UVA and UVB Sensors

(Order Codes UVA-BTA or UVA-DIN, UVB-BTA or UVB-DIN)

The UVA or UVB Sensor is an ultraviolet light sensor. Two different UV sensors are available—one responds primarily to UVA radiation (approx. 320 to 390 nm), and another responds primarily to UVB radiation (approx. 290 to 320 nm). Which sensor you use will depend upon the particular experiment you want to perform. For example, you can perform the following experiments:

- Compare ultraviolet transmission of various plastics and glasses.
- Compare ultraviolet intensity on cloudy and sunny days.
- Study the absorption of ultraviolet by sunscreen lotions and clothing.

What is included with the UVA and UVB Sensors?

The UVA and UVB Sensors each include a built-in light diffuser to make the readings somewhat less sensitive to the orientation of the sensor.

Using the UVA or UVB Sensor with a Computer

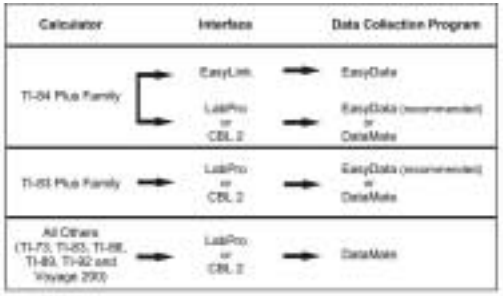
This sensor can be used with a computer and any of the following lab interfaces: Vernier LabPro®, Go!®Link, Universal Lab Interface, or Serial Box Interface.

1. Connect the UV Sensor, interface, and computer.
2. Start the Logger Pro® or Logger Lite® software.
3. The program will automatically identify the UV Sensor, and you are ready to collect data.[1]

Using the UVA or UVB Sensor with TI Graphing Calculators

This sensor can be used with a TI graphing calculator and any of the following lab interfaces: LabPro, CBL 2™, and Vernier EasyLink®. Here is the general procedure to follow when using the UV Sensor with a graphing calculator:

1. Connect the data-collection interface to the graphing calculator.
2. Connect the UV Sensor to any of the analog ports on the interface or to EasyLink.
3. Start the EasyData or DataMate App—the application you choose to use depends on your calculator and interface. See the chart for more information.



[1] If your system does not support auto-ID, open an experiment file in Logger *Pro*, and you are ready to collect data.

4. The UV Sensor will be identified automatically, and you are ready to collect data.

If the data-collection application is not on your calculator, use the following instructions to load it onto the calculator.

- **EasyData App**–This program may already be installed on your calculator. Check to see that it is EasyData version 2.0 or newer. If it is not installed or is an older version, it can be downloaded to your computer from the Vernier web site, www.vernier.com/easy/easydata.html. It can then be transferred from the computer to the calculator using TI-Connect and a TI unit-to-computer cable or TI-GRAPH LINK cable. See the Vernier web site, www.vernier.com/calc/software/index.html for more information on the App and Program Transfer Guidebook.
- **DataMate program**–This program can be transferred directly from LabPro or CBL 2 to the TI graphing calculator. Use the calculator-to-calculator link cable to connect the two devices. Put the calculator into Receive mode, and then press the Transfer button on the interface.

NOTE: This product is to be used for educational purposes only. It is not appropriate for industrial, medical, research, or commercial applications.

Using the UVA or UVB Sensor with Palm Powered™ Handhelds

These sensors can be used with a Palm Powered handheld and the LabPro.

1. Use the cable supplied in your Data Pro package to connect the interface to the Palm Powered device. Be sure to push both plugs in firmly.
2. Connect the UVA or UVB Sensor to an available analog port on the LabPro. In most cases, Channel 1 is used.
3. Start Data Pro.
4. Tap New. Tap New again. You are ready to collect data.

Specifications UVA

- UV peak sensitivity: one volt per 3940 mW/m^2 at 340 nm
- Wavelength sensitivity region, approximate: 320 to 375 nm, half-sensitivity points. See graphs for more detail.
- 12-bit resolution (LabPro): 5 mW/m^2
- 10-bit resolution (CBL 2): 20 mW/m^2
- Dimensions: 21 cm by 2 cm diameter
- Time response: approximately 2 seconds to reach 95% of final reading
- Calibration function
  slope (gain): 3940 mW/(m^2 V)
  intercept (offset): 0
  Irradiance = V_{out} * 3940 mW/(m^2 V)

Specifications UVB

- UV peak sensitivity: one Volt per 204 mW/m^2 at 315 nm
- Wavelength sensitivity region, approximate: 290 to 320 nm, half sensitivity points. See graphs for more detail.
- 12-bit resolution (LabPro): 0.3 mW/m^2
- 10-bit resolution (CBL 2): 1 mW/m^2
- Dimensions: 21 cm by 2 cm diameter
- Time response: approximately 2 seconds to reach 95% of final reading
- Calibration function

slope (gain): 204 mW/(m^2 V)
intercept (offset): 0
Irradiance = V_{out} * 204 mW/(m^2 V)

This sensor is equipped with circuitry that supports auto-ID. When used with LabPro, Go! Link, EasyLink, or CBL 2, the data-collection software identifies the sensor and uses pre-defined parameters to configure an experiment appropriate to the recognized sensor.

How the UVA or UVB Sensor Works

The Vernier UVA or UVB Sensor is built around a broadband UV sensitive silicon photodiode. The diode produces a current proportional to the UV intensity. A wavelength selective filter limits light striking the diode to only the UVA or UVB region. The signal from the diode is amplified and sent to the output.

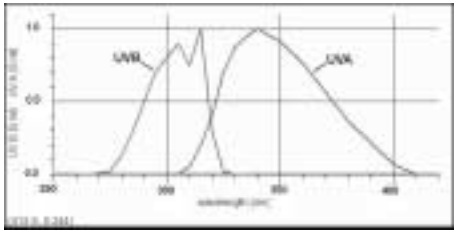
Do I Need to Calibrate the UVA or UVB Sensors? No

You do not have to perform a new calibration when using the UVA or UVB Sensors. You can use the appropriate calibration file that is stored in your data-collection program from Vernier.

1. If you are using Logger Pro software (version 2.2.1 or newer) on a computer with a LabPro interface, then a calibration (in mW/cm2) is automatically loaded when the UVA or UVB Sensors are detected. Older versions of Logger Pro require that you open an experiment file for the sensor.
2. The DataMate calculator program will automatically load calibrations for this sensor.
3. The Data Pro Palm Powered application will automatically load calibrations for this sensor.
4. Any version of DataPro has stored calibrations for this sensor.

It is quite difficult to calibrate a UV sensor to read in absolute units, since you must have a source of known UV intensity and spectral distribution. More often you will simply want to calibrate the sensor in terms of a relative intensity. In that case, you will point the sensor at a UV source (most often the sun) and define that intensity as 100%. To perform this kind of calibration, complete the following steps for a two-point calibration. One of the points is your zero, with no light striking the sensor. Cover the tip of the UVA or UVB Sensor with a clean opaque object. Select the calibration option of the program you are using. Enter 0 (zero) as the first known intensity. Now allow full UV intensity to strike the sensor. Since the orientation of the sensor affects the reading, it is best to hold the sensor in place with a ring stand or other clamp. To point the sensor directly at the sun, make the shadow of the sensor tube as small as possible. Enter 100 as the next known intensity. Subsequent measurements will be relative to this second intensity.

Note that you cannot calibrate a light sensor using a broadband light source (such as a lamp or the sun) against another light sensor of known calibration, unless the spectral response of the two sensors is exactly the same. Similarly, any intensity measurements of a broadband source using two sensors with different spectral response cannot be directly



compared. For example, a reading from another manufacturer's combination UVA and B sensor would not correspond to the readings from either the Vernier UVA or UVB sensors. In all these cases a direct comparison is not appropriate, since the reading from any light sensor is a convolution of the spectral distribution of the incident light and the spectral response of the sensor.

UV Terminology

The Vernier UVA and UVB Sensors respond to specific regions of the electromagnetic spectrum. The wavelength region from 320 to 400 nm is commonly called UVA radiation, and 280 to 320 nm is called UVB radiation. Wavelengths shorter than 280 nm fall into the UVC spectrum. Neither Vernier sensor is sensitive to UVC radiation.

Plants and animals respond differently to the three types of UV radiation. Although very harmful to plants and animals, UVC radiation is nearly completely absorbed by the ozone in the Earth's atmosphere. Some UVB radiation makes it through the atmosphere, although the degree of absorption depends critically on the angle of the sun and the amount of ozone along the light path. UVB radiation is thought to be responsible for reddening of the skin (erythema), cataracts, and skin cancers. UVA can also cause these effects on human skin, but to a lesser extent. It is generally agreed that UVB radiation is the primary danger to humans, but increasingly UVA is being shown to cause delayed, but significant, damage to skin and eyes.

The standard erythemal (or sunburning) action spectrum (McKinlay and Diffey, 1987) represents a combined estimate of the relative sensitivity of skin as a function of wavelength. Since knowledge of how UV light affects skin improves with time, the erythemal spectrum may not represent the latest thinking of UV danger.

There are several ways of measuring UV light intensity and exposure. The usual irradiance unit for measurement is mW/cm^2, but a simplified UV Index system is also in use. The UV Index is actually a forecast, not a measurement. For comparison with the forecast, some UV sensors can be calibrated in terms of UV Index. Since the UV Index includes a wavelength weighting corresponding to the erythemal action spectrum, only sensors matching the erythemal spectrum can logically be calibrated in terms of UV Index. An erythemally-weighted irradiance measurement of 0.25 mW/cm^2 corresponds to a UV Index of 10.

Since the Vernier UV sensors allow the separate measurement of UVA and UVB irradiance (instead of an erythemally weighted average) the individual readings of the Vernier sensors cannot strictly be converted to UV Index units. The erythemal action spectrum is predominately UVB, however, so an *estimate* of the UV index can be calculated by multiplying the UVB sensor reading by a factor of 40 index-cm^2/mW—but this is only an estimate. The UVA sensor reading cannot be used to estimate UV index.

Suggested Experiments

1. Measure the UV intensity as a function of time throughout the day. Do you need to worry about sunscreen at 8:00 in the morning?
2. Measure the UV transmittance of various sunglasses and regular glasses. Do your sunglasses protect your eyes from both UVA and UVB? Can you get a sunburn through a car window?
3. Measure the UV transmittance of fabrics, both wet and dry. Does a wet tee-shirt provide much solar protection?

References

1. McKinlay, A. F., and B. L. Diffey, 1987: A reference spectrum for ultraviolet-induced erythema in human skin. *Human Exposure to Ultraviolet Radiation: Risks and Regulations.* W. F. Passchier and B. F. Bosnajakovic, eds., Elsevier, 83-87.

Warranty

Vernier warrants this product to be free from defects in materials and workmanship for a period of five years from the date of shipment to the customer. This warranty does not cover damage to the product caused by abuse or improper use.

Measure. Analyze. Learn.™

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