Measuring devices

A versatile and cheap tool for LEDs measurements

What is required in this small meter is not the accuracy of measurement (on eBay lux meters are calibrated with precision for about 20 euro) but the flexibility, ie the possibility to adapt its sensitivity and to calibrate it for each type of measurement, with just replacing the probe. The probes are constituted by a photodiode and a calibration resistor and cost a few euro. In this way it eliminates the switch and each constructive difficulty and you also get the advantage of being able to fix each probe in a stable manner without moving from a measuring apparatus to another.

Building

1) Buy a: BUILT-IN DIGITAL VOLTMETER LCD 3 1/2 DIGIT
at: www.futurashop.it

Code 8220-PMLCDL
Price: 5.00 € (excluding VAT)
(It costs very little and consumes only 1mA)

Features

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Automatic reset
Selection of decimal places
Automatic polarity
LCD Display:            3 1/2 digits
Full scale reading:     200mV
Power supply:           9V DC (7 - 12Vdc)
Height of digits:       13mm (0.52 ")
Sampling:               2-3 readings per sec.
Input impedance:        > 100Mohm
Accuracy:               + / - 0.5%
Consumption:            1mA DC
Panel cut-out:          54.5 x 38mm
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2) Buy a photodiode Sharp BS520

(A little 'hard to find - RS 315 to 321 - 3.77 €)

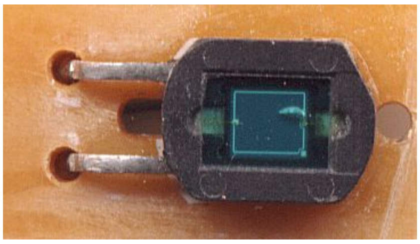
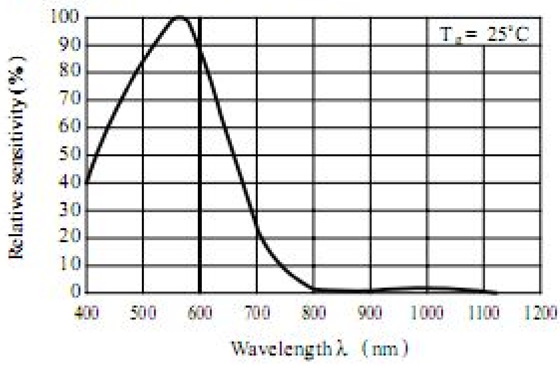
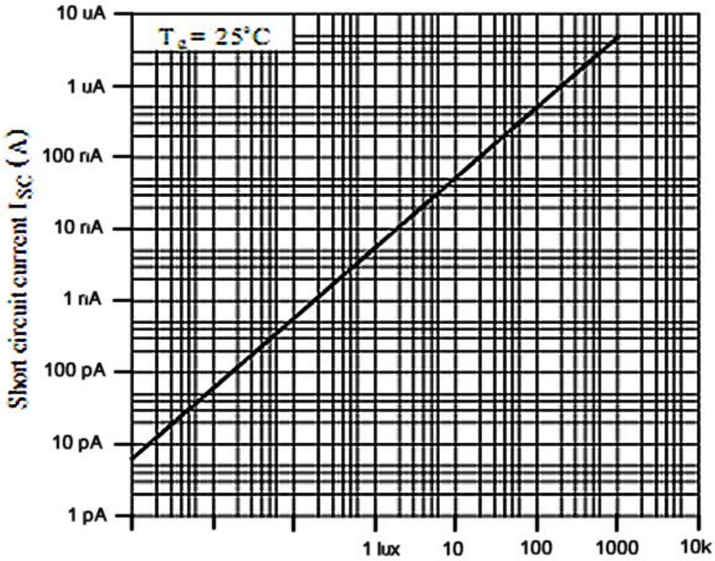


Fig. 4 Spectral Sensitivity



Short Circuit Current vs. illuminance



The BS520, without calibration, is already accurate 0.55uA with 100lux (+/- 15%)
The color sensitivity is corrected to be similar to that of the human eye.
The active area is equal to 5.34 sqmm

If you do not use the BS520 sensitivity changes and then you must recalculate the calibration resistors.

They could also go well BS120, BS100 on the BS500B or BPW21 (all with color sensitivity correct), or any other photodiode BPW34 or without correction of the color sensitivity.

To be suitable for the photodiode must generate current when illuminated (some do not), and place four inches from an incandescent bulb 50 .. 100W, must give a current of a few microamps to a few hundred microamps.

Connect the instrument read

9V battery (negative) ----
9V battery (Positive) ----
Photodiode (Negative) ----
Photodiode (Positive) ----

In parallel with the photodiode
you put a resistor as per the following table
(Valid values when using the photodiode BS520)

Resistor ohm	Full Scale lux	Minimum step lux	Current full scale	Current minimum step
200	200 000	100	1 mA	500 nA
2 k	20 000	10	100 uA	50 nA
20 k	2000	1	10 uA	5 nA
200 K	200	0.1	1 uA	500 pA
2 mega	20	0.01	100 nA	50 pA
20 mega	2	0.001	10 nA	5 pA

At this point the Lux meter is able to provide approximate values (+/- 15%) for a more precise calibration it is put to the sun (Clear and high in the sky) and tare for a hundred thousand lux.

If you want to do the best you add a power switch, a switch to change the course of a resistor + calibration trimmer for each course and finally is calibrated by comparison with a lux meter bought on eBay.

As a lux meter on eBay costs about 20 euro, shipping included, you might think about using that one issue. But the courses are few, the sensor is too large for measurements on LEDs and it is not possible integration into a test bench, with flow rates corrected for non-standard distances.

Bring in milli-candles

A millisecond is a thousandth of a candle foot-candle.
The foot-candle is measured by the led to a foot (one foot = 12 inches = 304.8 mm)
The lux meter is a hand-candle, and should be measured at one meter from the LEDs.

To obtain the thousand-candle should be measured at a distance of 304.8mm and split lux (1000 / 304.8 in the second) = 10.76391042, and then multiply by a thousand.

To avoid the uncomfortable relationship 10.76391042 simply place the photodiode at 333 mm from the LED (instead of 304.8 mm) the distance is almost the same but the relationship becomes a nice round 10 and you get to the table below, always using the same calibration resistors .

Bring in milli-candles if you measure 333 mm from the LED

Resistor ohm	Full Scale milli candle	Minimum step milli candle
200	20000000	10 000
2 k	2000000	1000
20 k	200 000	100
200 K	20 000	10
2 mega	2000	1
20 mega	200	0.1

For ease of construction of the measurement device can shorten the distance to 100 mm and then divide by ten the measured value, then coming to the table below.

Bring in milli-candles if you measure 100 mm from the LED

Resistor ohm	**Full Scale milli candle**	**Minimum step milli candle**
200	2000000	1000
2 k	200 000	100
20 k	20 000	10
200 K	2000	1
2 mega	200	0.1
20 mega	20	0.01

Calibration Resistors

The scales useful for measuring the various conditions are many.

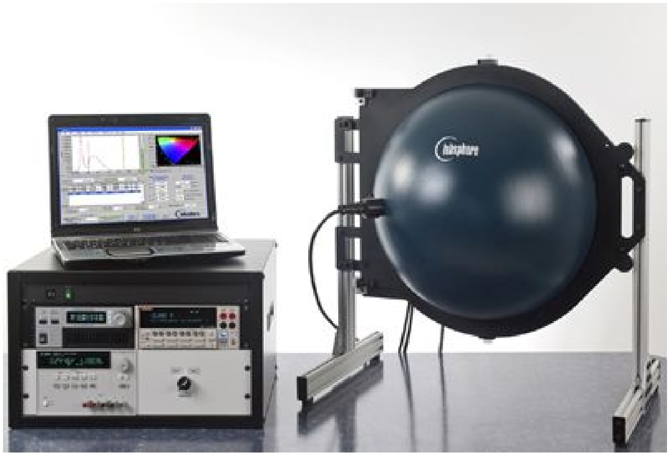
- Six scales to measure the photodiode lux with BS520
- Two scales to measure milli-candle with the BS520
- Two scales to measure the total power with the solar cell
- Any additional steps that might be useful later

An additional scale, for example, serve for a mirror ball to measure the total light power emitted independently from the opening of the beam.

Measure the total light output with ball integration

A ball of light integration (Integrating sphere) allows measures indipendents from the aperture of the beam.

Since the spheres commercial cost inflated figures it is necessary to find an alternative "do it yourself". Probably a ball christmas tree with silver lining, it could go well (yet to try)



Characteristics of some sensors

Type of sensor	1 lux	200 lux	FLUORESC. 1,000 lux	SUN 100000 Lux
BPW34 (0.62A / W @ 850nm)	30 nA (?)	1uA (?)	30 uA (?)	3000uA (?)
BS520 - Sharp (Eye corrected)	5 nA		10 uA	500uA
Phototransistor FPT100A (Used as a diode)	3 nA	0.6 uA	3 uA	300uA
Phototransistor FPT100A (Used as a transistor, with 5V)		15 uA		
TSL235R	120 Hz		120 kHz	4000 lux 500kHz (max)

Measure the total light power in watts

To measure the total power emitted is very close to the LED (or laser) so that all the light falling on a sensitive area of the cell, then moves the position slightly until you find the maximum current.

It should use a small solar cell, or a fragment of the solar cell (must be a single cell and not more cells in series)

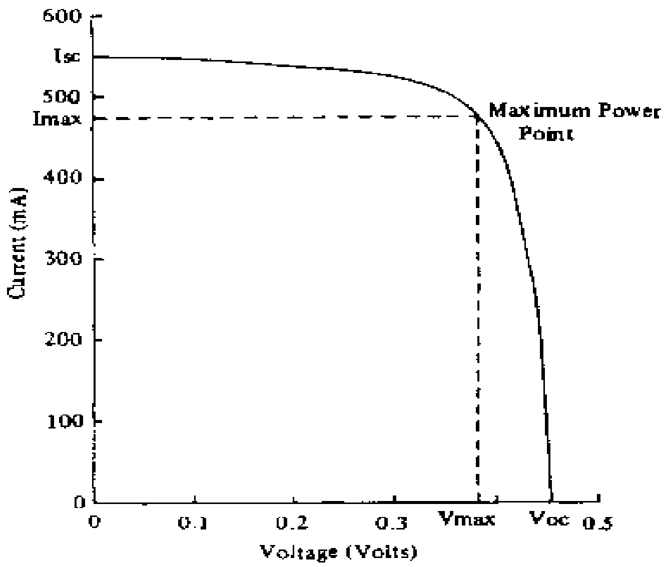
We measure the size of the sensitive part in mm2, subtracting the areas covered by silver.

Place the cell in full sun and measure the current. Since the sun provides about 1000w per square meter, it follows that each receives about a framework mm milliwatts.

Whereas the power curve of the solar cells, visible in the figure, each mW (divided by 0.38 volts) should give 2.63 mA at the point of maximum power.

The current measured at zero volts should be about 17% more for that one milliwatt = 3mA about

The efficiency of solar cells should be from 10% to 12%, so a milliwatts = approx 0.3 .. 0.36 mA



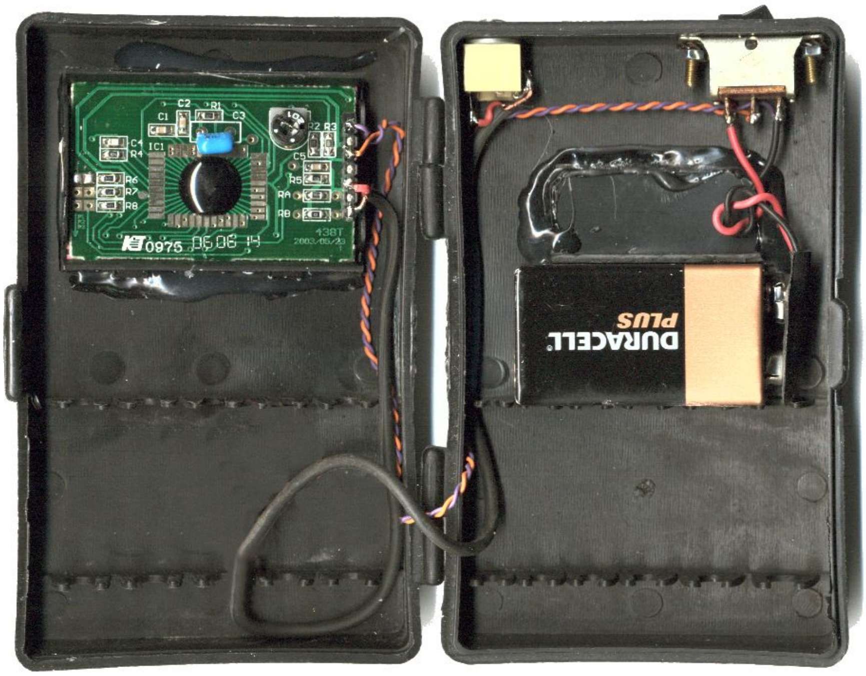
My test cell, from 64mmq produces 15mA under the sun, therefore:
15 mA = 64 mW
 1 mA = 4.3 mW
 1 mW = 0.23mA

So my cell has an efficiency of 7.75% which is a reasonable value when you consider that it was produced about fifteen years ago.

The milliamps multiplied by the measured mW for different mA (in my case 4.3) give the total light power emitted by the LED (or laser) From the watts you can move on to multiplying by 683 lumens (1 watt = 683 lumens of light)

Knowing the "W" or "Lumen" and the opening of the LED in "degrees" you can use the program "LedCalc" to calculate the "Milli-Candles"

A possible embodiment



A case for drill bits, cutter, hot glue, and four components ten minutes work.

The instrument finished with one of the probes.

The probes are constituted by a photodiode and a calibration resistor and cost a few euro. In this way it eliminates the switch and each constructive difficulty and you also get the advantage of being able to fix each probe in a stable manner without moving from a measuring apparatus to another. The calibration for **each type of photodiode and each measure** and 'immediate, just **connect the appropriate probe.**