Smart Q TECHNOLOGY

Ultraviolet sensor

(Product No. 3277)

Slow response ranges:

1. 0 - 500 mW/m^2
   Resolution: <0.4 mW/m^2
2. 0 - 5 W/m^2
   Resolution: <0.004 W/m^2
3. 0 - 50 W/m^2
   Resolution: <0.04 W/m^2

Fast response ranges:

1. 0 - 500 mW/m^2
   Resolution: <0.4 mW/m^2
2. 0 - 5 W/m^2
   Resolution: <0.004 W/m^2
3. 0 - 50 W/m^2
   Resolution: <0.04 W/m^2

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DS 064 No 5

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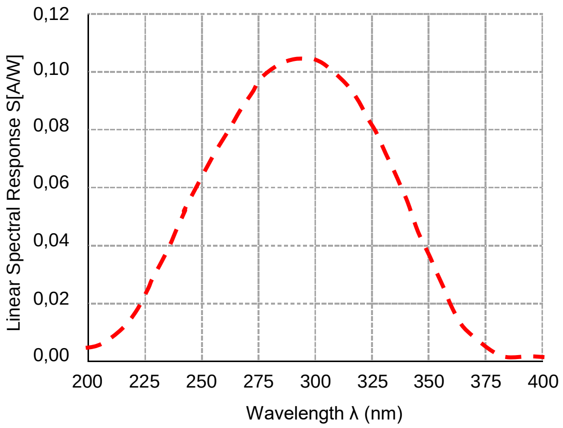
Introduction

The *Smart Q* Ultraviolet sensor will measure the intensity of electromagnetic radiation in the ultraviolet (UV) A and B bands. The Sensor uses a photodiode that is sensitive to UV in the range 215 nm to 365 nm (0.215 – 0.365 microns). It has maximum spectral sensitivity at 300 nm.

Spectral response of the photodiode:



The unit for ultraviolet irradiance is W/m². Measurements can be recorded at three levels using either a Slow or Fast response range.

- The slow response ranges are 0 - 500 mW/m², 0 - 5 W/m² and 0 - 50 W/m²
- The fast response ranges are 0 - 500 mW/m², 0 - 5 W/m² and 0 - 50 W/m²

The **slow** response is the most commonly used range and is suitable for use in most ultraviolet investigations. The response has been smoothed to remove rapid fluctuations of UV. If a slow range is selected it will be indicated by an S after the range on the sensor axis e.g. UV 5W/m²**S** (W/m²).

The **fast** range is used to show mains frequency ultraviolet fluctuations. These variations in UV intensity can be a source of interference for general work. If a fast range is selected it will be indicated by an F after the range on the sensor axis e.g. UV 5W/m²**F** (W/m²).

The *Smart Q* Ultraviolet sensor is equipped with a microcontroller that greatly improves its accuracy, precision and consistency. The microcontroller contains the calibration for the six ranges. The stored calibration for the selected range is automatically loaded when the Ultraviolet sensor is connected.

Connecting

- Push one end of the sensor cable (supplied with the EasySense logger) into the shaped socket on the Ultraviolet sensor. Connect the other end of the sensor cable to the input socket on the data logger.

- The logger will detect that the Ultraviolet sensor is connected and display values using the currently selected range. If the range is not suitable for your investigation, set to the correct range.

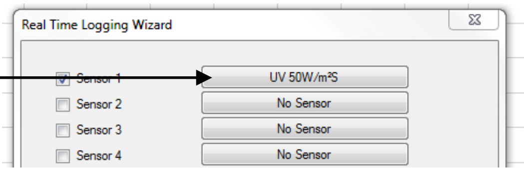
To set range

With some EasySense loggers it is possible to set the range from the logger. Please refer to the logger's user manual.

To alter the range in the EasySense software:

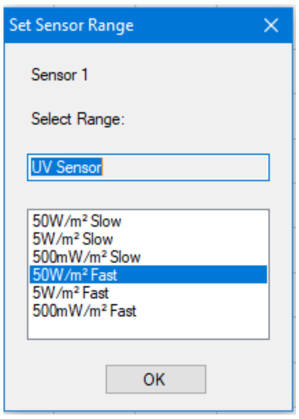
1. Select **EasyLog** from the Home screen.
2. Select the **New** recording wizard icon. 

3. Click on the sensor's name (it will be listed using its current range).
4. A set sensor range window will open. Select the required range, then OK.
5. Select Finish to exit the wizard.



Or

1. From the Home screen select **Sensor Config** from the Settings menu.
2. Select the Ultraviolet sensor from the list and click on the **Change Range** button.
3. The current range will be highlighted. Select the required range and click on OK.
4. Close Sensor Config.

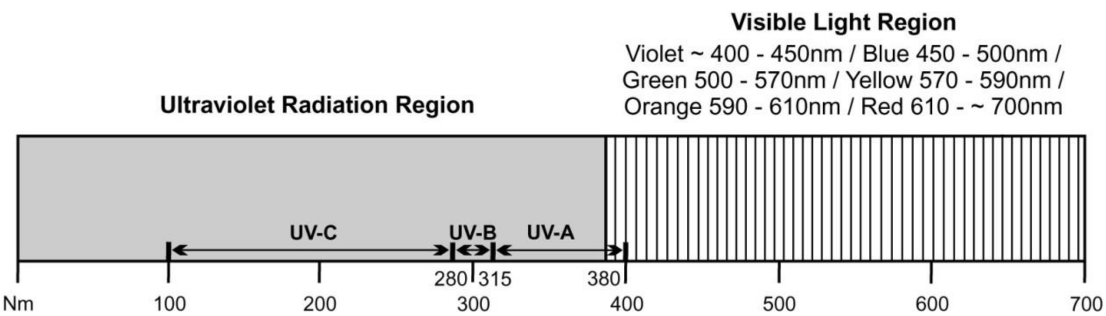


The range setting will be retained until changed by the user.

Background

Electromagnetic radiation is a transfer of energy through space via waves of oscillating electromagnetic fields. What distinguishes the parts of the electromagnetic spectrum is the frequency of the oscillation and consequently the wavelength.

The Ultraviolet (UV) radiation band in the electromagnetic spectrum extends from the very short wavelengths of 100 nm to 400 nm, which is just above violet light in the visible region of the spectrum (Latin word for beyond is ultra). True ultraviolet light is invisible.



The Ultraviolet spectrum is divided into four smaller bands according to the nature of the radiation. UV-A is closest in wavelength to visible light. Vacuum or UV-C are closer to the soft X-ray region of the electromagnetic spectrum.

	Wavelength	
Vacuum UV (far UV)	100 – 200 nm	The energy in this band can only be transmitted in vacuum
UV-C band	200 – 280 nm	UV-C radiation from the sun would be harmful but it is completely absorbed by the ozone in the Earth's upper atmosphere and does not reach the surface.
UV-B band Actinic radiation 'Burning rays'	280 – 315 nm	UV-B radiation from the sun is partly absorbed in the Earth's atmosphere, mainly by ozone. Also called actinic radiation, since the high photon energy of the radiation induces chemical processes including changes in biological systems (photo-biological systems), which can induce cancer. This band is the primary danger to humans.
UV-A band (near UV) 'Tanning rays'	315 – 400 nm	UV-A penetrates the Earth's atmosphere readily - 99% of the ultraviolet that reaches the Earth's surface is UV-A. In general this is the least harmful band of UV but with high exposure can cause reddening of the skin (sunburn). UV-A rays are longer and able to penetrate the skin more deeply. More responsible for premature ageing and wrinkling of the skin. Increasingly being linked to eye damage and the formation of skin cancer.

The cancer inducing properties of UV are proportional to its ability to damage cell DNA. The longer you are exposed to UV, the more likely that damage will take place.

Sunburn is not connected with the sensation of heat. When we are exposed to strong sunlight passing through glass in a window (that absorbs UV-B), despite the sensation of heat, our skin does not burn. When exposed to sunlight in cold weather at high altitudes, our skin can burn despite feeling cold.

The *Smart Q* Ultraviolet Sensor measures UV light intensity as irradiance in W/m^2. There are other ways that UV intensity and exposure are measured. E.g.

1. The Ultraviolet Index (UVI), which is a measure of the solar ultraviolet (UV) intensity at the Earth's surface relevant to the effect on human skin. The higher the UV index number, the greater the penetrating power of the UV radiation and the more likely the damage to skin.
2. The Effective UV Dose is directly related to the onset of sunburn and is an integral of the Effective UV Intensity over the exposure time. The dose unit is called MED or Minimal Erythemal Dose (minimum erythemal dosage units per hour).

Both the UVI and the MED/hour units take into account the erythemal response curve for reddening of skin. The response curve follows the varying sensitivity of the average person to different wavelengths. Skin sensitivity decreases rapidly over the UV-B range (approximately 100 times less sensitive every 20 nm) and decreases less rapidly over the UV-A range (approximately half as sensitive every 20 nm).

The Ultraviolet sensor does not have wavelength weighting corresponding to the erythemal action spectrum so the readings cannot be converted to the UVI or MED/hour units.

Practical information

- Ordinary glass can cut off some UV that has a wavelength less than 300 nm.
- An appropriate UV light source would be within the UV-A band because it's the least hazardous UV radiation to work with. A risk assessment should be made on the type of

UV light source used. Refer to local regulations or the school advisory service (e.g. SSERC, CLEAPSS) for guidance.

- Use a screen around a UV lamp so that pupils are not exposed to its direct rays.
- Even with UV-A care should be taken to reduce exposure to the source to as little time as possible.
- We made use of a small, hand-held battery powered ultraviolet light source, which emits mainly UV-A radiation. These are supplied commercially as security devices to identify markings made with a UV marker e.g. such as the 6V mini UV Fluorescent lantern with torch. The one we purchased was supplied without a risk assessment - check local regulations or the school advisory service (e.g. SSERC, CLEAPSS) for guidance.
- The output from an ultraviolet lamp is normally made visible by emitting some violet light – true ultraviolet is invisible.
- Fluorescent lamps produce UV light by the emission of low-pressure mercury gas. Fluorescence occurs when UV is absorbed by a phosphorescent coating on the inside of the tube and re-emitted as visible light.
- The sun is a source of UV. UV in sunlight can, in some cases, penetrate clouds, mist and fog. Fresh snow can reflect up to 85% of the sun’s rays.
- Halogen bulbs or lamps that are not UV protected by a plastic or glass shield are another source of UV.

Investigations

Using the **Slow** range:

- *Absorption of ultraviolet by different types of clothing (not related to colour)*
- *Whether the colour of clothing affects absorption of UV*
- *Investigate the UV protection provided by sunglasses*
- *Investigate absorption of UV radiation by suntan lotion*
- *Investigate how different material like plastic, glass (auto glass comparison), clothes, soft drinks, etc. absorb or reflect UV light*
- *Direct or diffuse solar radiation - a considerable amount of UV does not come directly from the sun but is scattered by the atmosphere*
- *Fluorescent rocks*
- *Fluorescent dyes from washing powders that absorb UV and then emit light*
- *Different light levels produce different UV levels*

Using the **Fast** range:

- *Variation of UV along a fluorescent tube compared to light output*

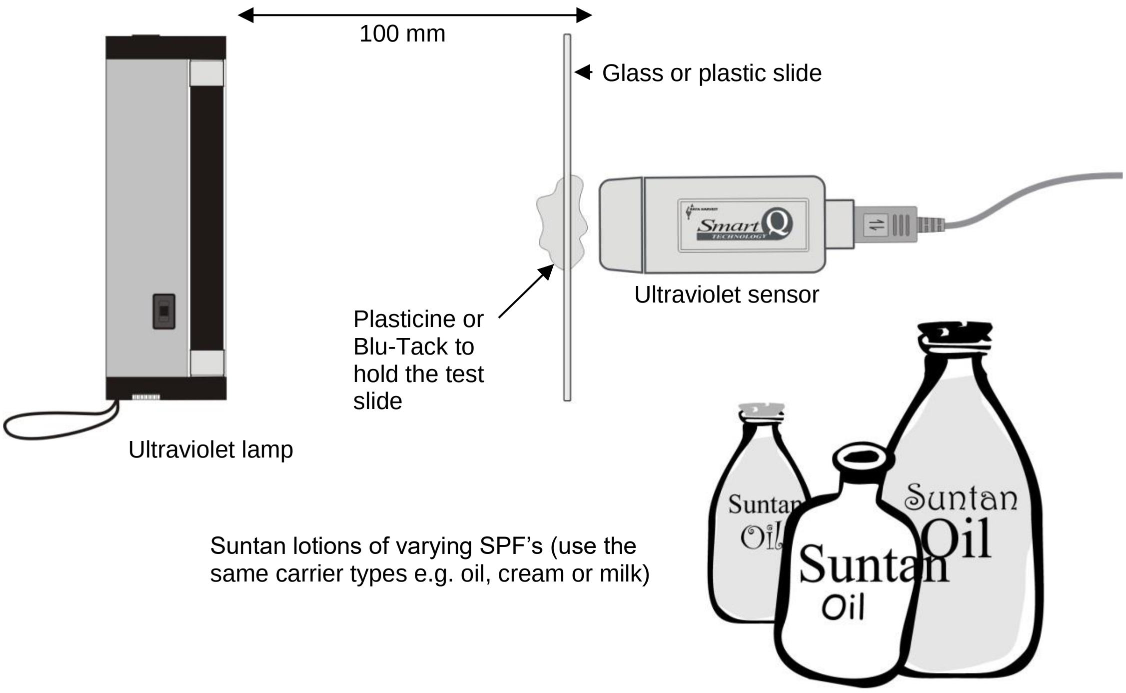
Investigate absorption of UV radiation by suntan lotion

The sun protection factor (SPF) was developed to rate the general effectiveness of sunscreens and lotions to block UV-B rays. (Historically UV-A was not seen as damaging and the ability to block this section of the UV spectrum was not included).

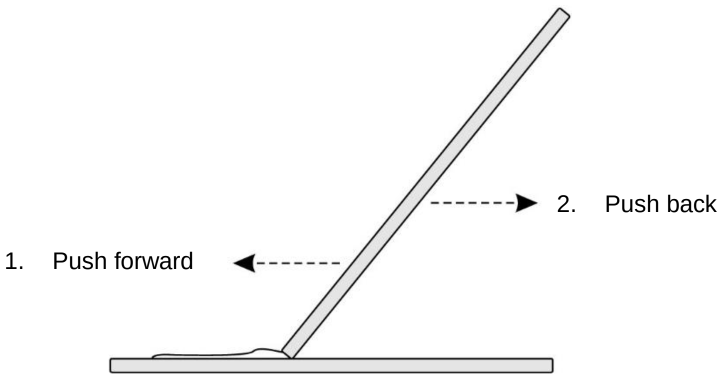
For this activity you would need a UV source. We used a small battery powered UV fluorescent lantern supplied as a security device for identifying markings made with a UV marker.

- Arrange the UV source so it shines at the Ultraviolet sensor at a distance of about 100 mm. Use a blob of plasticine to secure the Sensor in place.

- Turn on the UV lamp about 5 minutes before the investigation starts to allow the tube to warm up and stabilise.



- Make up a microscope slide for each SPF value of suntan lotion. Label the slide with the name and SPF value. Either smear a drop of the lotion over the surface of the slide or use second slide to drag the lotion across. You need to make sure the slide is coated evenly.



- Place another blob of plasticine about 20 mm in front of the Sensor to hold the test slide.
- Connect the Ultraviolet sensor to the data logger.
- Open the EasySense program and select **SnapShot** from the Home page. If the Y-Axis doesn't show a **slow** response range e.g. 5 W/m^2**S**, change to a slow range.
- Select **Test Mode** from the Tools menu and check that the reading from the Ultraviolet sensor is within range. If not change to a more suitable range (see page 2).
- Click on **Start** to begin recording.
- Position an untreated slide in front of the Sensor and click in the graph area to record the UV value for plain glass transmission.

- Swap the plain glass slide for a lotion-coated slide. Click on the graph area to record the UV value for this value SPF.
- Repeat until all slides have been tested and click on Stop.
- Use Add Text to identify each bar e.g. Plain glass, SPF value.

The investigation could be extended:

1. To test ‘home made’ lotions e.g. olive oil, bay oil, etc. to see if they have any effect.
2. The slides could be swished around in water to simulate swimming and retested.
3. The slides could be retested after several hours to see if the effectiveness of the lotion decays with time.
4. Does the lotion loose effectiveness if kept for a year?

Limited warranty

For information about the terms of the product warranty, see the Data Harvest website at: https://data-harvest.co.uk/warranty.

Note: Data Harvest products are designed for **educational** use and are not intended for use in industrial, medical or commercial applications.

WEEE (**W**aste **E**lectrical and **E**lectronic **E**quipment) Legislation

Data Harvest Group Ltd is fully compliant with WEEE legislation and is pleased to provide a disposal service for any of our products when their life expires. Simply return them to us clearly identified as ‘life expired’ and we will dispose of them for you.