GONIOPHOTOMETER WITH LARGE NUMBER OF DIGITAL PHOTO SENSORS.

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Abstract

The report describes goniophotometer measurement of light distribution which is constructed in University of mining and geology "St. Ivan Rilski. There are used many photo sensors installed on the wall and ceiling on the photometric laboratory. The sensors are Microprocessor devices with embedded 16-bit ADC discharge. Each of the photosensors is individually calibrated. The design allows the measurement of the light distribution to be done in less than 30 minutes at step of measuring the angles of respectively 2.5 and 5 degree. The kit includes a system for measuring the temperature of the luminaire.

1. Principle of measurement of light distribution for lighting

To be able to design a lighting system it requires the light distribution of the luminaire to be accurately measured. To capture the light distribution is usually used computer controlled goniofotometers. The process is labor intensive, slow and requires a trained personnel.

Measuring the spatial distribution of the light intensity can be performed in three patterns. The most common in practice is shooting the light distribution in γ-C plane system (Fig. 1) [1]

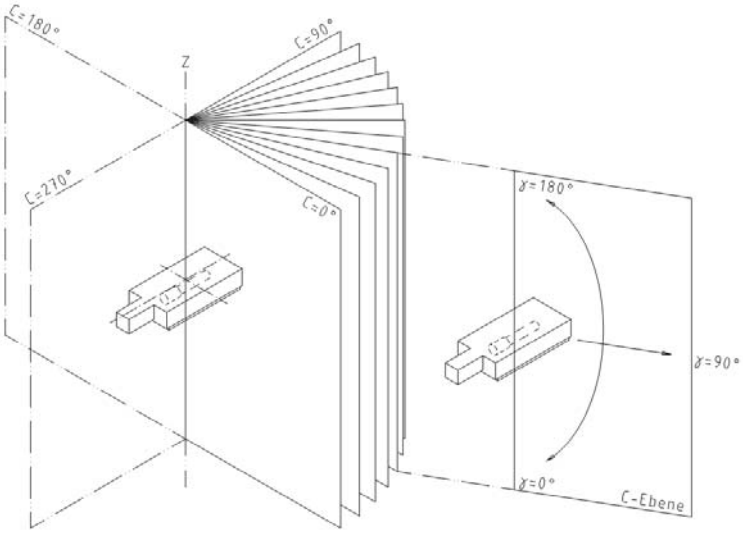


Fig. 1. γ-C plane system

The principle of measurement of the light distribution of the luminaries shown in Fig. 2. The luminaire is placed in the center of the coordinate system. It is possible to pivoted C and the photoreceiver is mounted on a movable arm and it is rotated by an angle γ. (Fig. 2).

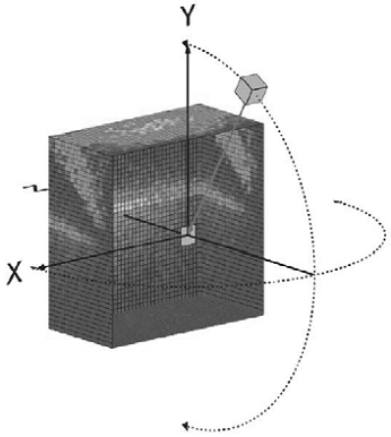


Fig. 2. Measurement principle

The main drawback of the existing types of goniofotometers is the long time to take a measurement. The reason for this is the ultimate speed at which to rotate the shoulder with photoreceiver or mirror. The problem is not mechanical - the large torque can be overcome with a more powerful engine. The restrictions come from the power of the lamps with variable voltage and frequency 50Hz. The minimum measurement time at one point should be continued for at least two half-period - 20 milliseconds. In order to increase the measurement accuracy, it is practiced to each point to a number of measurements that corresponds to the time 0.2 sec. If the arm or the mirror of the goniofotometer moves

evenly, then its rotational speed should be not higher than 0.5°/sec. When measuring during 5° C-plane, the measuring time is approximately 8 hours.

In order to eliminate this limitation, this sphere has a number of 39 optical sensors mounted on the wall and ceiling of the photometric laboratory. The sensors are devices with built-in 16 digit ADC microprocessors (Fig. 3).

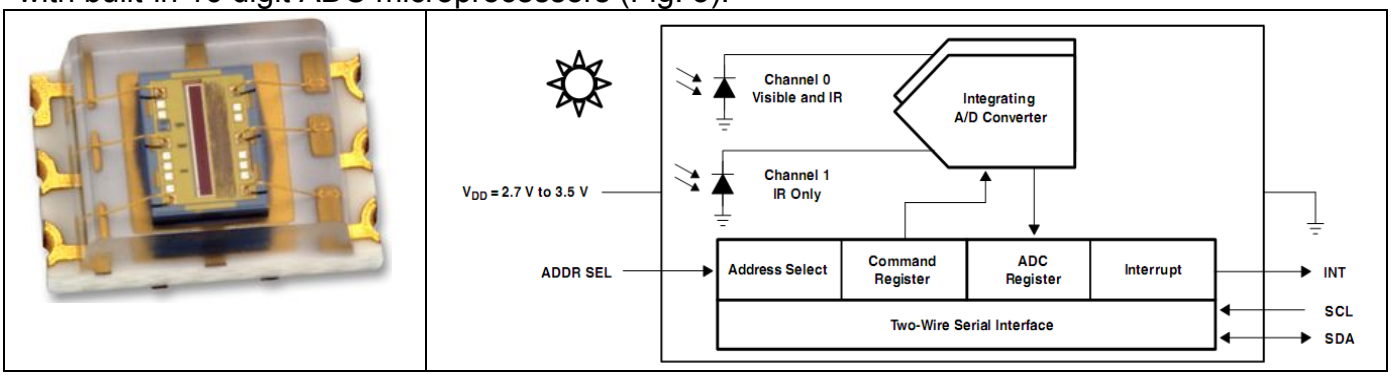


Fig. 3. Vashen type and structure of the photoreceiver.

Each light sensor consists two channels of analog-to-digital converter, which integrates the current of two photodiodes with different spectral sensitivities. The communication with the device is done by a standard two-wire line I2C serial bus. Each device matches a photodiode with a broad spectral range (visible plus infra-red light) and one infra-red photodiode on CMOS integrated circuit with the effective 20-bit dynamic range (16-bit resolution) (Fig. 4). From these two input signals we could get the illumination in lux empirical formula which provides a spectral response close to that of the human eye. [2]

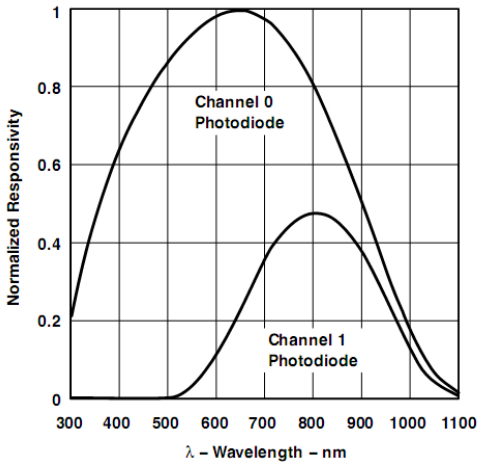
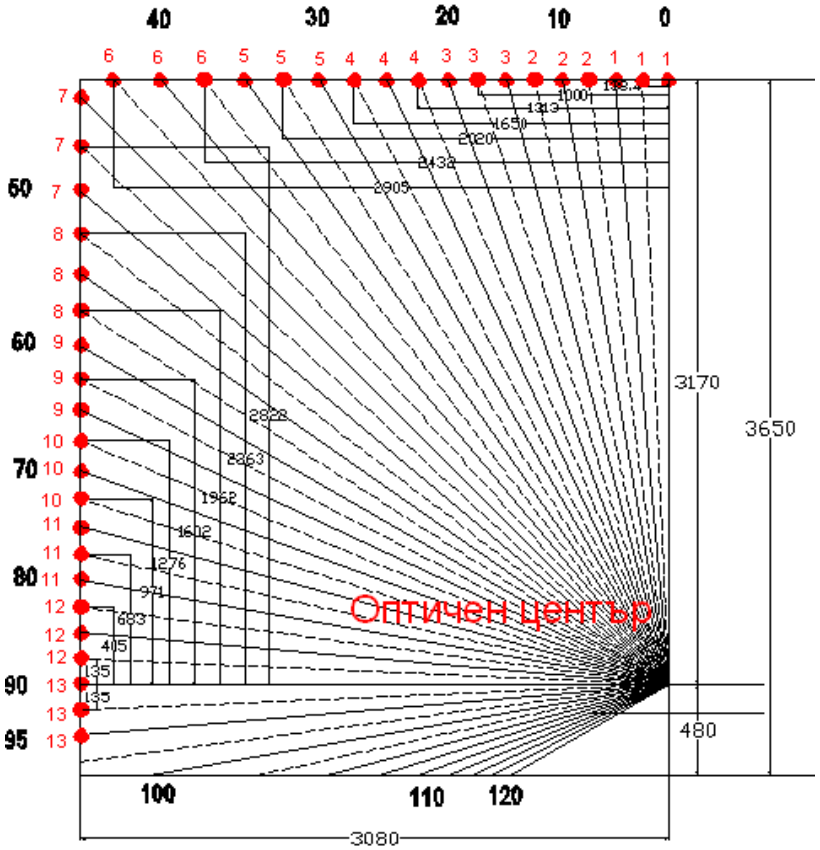
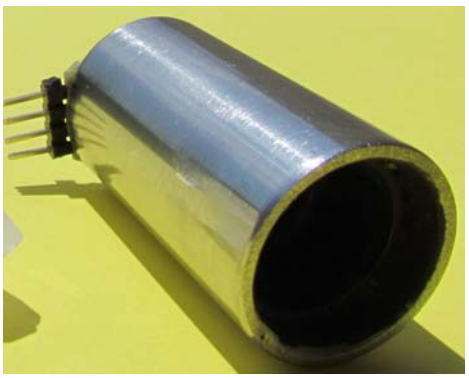


Fig. 4. Spectral sensitivity for each of the two channels.

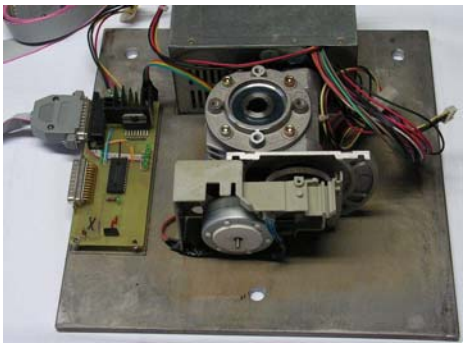
The sensors are installed on the wall and on the ceiling in such a way, that the photometer could occupy a minimal space and we could use the maximum distance from the luminaire to the photosensors (Fig. 5). For this purpose they are mounted on a splint hanging on the wall and ceiling. On a specific location in the room is placed a rotating table. The optical center of the luminaire should be located on the 17 cm above the center of the table. The sensors are arranged in that way, that the γ - plane and the optical center angled 2.5 degrees with each other (Fig. 5). The measurement of the γ - plane is performed by scanning and reading the information from the sensors - 39 pcs. The measurement at the C-planes is done by rotating the table at a predetermined angle - in this case - 5 degrees. The sensors measured the generated light. The distance between the sensors and the optical center is defined in advance. The predetermined intensity of light to each sensor is calculated using the formula: $I = E \times R^2$. The distances to the sensor depends on the geometry of the room and the location of the optical center. The measurement of the distances could be accomplished with a laser rangefinder, or by the construction of precise geometry. In the second case there must be payed attention if the walls are deviated from the 90 degree angle.

The light distribution is captured in the γ-plane system with a 2.5 ° step in the plane γ (0 ° - 95 °) and 5 ° in the plane C (0 ° - 360 °) according to BS EN 13032-1:2005 4.2.3. [1]





sensor



Base with reducer

Fig. 5. Scheme of installation of photosensors.

2. Description of the measurement program.

For the measurement of the luminous intensity is created a suitable software. Fig. 6 shows a print-screen of the performing at the moment the measurement software.

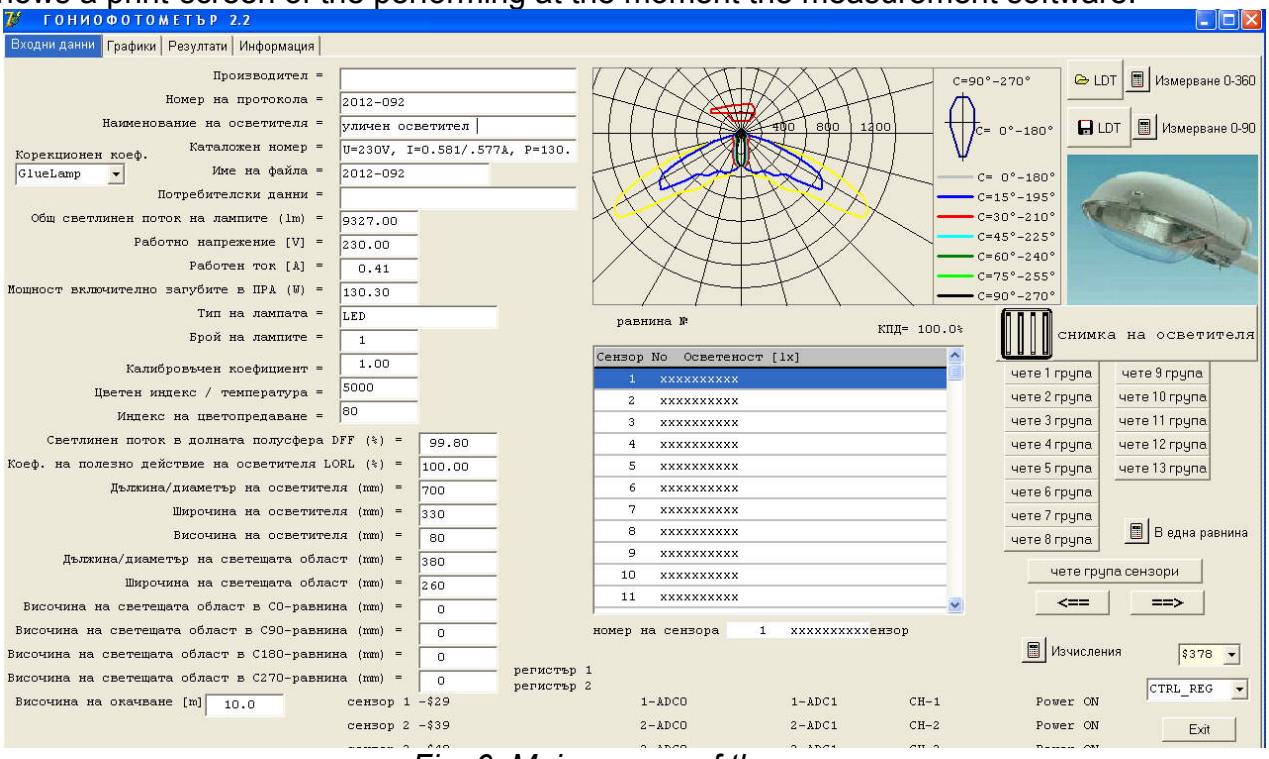


Fig. 6. Main screen of the program.

The program management is performed by the main menu which switches between four options:

1. An input data and a measurement;
2. Graphical visualization and printing of the measurement results;
3. Results of the generated illumination in tabular form;
4. Manual instructions for the program.

2.1. Input data and measurement.

On Fig. 6. is displayed the screen which serves as an input of data and measuring the light distribution of the luminaires.

All these data are necessary for the creation of files in EULUMDAT format.

2.2. Calibration of the Photodetectors.

Before the initial start of the goniofotometer, the photosensors must be calibrated. In general the photosensors are aging very weak and they are not affected by temperature, but the calibration of the photometer should be performed periodically – in every 6 months for example.

2.3. Measurement of the light distribution of the luminaire.

Before starting the measurement, the luminaire must be correctly mounted on the table of the goniofotometer. Due to the chosen scheme assembly shown in Fig. 5 and construction of the goniophotometer, the installation of the luminaire is made easier as it can simply be placed on the rotating table. Meanwhile it should be observed the proper orientation relative to the C-planes. Fig. 7. shows the orientation of the street lamp before the start of the measurements.

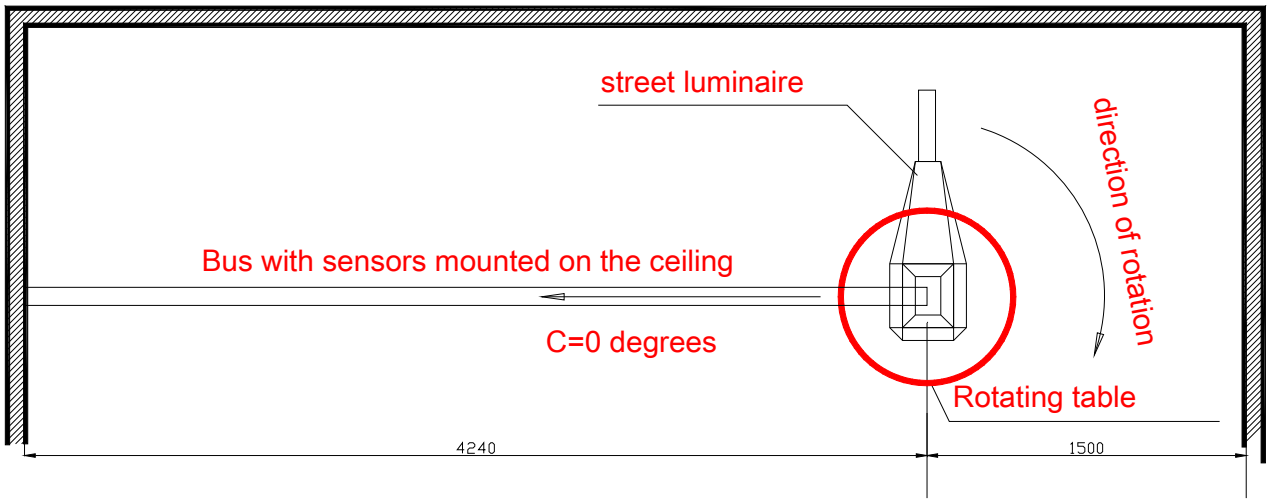


Fig. 7. Orientation of the street lamp (illuminator lights to the ceiling).

During the measurement, the visualization of the light distribution is displayed in a separate panel - Fig. 8.

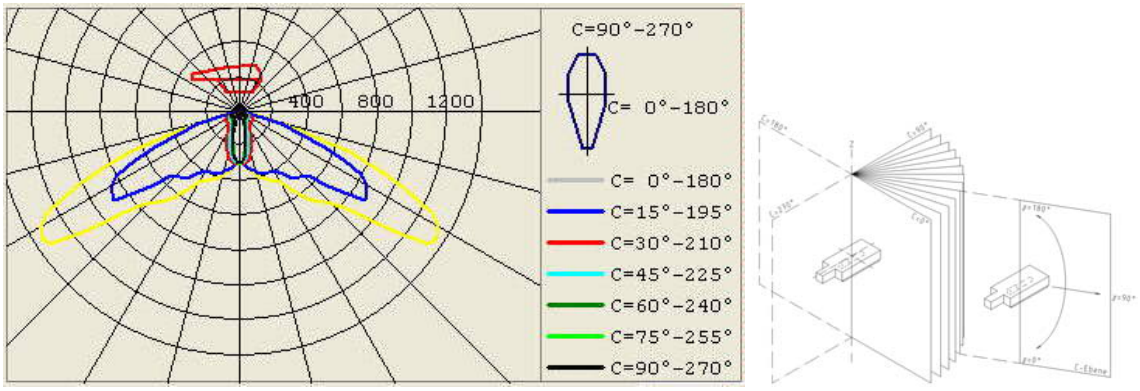


Fig. 8. Visualization of the measured light distribution.

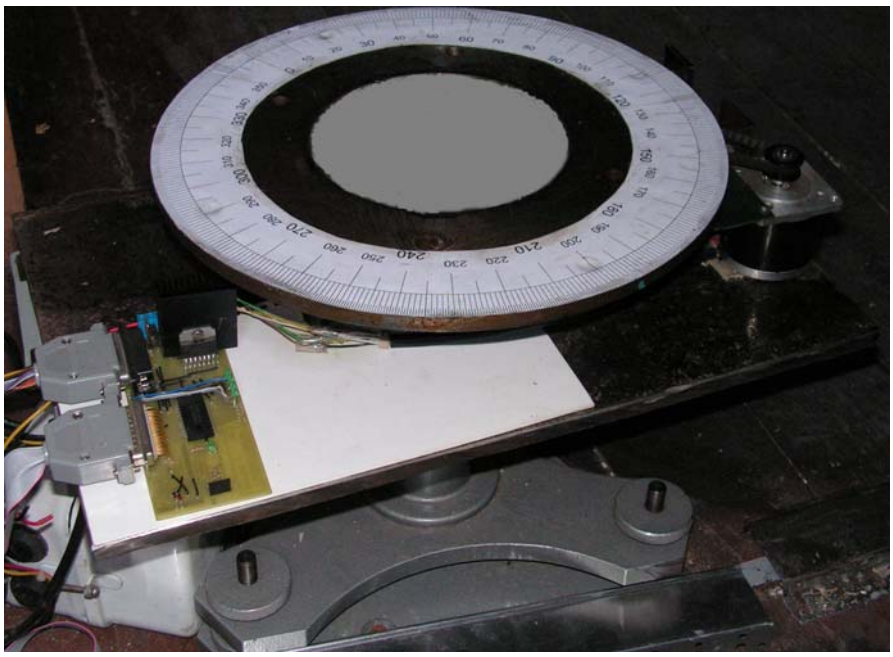


Fig. 9. Rotary table..

2.4 Generating of test-report of the measured luminaire.

The measurement results are represented text files of the following types:
- ***. Ldt - complete photometric data in a standard format
- ***. Ocb - complete data in tabular form.

The test report is generated automatically in pdf-format or printed directly to the printer.

To visualize the light distribution in 3D is using the ILEXA Ray-Viewer software [6]

For the proper documentation is necessary to take a picture of the lamp (in *. JPEG format). To control the electrical parameters of the lamps during the measurement is used the laboratory Power Meter HM-8115-2 (Fig. 10). It allows the measurement of the voltage, current, active and reactive power. The photometer is controled by a computer and the results obtained by the USB interface [3].

Fig. 10. Power Meter HM-8115-2

CONCLUSION

Created in the laboratory "Lighting" at University of mining and geology "St. Ivan Rilski " in 2010 the goniofotometer is intended for capturing light distribution of LED lamps and luminaires with linear dimensions smaller than 60 cm. [4,5]

The measurement time of the luminaire is about to 40 minutes. Using the principle of capturing light distribution in the plane γ due to the simultaneous operation of the 39 light sensors, it allows to express the captured light distribution of the luminaire. The measurement is accomplished at step of the 2.5 degrees in the γ-plane - and respectively at 5 degrees in C-plane.

Goniofotometer can be installed in a small-space room.

For connecting external devices - photo and thermal sensors is used a parallel and serial port on your computer and it does not require additional and extra hardware to be instaled.

There is also created a software which is developed to manages and reads all sensors and devices. The results are displayed immediately in the form of charts and graphics. After the measurement is automatically generated a test report. Until now, with this photometer are issued apox. 400 test reports for measuring luminaires. The type of the test report are shown in the appendix to the presented report.

According to the described photometer in the Light laboratory, there are others made for industrial purposes created for a company “Mareli” Ltd in 2011. and “Samel-90” Ltd – 2012.

REFERENCES

[1] BS EN 13032-1,2:2005, Light and lighting — Measurement and presentation of photometric data.

[2] Texas Advanced Optoelectronic Solutions Inc., TSL2561, LIGHT-TO-DIGITAL CONVERTER

[3] Hameg HM8115-2, Programmable AC Power Meter, http://www.testequipmentdepot.com/hameg/powersupplies/hm81152.htm

[4] Велинов К. GONIOPHOTOMETER FOR EXPRESS MEASUREMENT OF LED LUMINAIRES, XIV Национална конференция с международно участие BulLight / България Светлина 2010,10 – 12 Юни 2010, Варна, България.

[5] Велинов К, Goniophotometer modernization with large number of digital photo sensors, University of mining and geology “St. Ivan Rilski”, 19-20.10.2011..

[6] http://www.ilexa.de/ - ILEXA Ray-Viewer

APPENDIX

UNIVERSITY OF MINING AND GEOLOGY “Engineering” LTD
Laboratory "Lighting"

MEASUREMENT REPORT NUMBER 2013-008/23.01.2013

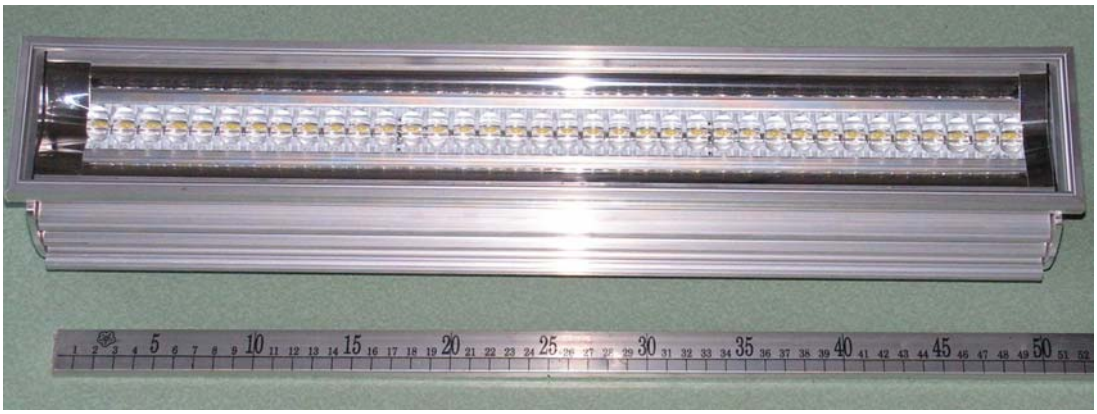
testing samples of products

Model number or type, referring to the manufacturer: LED Luminaire XXXXXXX
ID XXXXXXXX1
Company identification: Solar XXXXXXXXXXXX
Applicant testing: XXXXXXXXXXXX
Type of test: control measurements

Measurements have been performed:

- luxmeter PU 550, ID 263621/2586, calibration certificate of the METRA BLANSKO a.s.№2887/2012, 19.12.2012;
- luxmeter KYORITSU 5202, ID K0017929, calibration certificate of the National Centre of Metrology 181-ОИ/15.12.2012;
- luminance-meter L 1003 of angular field 1°, producer “LMT” Germany, ID 0686191, calibration certificate of the National Centre of Metrology 130-ОИ/20.12.2010;
- Ulbricht photometer with diameter 2м;
- Automated goniophotometer.
- Power Meter HM8115-2 ID 015447345, calibration certificate of the National Centre of Metrology 148-ЕЕИ/14.12.2012;
- Digital thermometer with temperature sensor DS18B20 ID 0000011697CDH, calibration certificate of the National Centre of Metrology 268-ТИ/14.11.2012;
- Ampermeter Д5101 ID 737/1990, calibration certificate of ‘ЛК УНИСИСТ’ Ltd №733/21.11.2012;
- MEGER UT512 ID 1111074682, calibration certificate of ‘ЛК УНИСИСТ’ Ltd №732/21.11.2012;
- Laser rangefinder DLE-40

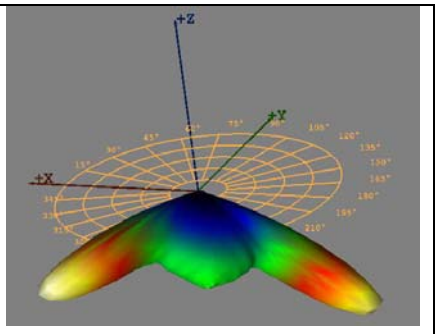
Technical specifications of documentation:
Luminescent luminaries: LED Luminaire XXXXX, ID XXXXX, Optics - lens

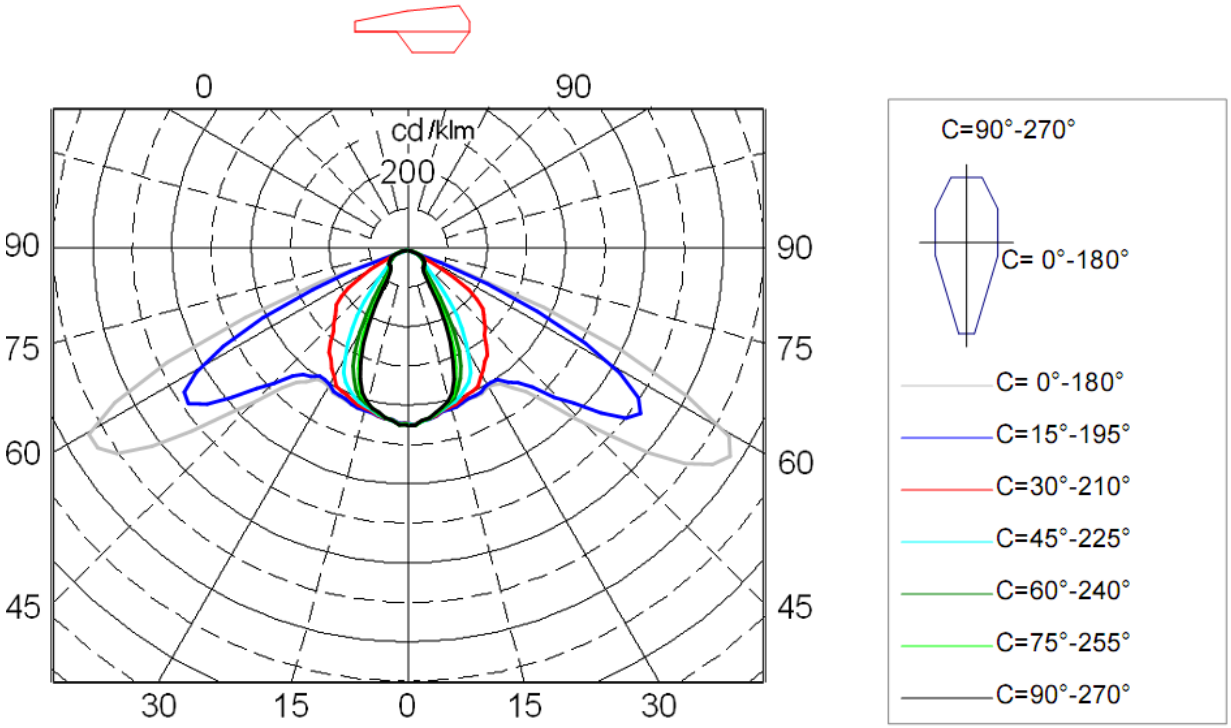


Luminaire

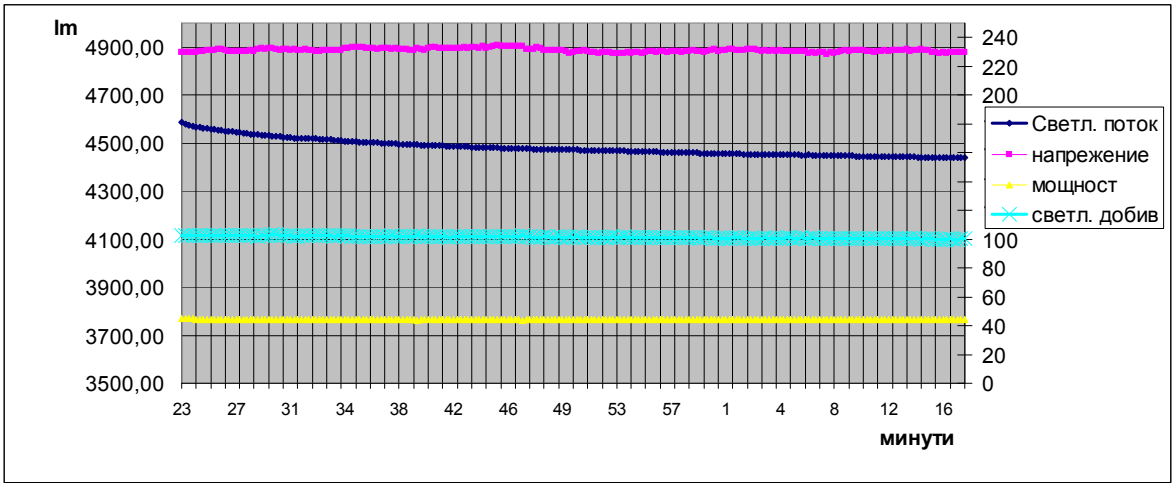
Results of test

	Lamp with power
Operating voltage	**AC 230V**
Operating Current	**AC 0.329A**
Wattage including ballast (watts)	**44.6**
Power factor	**0.59**
Luminous flux emitted by a luminaire	**4440 lm**
light output	**99.5 lm/W**

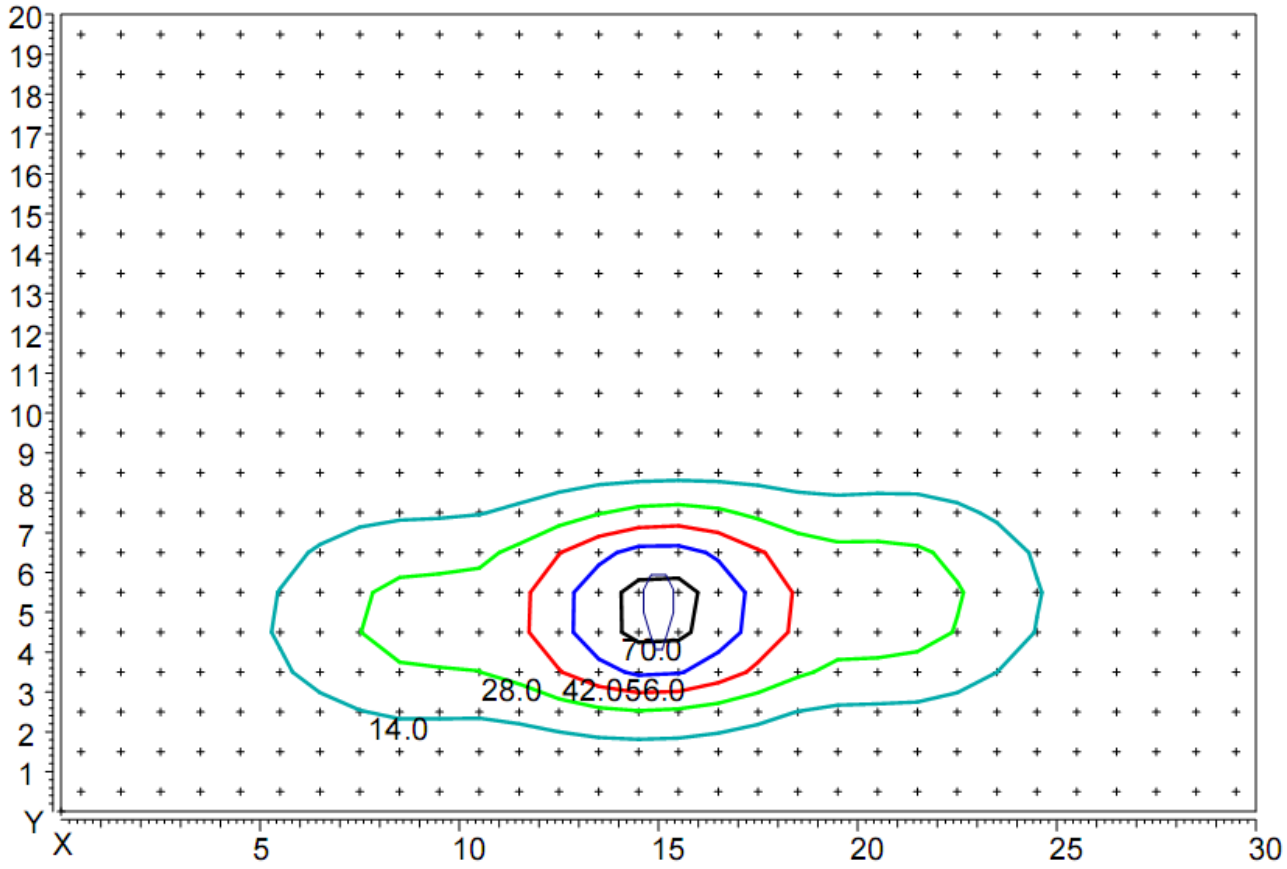




Luminaire light distribution of polar coordinates in the conditional flux 1000lm



Changing the light flux



Distribution of illumination in height hanging lamp 5 м
Coordinates of the luminaire X=15m, Y=5m.

Applications:
Files with the EULUMDAT format. Light distribution is captured in γ-C planes with step 2.5° in plane γ (от 0 ° - 95 °) и 5° in plane C (от 0 ° - 360 °) accordance with EN 13032-1 p 4.2.3.
Files with the measured values
- 2013-008.ldt - photometric data in a standard format
- 2013-008-P1.ldt - photometric data in a standard format for plane of symmetry C = 90° - 270
- 2013-008-P2.ldt - photometric data in a standard format for two plane of symmetry C = 0° - 180° и C = 90° - 270°,
- 2013-008.ocb - complete data in tabular form.
- File 2013-008.xls measurement results
Test results relate only to test samples.

Sofia 23.01.2013

The measurements:

/assoc. prof. d-r. Krasimir Velinov/