

LSM - Light Sensor Meter

Product Overview

The Light Sensor Meter (LSM) is a stand-alone logging instrument for the measurement of global solar radiation or photosynthetically active radiation (PAR).

The LSM can support up to 10 x pyranometers (PYR, SK-08), PAR (QSO-S) and linear PAR (LINPAR) sensors. The LSM can automatically calculate intercepted radiation by a plant canopy.

The LSM is a fully self-contained unit requiring power input from an 22W solar panel (field applications) or 24V power supply (glasshouse applications). Communication is via a USB port or wireless connectivity.

The LSM is IP-65 rated and has a Windows driven GUI interface for complete logging solutions including look-up tables, scripts and sensor calibration capabilities.



LINPAR positioned within a canopy

Applications

- Climate and ecosystem modelling
- Crop growth environment
- Intercepted radiation within and beneath canopy
- Photosynthetic activity within canopy and light use efficiency

Features

- Stand-alone, wireless data logging, low power requirement
- Up to 10 x sensor capacity
- Solar radiation and/or PAR measurements
- Automatic calculations of intercepted radiation by canopy
- Flexible sensor calibration, look-up tables, and user scripts
- IP-65 Intrusion Rating



Light Sensor Meter (LSM) & First Class Pyranometer (SK-08)

The LSM is ideally used in combination with the SFM sap flow meter (tree water use), PSY stem psychrometer (plant water potential), TSM temperature sensor meter (canopy temperature) and the ICT International automatic weather station.



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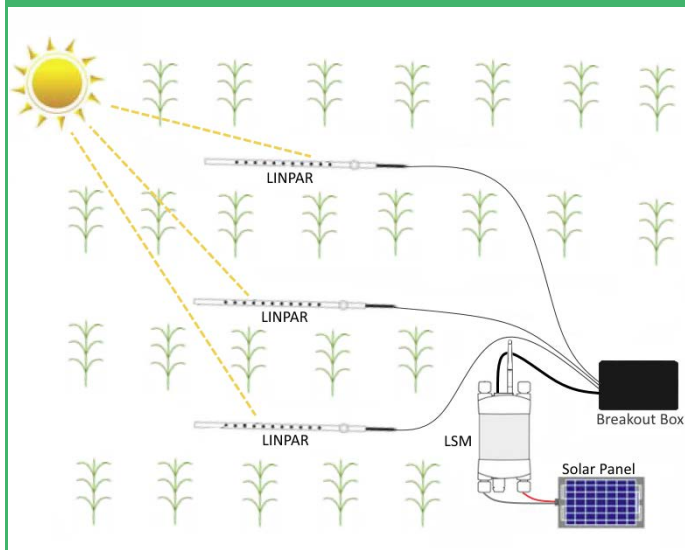
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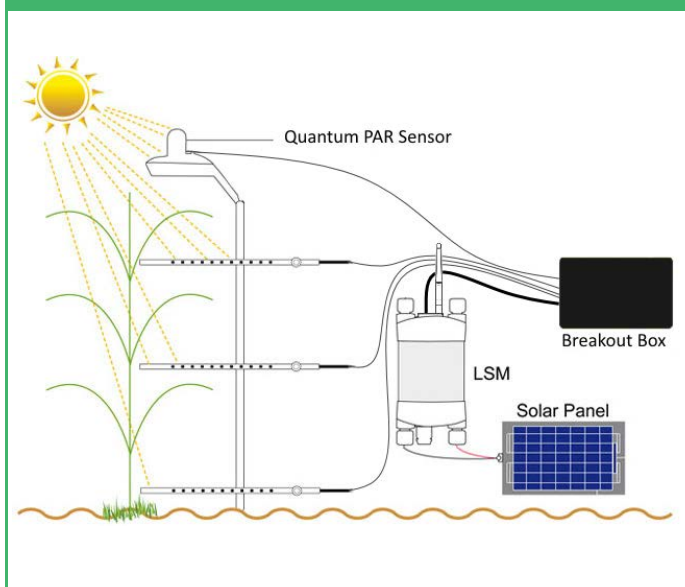
More Details

- The LSM is a stand-alone instrument and does not need extensive cables and power requirements. All data is stored within the unit on a removable MicroSD card.
- Communication with the LSM is made either with a USB or wireless connection. Wireless is capable of ranges up to 250m.
- In conjunction with an ICT web-based controller, the LSM and/or individual sensors can be controlled remotely. Real-time, live measurements can be made remotely from any location with internet access. Data can be logged directly onto a remote computer or stored in the field on an ICT log server which can then be accessed via the internet.
- The LSM has a Windows and Mac compatible configuration software. The software is GUI based and extremely user-friendly. Custom calibration equations or data can be entered and edited via the software. Real-time measurements, diagnostics and sensor configuration can easily be made.
- The LSM has 2 wire, non-polarized bus for power input. There is no chance of incorrect wiring of positive and negative voltage because the LSM is non-polarized.
- The LSM has an internal lithium-polymer battery that is kept charged by an external power supply (solar panel or mains). The instrument has an internal voltage regulation for maximum power reliability.
- The LSM is IP65 rated and has been demonstrated to operate in extreme environmental conditions. Units are being used in diverse environments from hot Australian deserts, tropical Amazon rainforests, temperate German forests, Indian agricultural fields and North American Arctic cold.

3 x LINPAR measuring light on a plant crop



Quantum PAR sensor and LINPAR measuring light above and within a canopy



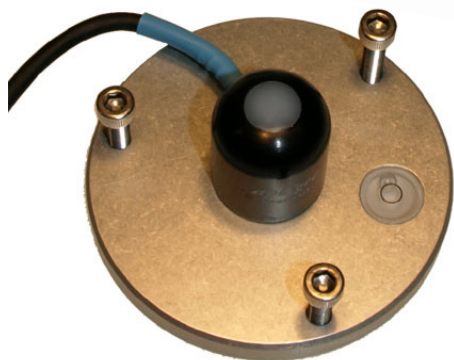
LSM - Compatible Sensors

LINPAR



- Photosynthetically Active Radiation (PAR; 400 to 700nm)
- Average reading of 33 PAR sensors
- Measurement range: 0 to 2,000 $\mu\text{mol} / \text{m}^2 / \text{s}$
- Accuracy: $\pm 1\%$
- Resolution: 0.01 $\mu\text{mol} / \text{m}^2 / \text{s}$

QSO-S



- Photosynthetically Active Radiation (PAR; 400 to 700nm)
- Single PAR sensor
- Measurement range: 0 to 2,000 $\mu\text{mol} / \text{m}^2 / \text{s}$
- Accuracy: $\pm 5\%$
- Resolution: 0.01 $\mu\text{mol} / \text{m}^2 / \text{s}$

PYR



- Global Solar Radiation (300 to 3000nm)
- Second Class
- Measurement range: 0 to 1750 W / m^2
- Accuracy: $\pm 5\%$
- Resolution: 0.01 W / m^2

SK-08



- Global Solar Radiation (300 to 3000nm)
- First Class
- Measurement range: 0 to 2000 W / m^2
- Accuracy: $\pm 1\%$
- Resolution: 0.01 W / m^2



**Any Radiation sensor can connect to the ICT International Light Sensor Meter
- Contact ICT International if you have a sensor not listed above.**

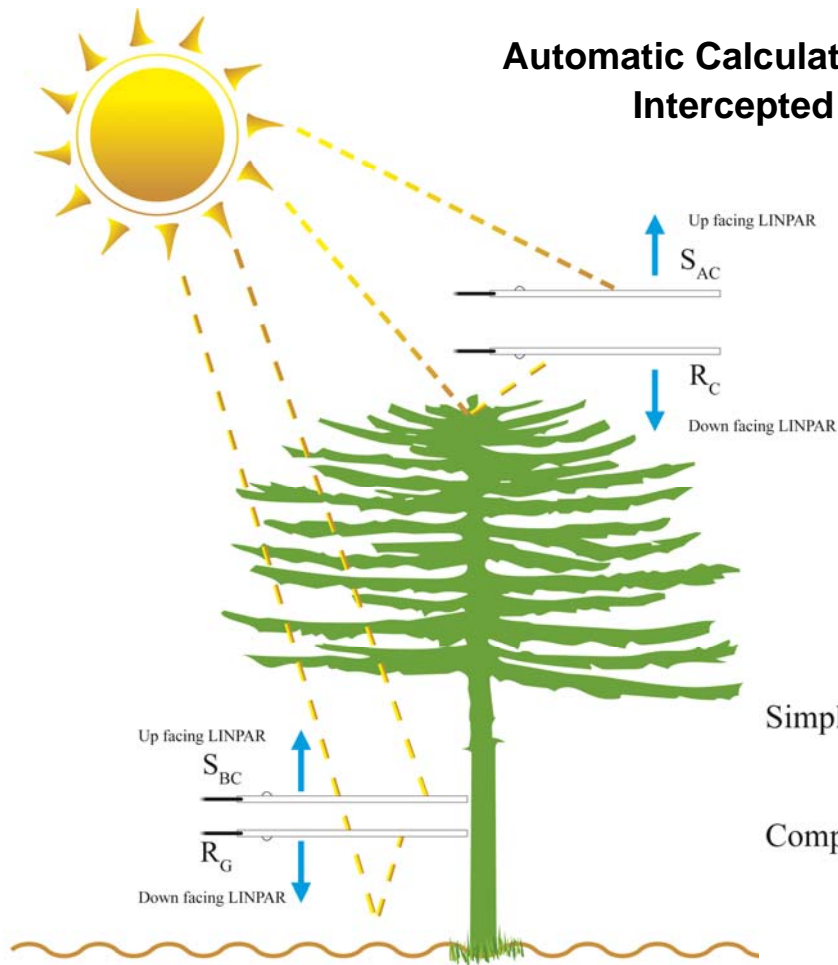
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LSM - Virtual Sensor

Automatic Calculation of Fraction of Intercepted Radiation



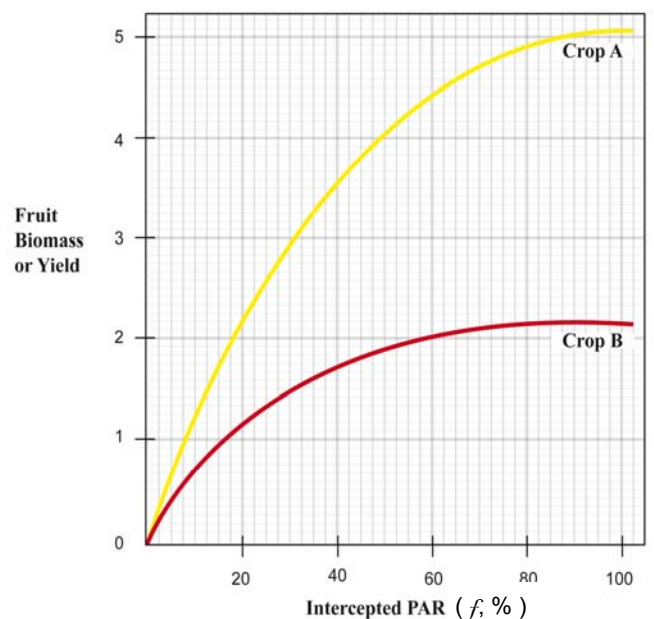
Simple Method: $f = 1 - t$
 $t = S_{AC} / S_{BC}$

Complex Method: $f = 1 - t - r + tr_g$
 $t = S_{AC} / S_{BC}$
 $r = R_C / S_{BC}$
 $r_g = R_G / S_{AC}$

The LSM automatically calculates the fraction of intercepted PAR (f).

The measurement of f is an indicator of a plant's light use efficiency or its ability to convert sunlight into biomass. The simple method (see equation in diagram above) requires at least one PAR sensor above the canopy to measure direct beam and two or more LINPAR sensors beneath the canopy (see diagram above).

The complex method (see equation in diagram above) also accounts for reflectance from the canopy and ground which can account for up to 5% of f . A LINPAR is necessary beneath or within a canopy because it samples a larger area and takes into account sunlight variability caused by the canopy. Plotting f over a growing season against some measure of yield or biomass indicates the light use efficiency of two or more crops.



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LSM - Case Studies

Custom Designed LSM and Solar Radiation Sensor

ICT International custom designs various instruments to meet special requirements of scientists.

Central Research Institute for Dryland Agriculture (CRIDA) and Indian Council of Agricultural Research (ICAR) approached ICT International to custom design a LSM with a first class pyranometer for climate change research in rice fields in India.

A LSM was specifically designed by ICT International's engineers to support an SK-08 sensor, a high quality and reliable first class pyranometer. This LSM with SK-08 custom instrument is currently measuring solar radiation in locations across India's rice belt.

The effects of climate change on cloudiness, solar radiation input and consequent crop yield are being monitored.

SK-08 sensor measuring solar radiation across India



Light and leaf development in *Acacia* species

Many species of the genus *Acacia* display dramatically different leaf types known as bipinnate leaves and phyllodes.

Scientists at the University of New South Wales, Sydney, Australia, found in previous experiments that the light environment favoured the development of one leaf type over another.

Further experiments will be conducted to assess the role of light quantity in this process. Different light filters placed around plants growing in pots in a glasshouse alter the total amount of solar radiation reaching leaves.

A LSM with a pyranometer was used to quantify differences between various experimental treatments created by the light filters.

Light and leaf experiment at the University of New South Wales



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Software & Communication

Software

Overview

ICT International instruments have customised software support. The software acts as an interface between the user, instrument and sensors. Each instrument has software pre-configured for the sensors it supports.

Look up Table

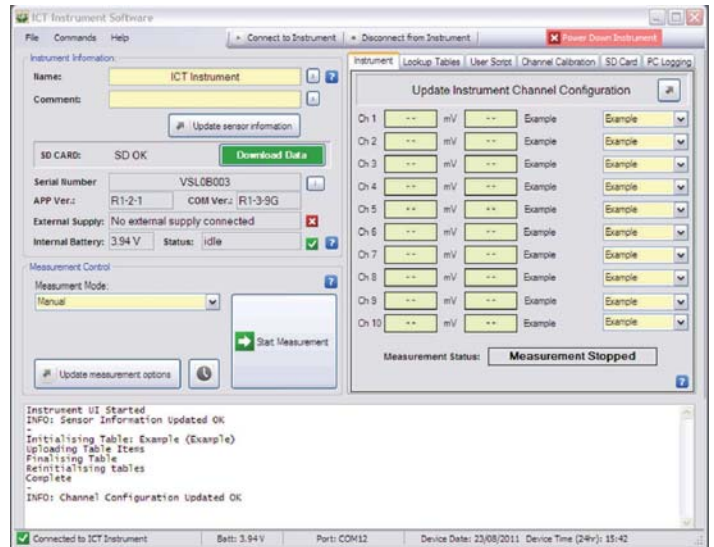
A look-up table is a linear conversion from a mV output from the sensor into any conversion units. A minimum of two values are needed: the lowest mV output and the highest mV output.

Script

For more complex conversions, such as exponential, logistic or polynomial equations, users can enter a script.

Self Calibration

Individual sensors can be calibrated using the ICT International software. A minimum three point calibration curve is required. Statistical analysis of calibrated data is automatically performed. Calibration curves can be saved, retained and modified. Calibration of individual sensors allows absolute precision data collection.



Software Overview

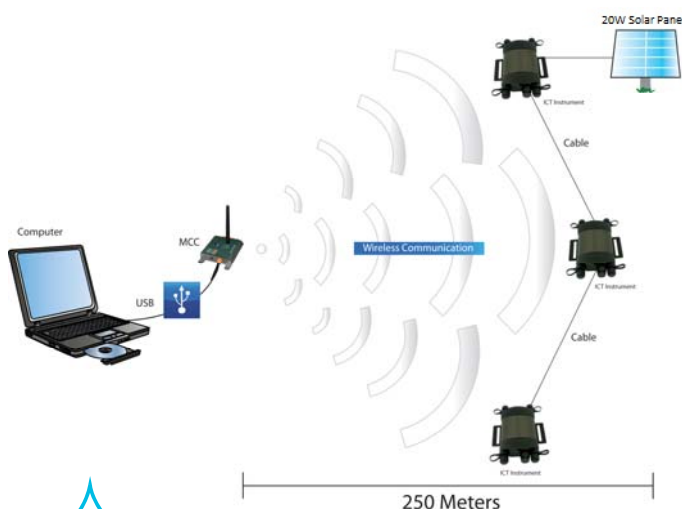
Date	Time	Chan1 (Example)	Chan2 (Example)	Chan3 (Example)	Chan4 (Example)	Chan5 (Example)	Internal Battery Voltage
30/07/2011	10:04:14	0	0	0	0	0	4.06
30/07/2011	10:15:53	0.03	0	0	0	0	4.09
30/07/2011	10:20:14	3.65	0	0	0	0	4.1
30/07/2011	10:40:14	274.84	294.48	291.45	329.22	0	4.09
30/07/2011	11:00:14	930.62	960.07	905.89	881.37	0	4.09
30/07/2011	11:20:15	413.49	409.63	332.88	251.18	0	4.08
30/07/2011	11:40:14	889.5	1024.53	990.23	1012.92	0	4.08

Example Output File

Communication

MCC

- Wireless communication with any ICT International instrument within 250m.
- Portable, easy to use via ICT International software interface.
- Connects directly into any Windows based computer via USB cable.
- Multiple channel ports, such as SDI-12, RS232, RS485, SI8, ICT-BUS & ICT Wireless Protocols, for highly flexible interfacing between ICT International instruments and third party devices.



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Components

Solar Panel / Power Supply

Field Applications:

- 22W Solar Panel (high demand)
- 12V Battery

Laboratory / Glasshouse Applications:

- 12V or 24V power supply



Power Supply



Solar Panel

4GB Removable SD Card

- Data stored internally on a 4GB removable MicroSD card
- Storage for months to years of data.
- Expandable up to 16 GB.



Micro SD Card

Breakout Board

- ICT International instruments can support up to 5x differential sensors or up to 10 x single ended sensors.
- Variable voltage excitation is software settable in the ICT Instrument Software.
- Internal or External power switch



Differential



Single Ended

GUI Software

- Customised software interface between user, instrument and sensors.
- Set logging intervals, parameters and data download.
- Look-up tables, user scripts and custom sensor calibration.



Customised software interface

MCC Wireless / USB Cable

- Communication with instrument is made directly via a supplied USB Cable
- Wireless communication is available with communication distance up to 250m.
- Connect MCC wireless device to USB port of computer.



USB Cable (1.8m length)



MCC Wireless Device




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LSM Specifications

LSM Logging	
Analogue Channels	5 differential or 10 single ended
Resolution	0.00001V-24-Bit
Accuracy	0.001V
Minimum Logging Interval	1 second
Delayed Start	Suspend Logging, Customised Intervals
Sampling Frequency	10Hz
Data	
Communications:	USB, Wireless Radio Frequency 2.4 GHz
Data Storage	MicroSD Card, SD, SDHC & SDXC Compatible (FAT32 Format)
Software Compatibility	Windows 7, 8, 8.1 & 10; Mac OS X
Data File Format	Comma Separated Values (CSV) format for compatibility with all software programs
Memory Capacity	Up to 16GB, 4GB microSD card included.
Operating Conditions	
Temperature Range	-40°C to +80°C
R/H Range	0 -100%
Upgradable	User upgradeable firmware using USB boot strap loader function
Power	
Power supply	8-30V DC 2-wire non polarized bus
Power Consumption	20 mA
Internal Battery Monitoring	Logging internal battery voltage & charging current
Charging Rate	Automatic variable rate of charging to maximise solar panel charging current on full sun days and/or under low light cloudy conditions. Variable current 60 mA to 200 mA

Features
Power Management <ul style="list-style-type: none"> • Internal Lithium-Polymer Battery • Power On/Off Switch • Internal Voltage Regulation • Optical Isolation Lightning Protection
Logging <ul style="list-style-type: none"> • Stand-Alone Logging • 24-Bit Resolution • MicroSD Expandable Memory • USB Connectivity • Wireless Data Transfer • IP65 Water Proof Rating • Free Windows Utility Configuration Software
Applications
<ul style="list-style-type: none"> • Intercepted radiation within and beneath canopy • Photosynthetic activity within canopy and light use efficiency • Crop growth environment
Accessories
<ul style="list-style-type: none"> • MCC • Quad Band GPRS, GSM, 3G CDMA Modem




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