



ORM400 OPTICAL RADIATION METER

User Manual



Contents

1 Introduction	3
2. ORM400	3
2.1 Introduction	3
2.2 Using the ORM	3
3. Signal detection	6
4. Using VL3701-1	6
4.1 Spectral Irradiance.....	6
4.2 Illuminance	6
4.3 Function matching error, f_1	6
4.4 Cosine response, f_2	6
5 Performing Measurements	6
6. Programming reference	6
7. GUARANTEE	8

1 Introduction

This manual is written to accompany the Bentham ORM400 optical radiation meter.

Operated from either the front panel, or via USB, the ORM400 is compatible with any current generating detector or filter radiometer.

Software control is possible via customer written programs based on the Bentham SDK (software development kit).

The ORM can also be provided with specific measurement related functionality, for example the provision of correction and calibration factors to enable quick and accurate measurements.

2. ORM400

2.1 Introduction

The Bentham ORM400 optical radiation meter is a dual channel device adapted to a wide range of radiometric and photometric applications.

The ORM400 consists of a 6-stage trans-impedance current amplifier combined with an analogue to digital converter (ADC) for the measurement and reporting of detector photocurrent, and, with the application of calibration (and, if applicable, correction) factors, the true measurement result.

The inputs have effectively zero input impedance and hence no voltage is generated across the device as a result of the photocurrent. This short circuit operation enhances linearity of detectors and reduces the effect of cable capacitance.

The ADC has a 2000 count resolution, and integrates over 10ms second periods. This period constitutes a single "read", a number of which might constitute a measurement point.

2.2 Using the ORM

The visual display of the ORM400 during measurement reports the current measurement value, and reports the mode in use.

The key functions are as follows:-

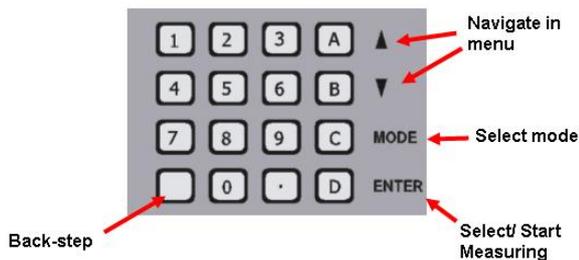


Figure 1: ORM400 front panel

The ORM400 powers on in the menu option.

The available menus are accessed by hitting either the **MODE** button or the number relating to the menu item (see the following flow diagram for a view of the menu options).

The menu contains the following:-

1. CW:- Commence measurement and define the configuration of the detection electronics: input used and whether or not to auto- or fix- range the amplifier .

During measurement, pushing the up/ down arrows permits toggling between viewing the current, minimum and maximum values.

The units reported depend on the calibration applied (see menu item 4.)

2. REMOTE MODE:- Operate the ORM400 via USB. Connect the USB, hit enter to select the mode. The ORM400 displays PC to show under USB control.

3. RATIO MODE:- Commence ratio measurement. One can define the channel in use, and the reference signal.

The reference can be either a measurement or in input value.

When selecting a measurement, set up the system, and perform measurement.

When values are input these should be in the base unit, ie 10mA reference should be input as 10E-3. Use the numerical keypad to input numbers. The first entry of the decimal key inserts a decimal point, the second inserts the exponent E. A negative value may be input by hitting the mode button before insertion of the exponent; a

negative exponent may be obtained by hitting mode when the exponent inserted.

Having input the reference, commencing measurements report in %.

4. DETECTOR CALS:-

A default (no calibration applied to read photocurrent) and up to six calibration factors can be programmed into the ORM400. This menu permits the selection of a factor for a given channel or the access to edit calibration factors. This latter can be performed also from PC.

When inputting calibration values, it is necessary to use arrow keys to select correct units (currently A, lx, lm, cd m⁻², W m⁻², W cm⁻², W sr⁻¹, W, W nm⁻¹), then input the numerical value and label.

Again, use the numerical keypad to input numbers. The first entry of the decimal key inserts a decimal point, the second inserts the exponent E. A negative value may be input by hitting the mode button before insertion of the exponent; a negative exponent may be obtained by hitting mode when the exponent inserted.

To enter text, the following is employed:-

Numbers & Symbols	ABC	DEF	Scroll up
GHI	JKL	MNO	Scroll down
PQRS	TUV	WXYZ	Move to next char
Back-space	Clear value	Toggle lower/UPPER case	Enter

5. DARK LEVEL:- Measure dark current of detectors on either input.

6. SET AVERAGING:- The ADC converter averages 10ms measurements. Selects number of such measurements to be averaged per measurement point (10ms being therefore a minimum read).

7. FACTORY RESET:- Revert to default values.

8. FIRMWARE VERSION:- Software version uploaded on ORM400.

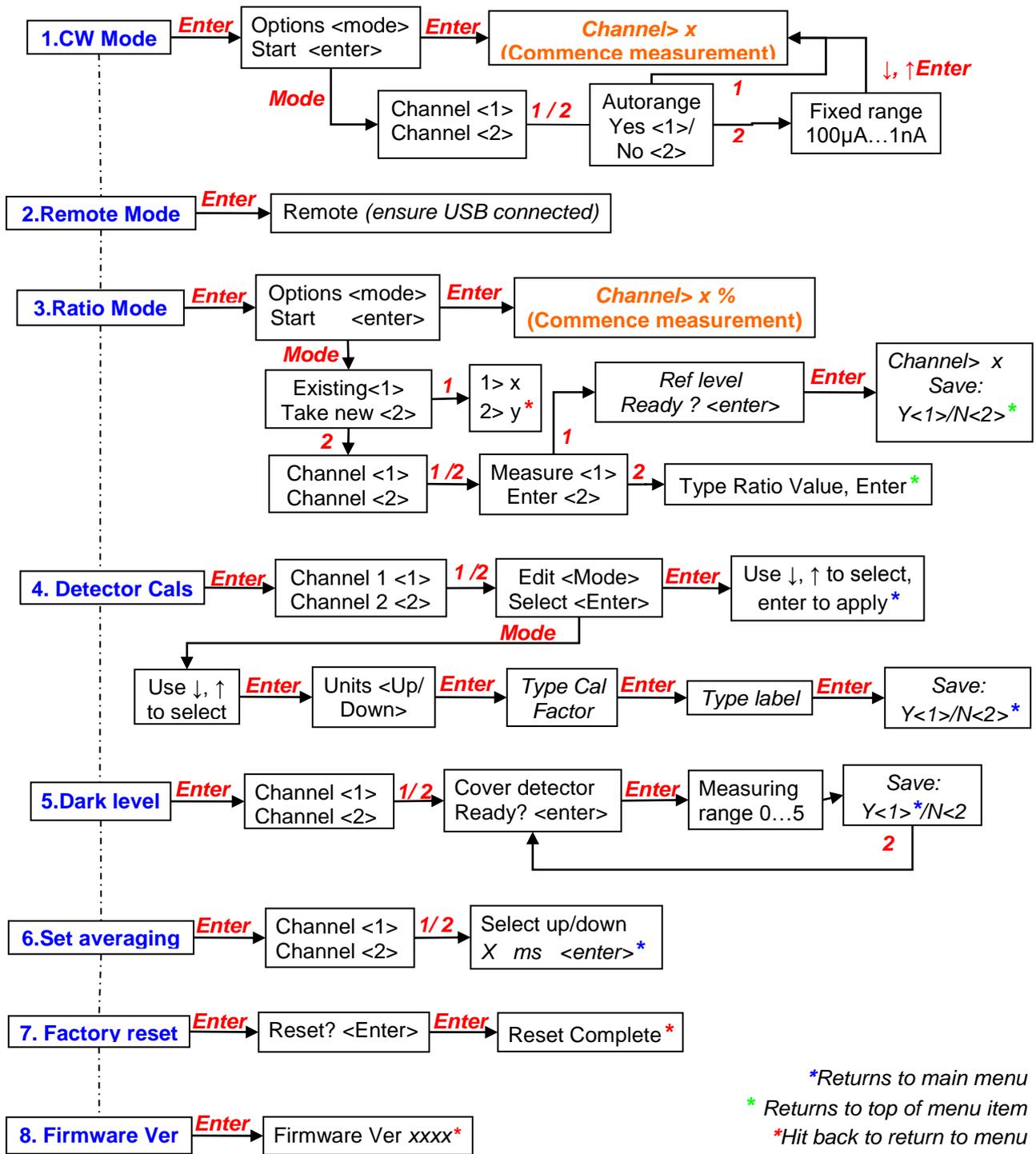


Figure 2:- ORM400 menu map

3.Signal detection

Any current generating detector or filter radiometer may be employed with the ORM400, connection being made via standard BNC connector. Please note that the central pin should be connected to the detector positive.

A calibration factor for the detector responsivity or, for example, photometric response, can be input to the ORM400.

4. Using VL3701-1

4.1 Spectral Irradiance

Spectral irradiance is defined as the incident radiant power, Φ issued from a source at a given distance, over surface area A, as a function of wavelength.

$$\text{Hence } E(\lambda) = \frac{\Phi(\lambda)}{A} \dots\dots\dots 4.1$$

In the measurement of irradiance it is important to take account of contributions from angles in the entire hemisphere above the input optic.

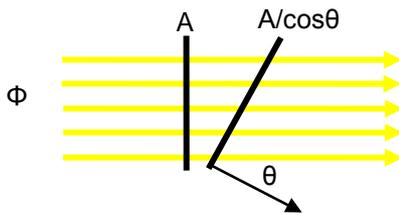


Figure 3:- On- and off-axis contributions

From the above, one obtains the angular component as a function of the orthogonal component,

$$E = E_{\text{normal}} \cos\theta \dots\dots\dots 4.2$$

This is called the cosine law. The input optic should therefore weight the incident radiation as a function of the cosine of the angle of the incident light.

Furthermore, one should take into account the distance between source and input optic. Irradiance is inversely proportional to distance, therefore it is necessary to reference all measurements to the measurement distance used.

The units of spectral irradiance is $W.m^{-2} nm^{-1}$, which when integrated over suitable limits yields the irradiance of the source at a given distance in $W.m^{-2}$.

4.2 Illuminance

Illuminance is the photometric equivalent to irradiance, taking into account a model of the human eye response. This latter is described by the CIE $V(\lambda)$ curve of luminous efficacy, with a peak value of 683 lm/ W at 555nm.

Weighing the spectral irradiance of a source by $V(\lambda)$ curve, and integrating between 380 and 780nm yields the source illuminance in lux.

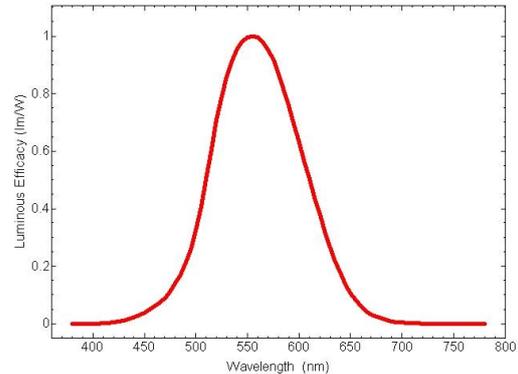


Figure 4:- CIE $V(\lambda)$ eye efficacy

4.3 Function matching error, f_1

The relative spectral responsivity of a filter radiometer is designed to match, as best as possible, a certain weighting function, be that UVA or the photopic curve above etc.

Should these two differ, wrong results may obtain.

The relative matching may be evaluated in one of two ways, by evaluating with and without reference to an illuminating source.

Without reference to an illuminating source one obtains:-

$$f_1' = \frac{\int_0^\infty |s(\lambda)_{rel}^* - s(\lambda)_{act,rel}| d\lambda}{\int_0^\infty s(\lambda)_{act,rel} d\lambda} \dots\dots\dots 4.3$$

Where:-

$s(\lambda)_{act,rel}$ - relative spectral actinic weighting function

$s^*(\lambda)_{rel}$ - normalised relative spectral responsivity according to Eq 4.5 (below)

With reference to an illuminating source one obtains:-

$$f_{index} = \frac{\int_0^{\infty} |s(\lambda)_{rel}^* - s(\lambda)_{act,rel}| S_{\lambda,Z} d\lambda}{\int_0^{\infty} s(\lambda)_{act,rel} S_{\lambda,Z} d\lambda} \dots\dots\dots 4.4$$

Where:-

$S_{\lambda,Z}$ - spectral distribution of the source in application

$s(\lambda)_{act,rel}$ - relative spectral actinic weighting function

$s(\lambda)_{rel}$ - relative spectral responsivity of the radiometer head

$s^*(\lambda)_{rel}$ - normalised relative spectral responsivity according to Eq 4.5

In both cases:-

$$s^*(\lambda)_{rel} = \frac{\int_0^{\infty} S_{\lambda,c} \cdot s(\lambda)_{act,rel} d\lambda}{\int_0^{\infty} S_{\lambda,c} \cdot s(\lambda)_{rel} d\lambda} \dots\dots\dots 4.5$$

Where:-

$S_{\lambda,c}$ - spectral distribution of the illuminant used for calibration

$s(\lambda)_{act,rel}$ - relative spectral actinic weighting function

$s(\lambda)_{rel}$ - relative spectral responsivity of the radiometer head

$s^*(\lambda)_{rel}$ - normalised relative spectral responsivity for the calibration source.

4.4 Cosine response, f_2

The directional response of a diffuser is characterised by f_2 , a measure of the deviation from a true cosine response.

$$f_2 = \frac{85 \cdot \pi}{180^2} \int_0^{\pi} f_2^* \sin 2\theta d\theta$$

where

$$f_2^* = \left| \frac{S(\theta)}{S(0) \cos(\theta)} - 1 \right|$$

θ is the angle from the perpendicular to the diffuser

$S(\theta)$ measured signal at angle θ

$S(0)$ measured signal one axis of diffuser

5 Performing Measurements

The ORM400 has been set up to operate from Input 1 with the calibration factor of the VL-3701-1 applied.

- Set up lamp/ optical system for measurement
- Connect detector to input 1 of ORM400
- Power on ORM400
- Hit enter to access CW mode
- Hit enter to commence measurements

6. Programming reference

Please refer to the Bentham USB instrument SDK manual for specific details of USB control of the ORM400.

The following table provides a reference of the ORM400 commands.

Command	Action
X0	Switch to local mode
X1	Switch to remote mode
R0	Take reading on input 1
R1	Take reading on input 2
G3	Get Last reading on input 1
G103	Get Last reading on input 2
D0	Take dark current on input 1
D1	Take dark current on input 2
G2	Get dark current on input 1
G102	Get dark current on input 1
S4:x	Set units for input 1
G4	Get units for input 1
S104:x	Set units for input 2
G104	Get units for input 2
S5:x	Set auto range for input 1
G5	Get auto range for input 1
S105:x	Set auto range for input 2
G105	Get auto range for input 2
S6:x	Set auto range averaging for input 1
G6	Get auto range averaging for input 1
S106:x	Set auto range averaging for input 2
G106	Get auto range averaging for input 2
S7:x	Set fixed range for input 1
G7	Get fixed range for input 1
S107:x	Set fixed range for input 2
G107	Get fixed range for input 2
S8:x	Set integration time (/10mS) for input 1
G8	Get integration time (/10mS) for input 1

S108:x	Set integration time (/10mS) for input 2
G108	Get integration time (/10mS) for input 2
S11:x	Set range delay for input 1
G11	Get range delay for input 1
S111:x	Set range delay for input 2
G111	Get range delay for input 2

7. GUARANTEE



BENTHAM INSTRUMENTS warrants each instrument to be free of defects in material and workmanship for a period of **one** year after shipment to the original purchaser. Liability under this warranty is limited to repairing or adjusting any instrument returned to the factory for that purpose. The warranty of this instrument is void if the instrument has been modified other than in accordance with written instructions from BENTHAM, or if defect or failure is judged by BENTHAM to be caused by abnormal conditions of operation, storage or transportation.

This warranty is subject to verification by BENTHAM, that a defect or failure exists, and to compliance by the original purchaser with the following instructions:

1. Before returning the instrument, notify BENTHAM with full details of the problem; including model number and serial number of the instrument involved.
2. After receiving the above information, BENTHAM will give you shipping instructions or service instructions. After receipt of Shipping instructions, ship the instrument "carriage paid" to BENTHAM. Full liability for damage during shipment is borne by the purchaser. It is recommended that instruments shipped to us be fully insured and packed surrounded by at least 2 inches of shock-absorbing material. Specific transit packaging as used in Monochromators etc. must be installed.

BENTHAM reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

This warranty is expressly in lieu of all other obligations or liabilities on the part of BENTHAM, and BENTHAM neither assumes, nor authorises any other person to assume for it, any liability in connection with the sales of BENTHAM'S products.

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