DIGITAL RADIOMETER

MODEL **PR203**

USER HANDBOOK

Handbook Ref No. IH001/Issue D
File Ref: PR203-v5D.doc

IRRADIAN
Light Measurement Systems & Calibration

DIGITAL RADIOMETER

MODEL **PR203**

USER HANDBOOK

CONTENTS:

1 INTRODUCTION

The Irradian portable phototherapy radiometer model PR203 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.

The radiometer comprises of a hand held display unit with micro processor control and a detector / amplifier assembly with connecting cable and associated filters. The sensor in the detector assembly is a silicon photodiode with excellent linearity and long term stability.

Note: The PR203 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

DISPLAY UNIT

Controller:	80C51 8bit micro-processor with a 3.1684MHz clock.
Memory	On board non volatile RAM for calibration factors and set-up parameters.
Key Operation	8 switch key board with 11 LED indicators.
Power Switch	Microprocessor reset at switch on. Unit settings stored prior to shut down.
Serial Interface	Three wire RS232 serial interface. 4800 baud, no parity, 1 stop bit.
Integration Time	0.33s
Conversion Scale	17 bit
Accuracy:	Measurement accuracy ±1digit with a linearity error of <1%.
Display:	4½ digit LCD display. Character height 10mm.
Display illumination:	A LED back light can be switched on to illuminate the display for readings in low ambient light situations.
Power Supply:	9 volt PP3 type battery.
Power Consumption:	Shut down mode <5µA Operating 10 - 20mA LED back light ~20mA
Battery Life	~ 50 hours without backlight use

2 SPECIFICATION **(continued):**

Ranges:

i) Irradiance

Up to 4 full scale decades measuring from*:

0 to 19.999 µW/cm^2/nm
0 to 199.99 µW/cm^2/nm
0 to 1999.9 µW/cm^2/nm
0 to 19999 µW/cm^2/nm

Resolution 0.001 µW/cm^2/nm on range 1.

* Other ranges available on request.

Calibration:

Absolute calibration accuracy,
±7.5% to national standards.

2 SPECIFICATION **(continued):**

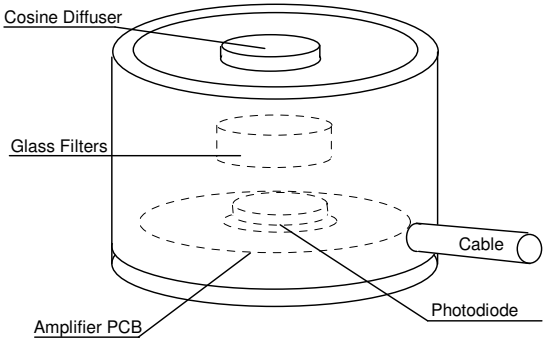
Front Panel Controls:

RANGE	Select auto ranging or manual range control.
SOURCE	Select between each of the three measurements of irradiance from different light sources; Halogen, Fluorescent or LED in $\mu W/cm^2/nm$.
ZERO	Initiates a zero or background measurement routine on all five ranges.
HOLD/RUN	Display is held at present reading until HOLD button is pressed again. Select to run or hold a special mode.
MODE	Select between AVERAGE, MIN, MAX and INTEGRATE modes.
FUNCTION/RESET	Press to reset function values to zero.
RESET	Press to return to normal measurement mode from manual range mode or special modes. Note the display hold is not reset.
⏻	Power on / off button.
⊗	Display backlight on off button. Display backlight will switch off after a programmable delay, factory setting 60 secs.

Connectors:	8 pin DIN type detector connector. 5 pin DIN type RS232 connector.
Temperature Range:	0 to 40℃. 80% RH.
Dimensions:	150 x 80 x 45mm. High impact polystyrene.
Weight:	350g

2 SPECIFICATION **(continued):**

DET203450 DETECTOR



The DET203450 detector comprises of an aluminium housing, photodiode, PR203 filter and PCB assembly.

Detector:	5.2 mm² High stability GaAsP photodiode.
Spectral Response:	Refer Figure 1.
Angular Response:	Accurately cosine corrected to Lambert's Cosine Law. Maximum error is less than ±5% from true response to 70° from normal incidence, reference Section 5.

Temperature Coefficient: <0.3 %/℃

Amplifier Gain	10^6 V/A to 10^3 V/A
Current to Frequency	0 - 0.5Mhz
Linearity Error:	<1% across range
Temperature Range:	Operation: -10 to +60℃ Storage: -20 to +70℃
Detector Housing:	Black anodised aluminium alloy housing.
Cable:	1 metre multicore cable to 8 pin DIN type connector
Weight:	approx. 140g

2 SPECIFICATION **(continued):**

DET203450 Detector
Typical Spectral response

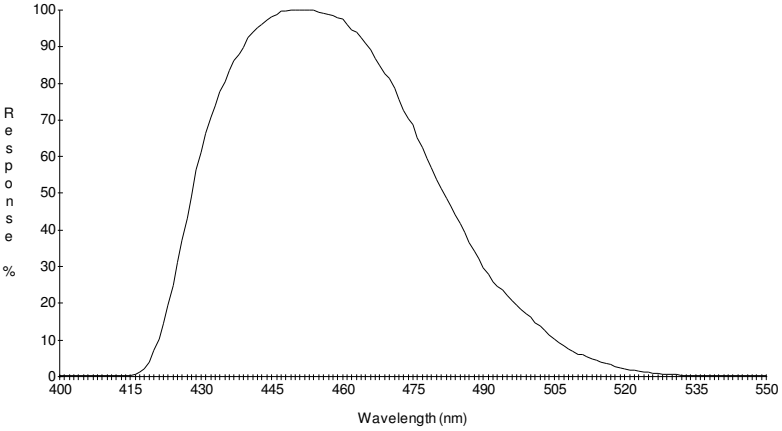


Figure 1

3 OPERATION

SETTING UP

1) With the unit OFF, plug the detector 8 way connector into the detector socket on the top of the display unit.

2) Clean the white diffuser on the detector if it is marked or dirty.

3) Press and release the power switch ⏻ on the PR203 display key pad. The micro controller will initiate with the display momentarily showing:-

The radiometer will now search for the optimum range on the detector amplifier. A typical display is shown below.

An LED will illuminate indicating the units and another to indicate which light source is required. This will be the same source prior to the last power off.

4) Press and release the SOURCE (bottom middle) switch to select the correct source required. For quartz tungsten halogen sources, the correct setting is Halogen. For irradiance measurements with a fluorescent source, the correct setting is Fluorescnt. and with a blue dominant wavelength LED the correct setting is LED.

5) It is recommended that the radiometer amplifier is nulled or zeroed periodically. Place the supplied blanking cover over the detector. Press and release the *ZERO* switch and the display will momentarily show:-

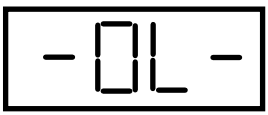
3 OPERATION **(continued):**

6) The micro controller will now measure the amplifier offset on each of the gain ranges and store these values in the non volatile memory. All subsequent measurements will first have one of these offsets subtracted before displaying the measurement.
At the end of the nulling sequence the display will show:-

7) Remove the light cover from the detector. The equipment is now ready for use.

AVERAGE

When the light is unstable, press and release the MODE switch. The radiometer will now switch to manual ranging, Manual LED on, if not yet previously in manual ranging. The Average LED will now switch on, but the SOURCE LED will remain unchanged.
To start an average sequence press and release the HOLD/RUN switch. Immediately the display will show a fluctuating signal, reflecting the light source fluctuations. After a short time the amplitude of the fluctuations will decrease and the display will begin to show a reading which represents the average light level during the period of the measurement.
At any time the averaging process can be halted by pressing the HOLD/RUN button. The display will flash 'HOLd' intermittently.
At any time the averaging sequence can be reset by pressing and releasing the FUNCTION RESET switch.
If the light level fluctuations are large and any one reading causes the detector amplifier to overload at this range the averaging process will be terminated and the display will show:-



To avoid an overload conditions RESET the radiometer and Manually change the RANGE to a lower lever. e.g. from a 34.00 range to 34.0.

3 OPERATION **(continued):**

MIN & MAX LEVELS

During an average measurement sequence the maximum and minimum values attained in the period are recorded. Press *HOLD* to halt the averaging sequence. Press the MODE button to select between *Average, Min* and *Max*. Note the Integrate display may overload and show - 0 L -.
It is also possible to view a *MIN* or MAX recording sequence by selecting *MIN or MAX* prior to selecting *RUN*.

Press *FUNCTION RESET* to set the maximum and average values to zero and the minimum to - 0 L -. Note the *FUNCTION RESET* will operate during a measurement sequence or in the *HOLD* mode.

INTEGRATE

For measurements of the integrated dosage or exposure press the MODE switch to select *Integrate*. Press the RUN switch to start the measurement. The display will now autorange as the dosage increases.

Note the detector amplifier will not autorange and as with Average measurements if the amplifier overloads the display will show - 0 L - and the measurement will halt.

Units for integrated measurements are µJ/cm²/nm.

At the end of the integration period *HOLD* the display. Use the *MODE* switch to also display the *Min*, *Max* and *Average* values.

Press *FUNCTION RESET* to set the integrate, maximum and average values to zero and the minimum to - 0 L -. Note the *FUNCTION RESET* will operate during a measurement sequence or in the *HOLD* mode.

4 SPECTRAL IRRADIANCE MEASUREMENTS

IT IS IMPORTANT TO NOTE THAT THE PR203 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.

Spectral irradiance is the measurement of radiometric light per unit area, microwatts per centimetre, per unit wavelength ($\mu W/cm^2/nm$). The part of the spectrum to be measured is defined by the filter fitted onto the detector and matches the bilirubin action spectrum. 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 and 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

Spectral irradiance is a measurement of the amount of light incident on a unit area, per unit wavelength (µW/cm²/nm). 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° 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°.

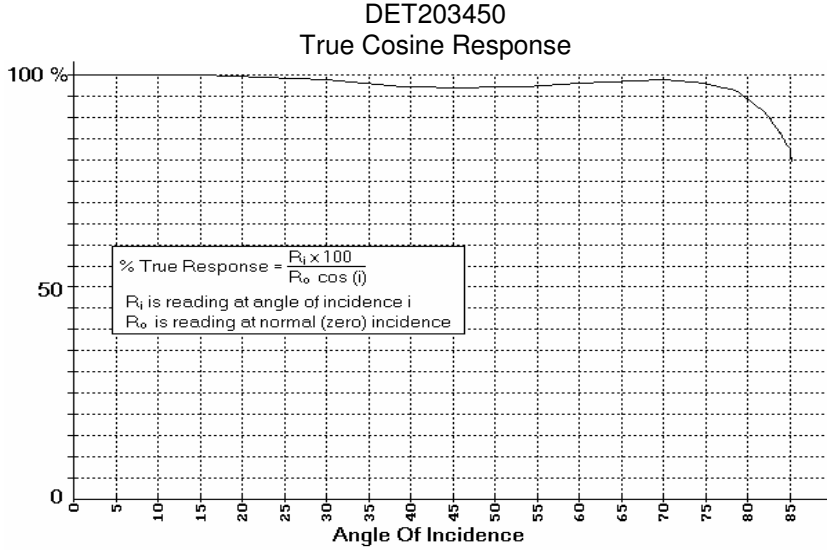


Figure 4

Irradian's cosine diffusers are corrected to match the cosine response to within ± 5 % up to angles of 70°. This ensures that the meter correctly reads the 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 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 $W/m^2/nm$.

iii) Spectroradiometric calibration. Each different phototherapy light source is scanned with a spectroradiometer between 425 and 475 nm. The total integrated irradiance is then recorded and divided by the spectral range to give calibration in units of $\mu W/cm^2/nm$ with the PR203 radiometer calibration adjusted to match the spectroradiometer.

iv) Each spectroradiometric value in (iii) can be adjusted with the action spectrum to form a *weighted* spectral irradiance with the PR203 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 many different phototherapy 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 PR203 display unit can be cleaned using a moist cloth with detergent. Do not use solvent or alcohol to clean surfaces.

2) The diffuser on the detector 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 BATTERY REPLACEMENT

1) Switch off the radiometer before changing the battery.

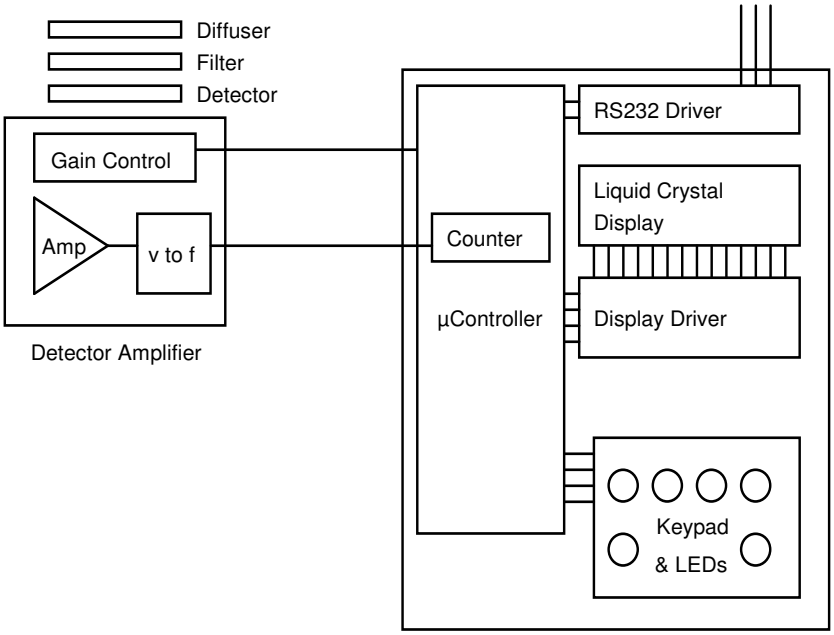
2) Slide open the battery compartment on the back of the radiometer and pull out the battery. Disconnect from the battery clip

3) Replace with a size PP3 9 volt battery.

4) Place battery inside compartment and slide cover closed.

5) Note it will be necessary to switch on and off the radiometer before normal operation will commence.

9 BLOCK DIAGRAM



10 PROGRAMMING VIA THE RS232 INTERFACE

Serial Port Settings: 4800 baud, no handshaking

Single letter commands

S	Toggle through possible gain ranges (manual mode) Reset to autorange with R command.
U	Toggle through possible light sources, Halogen, Fluorescnt. & LED as applicable
F	Toggle through possible functions
I	Function reset
H	Toggles hold/go
Z	Zeros light meter
R	Resets light meter
B	Toggles backlight
s	Sends data continuously via the RS232
o	Sends one set of data via the RS232

10 PROGRAMMING VIA THE RS232 INTERFACE (continued):

10.1 Windows 3.1 & Windows 95

Setting up remote control via Microsoft TERMINAL.EXE

1) Connect the cable between the RS232 socket on the light meter and the COM port on the PC.

2) Switch on the light meter.

3) Run *Terminal* program.

4) Go to the *Settings / Communications* screen and set the baud to 4800 and the COM port to suit.

5) Go to the *Settings / Text Transfers* and select *Line at a time* with *1/10th second delay*.

6) Check the RS232 link by a switch to the manual range, LED on using the command 'S', (capital S).

7) Reset to the auto range, LED off using the command 'R', (capital R).

8) Type 'o' for one packet of data and 's' for continuous data. Type 's' to stop the data flow.

9) To save the terminal setup go to *File / Save As* and save the settings. When restarting the program the settings can be reloaded with *File / Load filename*. Now actions 4 and 5 can be omitted.

Logging data continuously to a file using Microsoft TERMINAL.EXE

1) Run the Terminal program with the correct settings.

2) Set up the radiometer and send the command 's' via Terminal to transmit data continuously from the radiometer.

3) Go to *Transfers / Receive Text File*. Enter filename for the stored data (e.g. log1.txt).

4) On entering the file name, Terminal will now store all the readings transmitted from the radiometer in a file *log1.txt.* The file is saved to the computer by pressing STOP on the terminal screen.

10 PROGRAMMING VIA THE RS232 INTERFACE **(continued):**

10.2 Windows 95, Windows 98 and later editions

Setting up remote control via Microsoft HYPERTERMINAL.EXE

1) Connect the cable between the RS232 socket on the light meter and the COM port on the PC.

2) Switch on the light meter.

3) Run the *HyperTerminal* program.

4) Enter a name for the session (e.g. R203 etc.).

5) Select the type of connection required, either option 'direct to com 1' or 'direct to com 2' depending on which com port is to be used.

6) Enter the details for the serial connection: 4800 bits per second, 8 data bits, no parity, 1 stop bit and no flow control.

7) Click the properties icon or select via the *File / Properties* option to display the properties window.

8) Select the *Settings* tab and select Auto detect for the *Emulation* setting.

9) Click the *ASCII Setup* button. Enter 100 into the box marked *Line delay*. No other options are necessary. Click on OK to return to the main window.

10) Check the RS232 link by downloading a reading using the command 'o', (lowercase o). This also allows auto detect to correctly identify the meter settings, showing 4800 8-N-1 next to the Auto detect message in the status bar. A reading should appear in the main window if the connection has been made successfully.

11) To save the terminal setup go to *File / Save As* and save settings. When restarting the program the settings can be loaded directly by double-clicking on the *.ht icon that has been created. Now actions 4 to 9 can be omitted.

10 PROGRAMMING VIA THE RS232 INTERFACE
(continued):

Logging data to a file using Microsoft HYPERTERMINAL.EXE

1) Run the HyperTerminal program with the correct settings.

2) Set up the radiometer and send the command 's' via HyperTerminal to transmit data continuously from the radiometer.

3) Go to *Transfer / Capture Text*. Enter the filename for the stored data and the location to save to. (e.g. C:\HyperTerminal\Capture.txt).

4) Press the *start* button to store all the readings transmitted from the radiometer in a file *Capture.txt.* The status bar will now show a highlighted 'Capture' message. The file is saved to the computer by selecting *Transfer / Capture Text / Stop*.

5) Send the command 's' again via HyperTerminal to stop the continuous transitional of data from the radiometer.

11 ENVIRONMENTAL CARE, RECYCLING AND 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.

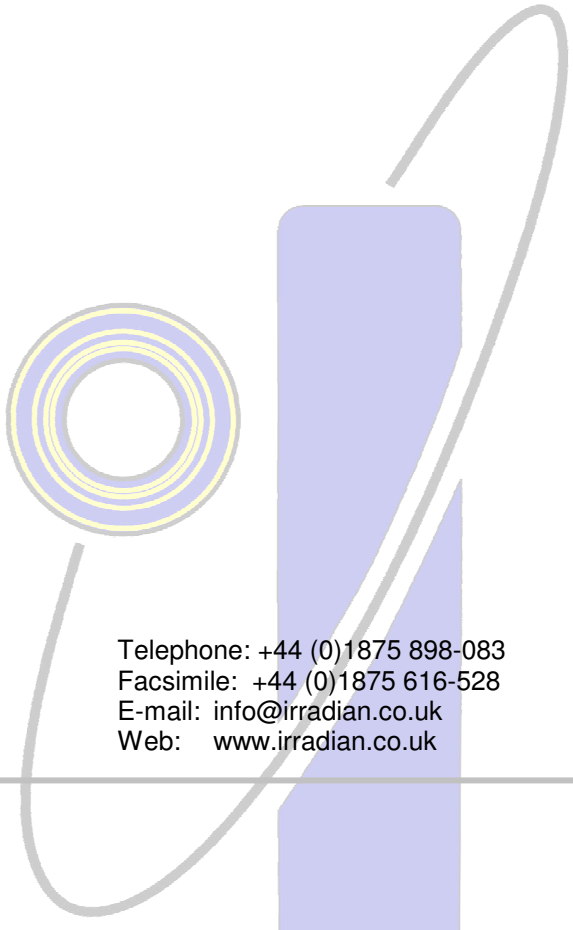
DO NOT DISPOSE OF THIS PRODUCT IN YOUR GENERAL WASTE BIN.

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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