

Measuring lumens with "VS-LUMEN"

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Version 1.0



Content/purpose

This document is a description of the calibration and validation of the lumen tube VS-LUMEN and the method of measuring the lumen output of flashlights.

VS-LUMEN description

The VS-LUMEN consists of:

- Lumen tube
- Lux meter NKTECH NK-W2, serial no. 01709094
- Adapter rings for different flashlight sizes

Calibration lightsource

To calibrate the VS-LUMEN we need to establish the correction factor and formula from the measured fc-value to the correct lumen. In order to do so we need to have a light source with a measured and correct lumen value. One of the highest regarded manufacturer that are considered to give correct lumen values on their flashlights are Fenix. We have chosen the LD60 as light source as it has three LED:s that can be turned on or of separately giving as many different lumen outputs as possible. This light has also been tested by Selfbuilt at <http://www.flashlightreviews.ca>

Table 1. Manufacturer stated values and results from tests by Selfbuilt:

Flashlight mode/ Number of batteries	LOW 1x 18650	LOW 2x 18650	LOW 3x 18650	MED 1x 18650	MED 2x 18650	MED 3x 18650	HIGH 1x 18650	HIGH 2x 18650	HIGH 3x 18650	TURBO 3x 18650
Value from manufacturer			160			500			1500	2800
Measured value by Selfbuilt	50	100	150	165	330	500	500	1000	1500	2850

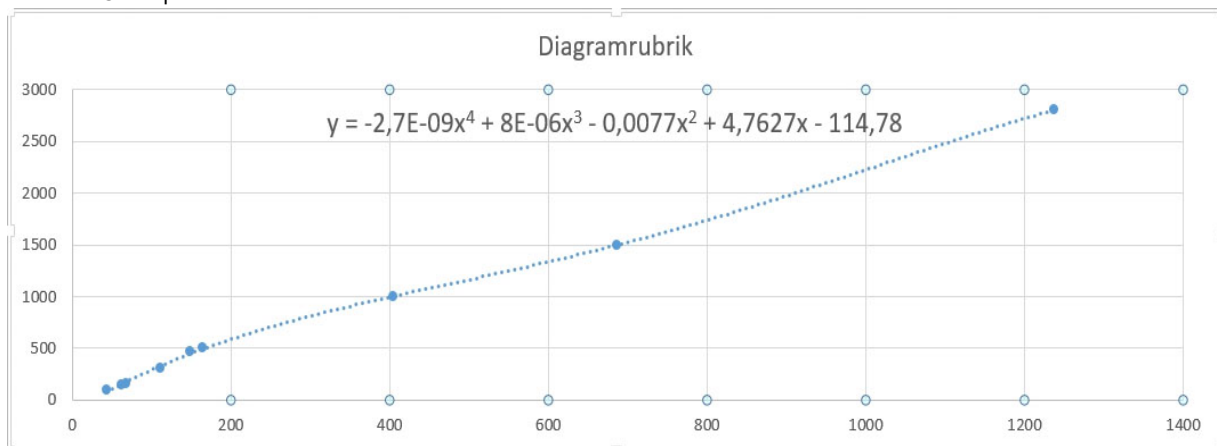
As this independent test verifies the values given by the manufacturer, we will use them as reference values for all our tests. Due to the fact that none of this values are tracable to an international standard by any means, all our results are only comparable to this particular lamp.

Correction value and formula

To get an equation for the fc-value to lumen conversion, we make measurements with all different light settings on our reference light. The measurements is done according to "Procedure of measurement".

All values are then imported to Microsoft excel and its nonlinear regression function is used to calculate the conversion formula.

Picture 1. Curve plotted in Excel



The conversion formula given by excel is:

$$lm = -2,7 \cdot 10^{-9} x^4 + 8 \cdot 10^{-6} x^3 - 0,0077 x^2 + 4,7627 x - 114,78$$

where x is the fc-value from the Nktech instrument.

This gives us all the values to fill in the table:

Table 3. Measurement results:

Flashlight mode/ Number of batteries	LOW 1x 18650	LOW 2x 18650	LOW 3x 18650	MED 1x 18650	MED 2x 18650	MED 3x 18650	HIGH 1x 18650	HIGH 2x 18650	HIGH 3x 18650	TURBO 3x 18650
Value from manufacturer	-	-	160	-	-	500	-	-	1500	2800
Measured value by Selfbuilt	50	100	150	165	330	500	500	1000	1500	2850
Fc-value from instrument	17	43	63	67	111	158	165	405	687	1237
Calculated lumen Eq. from excel	-36	76	157	172	330	475	495	1010	1516	2815
Deviation from target %	Out of range	34,0	-1,9	4,2	0	-5,0	-1,0	1,0	1,1	0,5

Conclusion

The above formula covers the range from 150 lumen up to 2800 with a deviation of max 5%. This gives us a pretty good picture of the light output from the tested flashlights.

Procedure of measurement

All batteries must be fully charged before measurement.

The Nktech instrument is turned on and the unit is switched to fc.

An adaptor ring with correct size for the flashlight is put on the glass and the flashlight is put in the middle.

The flashlight is turned on, and after 30 seconds of warmup, the value from the instrument is read.

The conversion formula is used to convert the measured fc-value to lumen.

All lumen values are always presented as highest possible lumen. This means the flashlight is measured at highest output setting and for flashlights with zoom function, the zoom is in the position where the highest output is read.