UVA and UVB Sensors

(Order Codes UVA-BTA or UVB-BTA)

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.

Collecting Data with the UVB Sensors

This sensor can be used with the following interfaces to collect data:

- Vernier LabQuest® as a standalone device or with a computer
- Vernier LabQuest® Mini with a computer
- Vernier LabPro® with a computer, TI graphing calculator, or Palm® handheld
- Vernier Go!®Link
- Vernier EasyLink®
- Vernier SensorDAQ®
- CBL 2™

Here is the general procedure to follow when using the UV Sensors:

1. Connect the UV Sensor to the interface.
2. Start the data-collection software[1].
3. The software will identify the UV Sensor and load a default data-collection setup. You are now ready to collect data.

Data-Collection Software

This sensor can be used with an interface and the following data-collection software.

- **Logger *Pro* 3** This computer program is used with LabQuest, LabQuest Mini, LabPro, or Go!Link
- **Logger *Pro* 2** This computer program is used with ULI or Serial Box Interface
- **Logger Lite** This computer program is used with LabQuest, LabQuest Mini, LabPro, or Go!Link
- **LabQuest App** This program is used when LabQuest is used as a standalone device.
- **EasyData App** This calculator application for the TI-83 Plus and TI-84 Plus can be used with CBL 2, LabPro, and Vernier EasyLink. We recommend version 2.0 or newer, which can be downloaded from the Vernier web site, www.vernier.com/easy/easydata.html, and then transferred to the calculator. See the Vernier web site, www.vernier.com/calc/software/index.html for more information on the App and Program Transfer Guidebook.
- **DataMate program** Use DataMate with LabPro or CBL 2 and TI-73, TI-83, TI-84, TI-86, TI-89, and Voyage 200 calculators. See the LabPro and CBL 2 Guidebooks for instructions on transferring DataMate to the calculator.
- **Data Pro** This program is used with LabPro and a Palm handheld.
- **LabVIEW** National Instruments LabVIEW™ software is a graphical programming language sold by National Instruments. It is used with SensorDAQ and can be used with a number of other Vernier interfaces. See www.vernier.com/labview for more information.

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

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.
13-bit resolution (SensorDAQ)		2.5 mW/m^2
12-bit resolution (LabPro, LabQuest, LabQuest Mini, Go!Link, EasyLink):		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
Stored Calibration	slope (gain)	3940 mW/(m^2 V)
	intercept (offset)	0
Irradiance		V_{out} * 3940 mW/(m^2 V)

[1] If you are using Logger *Pro* 2 with either a ULI or SBI, the sensor will not auto-ID. Open an experiment file for the UVB Sensorsin the Probes & Sensors folder.

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.
13-bit resolution (SensorDAQ):		0.13 mW/m^2
12-bit resolution (LabPro, LabQuest, LabQuest Mini, Go!Link, EasyLink):		0.25 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
Stored Calibration	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 LabQuest, LabQuest Mini, LabPro, Go! Link, SensorDAQ, 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.

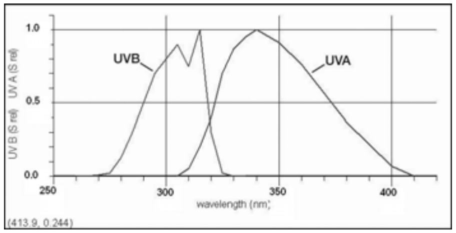
Do I Need to Calibrate the UVA or UVB Sensors? No

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, LabQuest, or LabQuest Mini interface, then a calibration (in mW/cm^2) 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.
3. The LabQuest App, DataMate, EasyData, or DataPro 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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Rev 4.09.10

Printed on recycled paper.