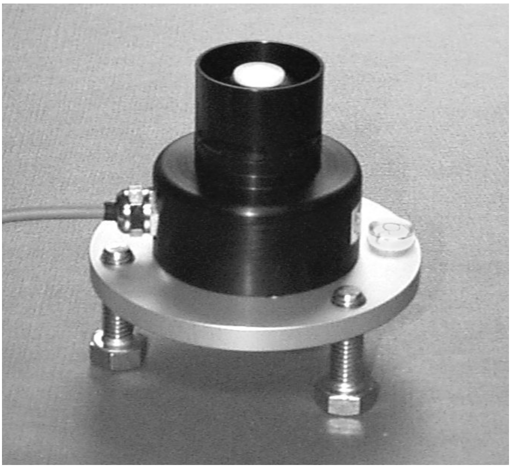
User Manual for the

UV Radiation Sensors

types ***UV3pA, B and AB***



UV3-UM-1.1

Delta-T Devices Ltd

Notices

Copyright

CE conformity

UV3pA, B, and AB

The sensors described in this document are CE marked by the manufacturer.

Design changes

Delta-T Devices Ltd reserves the right to change the designs and specifications of its products at any time without prior notice.

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Contents

Introduction

Summary of Features

The UV3p sensors are sensitive to ultra-violet radiation. They are intended for measurements of solar UV of interest to plant scientists and people involved in environmental monitoring.

The family of sensors covers different parts of the UV region of the solar spectrum. The B region has traditionally been associated with the most biological damage, but there is increasing interest in the biological effects of the lower energy A band. The AB sensor includes both A and B bands.

The sensors incorporate a photodiode detector and transimpedance amplifier, powered by a single rail power supply. This produces a standard millivolt output signal that is suitable for data logging.

The sensor can be supplied with an optional levelling mount.

The UV3p sensors are improved versions of the former UV2p sensors, with the following features:

- Millivolt output with preset, standard sensitivity
- Data logger compatible
- High stability, low temperature coefficient photodiodes
- Self cleaning, stay-dry diffuser with water drainage slots
- Good cosine response with infinity-error correction ring
- All-aluminium body with weather resistant anodising
- Individual sensor calibration and spectral response certificates.

Scope of This Manual

This manual contains the specifications and performance of the UV3pA, B and AB sensors, and describes their installation with Delta-T data loggers.

You may also need to refer to the appropriate Delta-T logger User Manual or On-line Help.

Installation

Unpacking

Check for any damage that may have occurred to the consignment in transit. Check that the contents of the consignment agree with the Packing List.

If any damage or shortage is apparent, notify the agents and the carriers immediately.

Make a note of the sensor(s) serial number(s), and check that the cable supplied is the length that was ordered. The serial numbers will be needed in any subsequent warranty claims, repairs or recalibration.

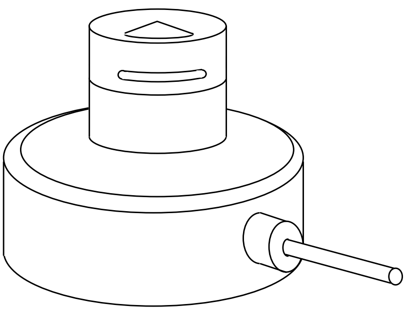
The parts supplied may include:

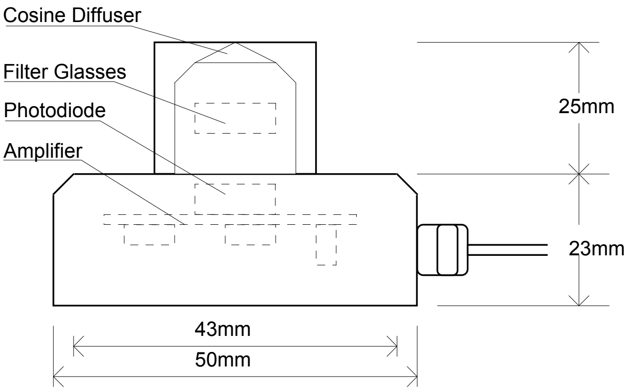
- UV3pA, B or AB sensor with cable fitted
- Levelling mount or other mounting bracket

Cable lengths, other than the standard 5m, that are pre-ordered will normally be fitted in unbroken lengths.

Description of Equipment

Outline Diagrams:





Mounting the Sensor

M4 mounting screws are provided for the two tapped holes in the base of each sensor. The mounting holes are at 43 mm spacing.

Warning! *Do not use the central hole for mounting the sensor. It is provided only for factory calibration purposes.*

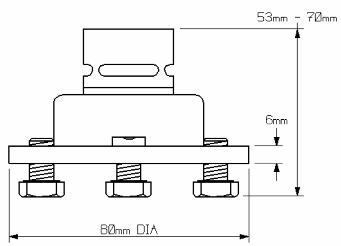
The sensor is usually mounted horizontally for most solar radiation insolation studies. The readings then give the irradiance ($W.m^{-2}$) of a horizontal surface.

A levelling mount is offered as an option, or you can easily make up your own mounting plate.

If you need to remove excess length of cable at this stage, simply cut off the excess, but allow for a sufficient length of the cable screen.

Levelling Mount type SRLF1

This is a freestanding platform with adjustable legs and bubble level to allow the sensor to be accurately mounted horizontally.



UV3p Sensor Connections

Outline Specs

Parameter	Value
Output	1 mV per $W.m^{-2}$ of radiation in the relevant wave band

Type	Waveband	Peak λ	FWHM*
UV3pA	UV A	373 ±2 nm	31 ±2 nm
UV3pB	UV B	313 ±2 nm	26 ±2 nm
UV3pAB	UV AB	360 ±5 nm	72 ±5 nm

* Full Width Half Maximum

Sensor Wiring

The sensors are fitted with 5m of 4-core screened cable, with bare wire ends as standard.

Conductor	Function	Notes
Blue	UV Signal HI	
Green	UV Signal LO	Common with Power 0V inside the sensor. Do not link this wire with Power 0V (yellow). It may create reading errors.
Red	Power V+	
Yellow	Power 0V	
Screen	screen	Connected to metal body of sensor. Not connected to any other conductors.

Power Requirements

Power supply	7 - 15 V dc, unstabilised (~2mA)
Power warm up time	10 seconds

Cable

Up to 100m of cable can be fitted at time of ordering.

The UV signal voltage output is not sensitive to the cable length within this limit.

Data Requirements

Typical common usage:

UV irradiance output	Sample every minute. Average every hour or half-hour.

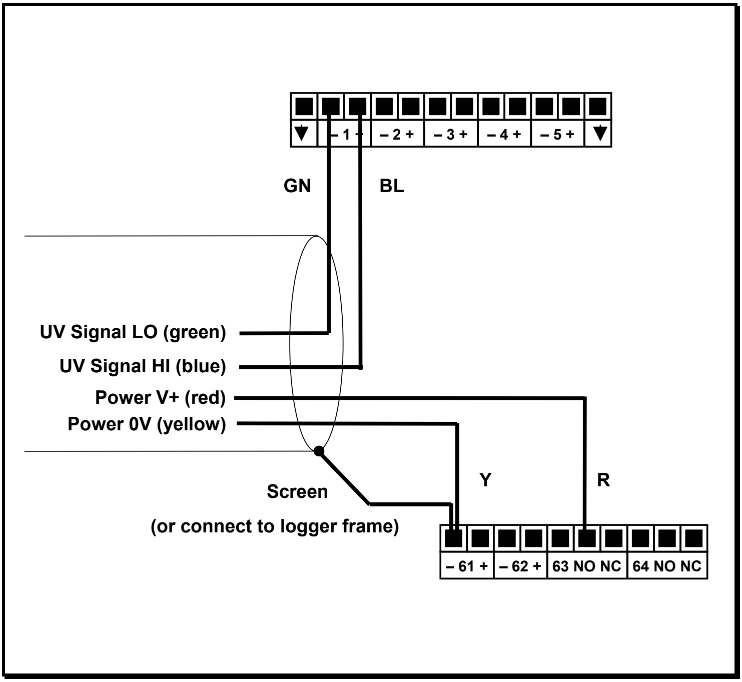
UV3p Logger Connections

DL2e Logger

Use with LAC1

This diagram shows the wiring connections for the LAC1 analogue input card. For use with other cards, please refer to the DL2e Logger User Manual

UV3p Wiring Schematic for DL2e



Settings

The example shows the UV3p sensor output connected to analogue channel number 1 in the DL2e logger.

The UV3p is a powered sensor with a low mV output. It should be read using a differential voltage channel, to avoid possible signal errors that may occur if connected single-ended.

The LAC1 input card is used in its 15-channel (differential) mode, with the 15-30 slider set to "15".

Power for the UV3p sensor is shown routed through relay channel 63. Power from the logger's own battery is connected to terminal 63 using the internal jumper in the DL2e logger. Alternative sources of power can be used, if preferred (see the DL2e User Manual).

Note: The cable screen is connected to channel 61- or 62- terminals for electrical screening purposes. These are the digital earth/frame connections of the DL2e, and are also used for the Power 0V return.

DL2e Sensor Codes

UV3pA, B or AB

When creating your DL2e logger configuration with the LS2e software, you can use the UVP sensor code provided.

Warning! *Do not use the sensor code "UV" from much earlier releases. It has a different conversion factor that will give incorrect results if used with the UV3p sensors.*

If you have an earlier release of the LS2e software, you can download the latest version from the Delta-T web site.

All that remains is to choose suitable sampling and logging intervals (see *data requirements*) in your logging configuration.

Relay warm up for powered channels

The UV3p sensor needs power warm-up. Specify one of the relay channels 63 or 64 and configure it for the warm-up function with a warm-up time of 10 seconds. This length of time is required for the zero settling of the sensor amplifier.

DL3000 Logger

Wiring Connections and Sensor Types

Refer to the on-line Help related to the former UV2p sensors. It remains valid for the UV3p sensors. Then select suitable sampling and logging intervals (see *data requirements*).

Please consult Delta-T Technical Support if you need further assistance.

Other Loggers

Any logger with a sensitive differential mV input range (e.g. 0 – 50 mV), and a facility for powering up sensors, can be used for the UV3p range of sensors.

Follow the general principles laid out above.

Specifications

Spectral Response

Figure 1

UV3pA Relative Spectral Response

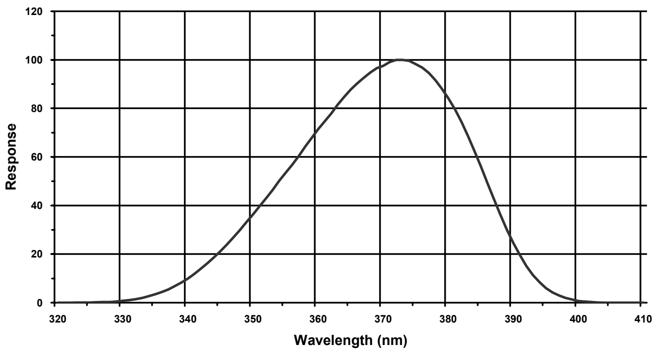


Figure 2

UV3pB Relative Spectral Response

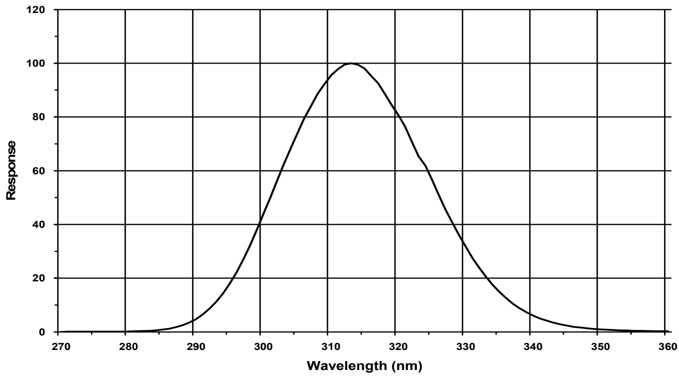
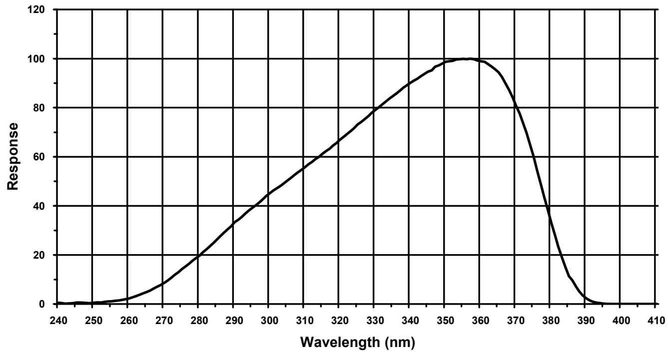


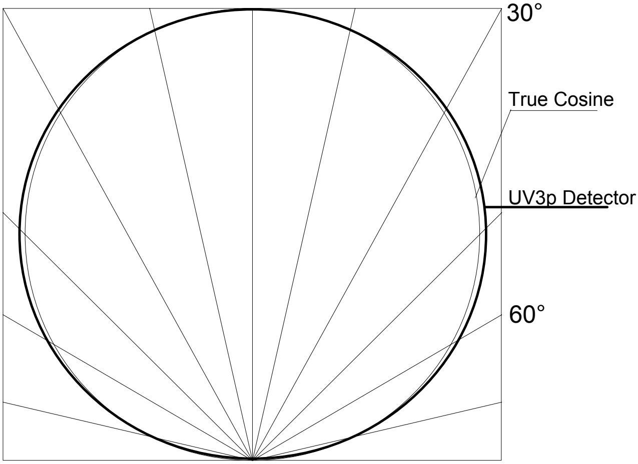
Figure 3

UV3pAB Relative Spectral Response



Cosine Response

Figure 4

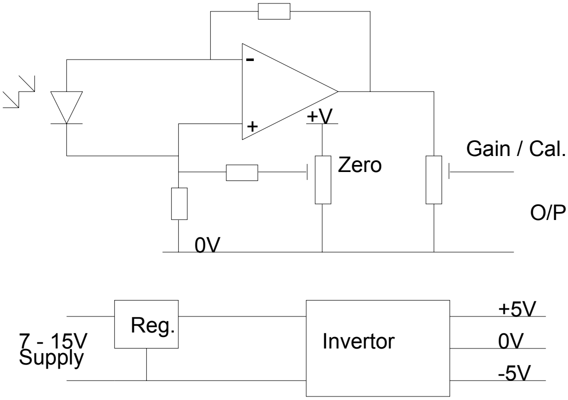


UV3p Specification Table

Parameter	Notes
Photodiode	High quality photodiodes: Si (A, B); GaAsP (AB)
Sensitivity	1 mV per W.m^{-2} of radiation in the respective waveband
Wavebands FWHM	A: 373 ±2nm peak; 31 ±2nm bandwidth B: 313 ±2nm peak; 26 ±2nm bandwidth AB: 360 ±5nm peak; 72 ±5nm bandwidth
Accuracy	±7.5% at 20°C
Calibration traceability	To UK National Physical Laboratory (NPL) standards
Linearity	<1% error
Temperature coeff't	<0.1% per °C typical (Photodiode only. See below)
Measuring limits full accuracy	0-150 W.m^{-2} (A, B) 0-200 W.m^{-2} (AB)
Cosine corrected	Within ±5% up to 70º incidence. See Fig 4
Operating range	-20 to 60 °C (A, B);-10 to 60 °C (AB)
Storage range	-40 to 60 °C (A, B);-20 to 60 °C (AB)
Voltage supply	7-15 V dc (~2 mA)
Warm up period	10 seconds, recommended
Amplifier type	Transimpedance
Amplifier offset drift	Typical 0.3 μV per °C. Positive for increasing temperature. Additional to photodiode error.
Size (mm)	48 high x 50 dia (base)
Weight (excl cable)	125 g
Base mounting	Two M4 tapped holes on 43 mm PCD
Finish	Black hard anodised
Enclosure rating	IP65
Spectral response	Individual graph
Cable type	4-core screened, 3 mm dia
Terminations	bare wires
Cable length	5 m standard; 100 m maximum

Amplifier characteristics

Schematic



Note that the transimpedance amplifier adjusters and power rails are not accessible to the user.

The 0V signal output is electrically common with the input Power 0V rail.

Input Offset Drift

Typical +0.3 μV per °C (=0.3 mW.m^{-2} per °C). Positive for increasing temperature. This error is in addition to any error contributed by the photodiode.

Certification

CE Conformity

Delta-T Devices Ltd holds a CE Declaration of Conformity issued by the manufacturer.

The manufacturer certifies that Ultra-violet detectors with integral amplifiers model numbers UV3pA, UV3pB and UV3pAB comply with European directive EMC (89/36/EEC) for Radiated Emissions, Conducted Emissions, Radiated Immunity and Fast Transients.

Certificate of Calibration

Calibration is carried out under a xenon arc light beam, at normal incidence to the sensor, by reference to transfer standards.

Individual Calibration Certificates and spectral response graphs are supplied with each UV3p sensor. The following details are included.

Example

CERTIFICATE OF CALIBRATION

The Manufacturers hereby certify that this instrument has been calibrated using standards whose accuracy is traceable to the National Physical Laboratory (NPL Certificate No. 120R11/921011/D18) and the National Bureau of Standards within the limitations of the NPL's and the NBS's calibration services, or have been derived from known values of physical contacts.

MODEL: UV3pA
SERIAL NUMBER: 6252/UV3pA-112
CERTIFICATE NUMBER: 7438/2
DATE ISSUED: 22nd June 2000
VALID: 12 months

CALIBRATION DETAILS:
SOURCE: Xenon Arc Lamp (LTE-030)
TRANSFER STANDARD: CAL105A-Cos (LTE-043) @ 373nm
POWER LEVEL: 0.94 W/m2
DETECTOR VOLTAGE: 0.94 mV ± 0.1 mV
SENSITIVITY: 1.0 mV/W/m^2
mV = 1.0 W/m^2

CALIBRATION NOTES:
Absolute calibration accuracy is ± 7.5%.
Detectors normalised spectral response graphed and supplied.
Definition: 1mV = 1W/m^2.
Calibrated By: (Signature) TEST ENGINEER

Maintenance

Routine Maintenance

The very low level of UV in solar radiation, and its susceptibility to absorption by dirt and grease, requires that the UV sensor diffuser be cleaned regularly. In most cases, weekly cleaning with a soft toothbrush, clean freshwater and liquid detergent will be sufficient.

Do not remove the base plate screws. There are no user accessible controls inside.

Recalibration

The calibration certificate validity period is 12 months. Annual recalibration is essential.

Return the sensor to Delta-T. Contact your agent (or Delta-T direct) in advance for prices and despatch instructions before returning the unit.

Storage

Observe the storage temperature limitations (see Specifications).

Warranty and Service

Terms and Conditions of Sale

Our Conditions of Sale (ref: COND: 1/00) set out Delta-T's legal obligations on these matters. The following paragraphs summarise Delta-T's position but reference should always be made to the exact terms of our Conditions of Sale, which will prevail over the following explanation.

Delta-T warrants that the goods will be free from defects arising out of the materials used or poor workmanship for a period of **twelve months** from the date of delivery.

Delta-T shall be under no liability in respect of any defect arising from fair wear and tear, and the warranty does not cover damage through misuse or inexpert servicing, or other circumstances beyond our control.

If the buyer experiences problems with the goods they shall notify Delta-T (or Delta-T's local agent) as soon as they become aware of such problem.

Delta-T may rectify the problem by supplying faulty parts free of charge, or by repairing the goods free of charge at Delta-T's premises in the UK, during the warranty period,

If Delta-T requires that goods under warranty be returned to them from overseas for repair, Delta-T shall not be liable for the cost of carriage or for customs clearance in respect of such goods. However, we much prefer to have such returns discussed with us in advance, and we may, at our discretion, waive these charges.

Delta-T shall not be liable to supply products free of charge or repair any goods where the products or goods in question have been discontinued or have become obsolete, although Delta-T will endeavour to remedy the buyer's problem.

Delta-T shall not be liable to the buyer for any consequential loss, damage or compensation whatsoever (whether caused by the negligence of the Delta-T, our employees or agents or otherwise) which arise from the supply of the goods and/or services, or their use or resale by the buyer.

Delta-T shall not be liable to the buyer by reason of any delay or failure to perform our obligations in relation to the goods and/or services, if the delay or failure was due to any cause beyond the Delta-T's reasonable control.

Service and Spares

Users in countries that have a Delta-T Agent or Technical Representative should contact them in the first instance.

Spare parts for our own instruments can be supplied from our works. These can normally be despatched within a few working days of receiving an order.

Spare parts and accessories for sensors or other products not manufactured by Delta-T, may have to be obtained from our supplier, and a certain amount of additional delay is inevitable.

No goods or equipment should be returned to Delta-T without first obtaining the agreement of Delta-T or our agent.

On receipt at Delta-T, the goods will be inspected and the user informed of the likely cost and delay. We normally expect to complete repairs within a few working days of receiving the equipment. However, if the equipment has to be forwarded to our original supplier for specialist repairs or recalibration, additional delays of a few weeks may be expected.

Troubleshooting

Technical Support

Technical Support is available on Delta-T products and systems. Users in countries that have a Delta-T Agent or Technical Representative should contact them in the first instance.

Technical Support questions received by Delta-T will be handled by our Tech Support team. Your initial enquiry will be acknowledged immediately with a “T number” and an estimate of time for a detailed reply (normally a few working days). Make sure to quote our T number subsequently so that we can easily trace any earlier correspondence.

In your enquiry, always quote instrument serial numbers, software version numbers, and the approximate date and source of purchase where these are relevant.

Contact details:

Tech Support Team
Delta-T Devices Ltd
128 Low Road, Burwell, Cambridge CB5 0EJ, U.K.
email: tech.support@delta-t.co.uk
Web site: www.delta-t.co.uk
Tel: +44 (0) 1638 742922
Fax: +44 (0) 1638 743155

Problems

Always try to isolate the source of the difficulty. This may fall into one of the following areas

- Is there a source of UV light?
- Is there a signal from the sensor?
- Is there a problem with the logger or other measuring instrument?
- Is the UV light calibration correct?

Use the following procedure when fault finding a UV3p sensor connected to a Delta-T logger:

- Disconnect the sensor from the logger.
- Connect an independent source of power to the sensor.
- Using an electronic test meter check the voltage output when the sensor is exposed to UV light.
- If the output is correct, re-make the logger connections.
- Re-check the logger channel configuration. Ensure that the warm-up function is correctly configured.

Symptom	**Possible cause or remedy**
No output from UV sensor	Check UV light output with another UV sensor. Provide another source of UV light.
Zero output signal from UV sensor in presence of UV light.	Check the power supply to the sensor.
Wildly variable readings	Intermittent contact or broken wire between sensor and logger.
Small negative readings in zero UV light conditions	Amplifier offset drift with temperature (e.g. overnight). Ignore.
UV light calibration appears incorrect	See appendices for the proper interpretation of readings. Check validity of calibration certificate. Return to Delta-T for recalibration.

Appendices

UV Measurement Techniques

The following sections emphasise the pitfalls that may be encountered when using broadband sensors for environmental monitoring, and for situations where the characteristic quality of the UV light may vary.

Please contact Delta-T if you need further guidance.

Environmental Monitoring Note (UV-AN 1.1)

Ozone depletion in the stratosphere caused by CFCs and other chemicals has raised the monitoring of solar ultraviolet radiation (UVR) to a new level of importance in environmental research. This note discusses the appropriate use of UV Sensors type UV3p in this research.

Biological effects of UV

The UVR portion of the solar spectrum is normally subdivided into two standard wavelength regions UVB (280-320 nanometres) and UVA (320-400 nm). These regions were originally defined for medical purposes but have also become more widely accepted in all areas of photobiological research. A third waveband, UVC (<280 nm), is entirely filtered out by the atmosphere and does not reach the earth’s surface. UVB radiation is important because it is known to cause damage to many biological systems, whereby the high energy quanta at short wavelengths disrupt proteins, DNA, and RNA. This damage manifests itself in sunburn and skin cancer in humans and animals; mutations, loss of productivity, and other destructive effects in plants and micro-organisms. In each case the damage caused by UVB is dependent both on the wavelength and the individual organism and can be represented by what is called an action spectrum, showing the relative damage effect at each wavelength. The role of UVA at naturally occurring levels is mainly considered to be beneficial; in many cases repairing the UVB damage.

Approaches to UV measurement

The detailed study of the effects of UVR can only properly be conducted using very expensive, complex and heavy instruments called scanning spectroradiometers which measure the solar radiation at each individual wavelength. Relative measurements of UVB and UVA, however, can be made cost effectively by using what is known as “broad band” sensors; such as the UV3p series. These sensors are particularly suited to record changes in solar UVR over time (days/seasons): a function to which spectroradiometry is less well adapted. Due to their response characteristics these “broad band” sensors do not measure uniformly across each waveband, for this reason each sensor is supplied with its own spectral response curve. This response, normally referred to as the FWHM (full width at half maximum), should always be given when presenting data. Data obtained from these sensors cannot be directly converted to biological damage action spectra.

Measurements from different light sources

UV3p sensors are calibrated under xenon illumination against transfer standards. These standards are themselves calibrated at *peak wavelength* against the NPL standard. This in effect means the UV sensors are calibrated at their peak wavelengths.

Consequently, the UV sensors only measure absolute $W.m^{-2}$ correctly if the source being measured is monochromatic light at the peak wavelength. This is a shortcoming of any broad band filtered sensor since no filter will give an absolutely flat spectral response.

A spectroradiometer is the only instrument capable of measuring a spectral region absolutely since it has a perfect flat spectral response.

To compare the UV sensors to the spectroradiometer, the source being measured must first be scanned using the spectroradiometer to measure the defined UV spectral region. The UV sensor is then used to measure the same source at the same distance. The figure from the UV sensor can then be corrected to match the figure from the spectroradiometer. Using this same correction factor will allow any source with the same spectral output to be measured accurately with the UV sensor.

This procedure must be repeated for sources of different spectral output. To match the measurement from the spectroradiometer to the UV sensor, the spectrum measured must be weighted with the response of the UV sensor.

Glossary

Terms and Units

These terms apply to solar radiation measured with the Delta-T range of energy sensors (types ES2, UV3p, GS1, GS2, TSL) and the PAR Quantum Sensor type QS2.

Cosine Corrected

Refers to a sensor that is designed to have a cosine response.

Cosine Response

A sensor with a true cosine response gives an output that is proportional to the cosine of the angle of incidence of the ray of light. The angle of incidence is the angle between a perpendicular to the sensor surface and the ray of light.

Daily Integral

This is commonly used for crop studies. It is the integral with respect to time (typically one day) of the energy or quantum flux.

Energy Flux

The flux of energy is expressed in watts per metre squared ($W.m^{-2}$).

Daily Integral units for energy flux are typically: mega joules per metre squared ($MJ.m^{-2}$)

Irradiance

The flux of quanta or energy incident on unit surface area.

PAR

Photosynthetically Active Radiation is defined as radiation within the (visible) band 400-700 nm. It can be expressed in terms of the quantum flux or the energy flux.

Quantum Flux

The flux of quanta of PAR radiation is expressed in micromoles per metre squared per second ($\mu mol.m^{-2}.s^{-1}$). Daily Integral units for quantum flux are typically: $mol.m^{-2}$

The term photon is occasionally used instead of PAR quantum.

A mole of quanta is an amount of substance (6.022×10^{23} quanta: Avogadro's constant).