4 Channel Light Sensors

SKR 1860

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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.

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1 INTRODUCTION

The SKR 1860 is a four channel sensor with the ability to simultaneously detect and measure four separate bands of light that are chosen at the time of ordering by the purchaser. The wavelengths can be between 400 and 2400nm. The exact wavebands will be shown on the Calibration Certificate of each sensor for each of the four channels in each sensor. The sensor is supplied with either a cosine-corrected head (SKR1860D) or as a narrow angle sensor (SKR 1860ND).

Sensors that are supplied in pairs will normally have one sensor fitted with a cosine-corrected diffuser and one fitted with a plain glass cover. 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 with the plain glass cover 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. some versions of Skye SpectroSense 2+), or alternatively with a third party display meter or logger.

SKR 1860D/A and SKR 1860ND/A are optically and externally physically identical to the SKR 1860D, SKR 1860ND but have a built in amplifier to give a higher output level of millivolts (typically ranging 0 to several volts) as opposed to the small current outputs of the standard SKR 1860 sensor.

Models with up to a 0 – 2 volt output require a power supply between 5 and 15 volts.

Models with up to a 0 – 5 volt output require a power supply between 9 and 15 volts.

Please ascertain which model you have before making connections to it. Refer to the part number label or its unique Calibration Certificate.

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2 OPERATION

The sensor is machined mainly from an aluminium alloy material and plain anodised.

The optics and electronics are fully sealed and weatherproof. It is suitable for use in any orientation. 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 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 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.

N.B. - Do not attempt to unscrew the cable glad, this will invalidate your warranty.

N.B. - Do not attempt to unscrew either the cosine correcting diffuser or the reflected light diffuser, this will invalidate your warranty.

2.1 Sensor Maintenance

Light Sensors require very little maintenance apart from keeping the top light collecting surface (white diffusing disc or glass 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.

3 OUTPUTS

3.1 SKR 1860D, SKR 1860ND Current Output Sensor

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 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.

When the cosine diffusing head is in place (SKR1860D) the Calibration Certificate shows the output current for a stated amount of light falling on the surface of the sensor. For narrow angle sensors (SKR1860ND) the Calibration Certificate shows the output current for a stated amount of light reflected from the surface within the field of view of the sensor.

The bandwidth shown on the calibration certificate is the FWHM (Full Width Half Maximum) range 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 1860 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 bandwidths of the channels.

If a voltage output is needed to drive a logger or similar, then a resistor may be employed as a current to voltage converter. Section 4.1 shows how this may be accomplished.

The maximum value of resistor that should be used in this connection is 5 to 10 kΩ. 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 = µA per light unit * resistor (kΩ)

3.2 SKR 1860D/A, SKR 1860ND/A Amplified Voltage Output Sensor

This model, as mentioned previously is optically and externally physically identical to the SKR 1860 but instead of giving low level current outputs has an integral amplifier (4 channels) to give outputs in millivolts.

The gain of this amplifier and hence the output in millivolts per unit of light will vary from unit to unit (It may be specified by the user at the time of ordering). The scaling (millivolts/light units) is given on the calibration certificate for each channel of the sensor.

Sensor Output:	**Power Supply Required:**
Up to 0-2 V	5-15 V DC
Up to 0-5 V	9-15 V DC

The current required is less than 3mA. The power should be applied to the amplifiers at least 500ms (0.5s) before readings are taken.

Most data loggers allow a greater time than this.

The output impedance of the amplifier is fairly low, but they should only be used to feed high impedance (5K or more) inputs. Almost all loggers, digital meters, chart recorders have suitably high input impedances.

Please note that with the internal amplifier only the voltage output (mV) may be used. The low level current output is not available.

The outputs of the amplifiers should not be shorted together or to ground. They should never be shorted to the positive supply input. This may damage the sensor.

The output of the amplifier will be nominally zero in the dark (when the sensor receives no light) but a small zero offset will almost certainly be present. This offset will vary from channel to channel, but will be a constant offset that for the very highest precision should be added (if negative) or subtracted (if positive) from all readings. The magnitude of the offset will depend to a degree on the gain of the amplifier (higher gain, higher offset) but will generally be below 1mV. In many cases it will be low enough to be reasonably ignored, if chosen to do so.

3.3 Sensors Incorporating Channels with Wavelengths Over 1000nm

The detectors employed in these sensors are of the InGaAs and Extended InGaAs types. When amplified, these detectors produce a current in the dark which changes over the temperature range of the sensor i.e. -20°C to +40°C. The dark current is a result of internal characteristics of each detector and its current to voltage converter amplifier. It is different for each channel of each sensor. Although highly repeatable for each channel with varying temperature, the changes are not predictable to a satisfactory level of accuracy and hence a 'lookup' table approach must be employed.

In order to characterise to its dark offsets, each sensor is cycled a number of times through the temperature range to produce a look-up table of dark offset versus temperature. This look up table must be used in conjunction with readings obtained from the sensor and the dark current value of the temperature at which the readings were taken must be subtracted. The temperature of the sensor is given by the temperature output channel (10mV / °C).

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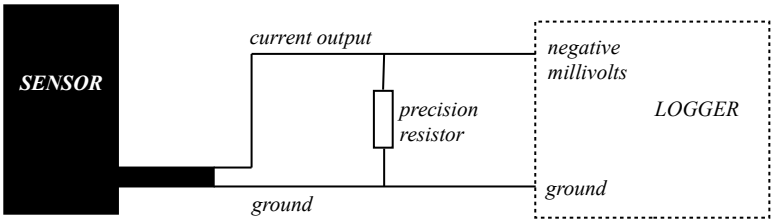
4. CONNECTIONS

The sensors may be supplied wire ended for connection to the user's own instruments, or may be fitted with a waterproof connector suitable for Skye's DataHog logger or SpectroSense2 meter.

4.1 SKR 1860D, SKR 1860ND, SKR 1860/SS2, SKR 1860/I - Current Output Sensor

Wire Colour:	**Function:**	**Pin Number:**
Red	Channel 1 negative current output	1
Yellow	Channel 2 negative current output	2
Green	Channel 3 negative current output	3
Blue	Channel 4 negative current output	4
White	Ground	5
Grey	Cable Screen / Sensor Body	5

The current output from this sensor is often very small, e.g. 1 µA or less. If the datalogger does not have a current input, then a precision resistor may be placed across each of the 4 sensor outputs to give a millivolt signal as below:



The millivolt signal will be proportional to the current output and resistor value as shown:

mV per unit of light = µA per unit of light * resistor (kΩ)

The resistor value should be as low as possible to get the mV output required for the anticipated light levels, and should not exceed 10 kΩ (10,000Ω). The millivolt output derived should not be greater than 60 mV otherwise a degree of non-linearity may occur. Wire ended sensors are supplied with one 1kΩ precision resistor as standard.

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4.2 SKR 1860D/X, SKR 1860ND/X - Current Output Sensor with Extension Cable EXT/2

Function:	**Pin Number:** (EXT/2 5 pin connector)
Channel 1 negative current output	1
Channel 2 negative current output	2
Channel 3 negative current output	3
Channel 4 negative current output	4
Ground	5
Cable Screen / Sensor Body	5

4.3 SKR 1860D/X, SKR 1860ND/X - Current Output Sensor with Extension Cable EXT/3

Wire Colour:	**Function:**
Black	Channel 1 negative current output
Red	Channel 2 negative current output
Yellow	Channel 3 negative current output
Green	Channel 4 negative current output
Blue	Ground
White	Cable Screen / Sensor Body

4.4 SKR 1860D/LT, SKR 1860ND/LT - Current Output Sensor

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

Moving; -20ºC to +80ºC
Fixed; -40ºC to +80ºC

Wire Colour:	**Function:**
Brown	Channel 1 negative current output
Yellow	Channel 2 negative current output
Grey	Channel 3 negative current output
White	Channel 4 negative current output
Green	Ground
Pink	Cable Screen / Sensor Body

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4.5 SKR 1860D/A, SKR 1860ND/A – Amplified Voltage Output Sensor

Wire Colour:	Function:	Pin Number:
Grey	Cable screen / sensor body	1
Blue + Black	Power supply ground	2
Purple + Green	Sensor signal ground	3
Red	Power supply positive	4
Brown	Channel 1 positive voltage output	5
White	Channel 2 positive voltage output	6
Orange	Channel 3 positive voltage output	7
Yellow	Channel 4 positive voltage output	8

4.6 SKR 1860D/A/X, SKR 1860ND/A/X - Amplified Voltage Output Sensor with Extension cable EXT/4

Wire Colour:	Function:
Brown	Cable screen / sensor body
Red	Power supply ground
Orange	Sensor signal ground
Yellow	Power supply positive
Green	Channel 1 positive voltage output
Blue	Channel 2 positive voltage output
Purple	Channel 3 positive voltage output
White	Channel 4 positive voltage output

4.7 SKR 1860D/A, SKR 1860ND/A – Amplified Voltage Output Sensor with Channels incorporating Wavelengths over 1000nm

Wire Colour:	Function:	Pin Number:
Brown	Channel 1 positive voltage output	1
White	Channel 2 positive voltage output	2
Orange	Channel 3 positive voltage output	3
Yellow	Channel 4 positive voltage output	4
Green	Sensor signal ground	5
Purple	Temperature positive voltage output	6
Blue + Black	Power supply ground	7
Grey	Cable screen / sensor body	8
Red	Power supply positive	9
-	-	10

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4.8 SKR 1860D/A/LT and SKR 1860D/A/LT – Amplified Voltage Output Sensor with Low Temperature Cable.

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

Wire Colour:	Function:	Pin Number:
Grey	Cable screen / sensor body	1
Blue + Black	Power supply ground	2
Purple + Green	Sensor signal ground	3
Red	Power supply positive	4
Brown	Channel 1 positive voltage output	5
White	Channel 2 positive voltage output	6
Pink	Channel 3 positive voltage output	7
Yellow	Channel 4 positive voltage output	8

4.9 SKR 1860D/A/LT and SKR 1860D/A/LT – Amplified Voltage Output Sensor with Low Temperature Cable and Channels Incorporating wavelengths over 1000nm.

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

Wire Colour:	Function:
Grey	Cable screen / sensor body
Blue + Black	Power supply ground
Green	Sensor signal ground
Purple	Temperature positive voltage output
Red	Power supply positive
Brown	Channel 1 positive voltage output
White	Channel 2 positive voltage output
Pink	Channel 3 positive voltage output
Yellow	Channel 4 positive voltage output

5. SPECIFICATIONS

	SKR 1860D, SKR 1860ND	SKR 1860D/A, SKR 1860ND/A
Sensor Output	Typically 3-10 nA / µmol m^{-2} s^{-1}	0-2V as standard, other ranges available.
Power supply	Not required	Output up to 2V: 5-15 VDC @ 2mA Output up to 5V: 9-15 VDC @ 2mA
Response Time	Typically < 100 ns	200 ms
Cable	Screened 7-1-4C military specification. 3m standard length	Screened 7-1-9C military specification. 3m standard length
Sensor Passband	4 channels each between 400-2400nm	
Construction	Plain anodised aluminium housing Optical glass diffuser/window Cable gland IP68 – Do not undo	
IP rating	IP65	
Filters	Metal interference and/or Glass	
Detectors	Si, GaAsP, InGaAs or extended InGaAs	
Temperature Range	-25 to +75 °C (Standard Cable when Fixed)	
Humidity Range	0-100%	
Dimensions	Height: 9.3cm Diameter at the widest point: 6.7cm	
Weight	600g with 3m cable	
Linearity	<0.2% over working range	
Cosine Error	Typically 3% to 80 degrees (SKR 1860D and SKR 1860D/A)	
Absolute Calibration Error	Typically 3%, but <5% *N.B. This error is to some extent dependant on bandwidth - wide bandwidths will be less subject to error than very low bandwidth channels*	
Mounting	M6 x 7mm tapped hole in the base. Sensor supplied with M6 x 16mm screw + 4 x 1.5mm washers to suit panel thicknesses of 3-10mm	

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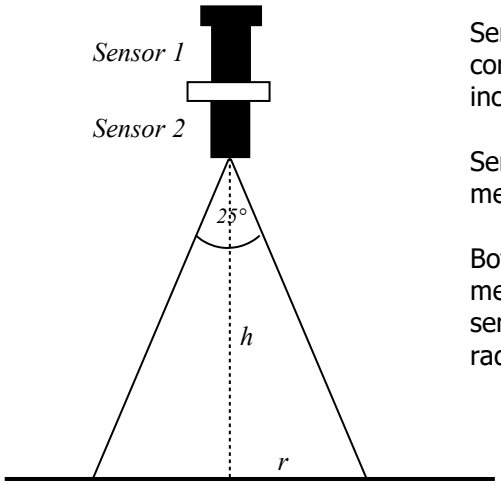
APPENDIX 1 – NARROW ANGLE LIGHT ACCEPTANCE AREA

The SKR 1860ND and SKR 1860ND/A, 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