

# ULTRAVIOLET PYRANOMETER MODEL UVB-1 / UVA-1

BULLETIN UVB-3S



**UVB-1 Broadband Pyranometer**

Typical UV Pyranometer applications include:

- Erythelial dose rate studies
- Effects of UV-B and UV-A on plants
- Climatological data gathering
- Ozone layer thickness monitoring

## Principle of Operation

The UVB-1 Pyranometer utilizes a fluorescent phosphor to convert UV-B light to visible light, which is in turn accurately measured by a solid-state photodiode. Solar radiation, both direct and scattered, is transmitted through the UV transmitting weather dome. Visible light, except for a small fraction of the red light, is absorbed by the first filter, a UV transmitting black glass. Light transmitted through this filter strikes the UV-B sensitive phosphor. This material absorbs UV-B light and re-emits it as visible light, predominantly in the green wavelengths. A second, green glass filter, passes the fluorescent light from the phosphor while blocking any of the red light passed by the black glass. The intensity of the fluorescent light is measured by a solid state (GaAsP) photodiode.



$$p = \frac{\rho RT}{m}$$

$$S(\lambda) = S_0(\lambda) e^{-\tau \delta(\lambda)}$$

$$B(T) = bT^4$$

## General Description

Model UVB-1 and UVA-1 Pyranometers are precision meteorological instruments for the measurement of biologically effective solar ultraviolet-B (UV-B) and UV-A radiation, respectively. The measurement technique employed in both instruments utilizes colored glass filters and a highly stable UV-sensitive fluorescent phosphor to stop all of the sun's visible light and convert UV photons into visible light, which, in turn, is measured by a solid-state photodetector. UVB-1 and UVA-1 pyranometers are rugged instruments, designed to ensure stability of operation during long term, unattended operation in remote field stations.

Both instruments measure global solar irradiance, the radiation received by a horizontal surface from the entire hemisphere of the sky. Global radiation includes both light transmitted directly through the atmosphere and light scattered by atmospheric gases and particulate matter in the atmosphere. Unlike the case of visible light, scattered UV-B light is a major and, under some conditions, a dominant component of the global radiation. The design of the UVB-1 Pyranometer ensures the proper measurement of both components.

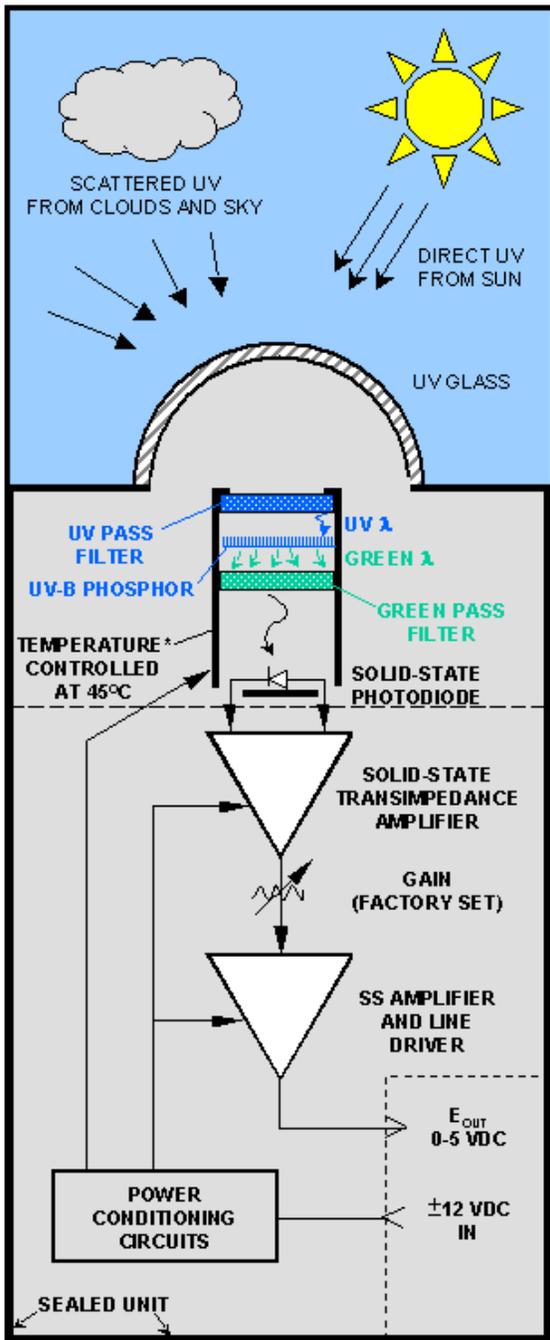
The Model UVA-1 is nearly identical to a UVB-1 but utilizes a phosphor that is sensitive out to 400 nm. Although the UVA-1 measures both UV-B (280-320 nm) and UV-A (320-400 nm), because the solar spectrum's UV-A irradiance component is approximately 100 times greater than the UV-B portion, the output is essentially UV-A.

## Applications

Light in the UV-B portion of the solar spectrum, 280 to 320 nm, is very strongly absorbed by ozone in the stratosphere and any changes in the total amount of ozone will be reflected in the levels of UV-B light reaching the ground. Measurements of solar UV-B irradiance, using the UVB-1 Pyranometer, can be used to monitor the ozone level as well as to verify independent ozone level measurements. The spectral response of the UVB-1 Pyranometer is very similar to the erythelial (sunburn) and DNA damage action spectra, making it also ideal for climatological and biological impact studies.

$$e_w(T_d) = \frac{p}{0.62197 + r}$$

$$\frac{dw}{dt} = \frac{1}{\alpha} \frac{\partial p}{\partial w} - 2.5 \Omega_w \sin \phi + F_x$$



**UV Pyranometer Schematic View**

A thermally stable transimpedance amplifier converts the diode's output current to a voltage. It drives a line amplifier that provides a low impedance 0 to +4 Vdc output signal. The glass filters, phosphor and photodiode are held at +45°C by means of an internal proportionally controlled oven to ensure that the output signal is not sensitive to changes in ambient temperature. An internal YSI type #44011 thermistor (100KΩ at +25°C) permits independent monitoring of the sensor's temperature.

## Specifications

Spectral Response (UVB-1):	280 to 320 nm
Spectral Response (UVA-1):	280 to 400 nm
Cosine Response:	Better than ±5% for 0°-60° SZA
Sensitivity (UVB-1):	2.0 (watt • m <sup>-2</sup> )/V, typical
Sensitivity (UVA-1):	28 (watt • m <sup>-2</sup> )/V, typical
Sensor Active Area:	Approx 1 in. (2.54 cm) dia.
Weight	3 lbs
Power Requirement:	-12 Vdc, @5 mA; +12 Vdc (load varies with ambient temperature: 120mA @+20°C to 500 mA @-40°C and during 2 minute initial warm-up). Input range is -11 to -14 Vdc and +11 to +14 Vdc
Analog Output:	0 to +4 Vdc (irradiance)
Temperature Monitor Output:	Resistance ≈100KΩ
Response Time:	Approx. 100 ms
Temperature Range:	Regulated for ±40°C

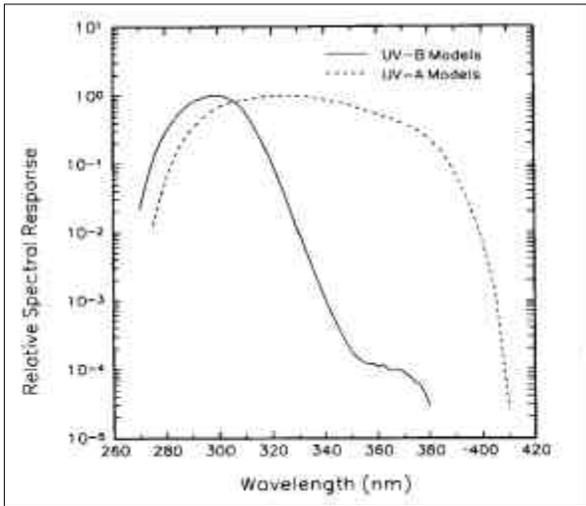
## Also Available

The Model SPUV-6/10 UV Sun Photometer is a discrete line filter-spectrometer for making direct-normal UV and visible measurements of the solar spectrum. Shown below on an Eppley tracker, it measures either six or ten narrow band irradiance channels. Designed to exceed WMO sun-photometer requirements, it is used to measure parameters such as turbidity and column ozone, water vapor, and NO<sub>2</sub> amounts.



**Model SPUV-6/10 UV Sun Photometer**



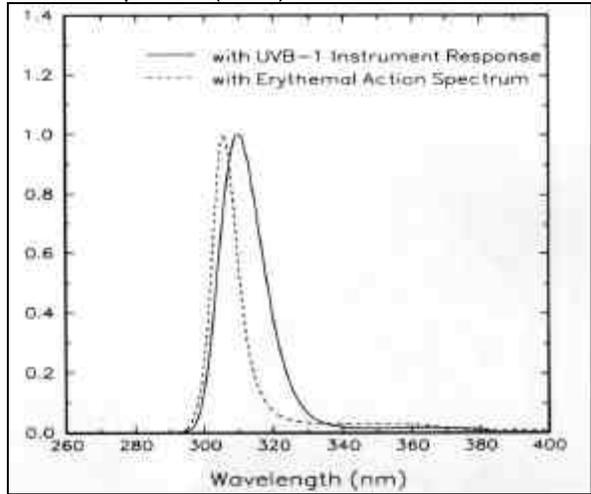


**Model UVB-1 and UVA-1 relative responses**

**Spectral Response**

The spectral response is determined primarily by the absorption spectrum of the inorganic phosphor, which depends on the thickness and uniformity of the phosphor layer. YES has a highly refined and reproducible method of depositing and binding the phosphor, resulting in exceptionally uniform and consistent layers. Typical measured spectral responses of UVB-1 and UVA-1 Ultraviolet pyranometers are shown above. Each unit is supplied with its specific relative spectral response and absolute calibration. The Model UVB-1 has a relative spectral response similar to the erythemal action

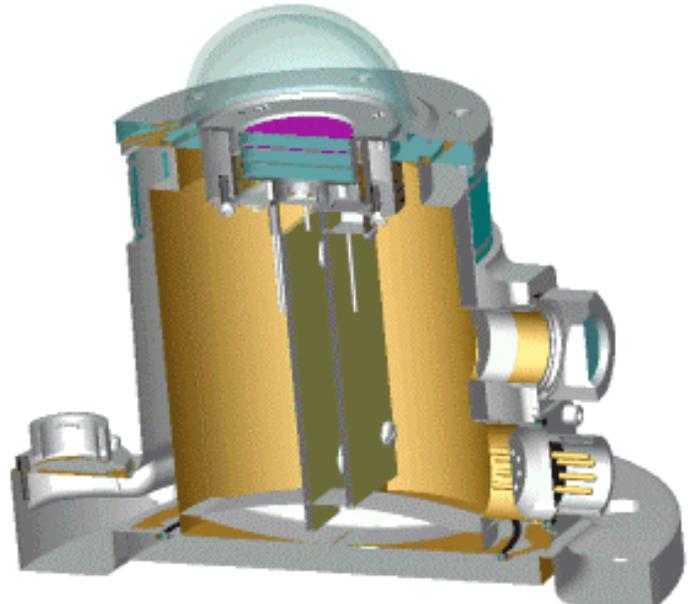
spectrum and is well suited to measuring erythemally effective solar irradiance. The convolution of a typical 30° SZA spectrum vs. the erythemal action spectrum of the UVB-1 instrument are shown here. The overlap between the erythemally effective solar irradiance and the effective spectrum measured by the UVB-1 does not vary appreciably with zenith angle up to about 60° and, therefore, the output signal of the UVB-1 can be used to accurately determine the erythemally effective radiant exposure (dose).



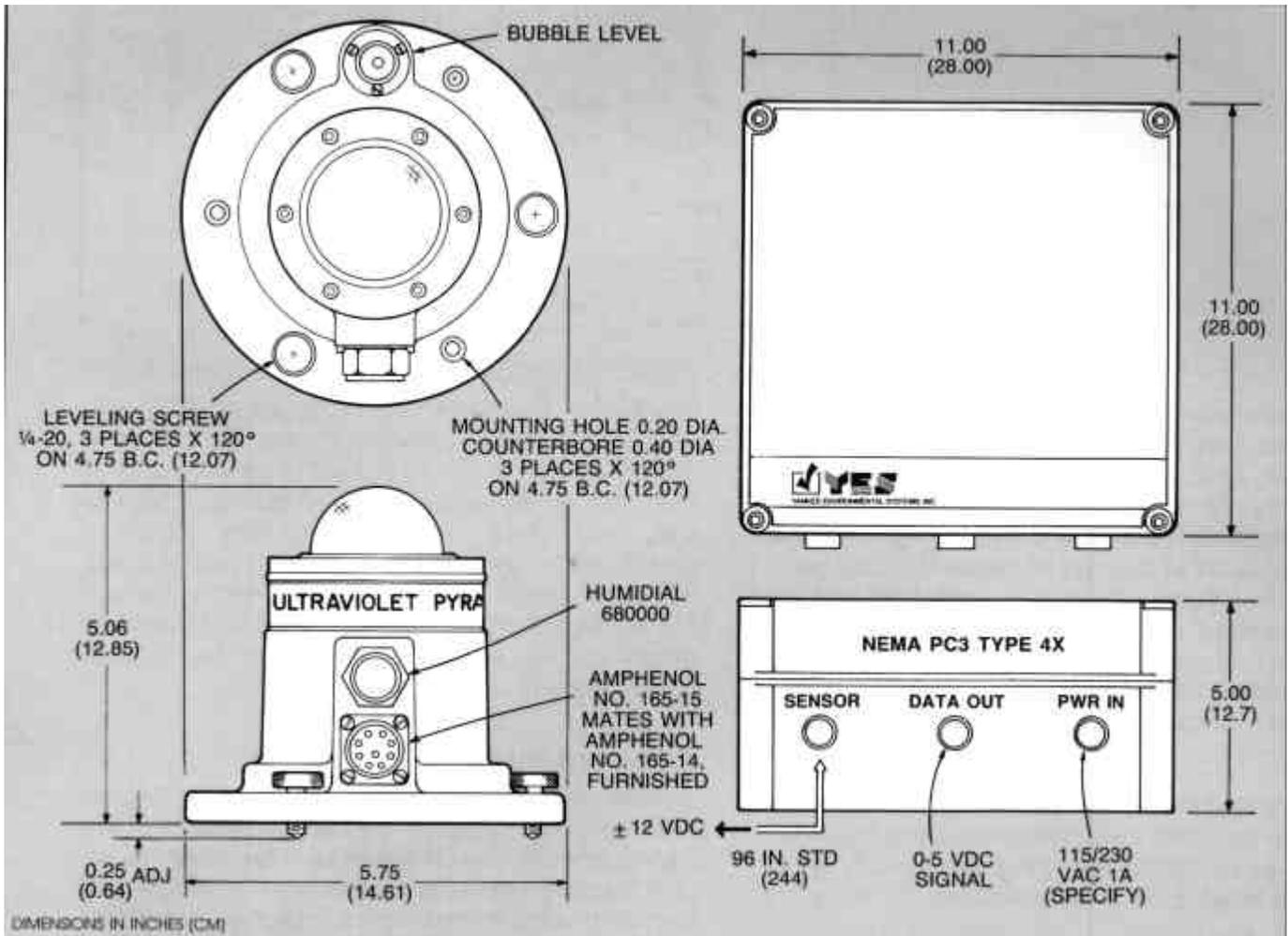
**Product of UVB-1 spectral response with typical outdoor solar spectrum**



**Solid Model of UV Pyranometer**



**Solid Model Cross Section showing internals**



## MECHANICAL INTERFACE

### Mechanical Configuration

The sensor is housed in a rugged, O-ring sealed, cast aluminum enclosure, designed for permanent outdoor installation. The unit is purged with dry air before sealing and is provided with a desiccant pack and a visible humidity indicator plug. The unit is fitted with an optical quality UV-transmitting Schott glass weather dome. The dome is a full 2 mm thick to minimize breakage under high G conditions. Finished in tough, baked-on white polyester, the sensor is provided with three stainless steel leveling screws and a circular bubble level. The sensor is mounted on three #10 screws, spaced 120 degrees apart on a 4.75" diameter bolt circle. These dimensions are compatible with many existing radiometer mounts.

### Electrical Requirements

Electrical connections to the sensor are made via a nine pin environmentally sealed receptacle (Amphenol 165-15) furnished with a pre-wired mating plug (Amphenol 165-14). Approximately 3 meters of nine

conductor (Belden No. 9539) cable is furnished with labeled pigtailed ends, stripped and tinned.

### Complete Package

Each UV Pyranometer is furnished with spectral response data. A thermistor resistance-vs-temperature tabulation for the internal monitor thermistor is provided. Data are NIST-referenced where applicable. Each system includes a pre-wired mating connector with 3m cable. A rugged, rotationally-molded shipping container, maintenance kit, comprehensive user's manual and *UV-CALC* software round out the package.

### UVPS-1 Power Supply Option

The optional Model UVPS-1 is an environmentally-packaged  $\pm 12$  Vdc regulated power supply operating from AC mains. Housed in a rugged NEMA-4X enclosure for permanent outdoor installation, it greatly simplifies setup. A 10m cable interfaces with your data acquisition system. (Please specify 110 or 220 Vac line voltage when ordering.)