EMRP ENG05 Metrology for Solid State Lighting
D2.4.1 Report on junction temperature vs. voltage characteristics for the selected SSL

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Introduction

Five different types of solid state lamps were disassembled:

1. Philips MASTER LED 12 W
2. Osram Parathom PAR16 4.5 W Spot
3. Osram Parathom CLASSIC A40 8 W
4. Osram Parathom CLASSIC A60 12 W and
5. Osram Parathom CLASSIC A80 12 W

Circuit boards containing the LEDs were wired so that the individual LEDs could be operated separately. The voltage – current characteristics were measured at temperatures 30, 50, 100 and 150 deg C.

Measurements

The junction voltage *U* measurements at different currents *I* and different temperatures *T* were made as follows. LEDs were installed in a thermostat which was controlled and stabilized to temperature *T*. We waited 1-2 hours untill the temperature reached one of the required (30; 50; 100 and 150 °C) temperatures. Three types of thermostats were used.

1. A metal block thermostat (Hart Scientific; type: 9260) with an inner diameter of 47 mm and a temperature range of 25-700 °C (Figure 1). We measured all types of LEDs in this thermostat which fitted in. The temperature was measured with a 100 ohm PRT and 10 mK accuracy. The 0,1 K temperature homogeneity of the measured space was the upper limit of the temperature uncertainty given for the LEDs.

Figure 1. Thermostat Hart Scientific; type: 9260.

2. A water bath thermostat (Huber) with an inner diameter of 70 mm and a temperature range of 5-90 ^{o}C (Figure 2). We measured all types of LEDs in this thermostat which did not fit in the metal block. The temperature was measured with a 100 ohm PRT and 10 mK accuracy. The 0,1 K temperature homogeneity of the measured space was the upper limit of the temperature uncertainty given for the LEDs. In this case the 70 mm inner diameter tube was located in the flowing temperature stabilized water bath.

Figure 2. Huber water bath thermostat.

3. An oil bath thermostat (Huber) with an inner diameter of 70 mm and a temperature range of 100-200 ^{o}C (Figure 3). We measured all types of LEDs in this thermostat which did not fit in the metal block. The temperature was measured with a 100 ohm PRT and10 mK accuracy. The 0,1 K temperature homogeneity of the measured space was the upper limit of the temperature uncertainty given for the LEDs. In this case the 70 mm inner diameter tube was located in the flowing temperature stabilized silicon oil bath.

Figure 3. Huber oil bath thermostat. The upper part of the metal tube was well isolated in order to decrease the nonuniformity of the space where the LEDs were located.

The measurement sequence can be characterized as follows:

1. Our goal to switch a current impulses as quick as possible on the LED (usually within 1 us can be realized)
2. Measure the junction voltage as quick as possible for 4 digits (we were able to use a sampling time of 19 us). The length of the impulse was 100 voltage measurement time, in our case 1,9 ms. This speed is required in order to measure the temperature change during the pulse. The measured values reflect the electrical capacitance of the LED as well (together with the junction voltage change caused by the junction temperature change)
3. The 100 junction voltage data is collected (together with several secondary data) by the controlling computer
4. In 10 sec. we repeat the pulse and the entire procedure 7 times in order to reduce the measurement uncertainty. We use the statistical procedure of median as a function of time for the 100 data.
5. Then we go to the next current and repeat the entire procedure
6. After we have finished the measurements on a LED, the multiplexer switch on the next LED and the entire procedure is repeated
7. If we have measured all LEDs, the program started with the first LED again. This makes possible repeatability measurements for the uncertainty judge

The temperature change was not programmed in the procedure due to safety reasons. Therefore to make the measurements at another temperature required personal presence. It was regularly checked whether the things are rolling well of course.

Electrical connections

We had to resolder the LEDs in order to make possible the computer controlled measurements. Therefore we have used 40 pole connectors soldered to the LEDs in 5 groups with a 10 color 40 wire strip cable:

1. - Philips Master LEDs MV 18 pc. (3x6)

LED marking: there was 3 panel marked by us with A; B and C and by the manufacturer got each LED a number: 1-6. Therefore each LED was characterized with

PH_ (as Philips) + A; B ore C (which panel) + 1; 2; 3; 4; 5 ore 6 (which LED),

for example**: PH_ A_1**

Figure 4. Cabling for Philips MASTERLEDs.

2. Osram PARATHOM CLASSIC A40 - 6 pc. (original) + Osram PARATHOM PAR 1620 - 4x3 = 12 pc.

LEDs are together on 40 wire strip cable

The 6 pcs. Osram PARATHOM CLASSIC A40 LEDs are located on one board and they are marked with D10 - D15

Figure 5. Cabling for Osram Parathom Classic A40.

3. 12 pc. LEDs Osram PARATHOM PAR 1620

Located on 4 boards (marked with B13-B16) and each LED on the board is marked with A; B; or C

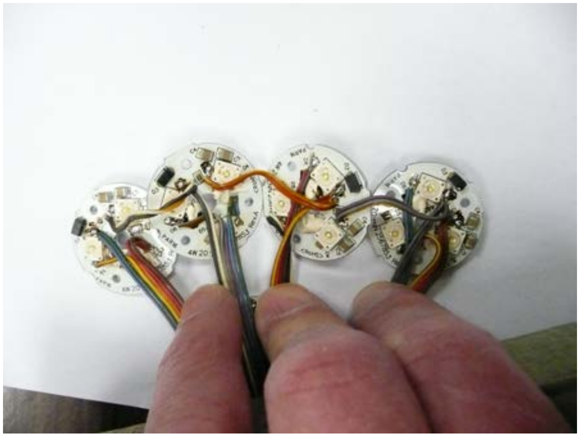

Figure 6. Cabling for Osram PAR 16.

4./ - 2x 9 pc.   LEDs Osram PARATHOM CLASSIC A 60

Measured in the original bulb. The LEDs were marked by me with numbers (1-18)

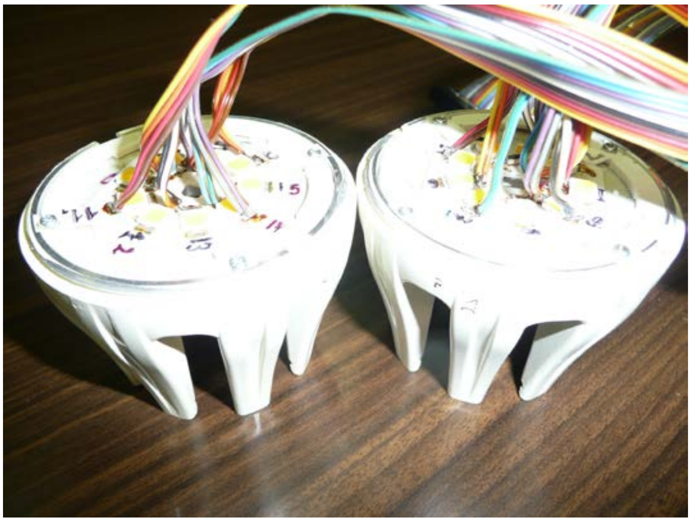

Figure 7. Cabling for Osram Parathom Classic A60.

5./ 10 pc. red and 9 pc. white Osram PARATHOM CLASSIC A 80 -

These LEDs are individual LEDs soldered in our laboratory. The LEDs in the bulb was not solderable due to the extreme good cooling contact. You were not able to solder them either.

We have marked the LEDs with a letter **R** (stands for red) or **W** (stands for white) and numbers (1-10 for reds, 1-9 for whites): R1-R10; W1-W9

Figure 8. Cabling for the red and white LEDs of PARATHOM CLASSIC A 80 .

Results

The results can be found in the attached Excel-file *D2.4.1.LED junction voltage results.xls*. Results of each lamp type are on separate sheets.

Some other measurement news

I am measuring 1,5 A Luxeon white LED with cooled base to 20± 0,1 °C since July 2011. The change I have observed: a flux decrease of 3% and a **Junction voltage decrease of 12 mV**. The change was approximately linear in time. This may require more measurement in our project as well.