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# PHOTOTHERAPY RADIOMETER

MODEL **PR450**

## USER HANDBOOK



Handbook Ref No. MH096/Issue G  
File Ref: PR450\_G.doc

 **IRRADIAN**  
Light Measurement Systems & Calibration



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# PHOTOTHERAPY RADIOMETER

MODEL PR450

## USER HANDBOOK

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# 1 INTRODUCTION

The Irradian portable phototherapy radiometer model PR450 is designed specifically to measure directly the irradiance of blue light for the treatment of hyperbilirubinaemia in new born babies.

The photodiode and colour glass filters are designed to give a spectral response closely matching the bilirubin phototherapy action spectrum. Good blocking of the detectors response outside the bandpass ensures the radiometer does not measure non-therapeutic light. The cosine corrected diffuser input ensures accurate measurements where ever the light source.

Note: The PR450 is NOT an ultra violet radiometer and should NOT be use to measure the output of ultra violet lamps in UV phototherapy treatment.

## 2 SPECIFICATION

### RADIOMETER

Range: 0 - 199.99  $\mu\text{W}/\text{cm}^2/\text{nm}$

Monochromatic Cal. The radiometer with detector / filter is calibrated with a 450nm monochromatic source.

Spectroradiometric Cal. The radiometer with detector / filter is calibrated to match the measurement of a spectroradiometer for a particular source, e.g. phototherapy halogen lamp or phototherapy fluorescent lamp.

Accuracy Absolute calibration accuracy  $\pm 7.5\%$  traceable to NPL standards.

### DISPLAY UNIT

Controller: PR450X  
80C51 based 8bit micro-processor with a 3.6864MHz clock.

Memory On board non volatile RAM for calibration factors and set-up parameters.

Integration Time 0.33s.

Conversion Scale 17 bit.

Conversion Accuracy: Measurement accuracy  $\pm 1$  digit with a linearity error of  $< 1\%$ .

Display:  $4\frac{1}{2}$  digit lcd display. Character height 10mm.

Power Supply: 9 volt 1200mAh, PP3 battery.

Power Consumption: Shut down mode  $< 5\mu\text{A}$ .  
Operating 10 - 20mA.

Battery Life  $\sim 50$  hours.

## 2 SPECIFICATION (continued):

Temperature Range: 0 to 40°C. 80% RH.

Dimensions: 150 x 80 x 45mm.  
High impact polystyrene.

Weight: Approximately 270g.

### Front Panel Controls:

**ZERO** Initiates a zero or background measurement Routine.

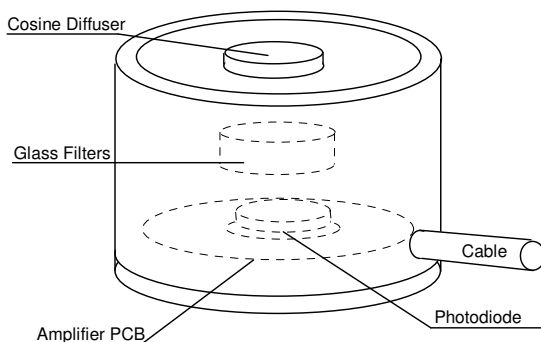
**HOLD/RUN** Display is held at present reading until HOLD button is pressed again.

ⓘ Power on / off button.

Connector: 8 pin mini DIN type detector connector.  
*6 pin mini DIN type RS232 connector for factory use only.*

## 2 SPECIFICATION (continued):

### DET201450 DETECTOR



The DET201450 detector comprises of an aluminium housing, photodiode, R450 filter and PCB assembly.

Detector:	5.2 mm <sup>2</sup> High stability GaAsP photodiode.
Spectral Response:	Refer Figure 1.
Angular Response:	Accurately cosine corrected to Lambert's Cosine Law. Maximum error is less than $\pm 5\%$ from true response to $70^\circ$ from normal incidence, reference Section 5.
Temperature Coefficient:	$<0.3\ \%/^{\circ}\text{C}$ .
Amplifier Gain	$5 \times 10^5\ \text{V/A}$ .
Current to Frequency	0 - 0.5Mhz.
Linearity Error:	$<1\%$ across range.
Temperature Range:	Operation: $-10$ to $+60^{\circ}\text{C}$ . Storage: $-20$ to $+70^{\circ}\text{C}$ .
Detector Housing:	Black anodised aluminium alloy housing.
Cable:	1 metre cable to 8 pin mini DIN type connector.
Weight:	Approximately 140g.



## 2 SPECIFICATION (continued):

DET201450 Detector  
Typical Spectral response

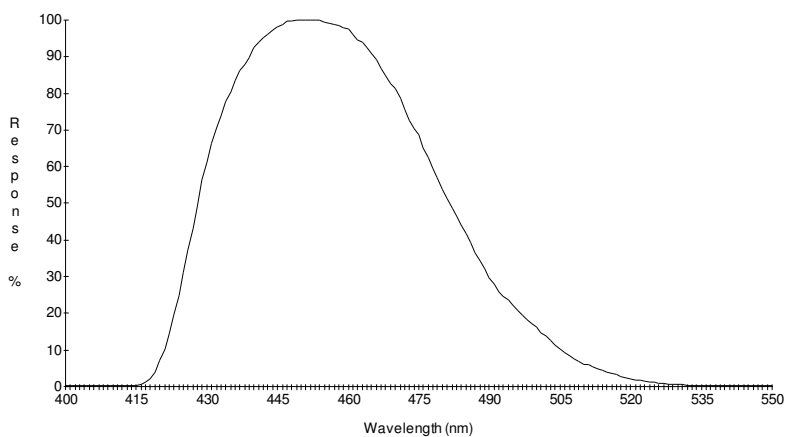


Figure 1

### 3 OPERATION

#### SETTING UP

- 1) With the unit OFF, plug the detector 4 way connector into the socket on the top of the display unit.
- 2) Press and release the power switch on the PR450 display key pad. The microcontroller will initiate, the display momentarily showing:-



The radiometer display will now change to show the units value. A typical display is shown below.



- 3) It is recommended that the radiometer amplifier is nulled periodically. Place the cover over the detector. Press and release the *ZERO* switch, the display will momentarily show:-



- 4) The micro controller will now measure the amplifier offset and store this value in the non volatile memory. All subsequent measurements will first have this offset subtracted before displaying the measurement.

At the end of the sequence the display will show:-



- 5) Remove the light cover from the detector. The equipment is now ready for use.
- 6) At any time the measurement process can be halted by pressing the HOLD/RUN button. Pressing the button once again will resume the measurement process.

## 4 IRRADIANCE MEASUREMENTS

IT IS IMPORTANT TO NOTE THAT THE PR450 IS A BLUE LIGHT PHOTOTHERAPY RADIOMETER AND **NOT** SUITABLE FOR THE MEASUREMENT OF ULTRA VIOLET LAMPS.

IRRADIAN OFFER A RANGE OF ULTRA VIOLET RADIOMETERS INCLUDING THE UV201, UV202 AND UV203.

Irradiance is the measurement of radiometric light per unit area, watts per metre,  $\text{W/m}^2$  (spectral irradiance  $\mu\text{W/cm}^2/\text{nm}$ ). The part of the spectrum to be measured is defined by the filter fitted onto the detector. Ideally this should be a filter with a square spectral response. In practice it rarely is and the filter is defined with a peak response wavelength and a full width half maximum, FWHM bandwidth. In all applications it is vital to know the part of the spectrum being measured by the detector and filter, and if possible to know the spectrum of the light source. In addition the radiometer should be calibrated to best suit the measurement conditions. It may even be necessary to have more than one calibration factor for the same detector / filter combination.

For most applications the measurement plane is horizontal and a cosine corrected diffuser is fitted to the front of the detector assembly. If the working surface is not horizontal then placing the detector on or parallel to the worktop is a more representative measurement of irradiance.

Note that all the light sources in the hemisphere above the detector will contribute to the measurement. The sources may be obvious, lamps or windows or even walls or other reflecting surfaces. Take care not to shadow the detector during all measurements.

For routine measurements of a phototherapy lamp it is necessary to record the distance to the lamp, the position of the detector with respect to the lamp and the orientation of the detector.

## 5 COSINE ANGULAR RESPONSE

Irradiance (or spectral irradiance) is a measurement of the amount of light incident on a unit area ( $\text{watts/m}^2$ ) (or  $\text{/nm}$  for spectral irradiance). Any detector will measure this reliably when measuring a beam of light perpendicular to the detectors surface, however when measuring scattered light or light from an extended source the sensor must have an accurate response over its  $180^\circ$  field of view. More importantly, this response should be proportional to the cosine of the angle of light incident on the detector. This comes from the fact that the projected area of any surface at an angle of  $i$  is proportional to  $\cos(i)$ .

To ensure that the integration of light from all angles is correct, the cosine diffuser matches the angular response so that response of the detector decreases with  $\cos(i)$  as the angle between the source and detector increases from  $0$  to  $90^\circ$ .

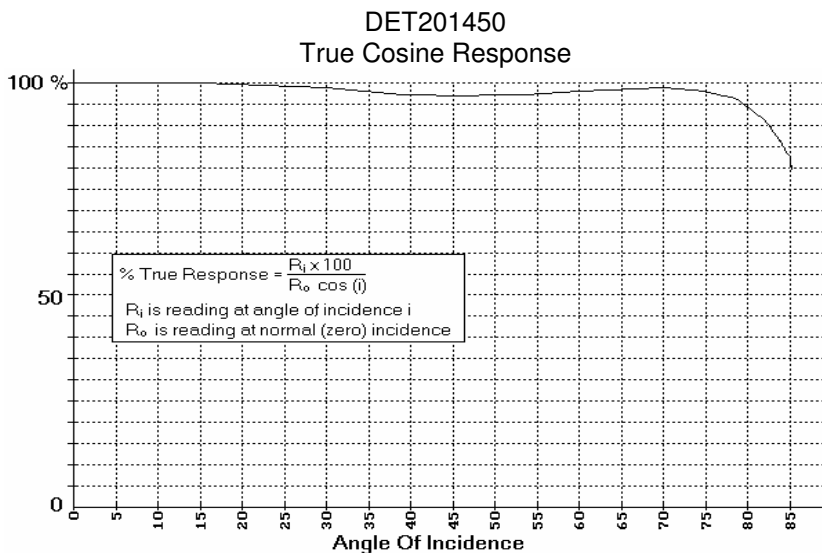


Figure 4

Irradian's cosine diffusers are corrected to match the cosine response to within  $\pm 5\%$  up to angles of  $70^\circ$ . This ensures that the meter correctly reads illuminance or visible light flux density whether it is measuring light from an extended or a point source.

## 6 CALIBRATION DESCRIPTION

Irradian holds a number of tungsten halogen and deuterium lamps and silicon photodiode standards which are routinely calibrated by the National Physics Laboratory in the UK.

Four methods for calibrating the radiometer are available:

- i) Radiometric calibration with monochromatic light at 450nm in units of  $\text{W/m}^2$ .
- ii) Radiometric calibration with monochromatic light at 450nm, the sensitivity is then divided by the bandwidth at FWHM to give a calibration in units of  $\text{W/m}^2/\text{nm}$ .
- iii) Spectroradiometric calibration. Light source is scanned with a spectroradiometer between 425 and 475nm. The total integrated irradiance is then recorded and divided by the spectral range to give calibration in units of  $\mu\text{W}/\text{cm}^2/\text{nm}$  with the PR450 radiometer calibration adjusted to match the spectroradiometer.
- iv) Each spectroradiometric value in (iii) can be adjusted with the action spectrum to form a weighted irradiance with the PR450 set to match this.

Note the spectroradiometric calibrations are dependent on the light source. It may be necessary to use correction values if accurate measurements are required for both fluorescent and discharge type lamps.

As with all measuring equipment a routine calibration is recommended, typically annually, but with frequent use by a number of different users a shorter recalibration period may be necessary.

## 7 CARE AND MAINTENANCE

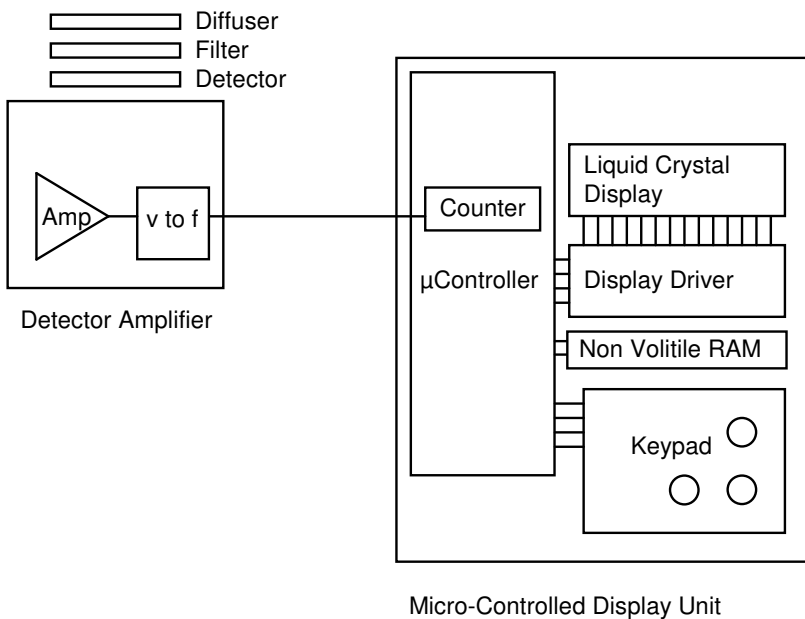
- 1) The PR450 display unit can be cleaned using a moist cloth with detergent. Do not use solvent or alcohol to clean surfaces.
- 2) The diffuser on each filter ring should be kept clean at all times.
- 3) The radiometer is a precision instrument, protect from shocks.
- 4) Avoid supporting the detector by the multi core cable.

## 8 OPTIONAL ACCESSORIES

The following items are available from Irradian:

- Leveling Plate (Three adjustable feet and built in spirit bubble).
- Extension cables.

## 9 BLOCK DIAGRAM



## 10 ENVIRONMENTAL CARE, RECYCLING & DISPOSAL

The purpose of the European Commission WEEE directive (Waste Electrical and Electronic Equipment; 2002/96/EC) is to ensure that electrical and electronic products are recycled using the best treatments, recovery and recycling techniques that are currently available. This is so that high health standards and a lasting environmental protection can be achieved and maintained.

This product has been designed and manufactured using high quality materials and components, many of which can be recycled and reused.

Please remember to observe the local regulations that govern both the disposal of the packaging materials accompanying this product and any used batteries.



**DO NOT DISPOSE OF THIS PRODUCT IN YOUR GENERAL WASTE BIN.**

Please inform yourself about your local WEEE collection system which is available for electrical and electronic products that are marked with the symbol shown here.

When disposing of this meter, please use one of the following options:

- 1) Use your local designated WEEE collection facilities to dispose of the complete product (including cables, detectors, filters & accessories).
- 2) Return the complete product back to Irradian, marking it clearly as intended for WEEE disposal.











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