

Sensors • Biologically Weighted UV-B Detector with LLG Adaptor

PMA2103



Measures Biologically Effective Ultraviolet Radiation from Solar Simulator Model 16S and 601 Equipped with Liquid Light Guides

Applications

- Skin and SPF Testing
- Clinical Studies
- In-Vitro Testing
- Phototherapy
- Photobiology
- Material Testing
- Chemistry Laboratories

Features and Benefits

- Dynamic Range 2×10^3
- Excellent Long-Term Stability
- NIST Traceable Calibration
- Radiometric and Biological Units
- Dose Controller Functionality

The PMA2103 detector gives an accurate measurement of biologically weighted ultraviolet radiation from Solar Simulators manufactured by Solar Light Co. Special mounting hardware allows direct coupling with 9mm Liquid Light Guides (LLG's).

The detector's spectral response follows closely the erythema action spectrum (Fig.1.)¹ Due to built-in Teflon diffuser the detector has negligible azimuthal error making the measurement insensitive to the rotation of the detector. Extended measurement range of 600 MED/Hr enables measurement of most intense radiation.

In conjunction with the Solar Simulator and Xenon Lamp Power Supply the PMA2100 with the PMA2103 detector can operate as a smart dose controller/monitor substantially enhancing the functionality of the Solar Simulator.

The measurement result can be shown in MED/Hr, $\mu\text{W}/\text{cm}^2$ as well as a time to accumulate 1 MED. High dynamic range of the detector allows measurements down to $0.1 \mu\text{W}/\text{cm}^2$ with the ability to measure radiation as strong as $3.5 \text{ mW}/\text{cm}^2$.

The biologic effectiveness of ultraviolet radiation is strongest for wavelengths between 280 to 315nm, classified as UV-B by the CIE. Several biologic action spectra, functions relating wavelength and the biologic effectiveness, are shown in Figure 3. The most commonly used, erythema action spectrum¹, also referred to as CIE 1987 action spectrum, represents the sensitivity of human skin to sunburn.

Other biologic action spectra also exhibit rapid decline in UV effect with an increase of wavelength over the UV-B range. In general the reading of an erythemally weighted detector cannot be directly interpreted as biological effectiveness other than erythema. However, there are ways to make the necessary correction numerically².

The biologic effectiveness of the UV radiation can be measured in terms of effective irradiance in radiometric units, for example $[\mu\text{W}/\text{cm}^2]$. It is often

related to the sensitivity of the human skin to sunburn and expressed in Minimal Erythelial Doses per Hour [MED/Hr]. One MED/Hr is the effective irradiance capable of causing minimum redness (erythema) in an average number 2 skin. Based on a study³, the relationship between MED/Hr and radiometric units was assumed: 1 [MED/Hr] = 5.83 [$\mu\text{W}/\text{cm}^2$].

This formula is programmed into the PMA2103 detector allowing for easy conversion of units. Consequently, the integrated effective dose can be expressed in [mJoules/cm²] or MED.

Calibration

The PMA2103 detector is calibrated by transfer, using Solar Simulator Model 16S as a source, from a reference detector. The reference detector, identical to the PMA2103, is periodically calibrated spectroradiometrically to show accurate values of the erythemal irradiance when exposed to radiation typical to that of Solar UV Simulator (Fig.2.). The basic calibration uncertainty is approximately 10% for UV-B detectors. Due to a small difference between an ideal erythemal action spectrum and the detector's response there measurement can be loaded with an additional error for sources of various spectral composition. Particular care should be exercised when measuring spectral line sources. Full description of the calibration procedure is available upon request. Yearly re-calibration is required.

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Specifications	
Spectral Response	Follows Erythema Action Spectrum Figure 1
Angular Response	5% for Angles <60°, Figure 2
Range	200 [MED/Hr], 1,160 [$\mu\text{W}/\text{cm}^2$]
Display Resolution	0.001 [MED/Hr], 0.01 [$\mu\text{W}/\text{cm}^2$]
Operating Environment	32 to 120 °F (0 to +50 °C) No Precipitation
Temperature Coefficient	1% /°C for Solar Radiation,
Cable	6 ft. Straight Cable (1.82m)
Diameter	1.6" (40.6mm)
Height	1.8" (45.8mm)
Weight	7.1 oz. (200 grams)
Irradiance from Typical Sources	Solar Radiation, 30°. SZA, 3mm Ozone, Clear Sky: 0.25 W/m ² (4.3 MED/Hr)
150W Xenon Lamp at 8"	Approx. 0.5 mW/cm ² (1 MED/Hr)
Solar Simulator Model 16S	1400 $\mu\text{W}/\text{m}^2$ (250 MED/Hr)
Ordering Information	
PMA2103	Biologically Weighted UV-B Detector with LLG Adaptor
PMA2103	Compatible with Multiport Solar Simulator Model 601 and 16S only if LLG option is used. Please Check PMA2105 Detector for use with Model 16S and Beam-Splitter

References

- McKinlay A.F. and B.L. Diffey, "A reference action spectrum for ultraviolet induced erythema in human skin", CIE Journal, 6, 17-22, 1987
- Morys M., D. Berger, "Accurate measurements of biologically effective ultraviolet radiation" SPIE Proc. 2049, pp. 152-161, 1993
- Parrish J.A., K.F. Jaenicke, R.R. Anderson "Erythema and melanogenesis action spectra of normal human skin" Photochem. Photobiol. 36, pp.187-191 (1982)

Maintenance

The product in test can come in contact with the optical input area of the detector and cause a reduced reading of the sensor. Clean the optical input area daily using a cotton-tipped swab with a small amount of Methanol to gently clean the inside of the LLG or homogenizer adaptor. Take care not to completely soak the swab with the alcohol. A soaked swab may cause alcohol to seep inside the detector affecting performance and may cause damage. After swabbing, dry the adaptor with compressed air.

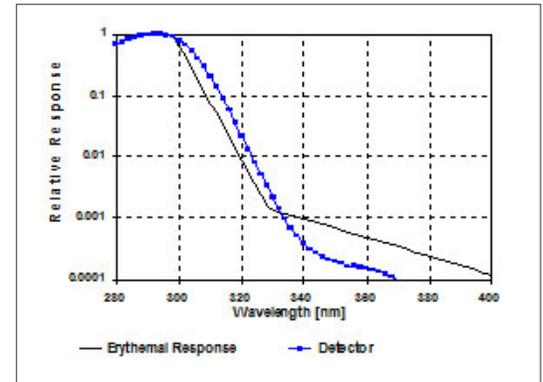


Fig. 1. PMA2103 Spectral Response

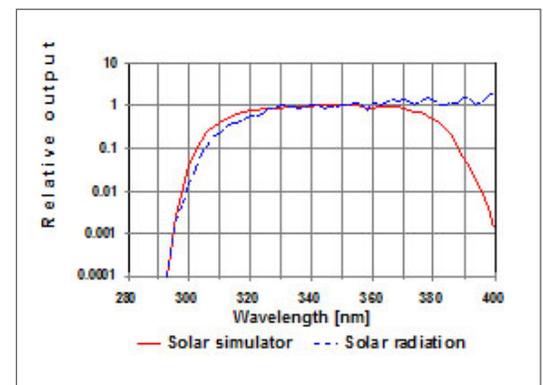


Fig. 2. PMA2103 Angular Response

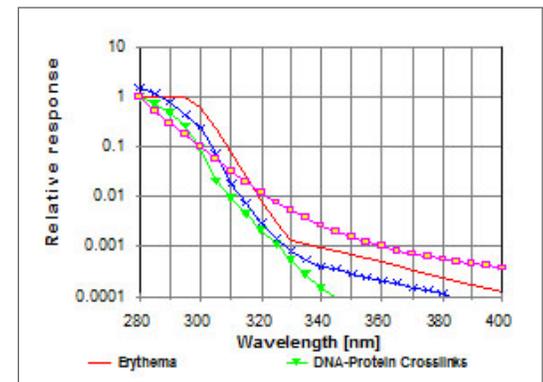


Fig. 3. PMA2103 Selected Biologic Action Spectra