Solar Radiation System for Photo Voltaics

SKYE INSTRUMENTS LIMITED
21, Ddole Enterprise Park
Llandrindod Wells
Powys, LD1 6DF
UK

TEL: +44 1597 824811
FAX: +44 1597 824812
General Email: skyemail@skyeinstruments.com
Technical Email: technical@skyeinstruments.com
Sales Email: sales@skyeinstruments.com
Web: www.skyeinstruments.com

Updated April 2009

CONTENTS

1 Introduction

The SKS 1100/1110PV Solar Radiation System for Photo Voltaics consists of a Solar Radiation Sensor connected to a Display Meter. A carry case is also supplied to keep the sensor clean and free from scratches, which could cause measurement errors.

The sensor and meter pair are calibrated together as a system, so sensors and meters should not be interchanged without a recalibration.

The Calibration Certificates are supplied in the accompanying Calibration Booklet.

2 Sensor

The SKS 1110 Solar Radiation Sensor, also called a Silicon Cell Pyranometer, has a cosine corrected head containing a special high grade silicon photocell. It is sensitive to light between 350 and 1100nm. The head 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 thermopiles, to obtain accurate readings the unit must be used under natural lighting.

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 m^{-2} (greater than normal solar irradiance).

The relative response curve are shown in Appendix 1.

3 Positioning the Sensor

When measuring incident solar radiation in meteorology, the pyranometer sensor is usually mounted perfectly levelled, so that its top light collecting surface is exactly horizontal. It is important to ensure there are no obstructions in the vicinity that may cause shadowing over the sensor and so cause any errors in the measurement.

When the purpose of measuring solar radiation is for the use of photovoltaic cells, the sensor is usually mounted in the same plane as the solar panel, in order to measure the radiation falling on its surface.

4 Cosine Correction.

Since the sensor is intended to measure units, on a horizontal plane of unit area from a whole hemisphere, it has to collect light as would that plane. This is why the sensor is cosine corrected. Light rays perpendicular to the sensor are fully measured, those at 90° are not accepted (they would pass parallel to the surface of the plane and never intercept it). Rays at intermediate angles are treated according to the cosine of their angle to the perpendicular (according to Lambert's Cosine Law). 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.

5 Sensor maintenance

The sensor requires 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.

The connection to obtain either mV or microamp output from the sensor 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.

7 The Display Meter

The SKS 1100 Display Meters is supplied with and calibrated for its matching pyranometer sensor head. Other sensors and meters should not be interchanged without a recalibration.

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 Display Meter.

An on/off switch is provided, but regardless of this, the Meter is switched off automatically by unplugging the pyranometer sensor head.

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

All sensors and meters are calibrated against standards traceable to the N.P.L., and subsequent recalibration every two years is recommended.

The measuring unit has three ranges, 0-20, 0-200 and 0-2,000 W m^{-2} (watts per square metre). At all times the most sensitive range possible should be selected, the Meter 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 <u>all</u> 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.

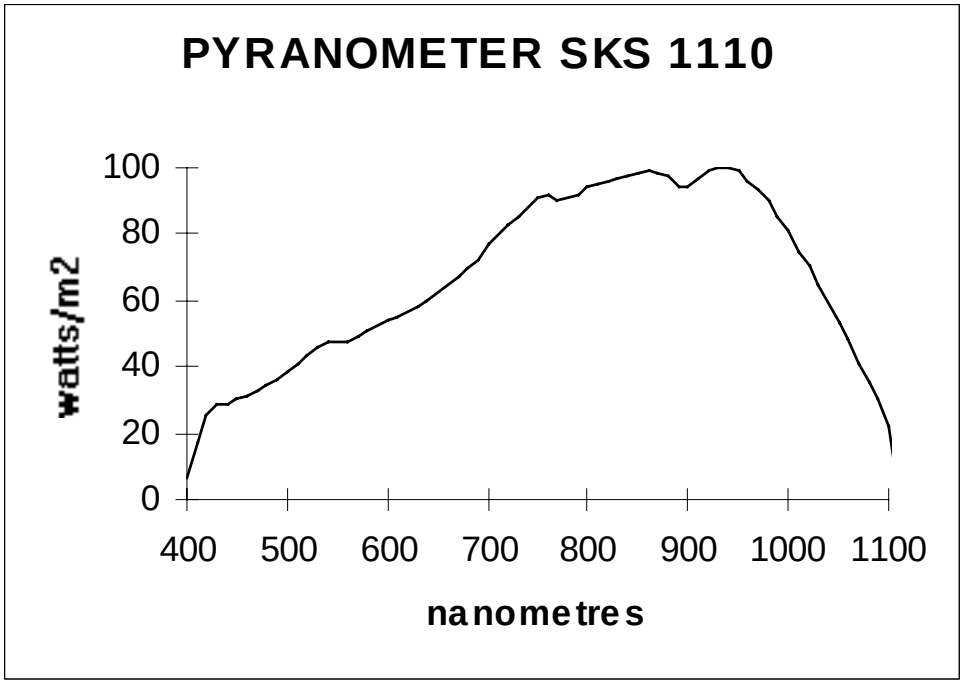
8 Display Meter Output Socket

A chart recorder output is available from the Display Meter. 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.

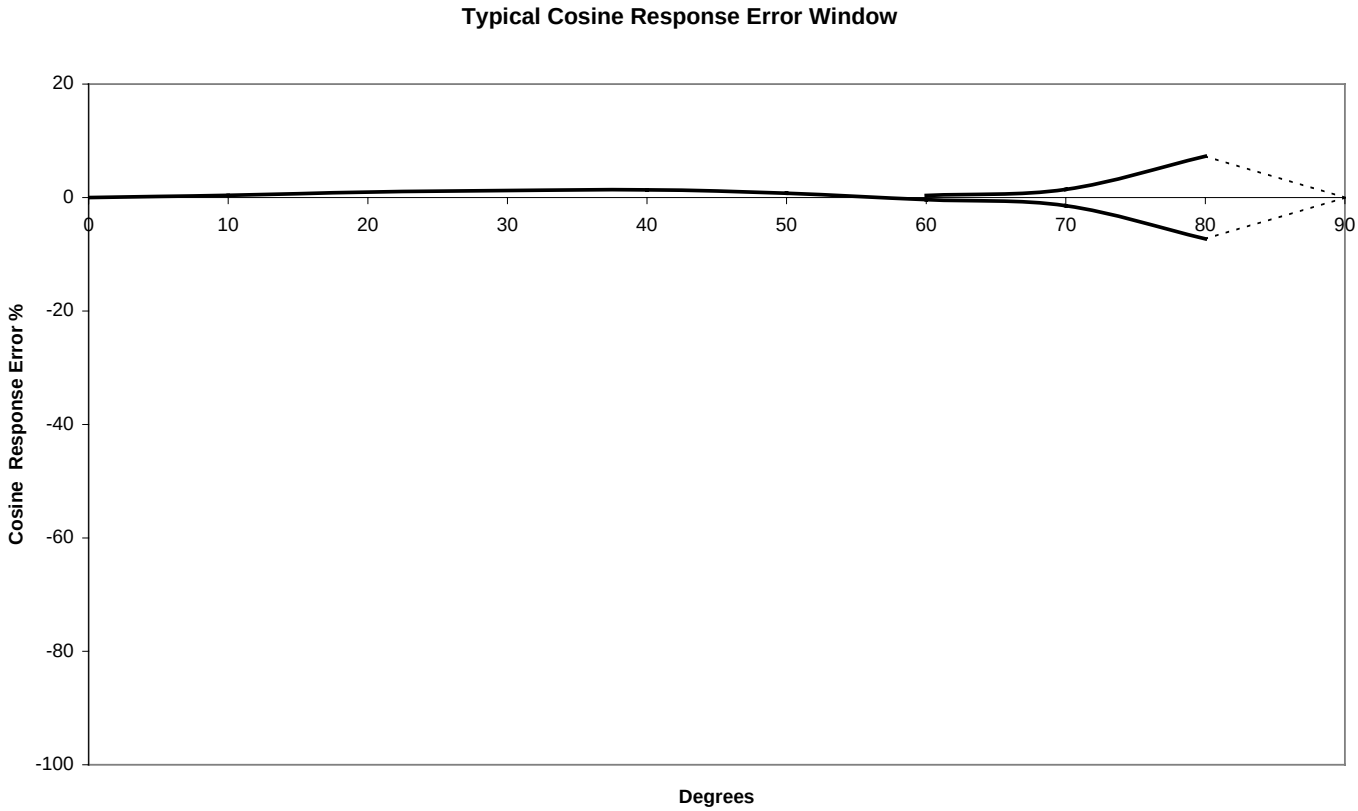
The output is scaled with the display, being normally 0 - 2 V as with the display in three ranges. The chart recorder output however, unlike the display will exceed 2.0 V. For example, on the 0 - 2,000 W m^{-2} range, 2.0 V at the recorder output corresponds with the display to 2,000 W m^{-2} , but if 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 W m^{-2}) 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.

APPENDIX 1 – SENSOR WAVELENGTH RESPONSE



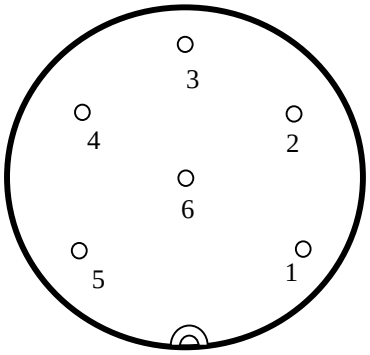
APPENDIX 2 – SENSOR COSINE RESPONSE



APPENDIX 3 - SENSOR CONNECTIONS

STANDARD 6 PIN PLUG
Connector suitable for Display Meter only

OUTSIDE PIN VIEW



NOTES

1 The sensor connector for a Skye Display Meter is wired with the blue wire to Pin 3, green wire to Pin 4 and red wire to Pin 6. Pins 1 and 2 are shorted.
2 For a current output connect using pins 3 and 4 (blue and green wires). Leave Pin 6 (red wire) unconnected.
3 For voltage output, short together Pins 3 and 6 (blue and red wires). The voltage output is between this junction and Pin 4 (green wire). Pin 4 (green wire) is positive in light.

APPENDIX 4 – SENSOR SPECIFICATIONS

	SKS 1110
Sensitivity - current (1) Sensitivity - voltage	5μA/ 100 W m^{-2} 1mV/100 W m^{-2}
Working range (2)	0-5000 $W.m^{-2}$
Linearity error - to above level	<0.2%
Absolute calibration error (3)	typ<3%, 5% max
Response time (7) - voltage output	10ns
Cosine error 4	3%
Azimuth error (5)	<1%
Temperature Co-efficient	±0.2%/^{o}C
Internal resistance - voltage output	c.180ohms
Longterm stability (6)	±2%
Material	Acetal
Dimensions	34mm diameter, 38mm height
Cable	2 core screened , 7 - 2 - 2C
Sensor Passband	350 - 1100 nm
Detector	Silicon photocell
Filters	Glass type and/or metal interference