sensor. If this meter or external current amplifier is used where the sensor is without the cosine correcting diffuser, then its gain as well as the factors which relate the currents of the channels will need to be taken into account.

4 CONNECTIONS

The sensor houses two large area semiconductor diodes which are connected back to back using a common ground connection. Thus there are three wires from each unit. These are shown below. The diodes are electrically fragile and no external sources of voltage or current should be applied to them.

4.1 SKR 1800, SKR 1800/SS2, SKR 1800/1 Current Output Sensor with standard cable

The green wire should be connected to the common ground of the logger or readout unit. If the sensor has been supplied with a Skye meter or logger then a connector shown below will have been fitted using the same wiring colours as shown below.

Wire Colour	*Function*	*Skye Connector*
-	no connection	Pin 1
-	no connection	Pin 2
Red	Channel 2 negative current output	Pin 3
Blue	Channel 1 negative current output	Pin 4
Green	Ground	Pin 5
Grey	Cable Screen	Pin 5

4.2 SKR 1800/LT Current Output Sensor with low temperature cable

From serial number 39666 onwards these sensors are fitted with a grey or purple cable that has the following temperature specifications;

Moving; -20°C to +80°C
Fixed; -40°C to +80°C

Wire colour	*Function*
Brown	Channel 1 negative current output
Yellow	Channel 2 negative current output
Green	Ground
Grey	Cable screen

4.3 SKR 1800/X Current Output Sensor with Extension cable EXT/1

If your sensor has a cable length greater than 10m and it is to be plugged into a SpectroSense or DataHog then it will be fitted with an EXT/1 extension cable. The sensor cable and the extension cable will already be connected when supplied. The connector at the other end of the extension cable will be fitted as shown below.

2 – Channel Light Sensor

Function	*Skye Connector*
no connection	Pin 1
no connection	Pin 2
Channel 2 negative current output	Pin 3
Channel 1 negative current output	Pin 4
Ground	Pin 5
Cable Screen	Pin 5

4.4 SKR 1800/X Current Output Sensor with Extension cable EXT/3

If your sensor has a cable length greater than 10m and is supplied wire ended then it will be fitted with an EXT/3 extension cable. The sensor cable and the extension cable will already be connected when supplied. The connection details are shown below.

The blue wire should be connected to the common of the logger or readout unit.

Wire Colour	*Function*
Black	no connection
Red	no connection
Yellow	Channel 2 negative current output
Green	Channel 1 negative current output
Blue	Ground
White	Cable Screen

4.5 SKR 1800/LT/X Current Output Sensor with Extension cable EXT/3/LT

If your sensor has a low temperature cable with a length greater than 10m and is supplied wire ended then it will be fitted with an EXT/3/LT extension cable. The sensor cable and the extension cable will already be connected when supplied. The connection details are shown below.

The green wire should be connected to the common of the logger or readout unit.

Wire Colour	*Function*
White	no connection
Grey	no connection
Yellow	Channel 2 negative current output
Brown	Channel 1 negative current output
Green	Ground
Black	Cable Screen

From serial number 42337 onwards 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

2 – Channel Light Sensor

5. SPECIFICATIONS

Range	Two channels each between 400-1050 nm.
Construction	Dupont "Delrin" acrylic. Cosine corrector head - acrylic & PVC. Unit completely waterproof with cosine corrector head removed, sealed with wide transparency glass flats "O" rings. Waterproof rating IP68, can be submersed up to 4m. Submersing with the cosine corrector head in place is not advised as water under the head will cause calibration errors.
Filters	Metal interference and/or glass depending on wavelengths & bandwidths chosen, to military specification
Detectors	GaP, GaAsP, or silicon depending on wavelengths and bandwidths chosen.
Cable	Screened. 7-4-C military specification. 3m. standard length.
Temperature Range	-25 to +75 °C (for a fixed PVC cable)
Humidity Range	0-100%
Dimensions	Height: 5.7 cm without cosine-corrector. 6.3 cm with cosine corrector. Width: 3.3 cm without cosine-corrector. 4.4 cm at the top of the sensor with the cosine-corrector.
Weight	180 grams.
Outputs	Current (nA) varies with filter used, No voltage output as stanard.
Power supply	Not required
Linearity	Better than 0.2% of scaled range
Cosine Error	Typically 3% to 80 degrees (cosine diffuser fitted)
Response Time	Typically less than 100 nanoseconds.
Absolute Calibration	Typically better than 5%. Note that this error is to some dependant on bandwidth - wide bandwidths will be less subject to error than very low bandwidth channels. Directly traceable to the UK National Physical laboratory.

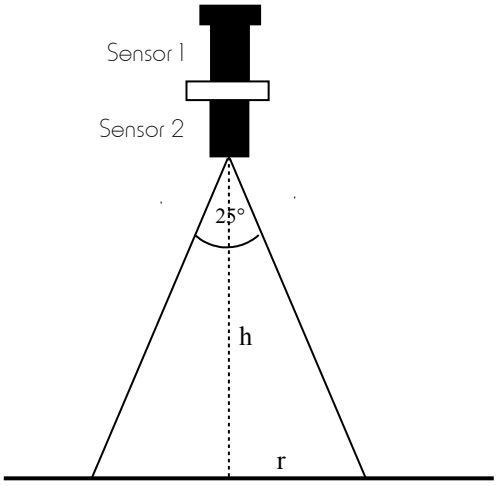
2 – Channel Light Sensor

APPENDIX 1 – NARROW ANGLE LIGHT ACCEPTANCE

The SKR 1800 2- channel light sensors are fitted with a removable cosine correcting light acceptance head. When taking incident or down-welling light measurements, the head is left in place so that the sensor is fully cosine corrected (accepts light in accordance with Lambert's Cosine Law).

For the measurement of reflected or up-welling light, the cosine head is removed converting the sensor into a narrow angle acceptance instrument. The sensor has a smaller, defined field of view and can accurately measure from a defined ground area.

Without the cosine head, the 2-channel sensors have a 25° cone field of view (12.5° off perpendicular). The area of ground in view to the sensor is then defined by the height above the ground, as shown below:



Sensor 1 is fitted with the cosine correcting head and is measuring incident light.

Sensor 2 is narrow angle and is measuring reflected light.

Both incident and reflected light is measured simultaneously by 2 identical sensors, to eliminate fluctuations in solar radiation

EXAMPLES OF MEASUREMENT AREA

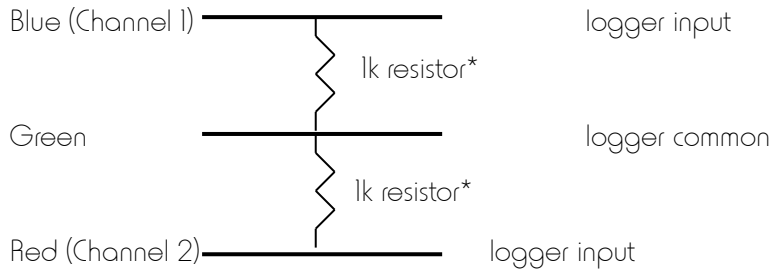
HEIGHT OF SENSOR (h)	RADIUS OF CIRCLE (r)	AREA OF MEASUREMENT
0.50m	0.11m	0.04m^2
0.75m	0.17m	0.09m^2
1.00m	0.22m	0.15m^2
1.25m	0.28m	0.24m^2
1.50m	0.33m	0.35m^2
1.75m	0.39m	0.47m^2
1.80m	0.40m	0.50m^2
2.00m	0.44m	0.62m^2

APPENDIX 2 – USING A RESISTOR FOR VOLTAGE OUTPUT

SKR 1800 2-channel light sensors are often supplied without display meters or amplifiers for connection direct to user's own data loggers. It is recommended, if possible, that a current input to the logger is used, the scaling factor is shown on the calibration certificate.

If this is not possible, then a voltage input may be used, by connecting a resistor across the input of the logger for each channel,

e.g. wiring diagram



If a precision resistor of 1K (0.1% ppm/deg.C.)* is used, then the output in millivolts of the sensor will be identical to the current output in microamps. For example, if the calibration certificate says Channel 1 output is 30.25 μmol.m^{-2}.s^{-1} per microamp, then when connected with a 1K resistor, 30.25 micromol will give an output of 1mV.

Other values of resistance may be calculated as follows:-

Sensitivity (Mmol m^{-2} s^{-1} per mV) = Sensitivity / Resistance (Mmol m^{-2} s^{-1} per MA) / (kohm)

Resistor values above 1 kohm should be used with caution, as they may give rise to pickup noise. 10 kohm is the maximum that should be used.

* Available from Skye Instruments.