



SpectroSense 2+ (+GPS)



SKL 906, SKL 908, SKL 920 & SKL 925

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Skye Instruments Ltd.

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1 INTRODUCTION

The SpectroSense2+ is a 4 or 8 channel logging display meter designed for use with light and radiation sensors, either from Skye or other manufacturers. There are four models of the meter, the SKL 906 (4 channel SpectroSense2+), SKL 908 (8 channel SpectroSense2+), SKL 920 (4 channel SpectroSense2+.GPS) and the SKL925 (8 channel SpectroSense2+.GPS). The GPS models have the added feature of a GPS module for storing latitude and longitude position with each measurement. All models have the option of storing measurement location as a text string.

The SpectroSense2+ is compatible with both current and voltage output light sensors, depending on the meter version chosen at time of ordering. Please see the Calibration Certificate in the separate booklet for the configuration of your meter.

Combinations of amplified and non amplified sensors, single and multi-channel sensors, Skye sensors and other manufacturers sensors can be used simultaneously with this meter, using the built-in auto-ranging feature.

The 4 channel SpectroSense2+ versions can be used with up to four single channel sensors, or two 2-channel sensors, or combinations of the two.. The meter can store a Sensor Library of calibration data for up to 16 sensors or wavebands for multichannel sensors allowing easy interchange between sensors and factors.

The 8 channel SpectroSense2+ versions can be used with four 2-channel sensors, two 4-channel sensors, 4 single channel sensors or combinations of the above totalling 8 channel inputs. The meter can store a Sensor Library of calibration data for up to 16 sensors or wavebands for multichannel sensors allowing easy interchange between sensors and factors.

The meter's 4 line scrolling display enables a 'live' readout of up to 8 sensors or channels simultaneously - with a **[Hold]** button on the keypad to freeze the display when taking measurements.

Ratios between sensor or channel pairs can also be displayed, as can a ratio of one sensor or channel reading against 3 other channels, or one sensor or channel against all 7 others currently being measured, for example a ratio between a pyranometer against 7 discrete wavelengths.

The **[F1]** special function button on the keypad can be easily configured to quickly and easily switch between the current display and your chosen 'favourite' mode as a shortcut.

In any of the display modes the **[Store]** button can be pressed to record the current values in memory, with data and time and location of the measurement (text label or GPS latitude / longitude). Automatic datalogging is also available in a choice of storage intervals.

A pre-programmed set of Vegetation Indices (NDVI) ratio can be displayed for Red / NIR incident and reflected light measurement applications, when the appropriate sensors are attached.

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As standard, SpectroSense2+ is splashproof only. An alternative waterproof housing is also available on request at time of purchase. Sensor socket inputs are Binder sub-miniature which are waterproof when mated. Blanking dustcaps should be used to protect sockets that have no sensor attached.

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2 PRINCIPLE OF OPERATION

2.1 Sensor Calibration Data

The SpectroSense2+ meter will store calibration factors and information for up to 16 different sensors or waveband channels in memory in the Sensor Library.

The information for each sensor or channel consists of:

Sensor / Channel Number	00 to 15, one for each sensor or channel
Sensor Units	5 characters to describe units, e.g. μmols , watts
Sensor Description	8 characters to describe the sensor or channel e.g. PAR_Quan, Skye UVA, SWIR, 660_UP etc.
Sensor Type	Current (C) or Voltage (V) output
Sensor Output*	Calibration or scaling factor e.g. +20.1234 μmols / nA
Sensor Offset	Zero offset of sensor / amplifier e.g. -0.12 watts

* NOTE – Sensor output is required to be entered in the format:

“Units per μA ” or “Units per mV” as appropriate. Each sensor has its own unique calibration/scaling factor – please see the calibration certificate that accompanied your sensor(s).

If you have purchased your SpectroSense2+ meter with light sensors directly from Skye, then your sensor calibration data will have already been programmed in the meter ready for use. Full details are shown on the Calibration Certificate in the separate booklet that come with your sensors.

If you have purchased the meter separately or for your own sensors, please enter the calibration data using the PC connection and Skye SpectroSense2+ software, please see **Chapter 4.5**. Alternatively all data can be entered via SpectroSense's keypad and **Menu Option 21 – Set Sensor Data**. Please see **Chapter 6.24** for details.

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2.2 Active Sensors

The SpectroSense2+ is an 8-channel logging meter which means it has inputs for measuring from up to 8 different sensors or channels simultaneously. These can be made up of various combinations, for example 4x 2-channel sensors, 2x 4-channel sensors, 8x 1-channel sensors etc..

SpectroSense can store the configuration details for a total of 16 sensors in the Sensor Library. As such it is necessary to let SpectroSense know which 8 sensors are presently connected for measurement, and to which sockets they are attached. These 8 are called the 'Active Sensors' and are numbered 0 to 7. The meter sockets are labelled C1, C2, C3, C4, C5, C6, C7 or C8 for current inputs or V1, V2, V3 or V4 for voltage inputs. This label will vary according to which SpectroSense meter version you have purchased. Please see **Appendix 5** for details of the different versions available.

To allocate Active Sensors to the appropriate input socket, use either the Skye SpectroSense2+ software (see **Chapter 4.6**), or use the meter's keypad and **Menu Option 19 Set Active Sensors** (**Chapter 6.22**).

It is just as simple to change the Active Sensors when using the SpectroSense2+ if you have more than 8 sensors or sensor channels you'd like to use in your project. If you have purchased your SpectroSense from Skye as a system with light sensors, the meter will have already been set up with a suggested Active Sensor arrangement, and will be shown on the meter's Configuration Certificate.

It is not necessary to have all 8 channels "Active" at once, and each can be switched off as necessary, for example if you are only using 2 or 4 channels or sensors in your current application.

A summary of the "Active Sensor" set up is always stored at the start of any datalogging activity, whether manual or automatic, and appears as a header at the start of the downloaded data file. If the Active Sensor set up is changed at any time, even if the logger memory is not cleared, the new set up is stored at the point in memory where it was changed. This makes viewing and analysis of data files easy and straightforward.

9	DemoSS2x	SKL908_1_026512			
0	0	0 C	61.86	0 Ch1 UP	umol0
1	1	1 C	43	0 Ch2 UP	umol1
2	2	2 C	64.16997	0 Ch1 DOWN	umol2
3	3	3 C	47.36	0 Ch2 DOWN	umol3
4	4	4 C	1	0 Rel1 UP	REL4
5	5	5 C	0.91	0 Rel2 UP	REL5
6	6	6 C	1	0 Rel1DOWN	REL6
7	7	7 C	0.97	0 Rel2DOWN	REL7

NB. Depending on the meter version and socket combination, it is possible to connect more than one sensor into the same hardware input:

e.g. SKL 925/1 has Socket 2 labelled C1 / C5 plus Socket 6 labelled C1 / C2 / C3 / C4

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If a 4-channel sensor is connected to Socket 6 then Socket 2 must not be used simultaneously as hardware input C1 will be reading from 2 sensors at once. No damage will be caused to the meter, but the display will show an inaccurate amalgamation of both sensors.

2.3 Display Light Readings

The SpectroSense2+ meter can display measurements simultaneously from all 8 channels, however as there are only 4 lines on the LCD display the user must scroll up or down to view all 8.

The [HOLD] button can be used to freeze the display at any time to enable the readings from all 8 channels at the point where [HOLD] was pressed to be viewed. There are two slightly different views of simple display readouts in Menu options 0 and 1:

Menu “0 – Read 8 Sensors *4L” (4L indicates 4 lines) shows 4 channels in one window, with a brief label for the Sensor/Channel (Library) Number to identify each sensor or channel, plus its measurement units. Use the ▲ ▼ buttons to switch between which 4 channels are displayed.

e.g. (Library Channel #)	(Reading)	(Units)
00	13.287	μmol
01	12.372	μmol
02	2.1534	μmol
03	1.9821	μmol

Menu “1 – Read 8 Sensors *2L” uses 2 lines per measurement meaning only 2 sensors or channels can be viewed in one window. Each measurement is accompanied by full sensor details including Sensor / Channel (Library) Number, Sensor Description and measurement units. Use the ▲ ▼ buttons to switch between which 2 channels are displayed.

e.g. 0 Sens00 - Red	
13.287	μmol
1 Sens01 - Far Red	
12.372	μmol

Pressing the [STORE] key on the meter at any time during these displays will store the current reading being measured by each of the 8 Active Sensors with time, date and plot location label (if activated). The menu from which the reading was stored will also be recorded (i.e. the reading “type”)– for example in Menu 0 the line of data in memory will be followed by the number 0, and in Menu 1 the line of data in memory will be followed by the number 1, and so on.

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2.4 Sensor Ratios

Before using the ratio features, it is useful to take time to understand how the SpectroSense2+ meter displays sensor ratios before setting up the relevant "Active Sensors".

2.4.1 Ratio Of Sensor Pairs

In Menu Options 9 and 10 the meter display will show live measurements of the ratio between sensor pairs. If you wish to view a ratio between sensors pairs, ensure that they are set up as the appropriate "Active Sensors"

Menu Option "9 – Ratio 0:1, 2:3 etc" display will show ratio of "Active Sensors" 0 : 1, "Active Sensors" 2 : 3, "Active Sensors" 4 :5 and "Active Sensors" 6 : 7.

Menu Option "10 – 0:2, 1:3, 4:6, 5:7" display will show ratio of "Active Sensors" 0 : 2, "Active Sensors" 1 : 3, "Active Sensors" 4 :6 and "Active Sensors" 5 : 7.

Example 1 - if you wish to measure the Red / Far-Red ratio of incident solar radiation using a Skye 2-Channel sensor (SKR 110), then you should choose Active Sensor 0 as the Red channel and Active Sensor 1 as the Far-Red channel.

i.e. Active Sensor 0 C1 Red channel - incident
 Active Sensor 1 C3 Far-Red channel – incident

The SpectroSense2+ Menu 2 display will show ratio of Active Sensors 0 : 1 (Red : Far-Red incident ratio).

Example 2 – if you have 2 SKR 110 Red / Far-Red radiation sensors, 1 incident and 1 reflected (one looking up, one looking down). Set the incident sensor on Active Channels 0 and 1 as in Example 1 above, then set the reflected sensor on Active Channels 2 and 3.

i.e. Active Sensor 0 C1 Red channel - incident
 Active Sensor 1 C3 Far-Red channel – incident
 Active Sensor 2 C2 Red channel - reflected
 Active Sensor 3 C4 Far-Red channel – reflected

The SpectroSense2+ Menu 9 display will show the ratio of Active Sensors 0 : 1 (Red : Far-Red incident ratio) and Active Sensors 2 : 3 (Red : Far-Red reflected ratio). You could then switch to Menu 10 which will display the ratio of Active Sensors 0 : 2 (Red incident : Red reflected ratio) and Active Sensors 1 : 3 (Far-Red incident : Far-Red reflected ratio).

NOTE: Each waveband of a Skye 2 or 4-channel sensor is calibrated individually and given a fully traceable factor in radiance and irradiance units. Previous to 2014, when the sensor was used without the cosine head, for narrow angle or measuring reflected light, calibration factors were only given for one channel relative to each of the other channels, not as radiance units. So it is not valid to make a direct ratio measurements between a cosine corrected incident light measuring sensor and a narrow angle (cosine head removed) reflected light measuring sensor if you are using sensors calibrated before 2014. However, if you would like your sensors re-calibrated to incorporate the radiance calibration of reflected sensors, then please contact Skye Instruments.

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However it is possible to take incident and reflected light measurements with the SpectroSense2+ meter for later calculating Vegetation Indices such as NDVI, please see **Chapter 2.3.4** below.

The above does not apply for the 2-channel SKR IIO sensor which has a fixed (non removable) cosine corrected head.

Pressing the [STORE] key on the meter at any time during these displays will simply store the current reading being measured by each of the 8 Active Sensors with time, date and plot location label (if activated). In Menu 9 the line of data in memory will be followed by the number 2, and in Menu 10 the line of data in memory will be followed by the number 3, indicating which menu was active when the data was stored. If you are viewing ratio data such as in Menu 2 or 9, or viewing NDVI values, the "row" data from each sensor is stored, along with the Menu # you "stored" the values.

2.4.2 Ratio of 4 Channels

In Menu Options "11 - 1,2,3:0 & 5,6,7:4" the meter display will show live measurements of the ratio of 3 sensors or channels relative to 1 other.

i.e. a display of Active Sensors 1 : 0, 2 : 0 and 3 : 0 and the ratio of Active Sensors 5 : 4, 6 : 4 and 7 : 4.

Example 3 – using a Skye 4-channel sensor with 4 different wavebands of blue, green, red and the full PAR range to measure the ratio of the colours in incident PAR radiation (cosine corrected head fitted).

i.e. To measure incident light from a Skye 4-channel sensor

Active Sensor 0	C1	Incident PAR 400-700nm
Active Sensor 1	C2	Incident Blue
Active Sensor 2	C3	Incident Green
Active Sensor 3	C4	Incident Red

The SpectroSense2+ display shows ratios of Active Sensors 1 : 0 (blue : PAR), 2 : 0 (green : PAR) and 3 : 0 (red : PAR).

**** NOTE:** Each waveband of a Skye 2 or 4-channel sensor is calibrated individually and an calibration factor is given for measurement of incident light when the cosine correcting head is fitted and from 2014 we also give radiance calibration factors for reflected light measurements. Previous to 2014 when the sensor is used without the cosine head, for narrow angle or reflected measurements, calibration factors were only given for one channel relative to each of the other channels, not as values. So for these sensors it is not valid to make a direct ratio measurements between a cosine corrected incident light measuring sensor and a narrow angle (cosine head removed) reflected light measuring sensor.

However, if the *RELATIVE* sensitivities between channels (with the cosine head removed) are each entered in the meter's Sensor Library as additional 'sensors', then it is perfectly valid to measure the ratio between these reflected channels.

Example 4 – using 2 identical Skye 4-channel sensors with 4 different wavebands of blue, green, red and the full PAR range to measure the ratio of the colours in incident (cosine corrected head fitted) and reflected (cosine corrected head removed) PAR radiation.

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i.e.	Active Sensor 0	C1	Incident PAR 400-700nm
	Active Sensor 1	C2	Incident Blue
	Active Sensor 2	C3	Incident Green
	Active Sensor 3	C4	Incident Red
	Active Sensor 4	C5	Reflected PAR 400-700nm (relative factor)
	Active Sensor 5	C6	Reflected Blue (relative factor)
	Active Sensor 6	C7	Reflected Green (relative factor)
	Active Sensor 7	C8	Reflected Red (relative factor)

The SpectroSense2+ display shows ratios of Active Sensors 1 : 0 (incident blue : incident PAR), 2 : 0 (incident green : incident PAR) and 3 : 0 (incident red : incident PAR), plus also ratios of Active Sensors 5 : 4 (reflected blue : reflected PAR), 2 : 0 (reflected green : reflected PAR) and 3 : 0 (reflected red : reflected PAR).

Pressing the [STORE] key on the meter at any time during this display will simply store the current reading being measured by each of the 8 Active Sensors with time, date and plot location label (if activated). In this menu the line of data in memory will be followed by the number 11, indicating that it was stored from Menu option 11.

2.4.3 Ratio of 8 Channels

In Menu Options "12 - 1, 2, 3, 4, 5, 6, 7 : 0" the meter display will show live measurements of the ratio of 7 sensors or channels relative 1 other.

i.e. a display of Active Sensors 1 : 0, 2 : 0, 3 : 0, 4 : 0, 5 : 0, 6 : 0 and 7 : 0.

Example 5 – using 4 individual sensors for total radiation, UVA, UVB and PAR plus a Skye 4-channel each with different wavebands to measure the ratio of the regions and colours in incident total solar radiation.

i.e.	Active Sensor 0	C1	Incident total solar radiation
	Active Sensor 1	V1	Incident UVB
	Active Sensor 2	V2	Incident UVA
	Active Sensor 3	C2	Incident PAR
	Active Sensor 4	C5	Incident Blue
	Active Sensor 5	C6	Incident Green
	Active Sensor 6	C7	Incident Red
	Active Sensor 7	C8	Incident Far-Red

The SpectroSense2+ display shows ratios of Active Sensors 1 : 0 (incident UVB : incident total), 2 : 0 (incident UVA : incident total) and 3 : 0 (incident PAR : incident total), plus also ratios of Active Sensors 4 : 0 (incident blue : incident total),

5 : 0 (incident green : incident total), 6 : 0 (incident red : incident total) and 7 : 0 (incident far-red : incident total).

Pressing the [STORE] key on the meter at any time during this display will simply store the current reading being measured by each of the 8 Active Sensors with time, date and plot location label (if activated). In this

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menu the line of data in memory will be followed by the number 12, indicating that it was stored from Menu option 12.

2.4.4 Vegetation Indices

Earth observation satellites, e.g. LANDSAT, MODIS, AVHRR etc. map the Earth's surface at various wavelengths throughout the electromagnetic spectrum. There are many useful phenomena which can be studied using the satellite maps, from vegetation productivity to rates of deforestation or desert encroachment, area coverage of primary crops, flood and drought monitoring to insect breeding ground identification. Different ground types, desert, forests, crops, water etc absorb and reflect differing amounts of different wavelengths of radiation, and so are easily identified.

Vegetation Indices are produced by calculating the ratios of different wavebands of reflected solar radiation, and are related to the abundance and activity of radiation absorbers such as water and plant chlorophyll. These indices enable the estimation of biomass, percentage cover, absorbed PAR (Photosynthetically Active Radiation) and Leaf Area Index.

The SpectroSense2+ and SpectroSense2+.gps have been pre-programmed with a number of the more popular vegetation indices. The indices are automatically calculated from the raw readings of the active sensors connected to the meter.

These pre-programmed indices are:

2.4.4.1 NDVI/PRI Ratio

NDVI or Normalised Difference Vegetation Index is a normalised ratio of Red (R) and Near Infra red (NIR) as defined by the equation:

$$\text{NDVI} = \frac{(\text{NIRr}/\text{NIRi}) - (\text{Redr}/\text{Redi})}{(\text{NIRr}/\text{NIRi}) + (\text{Redr}/\text{Redi})}$$

Where: NIRi incident reading (in $\mu\text{mol m}^{-2} \text{s}^{-1}$)
 Redi incident reading (in $\mu\text{mol m}^{-2} \text{s}^{-1}$)
 NIRr reflected reading (in $\mu\text{mol m}^{-2} \text{s}^{-1} \text{sr}^{-1}$)
 Redr reflected reading (in $\mu\text{mol m}^{-2} \text{s}^{-1} \text{sr}^{-1}$)

$$\text{PRI} = \frac{(\text{570r}/\text{570i}) - (\text{531r}/\text{531i})}{(\text{570r}/\text{570i}) + (\text{530r}/\text{530i})}$$

Where: 570i incident reading (in $\mu\text{mol m}^{-2} \text{s}^{-1}$)
 530i incident reading (in $\mu\text{mol m}^{-2} \text{s}^{-1}$)
 570r reflected reading (in $\mu\text{mol m}^{-2} \text{s}^{-1} \text{sr}^{-1}$)
 530r reflected reading (in $\mu\text{mol m}^{-2} \text{s}^{-1} \text{sr}^{-1}$)

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On the SpectroSense2+, menu option “2 – NDVI / PRI ” automatically displays the NDVI or PRI ratio as above from a pair of identical 2 channel sensors, each measuring Red and NIR (or Far-red). One sensor should be measuring incident Red and NIR (cosine corrected), while the second sensor should be simultaneously measuring reflected Red and NIR (with a narrow light acceptance i.e. cosine head removed).

The Active Sensors must be set up in the following way for this NDVI function to be correct:

Active Sensor 0	Red channel incident ($\mu\text{mol m}^{-2}\text{s}^{-1}$)
Active Sensor 1	NIR channel incident ($\mu\text{mol m}^{-2}\text{s}^{-1}$)
Active Sensor 2	Red channel reflected ($\mu\text{mol m}^{-2}\text{s}^{-1}$) pre 2014 (relative μA)*
Active Sensor 3	NIR channel reflected ($\mu\text{mol m}^{-2}\text{s}^{-1}$) pre 2014 (relative μA)*

For the PRI function:

Active Sensor 0	570nm channel incident ($\mu\text{mol m}^{-2}\text{s}^{-1}$)
Active Sensor 1	531nm channel incident ($\mu\text{mol m}^{-2}\text{s}^{-1}$)
Active Sensor 2	570nm channel reflected ($\mu\text{mol m}^{-2}\text{s}^{-1}$) pre 2014 (relative μA)*
Active Sensor 3	531nm channel reflected ($\mu\text{mol m}^{-2}\text{s}^{-1}$) pre 2014 (relative μA)*

** Pre 2014 when sensors were used without the cosine correcting head, i.e. in the narrow angle light acceptance mode, Skye provided relative calibration factors for one channel relative to each of the other channels, not values. So it is important to enter these RELATIVE sensitivities between channels (with the cosine head removed) in the meter's Sensor Library for reflected measurements. Please see Appendix 1 for full details how the and relative calibration values are used in the NDVI ratio calculation)*

The display simply shows the NDVI ratio as a value between -1 and +1 where:

- 1 values are generally from water
- 0 values represent no vegetation, barren areas of rock, sand or snow
- +1 values represent the highest possible density of green leaves.

Pressing the [STORE] key on the meter at any time during this display will simply store the current reading being measured by each of the 8 Active Sensors with time, date and plot location label (if activated). In this menu the line of data in memory will be followed by the number 2, indicating that it was stored from Menu option 2 – NDVI. The NDVI calculated value will not be stored but the individual sensor data is present if the user wishes to recalculate the ratios in Excel.

2.4.4.2 NDVI, LAI & fPAR

Menu option 3. This uses data from active sensors 0, 1, 2 and 3. The NDVI value is calculated first according to the traditional published formula for NDVI and as described in (1) above,

i.e

Active Sensor 0	Red channel incident ($\mu\text{mol m}^{-2}\text{s}^{-1}$)
Active Sensor 1	NIR channel incident ($\mu\text{mol m}^{-2}\text{s}^{-1}$)
Active Sensor 2	Red channel reflected ($\mu\text{mol m}^{-2}\text{s}^{-1}$) pre 2014 (relative μA)*
Active Sensor 3	NIR channel reflected ($\mu\text{mol m}^{-2}\text{s}^{-1}$) pre 2014 (relative μA)*

** Pre 2014 when sensors were used without the cosine correcting head, i.e. in the narrow angle light acceptance mode, Skye provided relative calibration factors for one channel relative to each of the other channels, not values. So it is important to enter these RELATIVE sensitivities between channels (with the cosine head removed) in the meter's Sensor Library for reflected*

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measurements.)

The NDVI result is displayed and used to calculate further derived results for fPAR and LAI as follows:

$$\text{fPAR} = (1.24 * \text{NDVI}) - 0.168$$

*Ref: Potential of MODIS ocean bands for estimating CO2 flux from terrestrial vegetation: A novel approach
A. F. Rahman,1 V. D. Cordova,2 J. A. Gamon,3 H. P. Schmid,4 and D. A. Sims1
GEOPHYSICAL RESEARCH LETTERS, VOL. 31, 2004
<http://onlinelibrary.wiley.com/doi/10.1029/2004GL019778/pdf>*

$$\text{LAI} = a * e(b * \text{NDVI})$$

where a and b are parameters specific to each vegetation type, but in this menu option the following default values are used:

$$a = 0.0148$$

$$b = 6.192.$$

e is the exponential function

Ref: <http://www.ierm.ed.ac.uk/homes/mwilliam/Street2007.pdf>

Journal of Ecology 2007 95, 139–150 Publishing Ltd

What is the relationship between changes in canopy leaf area and changes in photosynthetic CO2 flux in arctic ecosystems? L. E. STREET, G. R. SHAVER, M. WILLIAMS and M. T. VAN WIJCK*

2.4.4.3 LAI (Leaf Area Index) from PAR

This calculation uses data from Active Sensors 6 and 7. Active sensor no 6 will be a PAR Quantum Sensor above the canopy and active sensor no 7 will be a Line Quantum Sensor (or PAR Quantum Sensor) below the canopy. The sensors can be connected to any socket, it is the 'Active Sensor' number that is important.

$$\text{LAI} = -2 * \ln(\text{PARlq} / \text{PARi})$$

where PARlq is the sensor below the canopy

PARi the sensor above.

ln = logarithm

Ref: Canopy structure measurement by gap fraction analysis using commercial instrumentation

Jon M. Welles (Licor) and Shabtai Cohen

Journal of Experimental Botany, Vol. 47, No. 302, pp. 1335-1342, 1996

<http://jxb.oxfordjournals.org/content/47/9/1335.full.pdf>

2.4.4.4 RVI or WBI

This is the original Vegetation Index, before it became normalised in NDVI, The same ratio is also used for WBI

RVI Ratio Vegetation Index

Bands Red & NIR

SR RVI is sometimes called Simple Ratio

Bands Red & NIR

WBI Water Band Index

Bands 900nm & 970nm

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This indice takes data from active sensors 0, 1, 2 and 3.

Again each component should be a ratio of reflected : incident measurements, so the equation becomes:

$$RVI = \frac{(NIR_r / NIR_i)}{(Red_r / Red_i)}$$

where NIR_i incident reading is in $\mu\text{mol m}^{-2} \text{s}^{-1}$
 Red_i incident reading is in $\mu\text{mol m}^{-2} \text{s}^{-1}$
 NIR_r = reflected reading in $\mu\text{mol m}^{-2} \text{s}^{-1} \text{sr}^{-1}$
 Red_r = reflected reading in $\mu\text{mol m}^{-2} \text{s}^{-1} \text{sr}^{-1}$

$$WBI = \frac{970_r / 970_i}{900_r / 900_i}$$

where 970_i is 970nm band incident reading in $\mu\text{mol m}^{-2} \text{s}^{-1}$
 900_i is 900nm band incident reading in $\mu\text{mol m}^{-2} \text{s}^{-1}$
 970_r is 970nm band reflected reading in $\mu\text{mol m}^{-2} \text{s}^{-1} \text{sr}^{-1}$
 900_r is 900nm band reflected reading in $\mu\text{mol m}^{-2} \text{s}^{-1} \text{sr}^{-1}$

2.4.4.5 MODIS-EVI

The enhanced vegetation index (EVI) is an 'optimized' index designed to enhance the vegetation signal with improved sensitivity in high biomass regions and improved vegetation monitoring through a de-coupling of the canopy background signal and a reduction in atmosphere influences. EVI is computed following this equation:

$$EVI = \frac{G \times (NIR - RED)}{(NIR + C1 \times RED - C2 \times BLUE + L)}$$

where NIR/red/blue are atmospherically-corrected or partially atmosphere corrected (Rayleigh and ozone absorption) surface reflectances, L is the canopy background adjustment that addresses non-linear, differential NIR and red radiant transfer through a canopy, and C1, C2 are the coefficients of the aerosol resistance term, which uses the blue band to correct for aerosol influences in the red band. The coefficients adopted in the MODIS-EVI algorithm are:

$$L=1, C1 = 6, C2 = 7.5, \text{ and } G \text{ (gain factor)} = 2.5.$$

Again each component should be a ratio of reflected : incident measurements, so the equation becomes:

$$EVI = \frac{2.5 \times \{(NIR_r / NIR_i) - (Red_r / Red_i)\}}{(NIR_r / NIR_i) + C1 \times (Red_r / Red_i) - C2 \times (Blue_r / Blue_i) + L}$$

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$$((\text{NIRr} / \text{NIRi}) + (6 \times (\text{Redr} / \text{Redi})) - (7.5 \times (\text{Blue} / \text{Bluei}))) + 1$$

where NIRi incident reading is in $\mu\text{mol.m}^{-2}.\text{s}^{-1}$
 Redi incident reading is in $\mu\text{mol.m}^{-2}.\text{s}^{-1}$
 Bluei incident reading is in $\mu\text{mol.m}^{-2}.\text{s}^{-1}$
 NIRr = reflected reading in $\mu\text{mol.m}^{-2}.\text{s}^{-1}.\text{sr}^{-1}$
 Redr = reflected reading in $\mu\text{mol.m}^{-2}.\text{s}^{-1}.\text{sr}^{-1}$
 Blue = reflected reading in $\mu\text{mol.m}^{-2}.\text{s}^{-1}.\text{sr}^{-1}$

Active Sensors 0, 1, 2, 3, 4, 5

- 0 Red i
- 1 NIR i
- 2 Red r
- 3 NIR r
- 4 Blue i
- 5 Blue r

An error message will be displayed if the setup is entered incorrectly.

2.4.4.6 EVI2 & MSAVI

This calculation uses active sensors 0, 1, 2 and 3 and first calculates NDVI as in menu 3 and as per traditional published papers. Secondly it calculates EVI2.

EVI2 is EVI without the blue band. According to Users, the blue band has always been problematic, and its Signal to Noise ratio (S/N) quite poor. This is mainly due to the nature of the reflected energy in this part of the spectrum over land, which is extremely low.

$$\text{EVI2} = \frac{2.5 * ((\text{NIRr} / \text{NIRi}) - (\text{Redr} / \text{Redi}))}{(\text{NIRr} / \text{NIRi}) + 2.4 * (\text{Redr} / \text{Redi}) + 1}$$

where NIRi incident reading is in $\mu\text{mol m}^{-2}.\text{s}^{-1}$
 Redi incident reading is in $\mu\text{mol m}^{-2}.\text{s}^{-1}$
 NIRr = reflected reading in $\mu\text{mol m}^{-2}.\text{s}^{-1}.\text{sr}^{-1}$
 Redr = reflected reading in $\mu\text{mol m}^{-2}.\text{s}^{-1}.\text{sr}^{-1}$

Ref.: Jiang, Z., Huete, A. R., Didan, K. & Miura T. (2008). [Development of a two-band Enhanced Vegetation Index without a blue band](#). Remote Sensing of Environment, 112(10), 3833-3845.

Lastly MSAVI is calculated.

MSAVI (or MSAVI2) is a modification of SAVI. SAVI is an indice that was developed to take into account the soil background. When the NDVI calculation is made, unless the vegetation is 100% cover, the calculation will incorporate changes in soil moisture and the true NDVI value is not correct. The SAVI calculation uses an 'L' parameter, where 'L' is a soil adjustment factor with values between 0 and 1. 100% vegetation cover and

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$L=0$. 0% vegetation cover and $L = 1$. It is common to set L at 0.5.

However, MSAVI was developed to take away the requirement to incorporate an 'L' parameter. When results are compared using SAVI and MSAVI, there is virtually no difference.

$$SAVI = \frac{(NIR - RED)(1+L)}{NIR + RED + L}$$

where RED is the red band reflectance from a sensor, NIR is the near infrared reflectance and L is the soil brightness correction factor.

MSAVI uses the following formula to calculate L :

$$L = 1 - \frac{2 * s * (NIR - RED) * (NIR - s * RED)}{NIR + RED + L}$$

where s is the slope of the soil line from a plot of red versus near infrared brightness values.

When a red vs. near infrared feature space plot is created, a soil-line can be identified by the combinations of red and near-infrared pixel values where vegetation no longer occurs. The slope of this soil line is used in calculating L in the MSAVI equation.

Qi et al. (1994b), starting with the MSAVI equation, substituted $1-MSAVI(n)$ for a range of n and then solved the equation recursively until $MSAVI(n)=MSAVI(n-1)$. This yields the following formula, commonly called MSAVI2, which eliminates the need to find the soil line from a feature-space plot or even explicitly specify the soil brightness correction factor:

$$MSAVI2 = \frac{(2 * (NIR_r / NIR_i) + 1 - \sqrt{(2 * (NIR_r / NIR_i) + 1)^2 - 8 * ((NIR_r / NIR_i) - (RED_r / RED_i))})}{2}$$

where
 NIR_i incident reading is in $\mu\text{mol m}^{-2} \text{s}^{-1}$
 RED_i incident reading is in $\mu\text{mol m}^{-2} \text{s}^{-1}$
 NIR_r = reflected reading in $\mu\text{mol m}^{-2} \text{s}^{-1} \text{sr}^{-1}$
 RED_r = reflected reading in $\mu\text{mol.m}^{-2} \text{s}^{-1} \text{sr}^{-1}$

This formula is used in the SpectroSense2+

Ref.: Qi J., Chehbouni A., Huete A.R., Kerr Y.H., 1994. Modified Soil Adjusted Vegetation Index (SAVI). *Remote Sens Environ* 48:119-126.
<http://naldc.nal.usda.gov/download/50306/>

2.4.4.7 All NDVI Derived

This menu option enables the user to view an instant comparison of all the similar indices.

A scrollable display shows all the indices which are derived from the basic NDVI figure or principle and that

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have sensors using these connections,

ie

NDVI stays at the top of the display and will be compared to:

EVI2,
MSAVI,
LAI,
fPAR,
RVI

and then the display repeats,

2.5 Measurement / Plot Location

This feature is mainly of use when making field mapping measurements. Manual recordings can be made by pressing the [STORE] key when in any Display Mode, and storing the data with its location as the SpectroSense2+ meter system is moved from plot to plot.

The user can enter up to 100 plot location labels. Each label is an alphanumeric string up of 10 characters entered by the user via the PC software, e.g. "S.1.1", "S.1.2", "S.1.3"... "S.2.1." etc. (See **Chapter 4.7** for details.) These labels cannot be edited via the SpectroSense2+ keypad.

The user has three options for storing the plot location label. These include: **no storage**; select a different label manually for each measurement; or **automatically assign** the plot location labels sequentially with each successive measurement.

If "automatically assign" is chosen, it is obviously important to synchronise the entry of the plot location labels with the measurement sequence. The sequence will start at the last plot location label used, so it is advisable to use the option to choose the plot location label for the first measurement, and change to sequential mode for subsequent measurements.

When entering any sensor display menu option, the currently set location storage mode/Plot Location Label method is briefly shown on screen.

Plot location labels are also stored in automatic log mode. It is advisable to switch off the label storage in this mode. The manually select label option can be used if a plot label is required, the last chosen label is stored automatically with each measurement.

2.6 GPS Mode (SpectroSense 2+ (+GPS) - SKL925 only)

With the connection of a GPS module, the latitude and longitude location of each measurement can also be stored. The GPS module supplied by Skye connects to the 4 pin socket of the SpectroSense2+ meter, and receives power from the meter. Depending on where in the world it will be used, we supply two types

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of GPS modules.

Models with Navman Wireless GPS 3260 or GPS3264

When first powered up, the GPS's red LED will light up and blink slowly (equal on and off periods). It may take a few minutes to get its first "fix" on the present location, and then the LED will change to a short, sharp flash once a second. The GPS module may "remember" its last location and display this until the updated fix is received. The GPS module will provide the most accurate location values under a clear sky, with minimum obstructions such as buildings or trees. Rain and mist will also reduce the signal.

Models with Jupiter Solutions GPS MOUSE JS-3M

When first powered up, the GPS's orange LED will light up continuously until the position is fixed at which point it will go off. The Red LED will blink once every second after the position is fixed. The GPS module will provide the most accurate location values under a clear sky, with minimum obstructions such as buildings or trees. Rain and mist will also reduce the signal.

Models with BR-355 GPS Mouse

When first powered up, the GPS's red led will light up continuously until the position is fixed at which point it will flash. The GPS module will provide the most accurate location values under a clear sky, with minimum obstructions such as buildings or trees. Rain and mist will also reduce the signal.

General Information

The GPS module is able to receive two types of location "fix" to transmit to the SpectroSense2+ meter:

sps - standard positioning service fix, the most common type and gives a location resolution of about 3m

sbas - satellite based augmentation system fix, a more accurate fix but only available in Europe in clear sky views. This can give a location resolution of 1m

When fully logged on with a valid fix, the SpectroSense2+ meter will display the time from the GPS system in GMT, the quality of the fix (fix, void, sps or sbas), latitude and longitude in degrees and minutes north, south, east or west, plus altitude in metres above sea level.

In store or log mode, only the latitude and longitude location in degrees and minutes north, south, east or west is recorded. If no fix has been made then the letter "F" for Fail is recorded in both latitude and longitude positions.

When entering any sensor display menu option, the currently set location storage mode is briefly shown on screen.

It is possible to automatically record the GPS location in all logging mode intervals, although the occasional

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record may be lost when using 1 second logging (about 1 record every 40 seconds). Logging intervals of 2 seconds and above do not show this problem.

If using log mode to automatically log measurements and position from a moving system, remember that logging intervals over 10 seconds are “sampled” every 10 seconds and then averaged over the chosen logging period. Depending on the speed of movement a lot of ground can be covered within the 10 second sample period.

2.7 MJhr⁻¹ Integration

This menu option displays an accumulative integration of total solar radiation in Megajoules per hour (MJ/hr or MJ.hr⁻¹). This function is only valid for sensors calibrated in W m⁻², e.g. pyranometers.

MJ/day (or MJ/24hr) is a value of total solar radiation reaching the Earth's surface in a 24 hour period and is useful for monitoring plant growth and photosynthesis rates.

The SpectroSense2+ display shows the start time and date of the integration measurement, total MJ value, plus the number of hours elapsed in steps of 0.01 hour (or 36 seconds). The actual datalogging interval is every 10 seconds. When the period of measurement is finished, please make a note of the data on screen as this meter does not store the values. Please use the automatic datalogging function in menu option 10 for storing pyranometer measurements over time.

NOTE – the [HOLD] and [STORE] buttons are inactive in this display. If the [ESCAPE] button is pressed twice to leave this menu, all integration data is lost, so must be noted before returning to Main Menu.

2.8 Log Data

The SpectroSense2+ has full datalogging capabilities and the user can choose from logging intervals of 1, 2, 5, 10, 20, 30 seconds, 1, 2, 5, 10, 20, 30 minutes, 1 or 2 hours.

All 8 channels will be logged simultaneously at the chosen logging interval, with time and date of each measurement, plus plot location label or GPS position if activated. The Active Sensor set up is stored at the beginning of each datalogging activity to allow for easy and straightforward data interpretation.

At logging intervals of 20 seconds and above, the reading stored will be an average of measurements taken every 10 seconds. Logging intervals of 1 to 10 seconds will be ‘spot’ logs, i.e. no integration/averaging.

It is possible to automatically record the GPS location in all logging mode intervals, although the occasional record may be lost when using 1 second logging (about 1 record every 40 seconds). Logging intervals of 2 seconds and above do not show this problem.

If using log mode to automatically log measurements and position from a moving system, remember that logging intervals over 10 seconds are “sampled” every 10 seconds and then averaged over the chosen logging period. Depending on the speed of movement a lot of ground can be covered within the 10 second sample period.

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Please see **Chapter 6.17** for a table of logging interval against memory duration. Data can be downloaded to a PC by using the Menu Option **"30 – Connect to a PC"** and using the Skye SpectroSense2+ software, supplied with this meter, please see **Chapter 4.8** for details.

The data format is a comma separated, ASCII numerical file which can be viewed using a basic text editor such as Microsoft Notepad, and can be imported into a spreadsheet software such as Microsoft Excel. Each line of data stored in memory by the automatic datalogging function begin with plot location (shown as ++ ++ if disabled), time, date and a single number corresponding to which SpectroSense2+ meter Menu was active when data storage took place, followed by the data for each Active Sensor in turn. This means that the raw data from each sensor is stored, and not the value being viewed at time of "storing", e.g. ratios between channels, NDVI etc.

2.9 FI Function

The SpectroSense2+ keypad includes an **[FI]** button which the user can set up to quickly change the display to their favourite or most used display mode.

In Menu **"16 – Set FI function"** the user can choose which display option to set, from Menu options 0 to 13, please see **Chapter 6.19** for details.

While using any of the display options 0-13, pressing **[FI]** at any time will quickly change to the favourite display mode. Pressing **[FI]** again will return to the original display. **[HOLD]** and **[STORE]** button will operate as normal under either display e.g. Set **[FI]** to display Menu **"0 – Read 8 Sensors *4L"**. Then while displaying ratios it is easily to toggle between displaying individual measurements and ratios by pressing **[FI]** alternatively.

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3 KEYPAD AND DISPLAY



The SpectroSense2+ meter has a 4 line, 20 character alphanumeric liquid crystal display, plus a 12 button waterproof membrane keypad with audible keypress.

This meter includes auto-ranging functions and is designed to measure light levels from full sunlight to very low light, even moonlight. The last significant digits of the display will constantly be changing because of this high sensitivity, so it is advisable to use the **[HOLD]** button on the keypad to freeze the display to take a measurement, or note down 3 or 4 measurements and take an average. Ensure to quote sensible significant figures.

The fluctuations of the last significant digits on the display may be more noticeable at low light levels or high scaling factors, indoors and under artificial light sources, also when using long cables on light sensors. To minimise these fluctuations, try to avoid movement of the meter and sensor cables whenever possible by placing on a solid surface and leaving to settle for a moment without disturbance.

In the display modes of Menu options 0 to 6, the meter display is refreshed every second and the measurement shown is an average of the previous 2 seconds. Hence it may be noticeable when moving from a high light level to a low light level area that the display appears slow to change due to this 2 second averaging feature. Under natural sunlight conditions it is advantageous to take measurements in this way to even out rapidly fluctuating light levels. At all times, wait 3 to 4s at a sampling location for the reading to stabilise before storing.

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Keypad buttons are described below:

ON	Switches on power to the meter.
OFF	Switches off power to the meter
ESCAPE	Escapes from any mode or menu without changes Escape will also return to start or top of the Main Menu (Option 0)
NEXT	Proceeds to next menu option, moves cursor to the next sensor number, next letter, choice etc
ENTER	Chooses menu option or confirms entry(ies)
STORE	Active only in display modes of Menu Options 0 to 6. Stores individual readings of each Active Sensor in memory with time and date of measurement. Also stores the Menu Option number currently active when the Store button was pressed.
HOLD	Both Hold buttons are identical and interchangeable, designed for left and right handed use. Active in display Menu Options 0 to 6 only. Freezes the display for easy viewing. Pressing again toggles the hold function off
MENU	Escapes from any display mode back to the Main Menu. Quick jump from anywhere in Main Menu to halfway Menu option 12 – Set FI Function.
UP	Scrolls up through menu options Increases number or letter when editing data entries
DOWN	Scrolls down through menu options Decreases number or letter when editing data entries
FI	Active in display Menu Options 0 to 6 only. Repeated keypress toggles between current display and user set 'favourite' display
HOLD	Both Hold buttons are identical and interchangeable. Active in display Menu Options 0 to 6 only. Freezes the display for easy viewing. Repeated keypress toggles the freeze display on and off

The menu functions are described in detail in **Chapter 6**.

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4 PC SOFTWARE

Although the SpectroSense2+ meters can be set up and used entirely from the keypad if preferred, it is usually easier to do any initial setting up and entry of sensor data via the PC. The PC connection is essential for downloading data from the meter's memory.

4.1 PC Specification

Recommended Minimum PC Specification

Windows 98 or later. XP mode in Win7 & 8 advisable
Pentium 2 processor or better
32 Mb RAM
40 Mb Hard Disk Space
SVGA monitor
RS232 serial Comm Port
(USB-Serial converter available on request)

4.2 Software Installation

Insert the CD into the PC drive. If AutoPlay runs, confirm you want to open the .htm file. Navigate to the software files by clicking "Light Sensors & Systems" → "Software". Click the link to download the installation files to your hard drive. No internet connection necessary.

Alternatively:

Navigate to "My Computer". Double click on your CD Drive. The .htm file should start automatically. Navigate to the software files by clicking "Light Sensors & Systems" → "Software". Click the link to download the installation files to your hard drive. No internet connection necessary.

Navigate to the downloaded file's location on the hard drive, right-click, and "Extract All". Once extracted, double click setup.exe.

Follow on screen instructions choosing the default settings where possible, until you see the message that installation has been successful.

Remove the CD and store safely.

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4.3 Connection to SpectroSense2+

On the SpectroSense2+ meter choose menu Option “30 – Connect to a PC”, connect the data lead to the 8 pin RS232 socket on the SpectroSense, and the USB/Serial to the PC.

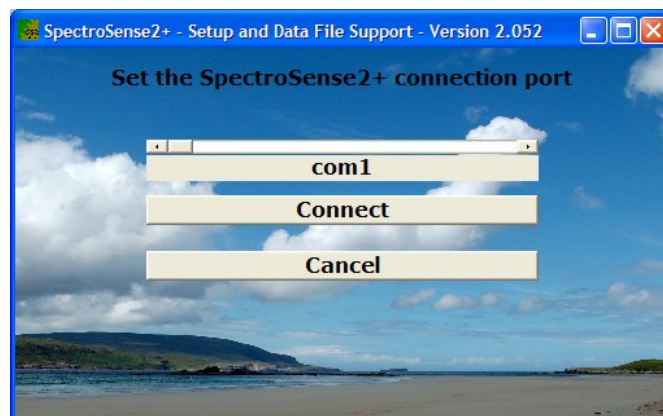
Start the Skye SpectroSense2+ software by clicking START, ALL PROGRAMS, “SS2plusGPSv.2.054 Setup” → SS2plusGPSv.2.054 Setup.

Click the “Auto-Find Target” button for the software to auto detect the meter as shown below:



Click Proceed to continue.

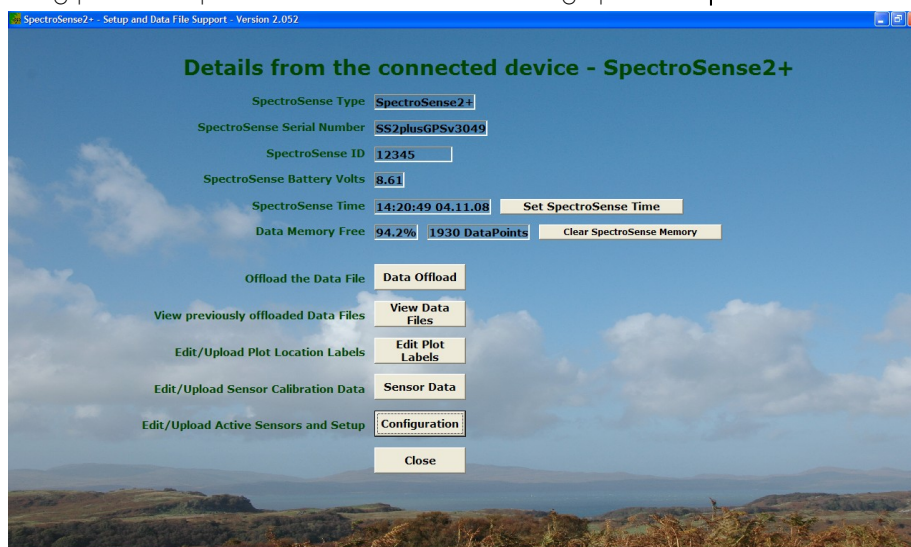
If the software does not automatically find the meter, check again that the PC cable is connected and the meter is in menu option “30 – Connect to a PC”.



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If you know the Comm Port you are trying to connect to you can use the Manual Connection button. Use the drop down box to choose SpectroSense2+ and the slider bar to choose the appropriate port as below. Click Connect.

If you are still having problems, please see the Troubleshooting tips in Chapter 8.



Once successfully connected, the software will download current settings from the meter and display them in the following window:

4.4 Clock and Memory Operations

The main screen shown above displays the SpectroSense2+ meter type, serial number, ID, battery voltage, date and time settings and memory status.

To set the meter's clock to be the same as your PC clock, simply click the "Set SpectroSense Time" button. Please make sure your PC clock is correct first! This is a very simple way to automatically synchronise several SpectroSense2+ meters without having to manually enter the time in each one.

To clear or reset the meter's memory, click on the "Clear SpectroSense Memory" button. To prevent accidental loss of data you will need to click OK to confirm you wish to proceed before the meter's memory is erased.

The display will refresh to confirm the memory now has 2043 data-points free, 100% of the memory space available for further datalogging.

4.5 Set up Sensor Data

From the main SpectroSense2+ meter screen, click the button labelled "Sensor Data" to show the Sensor Library data editing window below. The SpectroSense2+ meter will store calibration factors and information for up to 16 different sensors or waveband channels in memory in the Sensor Library.

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SpectroSense2+ - Setup and Data File Support - Version 2.052 - Stored Sensor Profiles, check and edit

	Descriptions	Type	Units	Output per mV or uA	Offset (units)
0	Red Up	C	umol	55.17	0
1	NIR Up	C	umol	81.57	0
2	Red Down	C	Rel	1	0
3	NIR Down	C	Rel	1.68	0
4	sensor04	V	nA	0	0
5	sensor05	V	nA	0	0
6	sensor06	V	mV	0	0
7	sensor07	V	mV	0	0
8	sensor08	C	umol8	0	0
9	sensor09	C	umol9	0	0
10	sensor10	C	umola	0	0
11	sensor11	C	umolb	0	0
12	sensor12	V	wattc	0	0
13	sensor13	V	wattd	0	0
14	sensor14	V	watte	0	0
15	sensor15	V	wattf	0	0

Each column of the above table allows unique information to be entered for every sensor or channel:

Sensor / Channel Number	00 to 15, one for each sensor or channel
Sensor Description	8 characters to describe the sensor or channel e.g. PAR_Quan, SKYE UVA, UP_660, DN_730, etc.
Sensor Type	Current (C) or Voltage (V) output
Sensor Units	5 characters to describe units, e.g. μ mol, watts
Sensor Output *	Sensitivity or calibration factor e.g. +20.1234 μ mol / μ A or mV
Sensor Offset	Zero offset of sensor / amplifier e.g. -0.12 watts

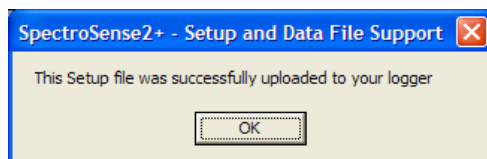
* NOTE – Sensor output is required to be entered in the format:
“Units per μ A” or “Units per mV” as appropriate

If you have purchased your SpectroSense2+ meter with light sensors directly from Skye, then your sensor calibration data will have already been programmed in the meter ready for use. Full details are shown on the Calibration Certificate in the separate booklet.

New sensors can be easily added to the library by editing the appropriate boxes as required. Click the “Confirm Changes” button to upload the new sensor data to the SpectroSense2+ meter. This will be

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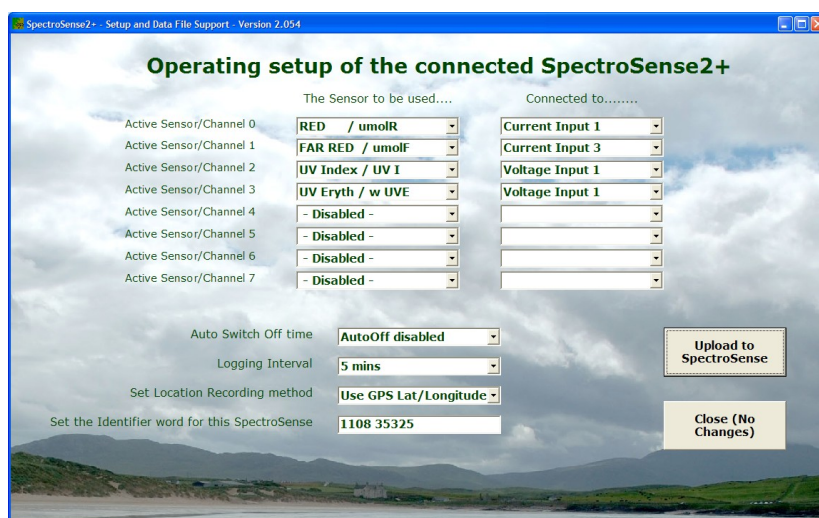
confirmed as follows:



Click the “Discard Changes” button to return to the main screen without uploading any data to the SpectroSense2+ meter.

4.6 Set Up SpectroSense2+ Configuration

Click on the “Configuration” button from the main screen, to see the following screen:



4.6.1 Set Up Active Sensors

The SpectroSense2+ is an 8-channel logging meter meaning it has inputs for measuring from 8 sensors or channels simultaneously. As there can be up to 16 sensor details in the Sensor Library then it is necessary to allocate which 8 sensors are presently connected to which meter socket for measurement. These 8 are called the ‘Active Sensors’ and are numbered 0 to 7.

Use the drop down boxes in the centre to choose a sensor or channel from the Sensor Library for each Active Sensor. You may choose to switch off or disable a channel if no sensor is connected.

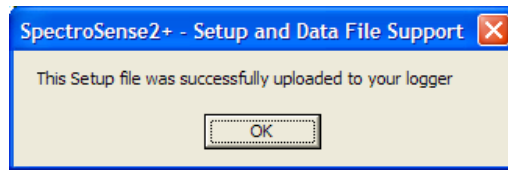
Use the drop down boxes on the right hand side to choose which socket (C1 to C8 or V1 to V4) this sensor is currently connected to.

NOTE – Every SpectroSense2+ is customised to each order, and as such different units may not have the same number of Current and Voltage sockets fitted, please check your socket labels when setting up Active Sensors. See **Appendix 5** for details.

Click the “Upload to SpectroSense” button to upload the new sensor data to the SpectroSense2+ meter. This

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will be confirmed as follows:



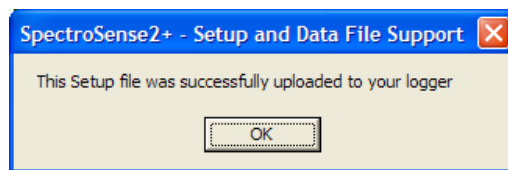
Click the “Close (No Changes)” button to return to the main screen without uploading any data to the SpectroSense2+ meter.

4.6.2 Set Up Auto Switch Off Time

The SpectroSense2+ meter has a ‘Auto Off’ feature where the meter will automatically switch itself off if no key presses are detected for a set period of time.

Use the drop down box to choose from time intervals of 15 seconds, 5, 10, 15 or 30 minutes, 1, 2 or 4 hours, or choose to disable this feature.

Click the “Upload to SpectroSense” button to upload the new sensor data to the SpectroSense2+ meter. This will be confirmed as follows:



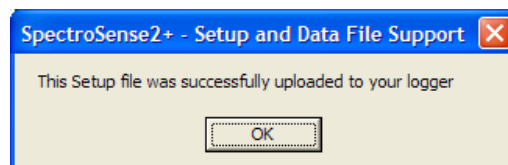
Click the “Close (No Changes)” button to return to the main screen without uploading any data to the SpectroSense2+ meter.

4.6.3 Set Up Logging Interval

Use the drop down box to choose from logging intervals of 1, 2, 5, 10, 20, 30 seconds, 1, 2, 5, 10, 20, 30 minutes, 1 or 2 hours.

For a full explanation of the logging functions please refer to Chapter 6.13.

Click the “Upload to SpectroSense” button to upload the new sensor data to the SpectroSense2+ meter. This will be confirmed as follows:



Click the “Close (No Changes)” button to return to the main screen without uploading any data to the

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SpectroSense2+ meter.

4.6.4 Set Up Location Recording Method (Model SKL 925 only)

Use the drop down box to choose from the 4 options:

- 0 - No Loc'n Recorded
- 1 - Select Loc'n Lbls
- 2 - Sequential Labels
- 3 - GPS Lat/Longitude

Option 0 - disables the storage of the GPS position or plot location label

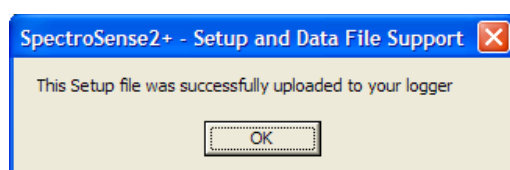
Option 1 - allows the user to manually select the plot location label required for each measurement. Each time the Store key is pressed in Display Menu Options 0 to 6, the user is prompted to choose the label required and press Enter to confirm.

Option 2 - automatically assigns the plot location labels sequentially with each successive measurement. When using this option it is important to synchronise the entry of the plot location labels (via the PC software, see Chapter 4.7) with the measurement sequence. It should also be noted that the sequence will start at the last plot location label used, so it is advisable to use Option 1 to choose the plot location label for the first measurement, and change to sequential mode for subsequent measurements.

Plot location labels are also stored in automatic log mode. It is advisable to Use Option 0 to switch off the label storage in this mode. Option 1 can be used if a plot label is required, the last chosen label is stored automatically with each measurement (without prompting the user).

Option 3 - (this option is only applicable if a GPS module is connected to SKL925 (SpectroSense2+GPS)) records the current GPS latitude / longitude position for each measurement. In store or log mode, the latitude and longitude location in degrees and minutes north, south, east or west is recorded. If no fix has been made then the letter "F" for Fail is recorded in both latitude and longitude positions.

Click the "Upload to SpectroSense" button to upload the new sensor data to the SpectroSense2+ meter. This will be confirmed as follows:



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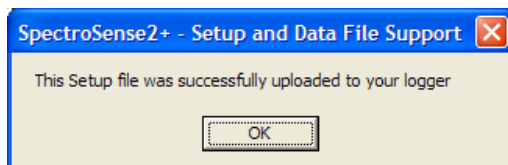
Click the “Close (No Changes)” button to return to the main screen without uploading any data to the SpectroSense2+ meter.

4.6.5 Set Up SpectroSense2+ Meter Identifier (Model SKL 925 only)

This allows the user to enter a 15 character alphanumeric unique meter identifier word or ID for each SpectroSense2+ meter. As default this ID is factory set to include the meter’s serial number. Only letters, numbers, spaces or _ are allowed.

This ID is included in the file of data downloaded from the SpectroSense2+ meter, for ease of data identification.

Click the “Upload to SpectroSense” button to upload the new sensor data to the SpectroSense2+ meter. This will be confirmed as follows:



Click the “Close (No Changes)” button to return to the main screen without uploading any data to the SpectroSense2+ meter.

4.7 Plot Location Labels

This feature is mainly of use when making field mapping measurements. Manual recordings can be made by pressing the [STORE] key when in any Display Mode, and storing the data with its location as the SpectroSense2+ meter system is moved from plot to plot.

The user can enter up to 100 plot location labels via this PC software – please note these labels cannot be edited via the SpectroSense2+ keypad.

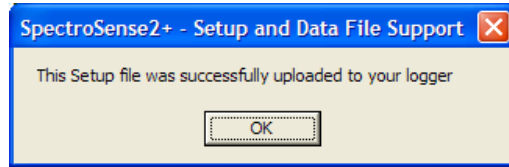

In the PC software main SpectroSense2+ menu, click on the “Edit Plot Labels” button to bring up the window below. Enter labels as required, up to 10 alphanumeric characters (i.e. letters and numbers) are allowed for



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each label.

Click the "Upload To SpectroSense" button to upload your changes to the meter. The software will confirm as below:



Click the “Close (No Changes)” button to return to the main screen without uploading any data to the SpectroSense2+ meter.

The SpectroSense2+ meter keypad has three options for storing the plot location label. No storage; select a different label manually for each measurement; or automatically assign the plot location labels sequentially with each successive measurement.

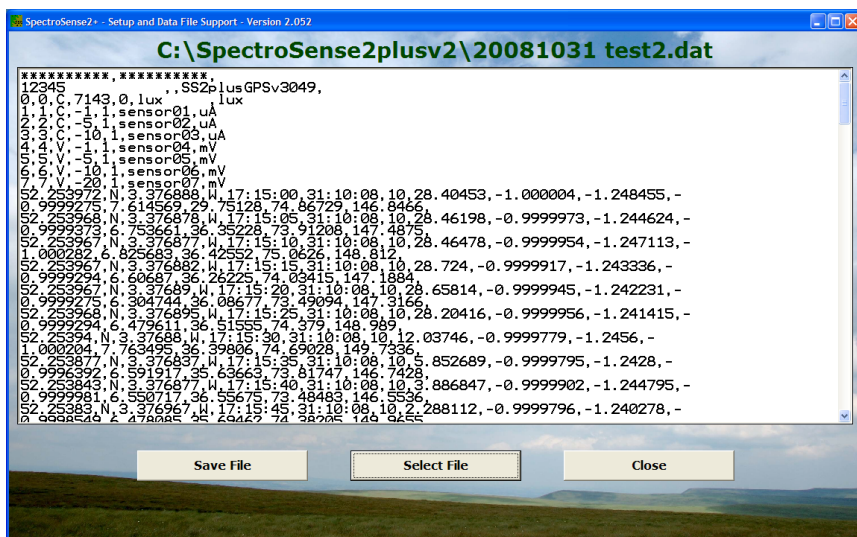
In this latter case it is obviously important to synchronise the entry of the plot location labels (via the PC) with the measurement sequence. It should also be noted that the sequence will start at the last plot location label used, so it is advisable to use the option to choose the plot location label for the first measurement, and change to sequential mode for subsequent measurements.

Plot location labels are also stored in automatic log mode. It is advisable to switch off the label storage in this mode (see [Chapter 4.6.4](#) and [Chapter 6.28](#)). The manually select label option can be used if a plot label is required, the last chosen label is stored automatically with each measurement.

4.8 Data Offload

Data may have been stored in memory either manually by pressing the **[STORE]** button on the meter's keypad while in the display modes, or by automatic logging in Menu Option 14.

To download the meter's stored readings, go to the SpectroSense2+ software main menu and click the "Data Offload" button. The data will be downloaded and displayed in the viewer as below. Click "Save File" to save and enter a file name when prompted. The default folder to store the data is C:\SpectroSense2plusv2 but you may choose any path or folder you wish.



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The file is saved as a “.dat” type data file as default but you may choose to save as “.txt”, “.asc” or other file extension as you prefer. The data format is a comma separated, ASCII numerical file, directly compatible with Microsoft Excel or similar.

The first 9 lines of the data file show the meter’s ID, serial number and the set up details of the 8 Active Sensors. Each of the following lines of data begin with GPS or plot label location (shown as ++++ if disabled), time, date and a single number corresponding to which SpectroSense2+ meter menu was active when data storage took place, followed by the data for each Active Sensor in turn.

E.g. in the above file each line of data shows latitude (e.g. 52.25N) and longitude (e.g. 3.38W) time, date, Menu Option 14 (automatic logging), followed by the stored data from each active channel.

If the Active Sensors are changed at any time without clearing the meter’s memory, the new set up will be stored at that point in time in the memory. Hence details of the Active Sensors may also appear in the middle of your data file, and will refer to all data following it.

Click “Close” to return to the main software screen.

4.9 View Data Files

To view previously downloaded data files, click the “View Data Files” button from the main screen. The file viewer shown above will appear and the last file downloaded will automatically open.

To choose another file to view click the “Select File” button, locate your file and click Open.

This is a simple viewer facility only, no other functions are available. The files will open easily in a basic word processing software package (e.g. notepad, wordpad, TextEdit etc.), or a spreadsheet package (e.g. Excel, Numbers, Calc etc.) for analysis, printing etc. The file format is a comma separated, ASCII numerical file.

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5 POWER

5.1 SKL 906 and SKL 908 SpectroSense2+

The SKL908 SpectroSense2+ meter is powered by a 9V PP3 / MNI604 / 6LF22 battery, fitted into the compartment at the rear of its case. Alternatively it can be powered by an external 12VDC supply via the RS232 socket, e.g. the Skye Solar Hog or Mains Hog or simply a 12V vehicle battery.

Take care to insert the PP3 battery in the correct orientation. However no damage to the meter will occur if the battery is inserted incorrectly by accident.

The expected battery life of a good quality alkaline PP3 cell, e.g. Duracell or Procell is approximately 40-50 hours of continuous use at 20°C. Longer lifetime is possible with different use, e.g. in automatic datalogging or MJ/hr integration mode battery life may be up to 300 hours. Rechargeable batteries may be used if preferred, but these will usually require recharging at more frequent intervals.

5.2 SKL 920 and SKL 925 SpectroSense2+.GPS

The SpectroSense2+ meter is powered by 6 x internal 1.5 volt AAA / MN2400 / LR03 batteries, fitted into the compartment at the rear of its case. Alternatively it can be powered by an external 12VDC supply via the RS232 socket, e.g. the Skye Solar Hog or Mains Hog or simply a 12V vehicle battery.

Take care to insert the batteries in the correct orientation. However no damage to the meter will occur if batteries are inserted incorrectly by accident.

The expected battery life of a good quality alkaline batteries, e.g. Duracell or Procell is approximately 40-50 hours of continuous use at 20°C. Longer lifetime is possible with different use, e.g. in automatic datalogging or MJ/hr integration mode battery life may be up to 300 hours. Rechargeable batteries may be used if preferred, but these will usually require recharging at more frequent intervals.

However, when a GPS module is connected, it is continuously powered from these same batteries and this greatly reduces the lifetime to just 6-8 hours.

5.3 Operation of Both Models

Menu Option "17 – Test the Battery" shows a display of actual battery voltage plus a statement of battery 'health', such as 9 volts "good", 7.5 volts "medium" or 6 volts "low". When the battery voltage shows approximately 5.9 volts, the battery health statement will also warn the user that this level is too low to make accurate measurements.

No data, configuration or set up details will be lost if power is removed.

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In automatic datalogging mode the SpectroSense2+ will not store any readings in memory if the battery voltage is below 5.9 volts. This is a safety feature to ensure only accurate measurements can be recorded.

The SpectroSense2+ has an 'Auto Off' feature in Menu Option 24 where the meter will automatically switch itself off if no key presses are detected for a set period of time. The user may choose from time intervals of 15 seconds, 5, 10, 15 or 30 minutes, 1, 2 or 4 hours, or choose to disable this feature. See Chapter 6.27 for details.

6 SPECTROSENSE 2+ MENU

6.1 Menu Overview

MAIN MENU ▲▼ scroll
[ENTER] to select...

- 0 - Read 8 Sensrs *4L
- 1 - Read 8 Sensrs *2L
- 2 - NDVI/PRI Ratio
- 3 - NDVI, LAI, & fPAR
- 4 - LAIndex from PAR
- 5 - RVI or WBI
- 6 - MODIS-EVI
- 7 - EVI2 & MSAVI
- 8 - All NDVI derived
- 9 - Ratio 0:1, 2:3, etc
- 10 - 0:2, 1:3, 4:6, 5:7
- 11 - 1, 2, 3:0 & 5, 6, 7:4
- 12 - 1, 2, 3, 4, 5, 6, 7:0
- 13 - MJhr-l integratn
- 14 - Log Data.....
- 15 - Clear Memory....
- 16 - Set FI function..
- 17 - Test the battery
- 18 - View Active Snrs
- 19 - Set Active Sensrs
- 20 - View Sensor Data
- 21 - Set Sensor Data
- 22 - Show ID/Time/Aoff
- 23 - Set the unit's ID
- 24 - Set AutoOff time
- 25 - Set the Clock...
- 26 - Display Version
- 27 - Check GPS output
- 28 - View Plot Labels
- 29 - Loc'n Record Mode
- 30 - Connect to a PC..
- 31 - Contact the Team
- 32 - ...not allocated

The SpectroSense2+ menu structure is shown above, as seen on the meter's display. Each menu item and its function is

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described fully in the following sections.

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6.2 Switch on and Welcome Screen

When the SpectroSense2+ meter is first switched on, a Welcome Message appears showing the meter's firmware version and its Identifier or ID string.

After showing the Welcome Message for 3 seconds, the screen changes to either the Main Menu, or it gives the user a 10 second option to resume operation in the last used function. If [ENTER] is not pressed within this 10 second option, then the Main menu is displayed as usual.

If no GPS mouse is connected to the unit then 'GPS not valid' will be displayed briefly.

6.3 Menu Option 0 – Read 8 Sensors *4L

This menu option displays live readings from the 8 sensors or channels which are currently set as Active Sensors (see Chapter 6.22). One sensor or channel is displayed per line, so as there are only 4 lines on the LCD display the user must press the [NEXT], [▲] or [▼] keys to scroll and display all 8 measurements.

Each line of the display shows the Sensor Number, live reading and units of measurement. The last significant digits of the display may be constantly changing because of the high sensitivity of the SpectroSense2+ meter, so it is advisable to use the [HOLD] button on the keypad to freeze the display to take a measurement, or let it stabilise as much as possible, and take 3 readings within about 30 seconds, and take an average of these values.

Pressing the [STORE] key on the meter at any time during this display will simply store the current reading being measured by each of the 8 Active Sensors with time, date and plot location (if activated). In this menu the line of data in memory will be preceded by the number 0, indicating that it was stored from Menu option 0.

Pressing [ESCAPE] or [MENU] returns to the Main Menu.

6.4 Menu Option 1 – Read 8 Sensors *2L

This menu option displays live readings from the 8 sensors or channels which are currently set as Active Sensors (see Chapter 6.22). One sensor or channel is displayed over 2 lines, so as there are only 4 lines on the LCD display the user must press the [NEXT], [▲] or [▼] keys to scroll and display all 8 measurements.

Each measurement is shown with its Sensor Number, sensor description, live reading and units of measurement. The last significant digits of the display may be constantly changing because of the high sensitivity of the SpectroSense2+ meter, so it is advisable to use the [HOLD] button on the keypad to freeze the display to take a measurement.

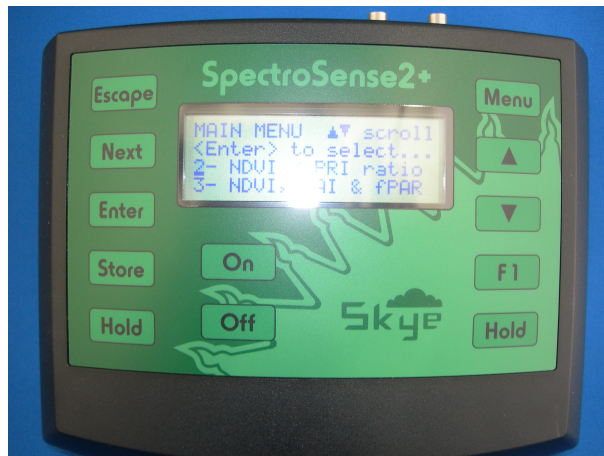
Pressing the [STORE] key on the meter at any time during this display will simply store the current reading being measured by each of the 8 Active Sensors with time, date and plot location (if activated).

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In this menu the line of data in memory will be preceded by the number 1, indicating that it was stored from Menu option 1.

Pressing [ESCAPE] or [MENU] returns to the Main Menu.

6.5 Menu Option 2 – NDVI/PRI Ratio



Please see section 2.4.4 for more detailed information.

Toggle [HOLD] will slow down the on-screen messages and [ESCAPE] will start the routine.

Pressing the [STORE] key on the meter at any time during this display will simply store the current reading being measured by each of the 4 Active Sensors with time, date and plot location label (if activated). In this menu the line of data in memory will be followed by the number 2, indicating that it was stored from Menu option 2 – NDVI/PRI. The NDVI or PRI calculated value will not be stored but the individual sensor data is present if the user wishes to recalculate the ratios in Excel.

6.6 Menu Option 3 - NDVI, LAI & fPAR



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Please see section 2.4.4 for more detailed information on this option

Toggle [HOLD] will slow down and stop the on-screen messages and [ESCAPE] will start the routine.

Pressing the [STORE] key on the meter at any time during this display will simply store the current reading being measured by each of the 4 Active Sensors with time, date and plot location label (if activated). In this menu the line of data in memory will be followed by the number 3, indicating that it was stored from Menu option 3 - NDVI, LAI, & fPAR. The calculated values will not be stored but the individual sensor data is present if the user wishes to recalculate the ratios in Excel.

6.7 Menu Option 4 - LAIndex from PAR



Please refer to section 2.4.4 for more detailed information on using this option.

Toggle [HOLD] will slow down and halt the on-screen messages and [ESCAPE] will start the routine.

Pressing the [STORE] key on the meter at any time during this display will simply store the current reading being measured by each of the 2 Active Sensors with time, date and plot location label (if activated). In this menu the line of data in memory will be followed by the number 4, indicating that it was stored from Menu option 4 - LAI from PAR. The calculated value will not be stored but the individual sensor data is present if the user wishes to recalculate the ratios in Excel.

6.8 Menu Option 5 - RVI or WBI



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Please refer to section 2.4.4 for further details on using this option.

Pressing [HOLD] will slow down the on-screen messages and [ESCAPE] will start the routine.

Pressing the [STORE] key on the meter at any time during this display will simply store the current reading being measured by each of the 4 Active Sensors with time, date and plot location label (if activated). In this menu the line of data in memory will be followed by the number 6, indicating that it was stored from Menu option 6 – NDVI/PRI. The NDVI or PRI calculated value will not be stored but the individual sensor data is present if the user wishes to recalculate the ratios in Excel.

6.9 Menu Option 6 – MODIS-EVI



Please see section 2.4.4 for more detailed information.

Pressing [HOLD] will slow down the on-screen messages and [ESCAPE] will start the routine.

Pressing the [STORE] key on the meter at any time during this display will simply store the current reading being measured by each of the 4 Active Sensors with time, date and plot location label (if activated). In this menu the line of data in memory will be followed by the number 2, indicating that it was stored from Menu option 2 – NDVI/PRI. The NDVI or PRI calculated value will not be stored but the individual sensor data is present if the user wishes to recalculate the ratios in Excel.

6.10 Menu Option 7 - EVI2 & MSAVI



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Please see section 2.4.4 for more detailed information.

Toggling [HOLD] will slow down the on-screen messages and [ESCAPE] will start the routine.

Pressing the [STORE] key on the meter at any time during this display will simply store the current reading being measured by each of the 4 Active Sensors with time, date and plot location label (if activated). In this menu the line of data in memory will be followed by the number 2, indicating that it was stored from Menu option 2 – NDVI/PRI. The NDVI or PRI calculated value will not be stored but the individual sensor data is present if the user wishes to recalculate the ratios in Excel.

6.11 Menu Option 8 - All NDVI Derived



This menu option enables the user to view an instant comparison of all the similar indices.

A scrollable display shows all the indices which are derived from the basic NDVI figure or principle and that have sensors using these connections, i.e.

NDVI stays at the top of the display and will be compared to EVI2, MSAVI, LAI, fPAR, RVI and then the display repeats,

6.12 Menu Option 9 - Ratio 0:1, 2:3, etc

This menu option measures the 8 sensors or channels which are currently set as Active Sensors (see Chapter 6.22), and displays the live readings as ratios between 2 sensor pairs.

i.e. the ratio of Active Sensors 0 : 1, Active Sensors 2 : 3, Active Sensors 4 : 5, and Active Sensors 6 : 7.

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Please see **Chapter 2.4.1** for examples of use of this feature. Use the [NEXT], [▲] or [▼] keys to scroll through the displays.

The last significant digits of the display may be constantly changing because of the high sensitivity of the SpectroSense2+ meter, so it is advisable to use the [HOLD] button on the keypad to freeze the display to take a measurement.

Pressing the [STORE] key on the meter at any time during this display will simply store the current reading being measured by each of the 8 Active Sensors with time, date and plot location (if activated). In this menu the line of data in memory will be preceded by the number 2, indicating that it was stored from Menu option 2.

Pressing [ESCAPE] or [MENU] returns to the Main Menu.

6.13 Menu Option 10 - 0:2, 1:3, 4:6, 5:7

This menu option measures the 8 sensors or channels which are currently set as Active Sensors (see **Chapter 6.22**), and displays the live readings as ratios between 2 sensor pairs.

i.e. the ratio of Active Sensors 0 : 2, Active Sensors 1 : 3, Active Sensors 4 : 5 and Active Sensors 6 : 7.

Please see **Chapter 2.4.1** for examples of use of this feature. Use the [NEXT], [▲] or [▼] keys to scroll through the displays.

The last significant digits of the display may be constantly changing because of the high sensitivity of the SpectroSense2+ meter, so it is advisable to use the [HOLD] button on the keypad to freeze the display to take a measurement.

Pressing the [STORE] key on the meter at any time during this display will simply store the current reading being measured by each of the 8 Active Sensors with time, date and plot location (if activated). In this menu the line of data in memory will be preceded by the number 3, indicating that it was stored from Menu option 3.

Pressing [ESCAPE] or [MENU] returns to the Main Menu.

6.14 Menu Option 11 - 1, 2, 3:0 & 5, 6, 7:4

This menu option measures the 8 sensors or channels which are currently set as Active Sensors (see **Chapter 6.21**), and displays the live readings as the ratios of 3 sensors or channels relative to the first sensor or channel.

i.e. the ratio of Active Sensors 1 : 0, 2 : 0 and 3 : 0 and 5 : 4, 6 : 4 and 7 : 4.

Please see **Chapter 2.4.1** for examples of use of this feature. Use the [NEXT], [▲] or [▼] keys to scroll through the displays.

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The last significant digits of the display may be constantly changing because of the high sensitivity of the SpectroSense2+ meter, so it is advisable to use the [HOLD] button on the keypad to freeze the display to take a measurement.

Pressing the [STORE] key on the meter at any time during this display will simply store the current reading being measured by each of the 8 Active Sensors with time, date and plot location (if activated). In this menu the line of data in memory will be preceded by the number 4, indicating that it was stored from Menu option 4.

Pressing [ESCAPE] or [MENU] returns to the Main Menu.

6.15 Menu Option 12 – 1, 2, 3, 4, 5, 6, 7:0

This menu option measures the 8 sensors or channels which are currently set as Active Sensors (see Chapter 6.21), and displays the live readings as the ratios of 7 sensors or channels relative to the first sensor or channel.

i.e. the ratio of Active Sensors 1 : 0, 2 : 0, 3 : 0, 4 : 0, 5 : 0, 6 : 0 and 7 : 0.

Please see Chapter 2.4.1 for examples of use of this feature. Use the [NEXT], [▲] or [▼] keys to scroll through the displays.

The last significant digits of the display may be constantly changing because of the high sensitivity of the SpectroSense2+ meter, so it is advisable to use the [HOLD] button on the keypad to freeze the display to take a measurement.

Pressing the [STORE] key on the meter at any time during this display will simply store the current reading being measured by each of the 8 Active Sensors with time, date and plot location (if activated). In this menu the line of data in memory will be preceded by the number 5, indicating that it was stored from Menu option 5.

Pressing [ESCAPE] or [MENU] returns to the Main Menu.

6.16 Menu Option 13 – MJ.hr-1 integration

This menu option displays an accumulative integration of total solar radiation in Megajoules per hour (MJ/hr or MJ.hr⁻¹). This function is only valid for sensors calibrated in watts m⁻², e.g. pyranometers.

MJ/day (or MJ/24hr) is a value of total solar radiation reaching the Earth's surface in a 24 hour period and is useful for monitoring plant growth and photosynthesis rates.

The SpectroSense2+ display shows the start time and date of the integration measurement, total MJ value, plus the number of hours elapsed in steps of 0.01 hour (or 36 seconds). The actual datalogging interval is

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every 10 seconds. When the period of measurement is finished, please make a note of the data on screen as this meter does not store the values. Please use the automatic datalogging function in menu option 10 for storing pyranometer measurements over time. **NOTE** – the [HOLD] and [STORE] buttons are inactive in this display. If the [ESCAPE] button is pressed twice to leave this menu, all integration data is lost, so it must be noted before returning to Main Menu.

6.17 Menu Option 14 – Log Data

When this menu option is first chosen the display will allow the user to check the meter's battery voltage and it gives a statement of battery 'status', such as 9 volts "good", 7.5 volts "medium" or 6 volts "low", to ensure there is sufficient power for the logging period.

If the battery voltage is below 5.9 volts the meter will not begin logging as readings are likely to be inaccurate. This is a safety feature to ensure only accurate measurements can be recorded.

If the battery voltage is sufficient, the user can choose from logging intervals of 1, 2, 5, 10, 20, 30 seconds, 1, 2, 5, 10, 20, 30 minutes, 1 or 2 hours by using the [NEXT], [▲] or [▼] arrows and [ENTER] to select. [ENTER] begins the datalogging sequence and the meter display is automatically switched off to conserve power. Press [ESCAPE] to stop logging – no other key will reactivate the meter's display.

All 8 channels will be logged simultaneously at the chosen logging interval, with time, date and GPS latitude / longitude or plot location label (if activated) of each measurement. The current Active Sensor set up is stored at the beginning of each datalogging activity to allow for easy and straightforward data interpretation.

At logging intervals of 20 seconds and above, the reading stored will be an average of measurements taken every 10 seconds. Logging intervals of 1 to 10 seconds will be 'spot' logs, i.e. no integration.

If the SpectroSense2+ meter is set to log every 1 or 2 seconds in rapidly changing light levels, the auto-ranging function may limit the speed of recording and may not be successful in taking a measurement of all 8 Active Channels every second. It is advised that to be sure of recording every 1 or 2 seconds, the number of Active Sensors are limited to 1 or 2 (by disabling the remaining Active Sensors). This precaution is unlikely to be necessary in constant light levels, or for logging intervals of 5 seconds or greater.

Logging Interval	Memory Duration
1 second	34 minutes
2 seconds	1 hr, 8 mins
5 seconds	2 hrs, 50 mins
10 seconds	5 hrs, 40 mins
20 seconds	11 hrs, 20 mins
30 seconds	17 hrs
1 minute	1 day, 10 hrs
2 mins	2 days, 20 hrs
5 mins	1 week
10 mins	2 weeks
20 mins	4 weeks
30 mins	6 weeks
1 hour	3 months
2 hours	6 months

It is possible to automatically record the GPS location in all logging mode intervals, although the occasional record may be lost when using 1 second logging (about 1 record every 40 seconds). Logging intervals of 2 seconds and above do not show this problem.

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If using log mode to automatically log measurements and position from a moving system, remember that logging intervals over 10 seconds are “sampled” every 10 seconds and then averaged over the chosen logging period. Depending on the speed of movement a lot of ground can be covered within the 10 second sample period.

The SpectroSense2+ meter has sufficient memory for 2048 measurements of each of the 8 Active Sensors or Channels. The first 5 ‘datapoints’ are always used to store the Active Sensor setup. If this set up is changed at any time without clearing the meter’s memory then a further 5 datapoints will be used to store the new setup.

The table can be used as a guide to how long before the memory becomes full using the different logging intervals. Once the memory is full, the meter will stop logging. No data will be lost if power is removed, data and all configuration details are stored in non-volatile EEPROM memory.

Data can be downloaded to a PC by using the Skye RS232/USB cable and using the Skye SS2+ Software. SpectroSense will need to be put in Menu Option “30 – Connect to a PC”. Please see **Chapter 4.8** for details.

The data format is a comma separated, ASCII numerical file, directly compatible with Microsoft Excel or similar. Each line of stored data begins with the plot location label (shown as ++++ if disabled), time, date and a single number corresponding to which SpectroSense2+ meter Menu was active when data storage took place, followed by the data for each Active Sensor in turn.

Several SpectroSense2+ meters can be synchronised for datalogging if required. Datalogging always occurs at set time intervals, e.g. 30 minute logging will always take place on the hour and on the half hour, no matter what time logging was initiated.

6.18 Menu Option 15 – Clear Memory

This menu option clears the memory of all data, whether stored by automatic logging or by pressing the [STORE] button. Firstly the display shows the number of free datapoints and the percentage of memory used. [ENTER] continues to clear the memory. Any other key quits the Clear Memory function and returns to the Main Menu without any changes.

* The memory can also be quickly and easily cleared via the PC connection and Skye SpectroSense2+ software, please see **Chapter 4.4**.

6.19 Menu Option 16 – Set FI Function

In Menu “16 – Set FI function” the user can choose which display option to set as a ‘favourite’ from Menu options 0 to 6. Use the [▲] and [▼] button to choose the option required, and [ENTER] to select.

While using any of the display options 0-6, pressing [FI] at any time will quickly change to the favourite display mode. Pressing [FI] again will return to the original display. [HOLD] and [STORE] button will operate as normal under either display.

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6.20 Menu Option 17 – Test the Battery

This menu option shows a display of actual battery voltage plus a statement of battery 'status', such as 9 volts "good", 7.5 volts "medium" or 6 volts "low". Pressing any key returns to the Main Menu.

NOTE - In automatic datalogging mode the SpectroSense2+ will not store any readings in memory if the battery voltage is below 5.9 volts. This is a safety feature to ensure only accurate measurements can be recorded.

* The battery voltage can also be quickly and easily viewed via the PC connection and Skye SpectroSense2+ software, please see [Chapter 4.4](#).

6.21 Menu Option 18 – View Active Sensors

Menu Option 18 allows the user to view a summary of the Sensor Numbers, Sensor Description and Input socket current set as the Active Sensors.

Use the [NEXT], [▲] or [▼] buttons to scroll through the sensors. Pressing [ESCAPE] or [MENU] returns to the Main Menu. To edit any Active Sensor data please use Menu Option "22 – Set Active Sensors".

* The Active Sensors can also be quickly and easily viewed via the PC connection and Skye SpectroSense2+ software, please see [Chapter 4.6](#).

6.22 Menu Option 19 – Set Active Sensors

Before setting any Active sensors using this menu option, it is advisable to ensure that your sensor calibration data has been entered into the meter's Sensor Library using the PC software (see [Chapter 4.6](#)) or manually via the meter's keypad and Menu Option 21 – Set Sensor Data. See [Chapter 6.24](#) for details.

If you have more than 8 sensors or channels in your Sensor Library, then you will need to choose which ones to make 'Active'. A maximum of 8 sensors can be Active at any one time. If you have less than 8 sensors or channels connected, then you may choose to 'switch off' some Active Sensor channels, so that the display is less cluttered and easier to read. "Active Sensors" are those connected to SS2+ and whose configuration information is used to display reading, and have an allocated input socket.

Each Active Sensor must be allocated to an input socket. The meter sockets are labelled C1, C2, C3, C4, C5, C6, C7 or C8 for current inputs or V1, V2, V3 or V4 for voltage inputs. This label will vary according to which SpectroSense2+ meter version you have purchased. Match the Sensor Number and Sensor Description to the socket you have connected the sensor to.

Edit each Active Sensor 0 to 7 in turn. Use the [▲] and [▼] arrows to choose a Sensor Number from the Sensor Library (00 to 15) to allocate to each Active Sensor, or choose or Sensor Number ' _ ' for no sensor connected and to switch an Active Sensor channel off. [ENTER] selects your choice, [ESCAPE] returns with no changes made.

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For the chosen Sensor Number the Sensor Description and its units of measurement will be displayed as a reminder whether it is a current or voltage output sensor. Then choose an input socket (i/p channel) to use e.g. CI or VI as appropriate.

Please see **Chapter 2.4** for explanations and examples of choosing Active sensors for ratio measurements. If you have purchased your SpectroSense from Skye as a system with some light sensors, the meter will have already been set up with a suggested Active Sensor arrangement, and will be shown on the meter's Configuration Certificate.

* The Active Sensors can also be quickly and easily set via the PC connection and Skye SpectroSense2+ software, please see **Chapter 4.6** for details.

6.23 Menu Option 20 – View Sensor Data

Menu Option 20 allows the user to view a summary of all data stored in the Sensor Library. Including Sensor Numbers, Sensor Description, Sensor Output, Units and Offset.

Use the [NEXT], [▲] or [▼] buttons to scroll through the sensors. Pressing [ESCAPE] or [MENU] returns to the Main Menu. To edit any sensor data please use Menu Option 21 – Set Sensor Data.

* The sensor data can also be quickly and easily viewed via the PC connection and Skye SpectroSense2+ software, please see **Chapter 4.5** for details.

6.24 Menu Option 21 – Set Sensor Data

In order to view accurate, calibrated measurements from light sensors, the SpectroSense2+ meter must be configured with the sensor's calibration data. This meter can store a Sensor Library of data for up to 16 sensors in total, for easy interchange between Active Sensors.

Menu Option 21 leads the user through a step by step process of entering the Sensor Library Number (00 to 15), Sensor Description, Sensor Output, Units and Offset.

NOTE – Sensor output is required to be entered in the format:

“Units per μA ” or “Units per mV” as appropriate

Use the [NEXT], [▲] or [▼] keys on the meter's keypad to move the cursor, scroll through numbers 0 to 9 plus decimal place, and upper and lower case letters. [ENTER] selects your choice, [ESCAPE] returns with no changes made.

* The Sensor Data can also be quickly and easily set via the PC connection and Skye SpectroSense2+ software, please see **Chapter 4.5** for details.

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6.25 Menu Option 22 – Show ID/Time/Aoff

Menu Option 22 allows the user to view a summary of the SpectroSense2+ meter settings. Includes the meter identifier or ID, Auto Off time, date and time.

[ESCAPE] or [MENU] returns to the Main Menu.

* The meter settings can also be quickly and easily viewed via the PC connection and Skye SpectroSense2+ software, please see Chapter 4.4 for details.

6.26 Menu Option 23 – Set the Unit's ID

Menu Option 23 allows the user to enter a 15 character alphanumeric a unique meter identifier or ID for each SpectroSense2+ meter. As default this ID is factory set to include the meter's serial number.

This ID is included in the file of data downloaded from the SpectroSense2+ meter, for ease of data identification.

To change, use the [NEXT], [▲] or [▼] keys on the meter's keypad to move the cursor, scroll through numbers 0 to 9 plus underscore and upper case letters.

[ENTER] will confirm your selection while [ESCAPE] or [MENU] will return to Main Menu without any changes taking place.

6.27 Menu Option 24 – Set the Auto-off Time

The SpectroSense2+ meter has a 'Auto Off' feature where the meter will automatically switch itself off if no key presses are detected for a set period of time. In Menu Option 24 the user may choose from time intervals of 15 seconds, 5, 10, 15 or 30 minutes, 1, 2 or 4 hours, or choose to disable this feature.

Use the [NEXT], [▲] or [▼] keys to choose the time required and [ENTER] to confirm your selection. [ESCAPE] or [MENU] will return to Main Menu without any changes taking place.

6.28 Menu Option 25 – Set the Clock

The SpectroSense2+ meter has real time clock which is backed by an internal lithium battery, meaning it will not lose its settings if the main power supply fails.

To set the date and time, use the [NEXT], [▲] or [▼] keys on the meter's keypad to move the cursor and scroll through numbers. Press [ENTER] to confirm.

The format for the clock entry is hh:mm:ss (for hours, minutes and seconds), DD.MM.YY (for day, month and year) and the last digit d is for day of the week. This last digit is for use in future firmware upgrades.

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Use the [▲] or [▼] keys to change each digit and [NEXT] to move to the next digit. [ENTER] will set the new time, while [ESCAPE] or [MENU] will return to Main Menu without any changes taking place.

Several SpectroSense2+ meters can be synchronised for datalogging if required. Datalogging always occurs at set time intervals, e.g. 30 minute logging will always take place on the hour and on the half hour, no matter what time logging was initiated.

* The clock can also be quickly and easily set via the PC connection and Skye SpectroSense2+ software, please see Chapter 4.4 for details.

6.29 Menu Option 26 – Display Version

Menu Option 26 allows the user to view the SpectroSense2+ meter firmware version. Please quote this version number to Skye if you have any questions about your meter. The screen also includes the meter identifier or ID, which is also useful if it still contains the meter's serial number.

[ESCAPE] or [MENU] returns to the Main Menu.

6.30 Menu Option 27 - Check GPS output (Model SKL 920 & 925 only)

This menu option allows the user to check the status of the GPS module. The module, supplied by Skye, connects to the 4 pin socket of the SpectroSense2+ meter, and receives power from the meter. (Please see section 2.6 for details of different GPS modules).

When first powered up, the GPS's red LED will light up and blink slowly (equal on and off periods). It may take a few minutes to get its first "fix" on the present location, and then the LED will change to a short, sharp flash once a second. The GPS module may "remember" its last location and display this until the updated fix is received.

When searching for a location fix, the GPS will operate quicker and better if there is a clear view of the sky, with the minimum of obstructions such as buildings or trees. Rain and mist will also reduce the signal.

The GPS module is able to receive two types of location "fix" to transmit to the SpectroSense2+ meter:

sps - standard positioning service fix, the most common type and gives a location of about 3m

sbas - satellite based augmentation system fix, a more accurate fix but only available in Europe in clear sky views. This can give a location resolution of 1m

In Menu Option 27, the SpectroSense2+ meter will display the time from the GPS system in GMT, the quality of the fix (void, sps or sbas), and the latitude and longitude in degrees and minutes north, south, east or west, plus altitude in metres above sea level. If the Fix quality status shows "GPS string not rx'd", this indicates there is no GPS module connected, or the SpectroSense2+ meter is unable to interpret the data.

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If the “Fix Quality” status shows VOID, the GPS module does not have a current valid fix, even if a latitude and longitude is shown on the display. The module has a small memory on board which remembers its last known position, aiding a quicker log on next time if at a nearby location. This previous location may be shown in Menu Option 27 even if the Fix status is VOID.

If the Fix status shows OK and sps or sbas, this indicates the type of successful fix and location resolution, as described above. The location and altitude displayed is as interpreted by the SpectroSense2+ meter. By pressing the [NEXT] button, the display will change to the raw data received direct from the GPS module itself, prefixed by “\$GPGGA”, as the standard NMEA GGA string. This can be useful for checking the module and meter are communicating correctly.

Press [NEXT] again to return to the SpectroSense2+ meter GPS display, and Escape to return to the Main Menu.

6.31 Menu Option 28 – View Plot Labels

Menu Option 28 allows the user to view a summary of the Plot Location Labels available for recording with the sensor measurements.

Use the [NEXT], [▲] or [▼] buttons to scroll through the labels. Pressing [ESCAPE] or [MENU] returns to the Main Menu.

* The labels can also be quickly and easily viewed or edited via the PC connection and Skye SpectroSense2+ software, please see [Chapter 4.7](#) for details.

6.32 Menu Option 29 – Loc’n Record Mode

Menu Option 29 allows the user to choose if or how the GPS latitude / longitude position or Plot Location Label is stored. There are 4 options:

- 0 – No Loc’n Recorded
- 1 – Select Loc’n Lbls
- 2 – Sequential Labels
- 3 – GPS Lat/Longitude

Use the [NEXT], [▲] or [▼] buttons to scroll through the labels and press [ENTER] to confirm. Pressing [ESCAPE] or [MENU] returns to the Main Menu.

When entering any sensor display menu option (0 to 6), the currently set location storage mode is briefly shown on screen.

Option 0 - disables the storage of the GPS position or plot location label

Option 1 - allows the user to manually select the plot location label required for each measurement. Each time the [STORE] key is pressed in Display Menu Options 0 to 6, the user is prompted to choose the label required and press [ENTER] to confirm.

SpectroSense 2+ (+GPS)

Option 2 - automatically assigns the plot location labels sequentially with each successive measurement. When using this option it is important to synchronise the entry of the plot location labels (via the PC software, see [Chapter 4.7](#)) with the measurement sequence. It should also be noted that the sequence will start at the last plot location label used, so it is advisable to use Option 1 to choose the plot location label for the first measurement, and change to sequential mode for subsequent measurements.

Plot location labels are also stored in automatic log mode. It is advisable to use Option 0 to switch off the label storage in this mode. Option 1 can be used if a plot label is required, the last chosen label is stored automatically with each measurement (without prompting the user).

Option 3 - (this option is only applicable if a GPS module is connected to SKL925 (SpectroSense2+.GPS)) records the current GPS latitude / longitude position for each measurement. In store or log mode, the latitude and longitude location in degrees and minutes north, south, east or west is recorded. If no fix has been made then the letter "F" for Fail is recorded in both latitude and longitude positions.

For full details on using the GPS mode, please see Chapters 2.6 and 6.26.

Pressing [ESCAPE] or [MENU] returns to the Main Menu.

6.33 Menu Option 30 – Connect to a PC

Although the SpectroSense2+ meter can be set up and used entirely from the keypad if preferred, it is usually easier to do any initial setting up and entry of sensor data via the PC. The PC connection is essential for downloading data from the meter's memory.

Simply choose menu Option "30 – Connect to a PC", connect the datalead between the 8 pin RS232 socket and the PC, and start the Skye SpectroSense2+ software.

The software will auto detect the meter and begin communications. Please see [Chapter 4](#) for full details of the software screens.

Pressing [ESCAPE] or [MENU] on the SpectroSense2+ meter when finished to return to Main Menu.

6.34 Menu Option 31 – Contact the Team

Skye contact details.

6.35 Menu Option 32

This option is reserved for future upgrades.

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7 SENSOR CONNECTION

SpectroSense2+ sensor socket inputs are Binder sub-miniature type. The mating plug can be connected to a Skye light sensor or sensors from other manufacturers. To connect a light sensor align the locating pin, push home and screw up gently – finger tight is sufficient as these connectors are waterproof and contain a rubber O ring seal.

There are several different types of socket inputs on the SpectroSense2+ meter, although not all types may be fitted to your model. Combinations include 2 or 4-channel current inputs and 1-channel voltage inputs. 2-channel inputs can be used for either 1 or 2 channel light sensors. Please see [Appendix 5](#) for details.

NB. Depending on the meter version and socket combination, it is possible to connect more than one sensor into the same hardware input:

e.g. SKL 925/1 has Socket 2 labelled C1 / C5 plus Socket 6 labelled C1 / C2 / C3 / C4

If a 4-channel sensor is connected to Socket 6 then Socket 2 must not be used simultaneously as hardware input C1 will be reading from 2 sensors at once. No damage will be caused to the meter, but the display will show an inaccurate amalgamation of both sensors.

7.1 SENSOR SOCKET WIRING DETAILS

7.1.1 1- and 2-Channel Current Inputs

These socket inputs are 5 pin female types and labelled C1/C3, C2/C4, C5 and C6 or C1/C5, C2/C6, C3/C7 and C4/C8.

PIN NUMBER	FUNCTION
Pin 1	Not connected
Pin 2	Not connected
Pin 3	Channel 2 negative current input
Pin 4	Channel 1 negative current input
Pin 5	Ground and cable screen

7.1.2 4-Channel Current Inputs

These socket inputs are 5 pin male types and labelled C1/C2/C3/C4 or C5/C6/C7/C8

PIN NUMBER	FUNCTION
Pin 1	Channel 1 negative current input
Pin 2	Channel 2 negative current input
Pin 3	Channel 3 negative current input
Pin 4	Channel 4 negative current input
Pin 5	Ground and cable screen

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7.1.3 Differential Voltage Inputs

These socket inputs are 5 pin female types and labelled V1, V2, V3 or V4

PIN NUMBER	FUNCTION
Pin 1	Positive 5V power supply to sensor
Pin 2	Not connected
Pin 3	Negative voltage input
Pin 4	Positive voltage input
Pin 5	Ground and cable screen

7.2 RS232 SOCKET WIRING DETAILS

This socket is an 8 pin female type and labelled RS232 for PC connection and / or external 12 VDC power supply.

PIN NUMBER	FUNCTION
Pin 1	Transmit data to PC
Pin 2	Receive data from PC
Pin 3	Ground and power supply negative
Pin 4	External power supply input – positive (8-15 VDC) ¹
Pin 5	Power supply reset ²
Pin 6	Plug detect ³
Pin 7	RTS handshake
Pin 8	CTS handshake

¹ The internal batteries can be left installed as a back up if required. No power is drawn from the internal battery unless the external supply drops below 10 volts.

² Pin 5 when shorted momentarily to ground (pin 3), will duplicate the action of the ON button on the keypad. This allows full remote operation of the unit. Do not connect permanently, or excess current will be drawn.

³ Pin 6 when shorted to ground (pin 3), will allow the SpectroSense2+ to know that a datalead is connected to the RS232 socket ready for PC connection. (Skye PC dataleads have pins 3 and 6 linked). Pin 6 can be permanently connected to ground, but the lowest current consumption and hence longest battery life is achieved by removing the datalead and ground connection.

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7.3 GPS MODULE CONNECTION (Model SKL925 only)

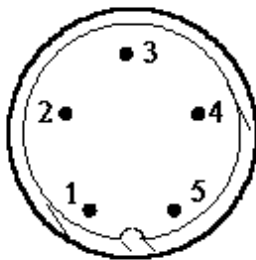
This socket is a 4 pin female type and labelled GPS for the connection of the Skye GPS module.

PIN NUMBER	FUNCTION
Pin 1	Positive 5V power supply to GPS module
Pin 2	Transmit data to GPS module
Pin 3	Receive data from GPS module
Pin 4	Ground and power supply negative

7.4 SOCKET PIN LOCATION (Model SKL925 only)

These diagrams represent the Pin numbers of the SpectroSense2+ sockets from the front or outside view. They also represent the back or inside view of matching connector or plug when soldering to the pins.

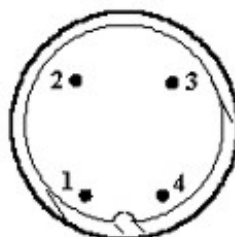
5 PIN SOCKETS



8 PIN SOCKETS



4 PIN SOCKETS



SpectroSense 2+ (+GPS)

8. SPECIFICATIONS

Operating Range:	-20 to +70°C, 0-100% RH
Construction:	Black ABS, sealed to IP54
Dimensions:	150 x 100 x 55 mm
Weight:	700g
Display:	20x4 line alphanumeric LCD
Keypad:	Membrane keypad with audible key press. 12 keys.
Connections:	Binder sub-miniature waterproof sockets. 5 or 8 pin for sensors. 4 pin for GPS module. 8 pin for RS232 serial PC connection
Power:	1x 9V PP3 GPS version: 6 x internal 1.5 volt AAA / MN2400 / LR03 batteries. Lifetime 40-50 hours in display mode, 300 hours in log mode, 6-8 hours in GPS mode. External 12VDC power supply via RS232 socket, from solar power, mains transformer or vehicle battery
Resolution:	Minimum 16 bit (1 part in 65536), better than 1 nA
Accuracy:	Typically 0.008% at 20°C for mid range
Sensor inputs:	Maximum 8 inputs, dependant on model. Combinations of 8 x current and / or 4 x voltage
Sensor input ranges:	Current: ± 20 nA to ± 2 mA Voltage: ± 2 mV to ± 2 V
Sensor power supply:	5V to voltage sockets only, permanently switched on in display and logging modes
GPS module:	(SKL925 model only) Uses SiRF Star III chipset, no subscription needed. Resolution typically 3m, 1m possible in SBAS areas. Powered by SpectroSense2+ meter.
Logging Intervals:	1, 2, 5, 10 seconds "spot" logging 20, 30 seconds, 1, 2, 5, 10, 20, 30 minutes, 1 or 2 hours storage of 10 second averages
Memory:	Sensor Library for 16 calibration factors. Measurement or plot location library of 100 alphanumeric labels. Over 2000 readings of each 8 inputs stored with date, time and location. Non-volatile EEPROM memory, no data loss if main power fails
Clock:	Real time clock powered by internal 10 year Lithium battery. Keeps date and time if main power fails. Ability to synchronise readings between several SpectroSense2 meters
Modes:	2 x 8 sensor / channel displays

SpectroSense 2+ (+GPS)

- 4 x ratio displays
- Fl 'favourite' display
- NDVI ratio display
- MJ.hr⁻¹ integration
- Store data on keypress
- Automatic datalogging
- Store plot location label manually or auto sequentially
- Store GPS latitude / longitude position
- Set up, memory functions, PC connection

SpectroSense 2+ (+GPS)

9 TROUBLESHOOTING

Q: The SpectroSense2+ display is blank and the [ON] button won't work, although I know the battery is good.

A: Is the meter in logging mode? Try pressing the [ESCAPE] button twice to quit logging mode.

Q: The SpectroSense2+ will not start automatic logging mode.

A: Check the battery voltage. If the battery is below 5.9V the meter will not start logging as the power is too low to make accurate measurements.

Q: The PC software says it can't find the SpectroSense2+

A: Are you running the correct software? Are you running the correct software? SpectroSense2+ v 3.049 requires the PC software version 2.054.

Is the meter switched on and in Menu Option 26 – Connect to a PC?

Is the data lead connected and secured using the screw connector to the meter's RS232 socket?

Is the data lead connected to the PC?

Q: The SpectroSense2+ display reading is higher than I would expect

A: Is there more than one sensor connected to a single hardware input?

For example a 1-channel sensor connected to socket C1 / C5 plus a 4-channel sensor connected the socket C1 / C2 / C3 / C4. In this example both sensors are connected to hardware socket C1, giving an inaccurate measurement

If you continue to have problems using your SpectroSense2+ meter, please do not hesitate to contact Skye's technical help team via telephone, email or web site using the details below:

SKYE INSTRUMENTS LIMITED
21, Ddole Enterprise Park
Llandrindod Wells
Powys, LD1 6DF, UK
TEL: +44 1597 824811
skyemail@skyeinstruments.com
www.skyeinstruments.com

SpectroSense 2+ (+GPS)

APPENDIX 1 – HAND-HELD POLE FOR SPECTROSENSE2+

SKL 910/2 and SKL 910/4 SpectroSense2+ hand-held pole

Skye can supply a hand-held pole that holds the SS2+ meter plus 2 or 4 sensors. This allows the user to be able to take concurrent measurement and logging of all active sensors of a sample site as accurately as possible. This is especially useful for large sampling areas, or teamed/grouped data collection, where data collection methodology consistency is important.

[Please click here see the separate manual for this product for full assembly and usage instructions](#)

Taking Light Measurements

1. Attach the sensors and meter and adjust the pole to the required height
2. Place the pole's rubber 'foot' in front of your own feet (or tucked between your feet to secure if more comfortable)
3. Lean the pole away from you until the level bubble is showing that the light sensors are level.
4. Use the SpectroSense2+ meter to take readings as required.

IMPORTANT

The light sensors must be protected from damage when not in use, especially the light collecting diffuser as any scratches may effect the sensor calibration. It is advisable to remove the sensor mounting arm from the top of the pole during transportation and storage.

This product is not intended for continuous outdoor use, and should not be exposed to the elements for long periods of time.

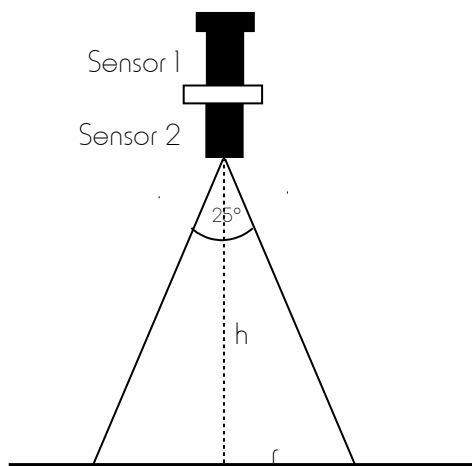
SpectroSense 2+ (+GPS)

APPENDIX 2 – AREA OF MEASUREMENT BY REFLECTED SENSORS

Skye SKR 1800 series 2 and 4 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, both 2 and 4 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
0.5m	0.11m	0.04m ²
0.75m	0.17m	0.09m ²
1m	0.22m	0.15m ²
1.25m	0.28m	0.24m ²
1.5m	0.33m	0.35m ²
1.75m	0.39m	0.47m ²
1.8m	0.40m	0.50m ²
2m	0.44m	0.62m ²

SpectroSense 2+ (+GPS)

APPENDIX 3 - WAVELENGTHS FOR NDVI SYSTEMS

There are no 'typical' wavelengths for NDVI systems, each system can be tailored to match the user's own research project as necessary. However, examples of popular wavelength configurations are listed below:

PROJECT	WAVELENGTHS
Red / Far-red ratio	Channel 1 – 660nm (10nm or 20nm FWHM) Channel 2 – 730nm(10nm or 20nm FWHM)
Crop Density	Channel 1 – 650nm (10nm or 40nm FWHM) Channel 2 – 800nm (10nm or 40nm FWHM) and/or Channel 1 – 630nm (40nm FWHM) Channel 2 – 800nm (40nm FWHM)
Ground truth for AHVRR satellite	Channel 1 – 580 - 680nm Channel 2 – 725 - 1000nm
Ground truth for Landsat 7 satellite	Channel 1 – 441 - 514nm Channel 2 – 519 - 600nm Channel 3 – 631 - 692nm Channel 4 – 772 - 898nm
Ground truth for MODIS satellite	Channel 1 – 459 - 479nm Channel 2 – 545 - 565nm Channel 3 – 620 - 670nm Channel 4 – 841 - 876nm

APPENDIX 4 – SPECTROSENSE2+ SOCKETS AND VERSIONS

SpectroSense 2+ (+GPS)

SKL 906

Option 1 : 906/1 – All Sockets for Current Output Sensors

Socket Number	Sensor Type	Socket Label	Socket Type
Socket 1	2 Channel Current	C1/C3	5 pin female
Socket 2	2 Channel Current	C2/C4	5 pin female
Socket 3	1 Channel Current	C5	5 pin female
Socket 4	1 Channel Current	C6	5 pin female
Socket 5	RS232	RS232	8 pin female

Option 2 : 906/2 – Combination of 2 Current and 2 Voltage Sensors

Socket Number	Sensor Type	Socket Label	Socket Type
Socket 1	2 Channel Current	C1/C3	5 pin female
Socket 2	2 Channel Current	C2/C4	5 pin female
Socket 3	Differential Voltage	V1	5 pin female
Socket 4	Differential Voltage	V2	5 pin female
Socket 5	RS232	RS232	8 pin female

Option 3 : 906/3 – All Sockets for Voltage Output Sensor

Socket Number	Sensor Type	Socket Label	Socket Type
Socket 1	Differential Voltage	V1	5 pin female
Socket 2	Differential Voltage	V2	5 pin female
Socket 3	Differential Voltage	V3	5 pin female
Socket 4	Differential Voltage	V4	5 pin female
Socket 5	RS232	RS232	8 pin female

Option 4 : SKL 906/4 – All Sockets of Customers Choice (except 4 Channel Current)

SKL 908

SpectroSense 2+ (+GPS)

Option 1 : 908/1 – All Sockets for Current Output Sensors

Socket Number	Sensor Type	Socket Label	Socket Type
Socket 1	2 Channel Current	C1/C5	5 pin female
Socket 2	2 Channel Current	C2/C6	5 pin female
Socket 3	2 Channel Current	C3/C7	5 pin female
Socket 4	2 Channel Current	C4/C8	5 pin female
Socket 5	4 Channel Current	C1/C2/C3/C4	5 pin male
Socket 6	4 Channel Current	C5/C6/C7/C8	5 pin male
Socket 7	RS232	RS232	8 pin female

Option 2 : 908/2 – Combination of 2 Current and 2 Voltage Sensors

Socket Number	Sensor Type	Socket Label	Socket Type
Socket 1	2 Channel Current	C1/C3	5 pin female
Socket 2	2 Channel Current	C2/C4	5 pin female
Socket 3	Differential Voltage	V1	5 pin female
Socket 4	Differential Voltage	V2	5 pin female
Socket 5	4 Channel Current	C1/C2/C3/C4	5 pin male
Socket 6	4 Channel Current	C5/C6/C7/C8	5 pin male
Socket 7	RS232	RS232	8 pin female

Option 3 : 908/3 – All Sockets for Voltage Output Sensor

Socket Number	Sensor Type	Socket Label	Socket Type
Socket 1	Differential Voltage	V1	5 pin female
Socket 2	Differential Voltage	V2	5 pin female
Socket 3	Differential Voltage	V3	5 pin female
Socket 4	Differential Voltage	V4	5 pin female
Socket 5	4 Channel Current	C1/C2/C3/C4	5 pin male
Socket 6	4 Channel Current	C5/C6/C7/C8	5 pin male
Socket 7	RS232	RS232	8 pin female

Option 4 : SKL 908/4 – All Sockets of Customers Choice (except 4 Channel Current)

SKL 920

SpectroSense 2+ (+GPS)

Option 1 – SKL 920/1

All sockets for current output sensors

Socket number	Sensor type	Socket Label	Socket type
Socket 1	GPS Module	GPS	4 pin female
Socket 2	2 channel current	C1/C3	5 pin female
Socket 3	2 channel current	C2/C4	5 pin female
Socket 4	1 channel current	C5	5 pin female
Socket 5	1 channel current	C6	5 pin female
Socket 6	PC Connection	RS232	8 pin female

Option 2 – SKL 920/2

Combination of 2 current & 2 voltage sockets

Socket number	Sensor type	Socket Label	Socket type
Socket 1	GPS Module	GPS	4 pin female
Socket 2	2 channel current	C1/C3	5 pin female
Socket 3	2 channel current	C2/C4	5 pin female
Socket 4	Differential Voltage	V1	5 pin female
Socket 5	Differential Voltage	V2	5 pin female
Socket 6	PC Connection	RS232	8 pin female

Option 3 – SKL 920/3

All sockets for voltage output sensors

Socket number	Sensor type	Socket Label	Socket type
Socket 1	GPS Module	GPS	4 pin female
Socket 2	Differential Voltage	V1	5 pin female
Socket 3	Differential Voltage	V2	5 pin female
Socket 4	Differential Voltage	V3	5 pin female
Socket 5	Differential Voltage	V4	5 pin female
Socket 6	PC Connection	RS232	8 pin female

Option 4 : SKL 920/4 – All Sockets of Customers Choice (except 4 Channel Current)

SKL 925

Option 1 – SKL 925/1

SpectroSense 2+ (+GPS)

All sockets for current output sensors

Socket number	Sensor type	Socket Label	Socket type
Socket 1	GPS Module	GPS	4 pin female
Socket 2	2 channel current	C1/C5	5 pin female
Socket 3	2 channel current	C2/C6	5 pin female
Socket 4	2 channel current	C3/C7	5 pin female
Socket 5	2 channel current	C4/C8	5 pin female
Socket 6	4 channel current	C1/C2/C3/C4	5 pin male
Socket 7	4 channel current	C5/C6/C7/C8	5 pin male
Socket 8	PC Connection	RS232	8 pin female

Option 2 – SKL 925/2

Combination of 4 current & 2 voltage sockets

Socket number	Sensor type	Socket Label	Socket type
Socket 1	GPS Module	GPS	4 pin female
Socket 2	2 channel current	C1/C3	5 pin female
Socket 3	2 channel current	C2/C4	5 pin female
Socket 4	Differential Voltage	V1	5 pin female
Socket 5	Differential Voltage	V2	5 pin female
Socket 6	4 channel current	C1/C2/C3/C4	5 pin male
Socket 7	4 channel current	C5/C6/C7/C8	5 pin male
Socket 8	PC Connection	RS232	8 pin female

Option 3 – SKL 925/3

Combination of 2 current & 4 voltage sockets

Socket number	Sensor type	Socket Label	Socket type
Socket 1	GPS Module	GPS	4 pin female
Socket 2	Differential Voltage	V1	5 pin female
Socket 3	Differential Voltage	V2	5 pin female
Socket 4	Differential Voltage	V3	5 pin female
Socket 5	Differential Voltage	V4	5 pin female
Socket 6	4 channel current	C1/C2/C3/C4	5 pin male
Socket 7	4 channel current	C5/C6/C7/C8	5 pin male
Socket 8	PC Connection	RS232	8 pin female

Option 4 : SKL 925/4 – All Sockets of Customers Choice (except 4 Channel Current)

NOTE – 2-channel current sockets are compatible with both 1-channel and 2-channel current output sockets.

SpectroSense 2+ (+GPS)

APPENDIX 5 – BLANK CONFIGURATION CERTIFICATE

For own notes:



SPECTROSENSE2+.GPS METER
HARDWARE CONFIGURATION

Skye Instruments Ltd
21 Doble Enterprise Park, Wundring Road Wells,
Pewsey, LD1 6DF, UK
Tel: 01897 924811
Email: skymail@skyeinstruments.com
Web: www.skyeinstruments.com

PART NO.:

SERIAL NO.:

Firmware Version: V#3.049

Meter ID: 0

Certificate Issue Date:

Sensor Library No.	Sensor Description	Sensor Units	Sensor Output	Sensor Offset	Sensor Serial No
00					
01					
02					
03					
04					
05					
06					
07					
08					
09					
10					
11					
12					
13					
14					
15					

Active Sensor No.	Sensor Library No.	Sensor Description	Sensor Units	Socket Input
0				
1				
2				
3				
4				
5				
6				
7				

DEFAULT ACTIVE SENSOR SET UP

GPS Unit	
Manufacturer:	
Model No:	
Serial No:	

Pyranometer sensors - Calibrated directly against a calibrated reference World Meteorological Office, First Class Pyranometer under natural day/light conditions.
 Power Light sensor - Calibrated against a National Physical Laboratory UK reference standard lamp.
 Uncertainty +5% (typical) +3% based on an estimated confidence of not less than 95%