DIGITAL PHOTOMETER

MODEL L201

HANDBOOK

Contents:

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Handbook Update Log

Issue	Date	Changes
A	5/06/01	New Issue
B	12/10/06	Updates and corrections

1 INTRODUCTION

The Macam L201 Digital Photometer is a portable instrument designed for accurate measurement of illuminance in Lux.

The photometer comprises of a hand held display unit, a detector /amplifier assembly with connecting cable. The sensor is a large area silicon photodiode with excellent linearity and long term stability. The Macam photopic filter set housed in the detector, and fitted in front of the silicon detector gives a response which closely matches the human eye response outlined by the CIE $V\lambda$ curve. This precise colour correction gives high accuracy of photometric measurements from light sources with different spectral distributions (see Calibration section).

For illuminance measurements, the cosine corrected diffuser which is fitted to the detector assembly, will integrate light from all sources in the hemisphere in front of the detector. Before leaving the factory, the instrument is calibrated to read directly in Lux.

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	3 switch key board.
Power Switch	Microprocessor reset at switch on.
Integration Time	0.33s
Conversion Scale	17 bit
Accuracy:	Measurement accuracy ±1digit with a linearity error of <1% from 1 to 20 000 Lux.
Display:	4½ digit lcd display. Character height 10mm.
Power Supply:	9 volt 1200mAh, Lithium Manganese battery.
Power Consumption:	Shut down mode <5µA Operating 10 - 20mA
Battery Life	~ 50 hours without backlight use
Ranges:	0 to 19 999 lux Resolution 1 lux.
Calibration	Absolute calibration accuracy ±5% traceable to NPL standards. Photopic colour correction integrated error of ±1% over visible spectrum.

2 SPECIFICATION (continued):

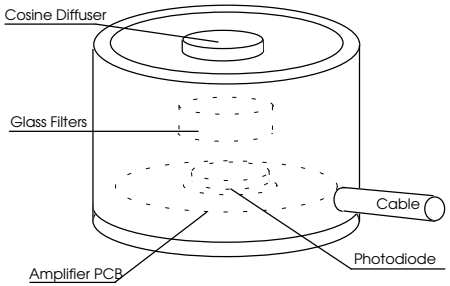
Front Panel Controls:

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

Connectors:	4 pin mini DIN type detector connector.
Temperature Range:	0 to 40°C. 80% RH.
Dimensions:	150 x 80 x 45mm. High impact polystyrene.
Weight:	350g

2 SPECIFICATION (continued):

LABORATORY DETECTOR, Model SD221



The SD221 laboratory detector comprises of a aluminium housing, photodiode and PCB assembly, glass filter set and cosine diffuser.

Detector:	13mm² silicon photodiode.
Temperature Coefficient: -0.10 %/°C	
Amplifier Gain	10^5 V/A
Current to Frequency	0 - 0.5Mhz
Linearity Error:	<1% from 1 to 20 000 Lux
Temperature Range:	Operation: -20 to +60°C Storage: -20 to +70°C
Detector Housing:	Black anodised aluminium alloy housing. The detector amplifier is connected to the display unit via a multicore cable to a four pin mini DIN type connector.

2 SPECIFICATION (continued):

Spectral Response:	Refer figure 1 and section 6.
Angular Response:	Accurately cosine-corrected to Lambert's Cosine Law. Maximum error is less than ±3.5% from true response to 70° from normal incidence, reference figure 2.
Detector assembly:	Black anodised aluminium alloy housing Multiple coloured filter glasses individually selected for close matching to Vλ.. Specially profiled acrylic diffuser for high accuracy cosine angular response.

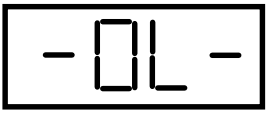
3 OPERATION

SETTING UP

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

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

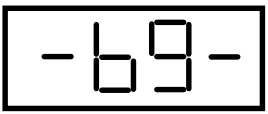
3) Press and release the power switch on the L201 display key pad. The micro controller will initiate with the display momentarily showing:-



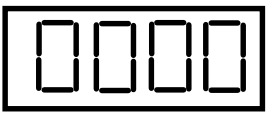
The photometer will give a typical display as shown below.

4) For illuminance measurements the correct units are Lux.

5) It is recommended that the photometer amplifier is nulled periodically. Place the cover over the filter ring or the end of the field of view probe. Press and release the *ZERO* switch, the display will momentarily show:-



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



3 OPERATION (continued):

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

At any time the measuring process can be halted by pressing the HOLD button.

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:-

4 ILLUMINANCE MEASUREMENTS

Illuminance is the measurement of photometric light per unit area, lumens per metre, Lux, or lumens per square foot, footcandle. 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 the illuminance.

Note that all the light sources in the hemisphere above the detector will contribute to the illuminance 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 illuminance measurements.

1) Set up the photometer as outlined in section 3.

2) Place the detector at the measuring point and record the value on the display.

3) The display can be read directly for light levels from 0 to 19 999 Lux.

CONVERSION FACTORS

1 Lux	=	0.0929 footcandle
1 Lux	=	1 candela @ 1 metre
1 Lux	=	d^2 candela @ d metres

5 BATTERY REPLACEMENT

1) Switch off the photometer before changing the battery.

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

3) Replace with a Lithium Manganese 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 photometer before normal operation will commence.

6 PHOTOPIC RESPONSE

Photometry is the measurement of visible light. Macam's photopic filter and photodiode closely matches the response of the standard human eye as published by the CIE (CIE Vλ). The spectral response of the photodiode detector with the photopic filter ring is plotted beside the ideal CIE response.

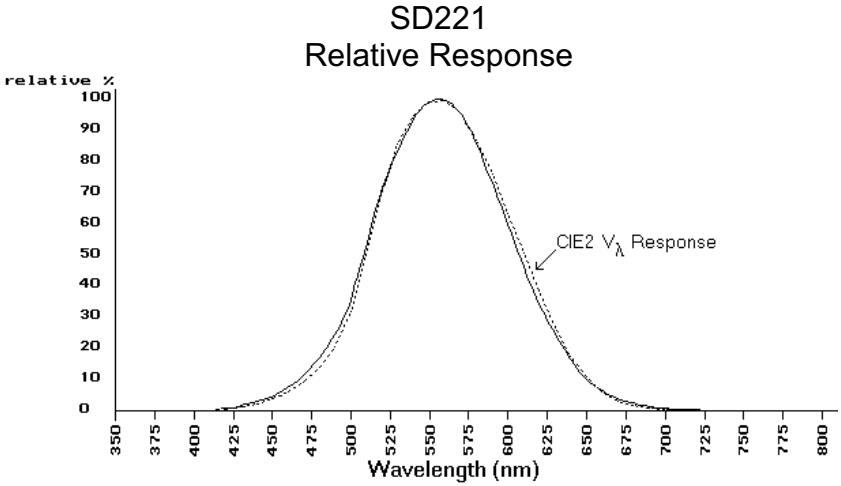


Figure 1

Photometers which do not closely match the response are often supplied with correction factors for different types of lamps and light sources. This means that the user has to identify the type of source being measured and correct the meter reading. This procedure becomes more unreliable when sources are mixed for example office lighting mixed with daylight through a window.

7 COSINE ANGULAR RESPONSE

Illuminance is a measurement of visible light incident on a unit area (Lumens/m²). A detector will measure this reliably when the light beam is perpendicular to the detector's surface. Accurate measurements of illuminance require that the detector should respond to light over a 180° field of view. More importantly, this response should be proportional to the cosine of the angle of light incident on the detector. To ensure that the integration of light from all angles is correct, the cosine diffuser fitted to the front of the detector is profiled such that the angular response of the detector decreases with cos(i) as the angle between the source and detector increases from 0 to 90°.

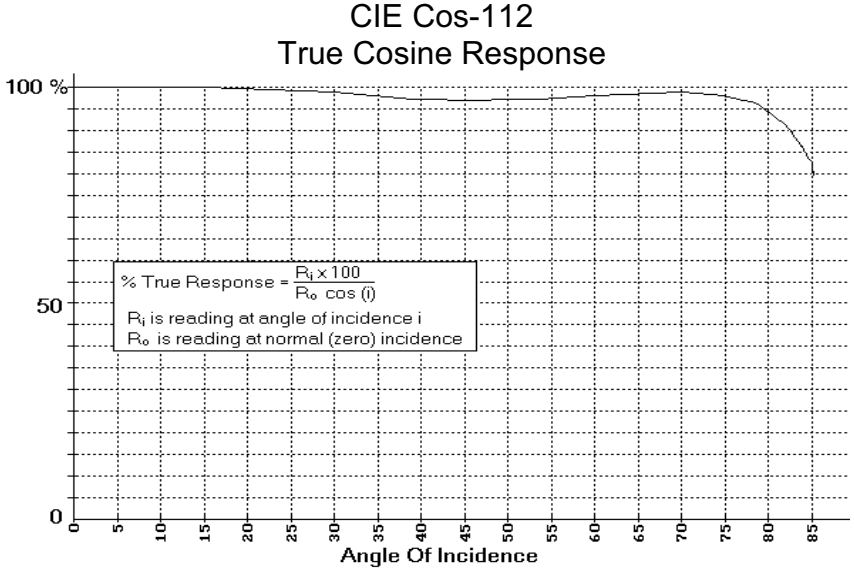


Figure 2

Macam's cosine diffusers are corrected to match the cosine response to within ±3.5% up to angles of 70°. This ensures that the meter correctly reads illuminance or visible light flux density whether it is measuring scattered light (from an overcast sky) or a point source (a single lamp in a dark room).

8 CALIBRATION DESCRIPTION

Macam Photometrics hold a number of tungsten halogen lamps, photometers and a silicon photodiodes which are routinely calibrated by the National Physics Laboratory in the UK.

The photometer is calibrated for illuminance using a lamp of colour temperature 2855K ±10K and for luminance using a highly uniform integrating sphere source of colour temperature 2600K ±10K.

Macam estimate the absolute accuracy error in calibration of each L201 photometers is ±5% for a source of illuminant A at normal incidence. The errors mentioned in section 4 namely spectral response and cosine angular error are small for most applications.

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.

9 BLOCK DIAGRAM