



Test Report

IES LM-80-15 Approved Method for Measuring Lumen Maintenance of LED Light Sources

Report no. : SLED-19-031-R02
 Testing start date : 2017.07.28
 Testing completion date : 2019.08.27
 Report issued date : 2019.05.31
 Report revised date : 2020.05.21

Client	Testing performed by
SAMSUNG ELECTRONICS LED BUSINESS Lighting Marketing Group	SAMSUNG ELECTRONICS LED BUSINESS 1, Samsung-ro, Giheung-gu, Yongin-si, Gyeonggi-do 17113, Korea e-mail) kwon.sc@samsung.com
Tested By	Technical Manager
 KyungYeup Kwak	 DooSung Park
Test Personal Name & Signatory	Approval Name & Signatory

The above test report is the accredited test result by Korea Laboratory Accreditation Scheme, which signed the ILAC-MRA.

※ If you need confirmation about the authenticity of the test report, please contact the above contact information.

SAMSUNG ELECTRONICS LED BUSINESS
 Accredited by KOLAS, Republic of KOREA

■ Test Report Information ■

1. ☒ This test report complies with KS Q ISO/IEC 17025 and KOLAS accreditation regulations.
2. ☐ This test report does not comply with KS Q ISO/IEC 17025 and KOLAS accreditation regulations.
3. The test results are limited to samples provided by the client and cannot be partially replicated without the approval of this authority, except as a whole.
4. If a statement of conformity is provided in this report, the applied decision rule does not apply the measurement uncertainty except for the case where the measurement uncertainty is mentioned in the above test method.
5. The test results marked © are not accredited by KOLAS.
6. The test results received from external providers for the test results marked ①.

■ Revision History ■

Data	Revision History	Writer	
		Drawn	Approved
2019.05.31	Rev.0 : New Version	K.Y.KWAK	D.S.PARK
2020.03.30	Rev.1 : Typos Correction	K.Y.KWAK	D.S.PARK
2020.05.21	Rev.2 : Extended Test Duration	K.Y.KWAK	D.S.PARK

■ Test Summary ■

Life test condition			Summary of result		
Test condition	Current (mA)	Case temperature (°C)	Test duration (h)	Average lumen maintenance (%)	Maximum chromaticity shift ($\Delta u'v'$)
1	1 000	55.2	17 000	98.1	0.000 8
2	1 000	85.1	17 000	97.9	0.001 4
3	1 000	105.1	17 000	96.5	0.002 3

1. Number of the sample

- 20 Packages tested at actual case temperature 55.2 °C
- 20 Packages tested at actual case temperature 85.1 °C
- 20 Packages tested at actual case temperature 105.1 °C

※ Sampling method : Minimum three manufacturing lots with each manufacturing lot built from different wafer lots built on non-consecutive days.

2. Description of LED light sources

- Tested model code : SPHWHTL3D50CE4W***
- Product series : LH351C (SPHWHTL3D50C*****)
- Sample manufacturer : Samsung Electronics
- Sample Type : LED Package
- Package dimension : (3.5 × 3.5) mm
- Minimum die spacing : -
- CCT / CRI (Nominal) : 2 700 K / 70

3. Location of Test

☒ Permanent Testing Lab ☐ On Site Testing

(Address : 1, Samsung-ro, Giheung-gu, Yongin-si, Gyeonggi-do 17113, Korea)

4. Description of auxiliary equipment and Operating time

- 1) Instrument Integrating sphere ISP1000-100
- 2) Instrument CAS140-CT
- 3) Keithley 2425 Sourcemeter
- 4) Electrical condition
 - Drive current : 1 000 mA
 - Typical voltage : 3.06 V
 - Total input power : 3.06 W
 - Average current density per LED die : 499 mA/mm²
 - Average power density per LED die : 1.52 W/mm²
- 5) Test duration : 17 000 h

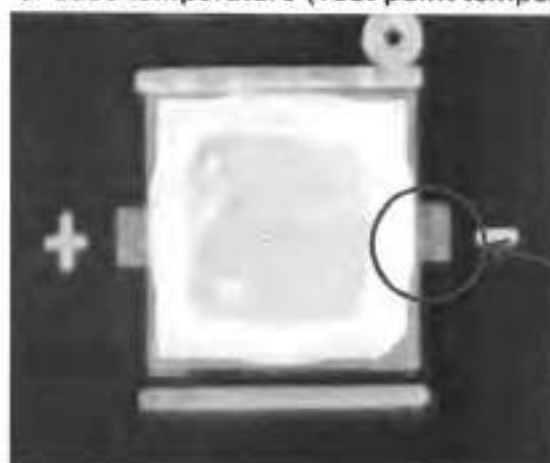
* LED packages are driven with a constant direct current.

5. Ambient conditions including airflow, temperature and relative humidity

The minimal airflow is maintained in chamber.

The ambient temperature around the LED packages inside chamber is controlled by air flowing and the thermocouple readings are monitored.

- Case temperature : Controlled to -2°C
- Surrounding air temperature : Controlled to -5°C
- Relative humidity : $< 65\%$ R.H.

6. Case temperature (Test point temperature)

Case Temperature
Measurement Point

7. Drive current of the LED light source during lifetime test

See Sub-clause 9.1, 9.2 and 9.3

8. Initial luminous flux and forward voltage

See the table

9. Lumen maintenance data for each individual LED light source

See the table

9.1 Test condition 1

55 °C

Drive Current

1.000 mA

Measurement Current

1 000 mA

[illegible]

9.1 Test condition 1

55 °C

Drive Current

1 000 mA

Measurement Current

1 000 nA

[illegible]

9.1 Test condition 1

55 °C

Drive Current

1 000 nA

Measurement Current

1 000 μ A

No.	u'	v	Chromaticity Shift ($\Delta u'v'$)						
	0 h		500 h	1 000 h	2 000 h	3 000 h	4 000 h	5 000 h	6 000 h
1	0.261 1	0.526 2	0.000 4	0.000 5	0.000 6	0.000 7	0.000 7	0.000 7	0.000 7
2	0.262 0	0.527 4	0.000 2	0.000 4	0.000 4	0.000 5	0.000 6	0.000 6	0.000 6
3	0.263 4	0.529 1	0.000 1	0.000 2	0.000 3	0.000 3	0.000 4	0.000 4	0.000 4
4	0.262 5	0.527 1	0.000 2	0.000 4	0.000 5	0.000 5	0.000 5	0.000 6	0.000 6
5	0.263 2	0.530 0	0.000 2	0.000 4	0.000 5	0.000 6	0.000 6	0.000 6	0.000 6
6	0.262 4	0.527 4	0.000 1	0.000 4	0.000 4	0.000 5	0.000 5	0.000 6	0.000 5
7	0.262 3	0.527 0	0.000 5	0.000 6	0.000 7	0.000 8	0.000 8	0.000 8	0.000 8
8	0.262 2	0.528 5	0.000 1	0.000 4	0.000 5	0.000 6	0.000 6	0.000 6	0.000 6
9	0.262 4	0.527 9	0.000 4	0.000 6	0.000 6	0.000 7	0.000 7	0.000 7	0.000 8
10	0.262 7	0.529 9	0.000 3	0.000 5	0.000 5	0.000 6	0.000 7	0.000 7	0.000 7
11	0.262 0	0.527 2	0.000 3	0.000 3	0.000 5	0.000 6	0.000 6	0.000 5	0.000 5
12	0.263 4	0.528 2	0.000 3	0.000 3	0.000 5	0.000 5	0.000 5	0.000 6	0.000 6
13	0.263 0	0.526 6	0.000 0	0.000 4	0.000 5	0.000 5	0.000 6	0.000 6	0.000 6
14	0.262 1	0.526 8	0.000 3	0.000 4	0.000 4	0.000 5	0.000 5	0.000 6	0.000 6
15	0.262 3	0.527 8	0.000 4	0.000 5	0.000 6	0.000 7	0.000 7	0.000 7	0.000 8
16	0.262 5	0.526 9	0.000 4	0.000 4	0.000 6	0.000 5	0.000 6	0.000 6	0.000 6
17	0.262 1	0.526 8	0.000 3	0.000 5	0.000 6	0.000 6	0.000 6	0.000 7	0.000 7
18	0.260 9	0.526 6	0.000 1	0.000 4	0.000 4	0.000 5	0.000 6	0.000 6	0.000 6
19	0.263 3	0.528 2	0.000 4	0.000 4	0.000 5	0.000 6	0.000 6	0.000 6	0.000 7
20	0.262 3	0.528 0	0.000 2	0.000 4	0.000 6	0.000 5	0.000 5	0.000 6	0.000 6
Mean	0.262 4	0.527 7	0.000 3	0.000 4	0.000 5	0.000 6	0.000 6	0.000 6	0.000 6
Median	0.262 3	0.527 4	0.000 3	0.000 4	0.000 5	0.000 5	0.000 6	0.000 6	0.000 6
std.dev	0.000 7	0.001 1	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1
Max	0.263 4	0.530 0	0.000 5	0.000 6	0.000 7	0.000 8	0.000 8	0.000 8	0.000 8
Min	0.260 9	0.526 2	0.000 0	0.000 2	0.000 3	0.000 3	0.000 4	0.000 4	0.000 4

9.1 Test condition 1

55 °C

Drive Current

1 000 mA

Measurement Current

1 000 mA

No.	Chromaticity Shift ($\Delta u'v'$)								
	7 000 h	8 000 h	9 000 h	10 000 h	11 000 h	12 000 h	13 000 h	14 000 h	15 000 h
1	0.000 7	0.000 7	0.000 8	0.000 7	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8
2	0.000 6	0.000 6	0.000 6	0.000 6	0.000 7	0.000 6	0.000 6	0.000 6	0.000 6
3	0.000 5	0.000 5	0.000 5	0.000 4	0.000 5	0.000 5	0.000 5	0.000 5	0.000 5
4	0.000 6	0.000 7	0.000 7	0.000 6	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7
5	0.000 6	0.000 6	0.000 7	0.000 6	0.000 7	0.000 6	0.000 7	0.000 7	0.000 6
6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6
7	0.000 8	0.000 9	0.000 9	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8
8	0.000 7	0.000 7	0.000 7	0.000 7	0.000 8	0.000 7	0.000 7	0.000 7	0.000 7
9	0.000 8	0.000 8	0.000 9	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8
10	0.000 7	0.000 8	0.000 7	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8
11	0.000 6	0.000 6	0.000 6	0.000 5	0.000 6	0.000 5	0.000 6	0.000 5	0.000 5
12	0.000 6	0.000 6	0.000 6	0.000 6	0.000 7	0.000 6	0.000 6	0.000 6	0.000 6
13	0.000 6	0.000 6	0.000 7	0.000 6	0.000 7	0.000 6	0.000 7	0.000 7	0.000 7
14	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6
15	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 6	0.000 6
16	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 8	0.000 7	0.000 7
17	0.000 7	0.000 7	0.000 8	0.000 7	0.000 8	0.000 7	0.000 8	0.000 8	0.000 7
18	0.000 6	0.000 6	0.000 6	0.000 6	0.000 7	0.000 6	0.000 6	0.000 6	0.000 6
19	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7
20	0.000 7	0.000 7	0.000 7	0.000 6	0.000 7	0.000 7	0.000 7	0.000 6	0.000 7
Mean	0.000 7	0.000 7	0.000 7	0.000 6	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7
Median	0.000 7	0.000 7	0.000 7	0.000 6	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7
std.dev	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1
Max	0.000 8	0.000 9	0.000 9	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8
Min	0.000 5	0.000 5	0.000 5	0.000 4	0.000 5	0.000 5	0.000 5	0.000 5	0.000 5

9.1 Test condition 1

55 °C

Drive Current

1 000 mA

Measurement Current

1 000 μA [illegible]

9.1 Test condition 1

55 °C

Drive Current

1.000 nA

Measurement Current

1 000 nA

[illegible]

9.1 Test condition 1

55 °C

Drive Current

1 000 mA

Measurement Current

1 000 mA

No.	CCT (K)								
	7 000 h	8 000 h	9 000 h	10 000 h	11 000 h	12 000 h	13 000 h	14 000 h	15 000 h
1	2 743	2 743	2 744	2 743	2 744	2 742	2 743	2 742	2 742
2	2 716	2 716	2 715	2 716	2 716	2 715	2 715	2 715	2 714
3	2 676	2 676	2 676	2 675	2 676	2 675	2 675	2 675	2 674
4	2 706	2 708	2 707	2 707	2 708	2 707	2 707	2 707	2 707
5	2 682	2 682	2 683	2 682	2 682	2 681	2 682	2 681	2 681
6	2 707	2 707	2 707	2 707	2 707	2 706	2 707	2 706	2 706
7	2 716	2 716	2 716	2 715	2 716	2 714	2 715	2 714	2 713
8	2 710	2 710	2 710	2 709	2 710	2 709	2 709	2 708	2 708
9	2 707	2 708	2 709	2 707	2 708	2 707	2 708	2 707	2 707
10	2 693	2 694	2 693	2 694	2 694	2 693	2 693	2 693	2 693
11	2 717	2 717	2 717	2 716	2 716	2 715	2 715	2 714	2 714
12	2 683	2 682	2 682	2 681	2 683	2 681	2 682	2 681	2 681
13	2 698	2 698	2 699	2 699	2 699	2 698	2 699	2 698	2 698
14	2 716	2 716	2 716	2 716	2 716	2 715	2 715	2 715	2 714
15	2 709	2 710	2 710	2 709	2 709	2 708	2 708	2 707	2 706
16	2 708	2 708	2 709	2 707	2 709	2 707	2 708	2 707	2 707
17	2 717	2 718	2 719	2 718	2 719	2 717	2 718	2 717	2 717
18	2 743	2 743	2 743	2 743	2 744	2 742	2 742	2 742	2 741
19	2 685	2 685	2 685	2 685	2 685	2 684	2 684	2 684	2 683
20	2 708	2 708	2 708	2 707	2 708	2 707	2 707	2 706	2 706
Mean	2 707	2 707	2 707	2 707	2 708	2 706	2 707	2 706	2 706
Median	2 708	2 708	2 709	2 707	2 709	2 707	2 708	2 707	2 707
std.dev	18	18	18	18	18	18	18	18	18
Max	2 743	2 743	2 744	2 743	2 744	2 742	2 743	2 742	2 742
Min	2 676	2 676	2 676	2 675	2 676	2 675	2 675	2 675	2 674

9.1 Test condition 1

55 °C

Drive Current

1 000 mA

Measurement Current

1 000 μA [illegible]

9.2 Test condition 2

85 °C

Drive Current

1 000 nA

Measurement Current

1 000 nA

No.	Flux (lm)	Vf (V)	Lumen Maintenance (%)						
	0 h		500 h	1 000 h	2 000 h	3 000 h	4 000 h	5 000 h	6 000 h
1	339.4	3.084	98.9	98.9	98.8	98.7	98.2	98.3	98.1
2	335.6	3.055	99.3	98.7	98.4	98.2	97.9	97.9	98.1
3	344.1	3.029	99.7	99.2	99.3	99.0	98.5	98.7	98.6
4	332.5	3.037	99.9	99.5	99.0	98.9	98.6	98.8	98.5
5	339.4	3.043	99.3	99.4	99.2	99.0	98.7	98.6	98.4
6	343.6	3.104	99.7	99.4	98.6	98.6	98.5	98.5	98.4
7	334.1	3.093	99.6	98.9	98.5	98.4	98.1	98.3	98.2
8	336.1	3.073	99.1	99.0	98.6	98.2	98.0	98.1	98.1
9	333.9	3.058	98.9	98.7	98.5	98.4	97.9	98.0	97.9
10	333.8	3.033	99.5	99.4	99.1	98.9	98.6	98.7	98.5
11	342.9	3.082	99.6	98.9	98.6	98.5	98.5	98.5	98.3
12	338.3	3.056	99.6	98.8	98.3	98.2	97.7	98.0	97.9
13	336.8	3.041	99.3	99.0	98.7	98.1	97.8	98.0	97.9
14	337.9	3.033	99.6	99.3	98.7	98.6	98.3	98.4	98.2
15	335.2	3.028	99.8	99.0	98.6	98.3	98.1	98.2	98.0
16	332.7	3.074	99.1	98.7	98.4	98.3	98.0	98.1	98.1
17	331.6	3.085	99.0	98.7	98.3	98.2	97.8	97.9	97.8
18	346.2	3.063	99.0	98.8	98.5	98.4	98.2	98.4	98.2
19	336.9	3.105	99.3	98.9	98.7	98.4	98.2	98.4	98.3
20	337.2	3.016	99.8	99.2	99.0	98.6	98.2	98.2	98.1
Mean	337.4	3.06	99.4	99.0	98.7	98.5	98.2	98.3	98.2
Median	336.8	3.06	99.4	99.0	98.6	98.4	98.2	98.3	98.2
std.dev	4.1	0.03	0.3	0.3	0.3	0.3	0.3	0.3	0.2
Max	346.2	3.10	99.9	99.5	99.3	99.0	98.7	98.8	98.6
Min	331.6	3.02	98.9	98.7	98.3	98.1	97.7	97.9	97.8

9.2 Test condition 2

85 °C

Drive Current

1 000 μA

Measurement Current

1 000 μA

No.	Lumen Maintenance (%)								
	7 000 h	8 000 h	9 000 h	10 000 h	11 000 h	12 000 h	13 000 h	14 000 h	15 000 h
1	98.0	98.0	97.9	97.9	97.7	97.7	97.6	97.7	97.7
2	98.2	98.0	98.0	98.2	98.0	97.9	98.0	98.1	98.3
3	98.5	98.4	98.4	98.3	98.2	98.2	98.3	98.2	98.4
4	98.6	98.3	98.3	98.2	98.1	98.0	98.0	98.1	98.1
5	98.5	98.5	98.2	98.4	98.1	98.1	98.2	98.3	98.2
6	98.4	98.3	98.2	98.4	98.1	98.2	98.2	98.1	98.3
7	98.2	98.2	98.1	98.1	98.0	98.1	98.1	98.2	98.3
8	98.1	98.1	98.0	98.1	98.0	98.1	98.2	98.2	98.4
9	98.0	97.8	97.8	97.8	97.6	97.7	97.7	97.8	97.8
10	98.5	98.4	98.4	98.3	98.1	98.1	98.2	98.3	98.3
11	98.4	98.2	98.0	98.0	97.8	97.8	97.8	97.9	97.9
12	98.3	98.3	98.2	98.1	98.2	98.0	98.2	98.1	98.1
13	98.1	97.9	97.9	97.8	97.8	97.9	97.9	98.0	98.1
14	98.1	98.0	97.9	98.0	97.8	97.7	97.5	97.5	97.7
15	98.1	98.0	97.9	97.9	97.7	97.6	97.7	97.7	97.9
16	97.9	97.8	97.7	97.7	97.6	97.5	97.5	97.5	97.6
17	97.8	97.6	97.5	97.5	97.5	97.4	97.4	97.4	97.5
18	98.3	98.2	98.1	97.9	97.9	97.9	97.9	98.0	98.1
19	98.1	97.8	97.7	97.6	97.4	97.3	97.3	97.3	97.4
20	97.9	97.8	97.7	97.6	97.4	97.3	97.3	97.4	97.3
Mean	98.2	98.1	98.0	98.0	97.9	97.8	97.9	97.9	98.0
Median	98.1	98.1	98.0	98.0	97.9	97.9	97.9	98.0	98.1
std.dev	0.2	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3
Max	98.6	98.5	98.4	98.4	98.2	98.2	98.3	98.3	98.4
Min	97.8	97.6	97.5	97.5	97.4	97.3	97.3	97.3	97.3

9.2 Test condition 2

85 °C

Drive Current

1 000 mA

Measurement Current

1 000 μA [illegible]

9.2 Test condition 2

85 °C

Drive Current

1 000 μ A

Measurement Current

1 000 μ A

No.	u'	v'	Chromaticity Shift ($\Delta u'v'$)						
	0 h		500 h	1 000 h	2 000 h	3 000 h	4 000 h	5 000 h	6 000 h
1	0.262 3	0.527 9	0.000 3	0.000 4	0.000 6	0.000 6	0.000 6	0.000 7	0.000 7
2	0.263 3	0.529 2	0.000 1	0.000 4	0.000 4	0.000 5	0.000 6	0.000 7	0.000 6
3	0.262 4	0.528 2	0.000 1	0.000 4	0.000 4	0.000 6	0.000 6	0.000 7	0.000 6
4	0.263 5	0.527 6	0.000 4	0.000 5	0.000 6	0.000 6	0.000 7	0.000 7	0.000 7
5	0.261 9	0.528 6	0.000 4	0.000 5	0.000 6	0.000 6	0.000 6	0.000 7	0.000 7
6	0.261 7	0.527 2	0.000 1	0.000 4	0.000 5	0.000 6	0.000 7	0.000 7	0.000 7
7	0.261 3	0.527 6	0.000 2	0.000 4	0.000 4	0.000 5	0.000 5	0.000 6	0.000 6
8	0.262 4	0.529 1	0.000 3	0.000 5	0.000 7	0.000 6	0.000 8	0.000 7	0.000 7
9	0.262 9	0.528 4	0.000 3	0.000 4	0.000 6	0.000 5	0.000 6	0.000 7	0.000 6
10	0.261 5	0.527 8	0.000 3	0.000 5	0.000 6	0.000 6	0.000 7	0.000 7	0.000 7
11	0.263 7	0.529 0	0.000 2	0.000 4	0.000 5	0.000 6	0.000 7	0.000 6	0.000 7
12	0.262 3	0.527 8	0.000 4	0.000 5	0.000 6	0.000 7	0.000 9	0.000 9	0.000 9
13	0.261 3	0.527 0	0.000 4	0.000 5	0.000 7	0.000 9	0.000 8	0.000 9	0.000 9
14	0.263 5	0.528 7	0.000 4	0.000 4	0.000 5	0.000 5	0.000 7	0.000 8	0.000 6
15	0.262 1	0.527 7	0.000 3	0.000 6	0.000 8	0.000 8	0.000 9	0.000 8	0.000 8
16	0.261 4	0.527 1	0.000 2	0.000 5	0.000 6	0.000 7	0.000 9	0.000 8	0.000 8
17	0.262 5	0.527 3	0.000 3	0.000 3	0.000 5	0.000 6	0.000 6	0.000 7	0.000 7
18	0.261 9	0.527 0	0.000 3	0.000 4	0.000 6	0.000 6	0.000 7	0.000 8	0.000 7
19	0.263 2	0.528 1	0.000 2	0.000 3	0.000 5	0.000 5	0.000 6	0.000 5	0.000 6
20	0.264 0	0.529 6	0.000 2	0.000 4	0.000 4	0.000 5	0.000 6	0.000 6	0.000 7
Mean	0.262 4	0.528 0	0.000 3	0.000 4	0.000 6	0.000 6	0.000 7	0.000 7	0.000 7
Median	0.262 3	0.527 8	0.000 3	0.000 4	0.000 6	0.000 6	0.000 7	0.000 7	0.000 7
std.dev	0.000 8	0.000 8	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1
Max	0.264 0	0.529 6	0.000 4	0.000 6	0.000 8	0.000 9	0.000 9	0.000 9	0.000 9
Min	0.261 3	0.527 0	0.000 1	0.000 3	0.000 4	0.000 5	0.000 5	0.000 5	0.000 6

9.2 Test condition 2

85 °C

Drive Current

1.000 mA

Measurement Current

1 000 mA

No.	Chromaticity Shift ($\Delta u'v'$)								
	7 000 h	8 000 h	9 000 h	10 000 h	11 000 h	12 000 h	13 000 h	14 000 h	15 000 h
1	0.000 6	0.000 6	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7
2	0.000 6	0.000 6	0.000 7	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 7
3	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6	0.000 6
4	0.000 8	0.000 8	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7
5	0.000 6	0.000 8	0.000 7	0.000 6	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7
6	0.000 7	0.000 7	0.000 8	0.000 7	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8
7	0.000 6	0.000 6	0.000 5	0.000 6	0.000 5	0.000 5	0.000 5	0.000 5	0.000 6
8	0.000 8	0.000 8	0.000 8	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7
9	0.000 6	0.000 7	0.000 7	0.000 6	0.000 7	0.000 7	0.000 7	0.000 7	0.000 7
10	0.000 7	0.000 7	0.000 8	0.000 7	0.000 7	0.000 7	0.000 7	0.000 8	0.000 8
11	0.000 9	0.000 9	0.001 0	0.001 0	0.001 0	0.001 0	0.001 0	0.001 1	0.001 1
12	0.000 9	0.001 0	0.001 1	0.001 1	0.001 2	0.001 2	0.001 2	0.001 3	0.001 3
13	0.001 0	0.001 0	0.001 1	0.001 2	0.001 2	0.001 2	0.001 2	0.001 2	0.001 3
14	0.000 8	0.000 8	0.001 0	0.001 0	0.001 1	0.001 1	0.001 2	0.001 2	0.001 2
15	0.001 0	0.001 0	0.001 0	0.001 0	0.001 0	0.001 1	0.001 1	0.001 1	0.001 2
16	0.001 0	0.001 0	0.001 1	0.001 0	0.001 1	0.001 1	0.001 1	0.001 1	0.001 1
17	0.000 8	0.000 9	0.000 9	0.000 9	0.001 0	0.001 1	0.001 1	0.001 1	0.001 1
18	0.000 9	0.000 9	0.001 0	0.001 1	0.001 1	0.001 1	0.001 1	0.001 2	0.001 2
19	0.000 7	0.000 8	0.000 8	0.000 8	0.000 8	0.000 9	0.000 9	0.001 0	0.001 0
20	0.000 8	0.000 7	0.000 8	0.000 8	0.000 8	0.000 9	0.000 9	0.000 9	0.000 9
Mean	0.000 8	0.000 8	0.000 8	0.000 8	0.000 8	0.000 9	0.000 9	0.000 9	0.000 9
Median	0.000 8	0.000 8	0.000 8	0.000 7	0.000 8	0.000 8	0.000 8	0.000 9	0.000 9
std.dev	0.000 1	0.000 2	0.000 2	0.000 2	0.000 2	0.000 2	0.000 2	0.000 2	0.000 2
Max	0.001 0	0.001 0	0.001 1	0.001 2	0.001 2	0.001 2	0.001 2	0.001 3	0.001 3
Min	0.000 6	0.000 6	0.000 5	0.000 6	0.000 5	0.000 5	0.000 5	0.000 5	0.000 6

9.2 Test condition 2

85 °C

Drive Current

1 000 μA

Measurement Current

1 000 nA

[illegible]

9.2 Test condition 2

85 °C

Drive Current

1.000 mA

Measurement Current

1 000 mA

No.	CCT (K)							
	0 h	500 h	1 000 h	2 000 h	3 000 h	4 000 h	5 000 h	6 000 h
1	2 698	2 702	2 704	2 708	2 707	2 707	2 708	2 707
2	2 672	2 673	2 677	2 678	2 680	2 681	2 681	2 680
3	2 694	2 695	2 700	2 700	2 703	2 703	2 704	2 703
4	2 673	2 678	2 680	2 682	2 682	2 683	2 683	2 683
5	2 703	2 709	2 710	2 712	2 711	2 712	2 713	2 712
6	2 712	2 713	2 718	2 719	2 721	2 722	2 722	2 721
7	2 720	2 723	2 726	2 727	2 728	2 728	2 729	2 728
8	2 691	2 695	2 699	2 701	2 700	2 703	2 701	2 700
9	2 683	2 687	2 688	2 691	2 690	2 691	2 692	2 691
10	2 715	2 720	2 722	2 724	2 725	2 725	2 726	2 724
11	2 663	2 665	2 668	2 669	2 671	2 672	2 672	2 672
12	2 698	2 703	2 705	2 706	2 709	2 711	2 711	2 711
13	2 722	2 728	2 729	2 732	2 735	2 734	2 736	2 735
14	2 669	2 674	2 674	2 676	2 676	2 679	2 680	2 677
15	2 702	2 707	2 711	2 714	2 713	2 715	2 715	2 714
16	2 719	2 721	2 726	2 727	2 729	2 732	2 730	2 730
17	2 696	2 700	2 700	2 704	2 705	2 705	2 706	2 705
18	2 709	2 714	2 715	2 719	2 718	2 720	2 722	2 719
19	2 678	2 680	2 682	2 685	2 683	2 685	2 685	2 684
20	2 654	2 657	2 659	2 660	2 661	2 663	2 663	2 663
Mean	2 694	2 697	2 700	2 702	2 702	2 704	2 704	2 703
Median	2 697	2 701	2 702	2 705	2 706	2 706	2 707	2 706
std.dev	20	21	21	21	21	21	21	21
Max	2 722	2 728	2 729	2 732	2 735	2 734	2 736	2 735
Min	2 654	2 657	2 659	2 660	2 661	2 663	2 663	2 663

9.2 Test condition 2

85 °C

Drive Current

1 000 μA

Measurement Current

1 000 μA

No.	CCT (K)								
	7 000 h	8 000 h	9 000 h	10 000 h	11 000 h	12 000 h	13 000 h	14 000 h	15 000 h
1	2 707	2 706	2 707	2 705	2 706	2 705	2 705	2 705	2 704
2	2 680	2 679	2 680	2 678	2 678	2 678	2 677	2 677	2 677
3	2 702	2 701	2 700	2 701	2 700	2 699	2 699	2 699	2 698
4	2 684	2 683	2 682	2 680	2 680	2 680	2 679	2 679	2 679
5	2 711	2 713	2 711	2 710	2 710	2 710	2 709	2 709	2 709
6	2 721	2 720	2 722	2 720	2 721	2 720	2 720	2 720	2 720
7	2 728	2 727	2 725	2 726	2 725	2 724	2 724	2 724	2 723
8	2 702	2 701	2 701	2 698	2 698	2 698	2 698	2 697	2 697
9	2 691	2 692	2 691	2 689	2 690	2 689	2 689	2 689	2 689
10	2 725	2 723	2 725	2 723	2 723	2 723	2 723	2 722	2 722
11	2 675	2 675	2 675	2 675	2 676	2 676	2 675	2 676	2 675
12	2 711	2 712	2 713	2 713	2 714	2 714	2 714	2 714	2 715
13	2 736	2 736	2 738	2 738	2 739	2 738	2 737	2 737	2 738
14	2 680	2 679	2 682	2 682	2 683	2 683	2 684	2 683	2 684
15	2 716	2 716	2 716	2 715	2 715	2 716	2 716	2 716	2 716
16	2 733	2 733	2 733	2 733	2 733	2 733	2 733	2 732	2 732
17	2 706	2 708	2 708	2 708	2 709	2 709	2 709	2 709	2 709
18	2 722	2 721	2 723	2 723	2 723	2 724	2 723	2 724	2 724
19	2 687	2 687	2 686	2 686	2 687	2 687	2 688	2 688	2 688
20	2 665	2 664	2 665	2 664	2 665	2 665	2 664	2 665	2 665
Mean	2 704	2 704	2 704	2 703	2 704	2 704	2 703	2 703	2 703
Median	2 706	2 707	2 707	2 707	2 707	2 707	2 707	2 707	2 707
std.dev	21	21	21	21	21	21	21	21	21
Max	2 736	2 736	2 738	2 738	2 739	2 738	2 737	2 737	2 738
Min	2 665	2 664	2 665	2 664	2 665	2 665	2 664	2 665	2 665

9.2 Test condition 2

85 °C

Drive Current

1 000 mA

Measurement Current

1 000 μA [illegible]

9.3 Test condition 3

105 °C

Drive Current

1 000 μA

Measurement Current

1 000 μA [illegible]

9.3 Test condition 3

105 °C

Drive Current

1 000 μ A

Measurement Current

1 000 μ A

No.	Lumen Maintenance (%)								
	7 000 h	8 000 h	9 000 h	10 000 h	11 000 h	12 000 h	13 000 h	14 000 h	15 000 h
1	97.4	97.4	97.5	97.4	97.3	97.2	97.2	97.1	97.2
2	96.9	96.8	97.0	97.0	96.9	97.0	97.0	97.0	97.1
3	97.4	97.1	97.3	97.3	97.2	97.2	97.1	97.1	97.2
4	97.2	97.2	97.4	97.1	97.1	97.0	97.0	96.9	97.0
5	97.1	96.9	97.0	97.0	96.7	96.7	96.6	96.5	96.6
6	97.0	97.0	97.2	97.0	96.8	96.8	96.8	96.7	96.8
7	96.7	96.7	96.8	96.8	96.6	96.5	96.5	96.4	96.4
8	96.6	96.6	96.5	96.4	96.4	96.3	96.2	96.0	96.1
9	97.1	97.0	97.2	97.1	97.0	97.0	97.0	96.9	97.0
10	97.5	97.3	97.5	97.4	97.3	97.1	97.0	96.9	96.9
11	97.0	96.9	97.1	97.1	97.0	97.0	97.1	97.0	97.1
12	96.9	97.0	96.9	96.9	96.8	96.8	96.9	96.7	96.9
13	97.2	97.0	97.1	96.9	96.7	96.7	96.6	96.6	96.7
14	97.2	96.9	96.8	96.6	96.3	96.1	96.1	96.0	96.0
15	97.7	97.2	97.2	97.2	96.9	96.7	96.5	96.3	96.3
16	97.3	97.2	97.1	97.0	96.9	96.8	96.7	96.6	96.6
17	97.0	97.0	97.1	97.1	97.0	97.0	97.0	96.8	96.9
18	97.0	97.0	97.1	97.0	96.9	96.9	96.9	96.9	96.9
19	97.2	97.1	97.3	97.1	97.1	97.0	97.1	97.0	97.1
20	96.9	96.6	96.9	96.6	96.5	96.4	96.4	96.2	96.3
Mean	97.1	97.0	97.1	97.0	96.9	96.8	96.8	96.7	96.8
Median	97.1	97.0	97.1	97.0	96.9	96.9	96.9	96.8	96.9
std.dev	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4
Max	97.7	97.4	97.5	97.4	97.3	97.2	97.2	97.1	97.2
Min	96.6	96.6	96.5	96.4	96.3	96.1	96.1	96.0	96.0

9.3 Test condition 3

105 °C

Drive Current

1 000 mA

Measurement Current

1 000 mA

[illegible]

9.3 Test condition 3

105 °C

Drive Current

1 000 mA

Measurement Current

1 000 mA

[illegible]

9.3 Test condition 3

105 °C

Drive Current

1 000 mA

Measurement Current

1 000 μA

No.	Chromaticity Shift ($\Delta u'v'$)								
	7 000 h	8 000 h	9 000 h	10 000 h	11 000 h	12 000 h	13 000 h	14 000 h	15 000 h
1	0.001 8	0.002 0	0.002 0	0.002 0	0.002 0	0.002 1	0.002 1	0.002 1	0.002 2
2	0.001 1	0.001 0	0.001 2	0.001 1	0.001 2	0.001 3	0.001 3	0.001 3	0.001 3
3	0.001 7	0.001 6	0.001 6	0.001 5	0.001 6	0.001 6	0.001 6	0.001 6	0.001 6
4	0.001 7	0.001 6	0.001 6	0.001 5	0.001 6	0.001 6	0.001 6	0.001 6	0.001 7
5	0.001 4	0.001 7	0.001 6	0.001 5	0.001 7	0.001 8	0.001 8	0.001 8	0.001 9
6	0.001 0	0.000 9	0.001 1	0.001 2	0.001 2	0.001 3	0.001 3	0.001 3	0.001 4
7	0.001 3	0.001 3	0.001 2	0.001 2	0.001 3	0.001 3	0.001 3	0.001 3	0.001 4
8	0.001 6	0.001 6	0.001 5	0.001 4	0.001 6	0.001 6	0.001 5	0.001 5	0.001 6
9	0.001 4	0.001 6	0.001 6	0.001 4	0.001 6	0.001 6	0.001 6	0.001 6	0.001 7
10	0.001 3	0.001 2	0.001 4	0.001 3	0.001 4	0.001 4	0.001 4	0.001 4	0.001 5
11	0.001 5	0.001 5	0.001 5	0.001 6	0.001 6	0.001 7	0.001 7	0.001 7	0.001 8
12	0.001 5	0.001 6	0.001 5	0.001 5	0.001 6	0.001 6	0.001 6	0.001 5	0.001 6
13	0.001 5	0.001 7	0.001 7	0.001 7	0.001 8	0.001 9	0.001 9	0.001 9	0.002 0
14	0.001 5	0.001 5	0.001 7	0.001 6	0.001 7	0.001 8	0.001 7	0.001 7	0.001 8
15	0.001 3	0.001 2	0.001 5	0.001 3	0.001 4	0.001 5	0.001 4	0.001 4	0.001 5
16	0.001 8	0.001 9	0.001 9	0.001 8	0.001 9	0.002 0	0.002 0	0.002 0	0.002 1
17	0.001 2	0.001 4	0.001 3	0.001 3	0.001 4	0.001 5	0.001 5	0.001 5	0.001 5
18	0.001 2	0.001 2	0.001 4	0.001 3	0.001 3	0.001 4	0.001 4	0.001 4	0.001 5
19	0.001 3	0.001 3	0.001 6	0.001 5	0.001 6	0.001 6	0.001 7	0.001 6	0.001 7
20	0.001 6	0.001 6	0.001 5	0.001 5	0.001 6	0.001 6	0.001 5	0.001 5	0.001 6
Mean	0.001 4	0.001 5	0.001 5	0.001 5	0.001 6	0.001 6	0.001 6	0.001 6	0.001 7
Median	0.001 5	0.001 5	0.001 5	0.001 5	0.001 6	0.001 6	0.001 6	0.001 5	0.001 6
std.dev	0.000 2	0.000 3	0.000 2	0.000 2	0.000 2	0.000 2	0.000 2	0.000 2	0.000 2
Max	0.001 8	0.002 0	0.002 0	0.002 0	0.002 0	0.002 1	0.002 1	0.002 1	0.002 2
Min	0.001 0	0.000 9	0.001 1	0.001 1	0.001 2	0.001 3	0.001 3	0.001 3	0.001 3

9.3 Test condition 3

105 °C

Drive Current

1 000 μA

Measurement Current

1 000 mA

[illegible]

9.3 Test condition 3

105 °C

Drive Current

1 000 mA

Measurement Current

1 000 mA

[illegible]

9.3 Test condition 3

105 °C

Drive Current

1 000 mA

Measurement Current

1 000 mA

No.	CCT (K)								
	7 000 h	8 000 h	9 000 h	10 000 h	11 000 h	12 000 h	13 000 h	14 000 h	15 000 h
1	2 763	2 765	2 763	2 760	2 761	2 761	2 760	2 760	2 760
2	2 664	2 662	2 661	2 657	2 658	2 658	2 656	2 656	2 655
3	2 733	2 732	2 727	2 723	2 724	2 722	2 719	2 717	2 717
4	2 744	2 741	2 737	2 733	2 734	2 732	2 730	2 728	2 728
5	2 695	2 698	2 695	2 690	2 694	2 694	2 692	2 692	2 693
6	2 691	2 689	2 689	2 686	2 686	2 685	2 683	2 682	2 681
7	2 682	2 679	2 674	2 672	2 672	2 670	2 667	2 665	2 665
8	2 714	2 713	2 708	2 705	2 706	2 704	2 701	2 700	2 699
9	2 700	2 703	2 699	2 694	2 696	2 694	2 692	2 691	2 691
10	2 734	2 732	2 732	2 727	2 727	2 725	2 722	2 721	2 721
11	2 704	2 702	2 699	2 700	2 698	2 698	2 696	2 694	2 694
12	2 728	2 727	2 723	2 720	2 720	2 719	2 716	2 715	2 714
13	2 734	2 736	2 734	2 730	2 732	2 732	2 730	2 730	2 730
14	2 726	2 726	2 728	2 724	2 725	2 725	2 723	2 722	2 722
15	2 715	2 712	2 714	2 707	2 708	2 707	2 705	2 703	2 703
16	2 741	2 744	2 740	2 734	2 737	2 736	2 734	2 733	2 734
17	2 739	2 743	2 738	2 735	2 736	2 734	2 732	2 731	2 732
18	2 736	2 735	2 734	2 727	2 728	2 726	2 723	2 722	2 722
19	2 686	2 685	2 687	2 684	2 684	2 683	2 682	2 680	2 680
20	2 737	2 735	2 731	2 727	2 727	2 725	2 723	2 721	2 721
Mean	2 718	2 718	2 716	2 712	2 713	2 712	2 709	2 708	2 708
Median	2 727	2 726	2 725	2 721	2 722	2 720	2 718	2 716	2 716
std.dev	25	26	26	25	25	25	26	26	26
Max	2 763	2 765	2 763	2 760	2 761	2 761	2 760	2 760	2 760
Min	2 664	2 662	2 661	2 657	2 658	2 658	2 656	2 656	2 655

9.3 Test condition 3

105 °C

Drive Current

1 000 mA

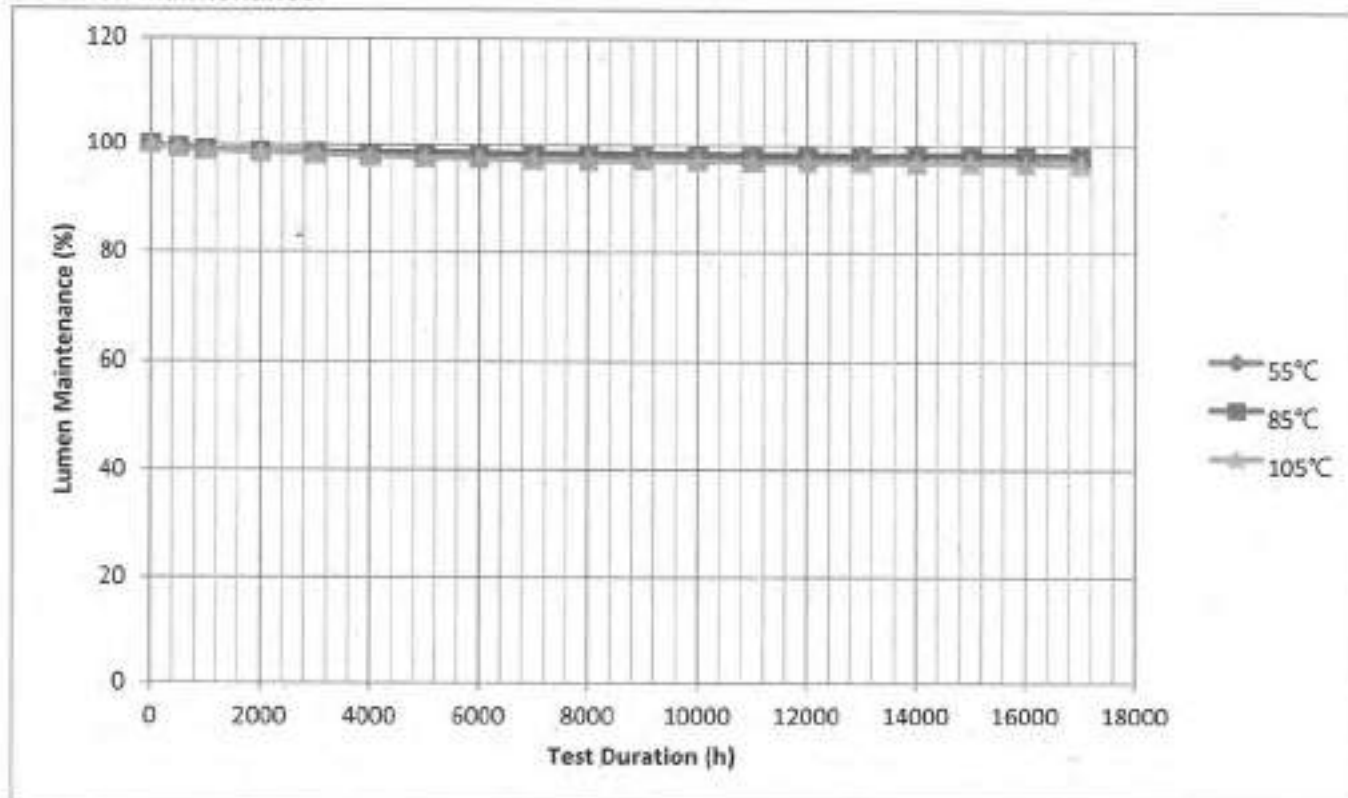
Measurement Current

1 000 mA

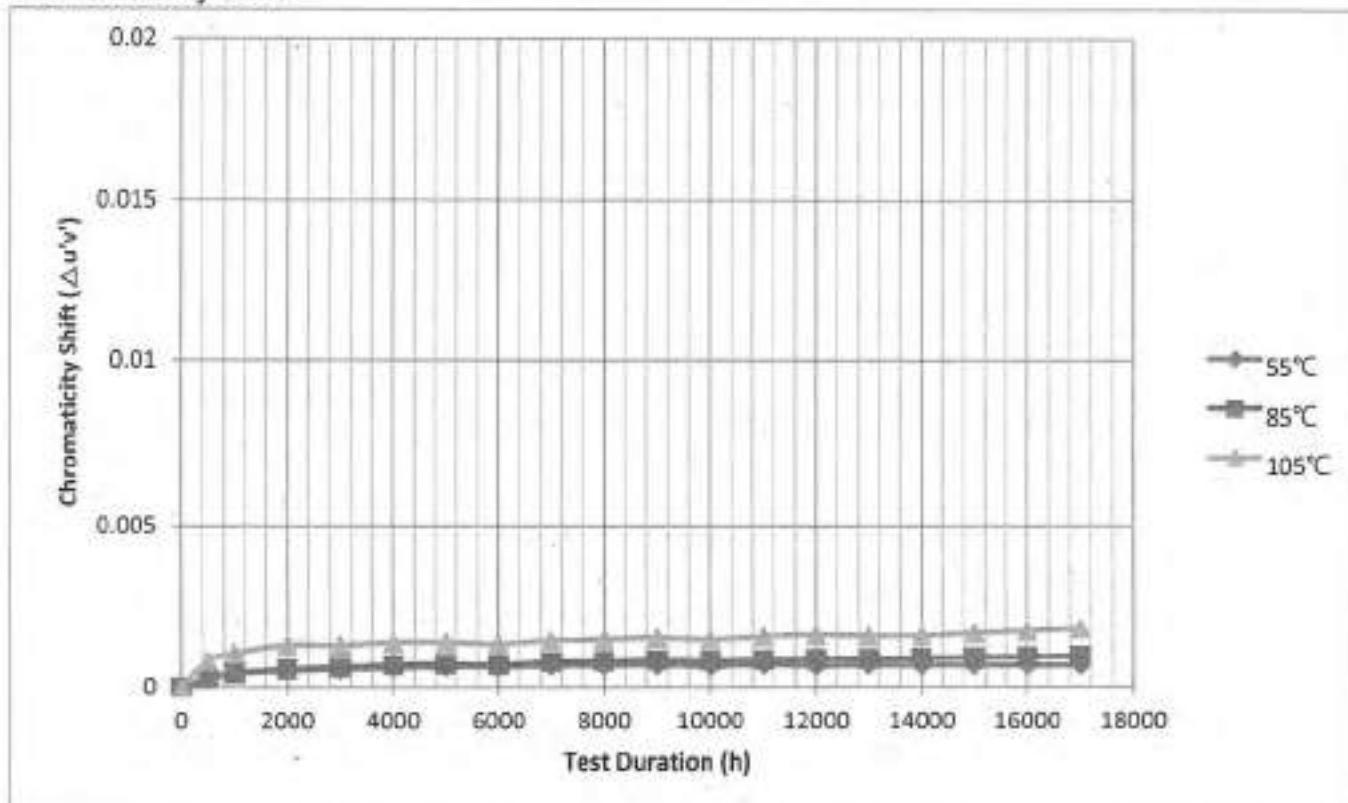
[illegible]

9.4 Chart

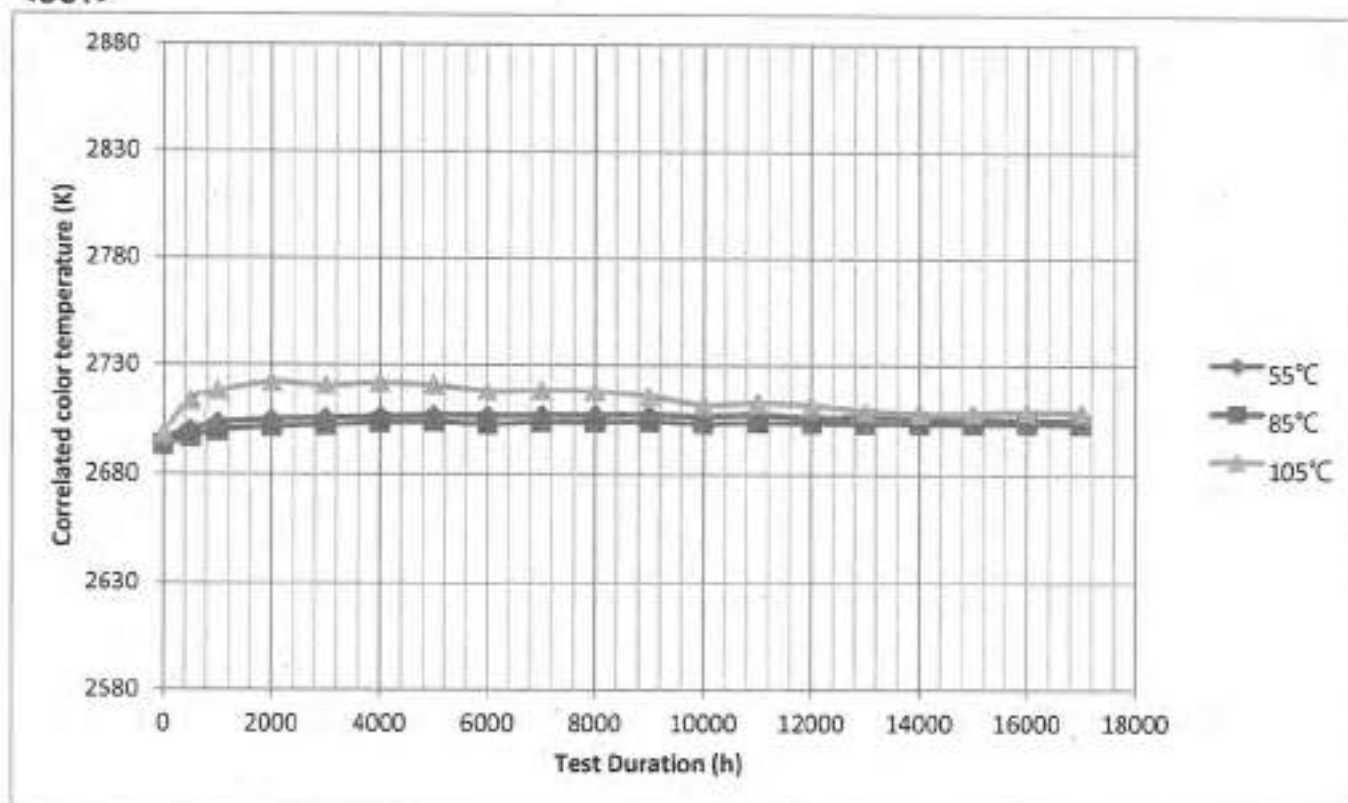
<Lumen Maintenance>



<Chromaticity Shift>



<CCT>

**10. Observation of failures**

No optical, Electrical or mechanical failure of any LED Package was seen during the lifetime testing.

11. LED light source monitoring interval

0 500 1 000 2 000 3 000 4 000 5 000 6 000 7 000 8 000
 9 000 10 000 11 000 12 000 13 000 14 000 15 000 16 000 17 000

12. Photometric measurement uncertainty

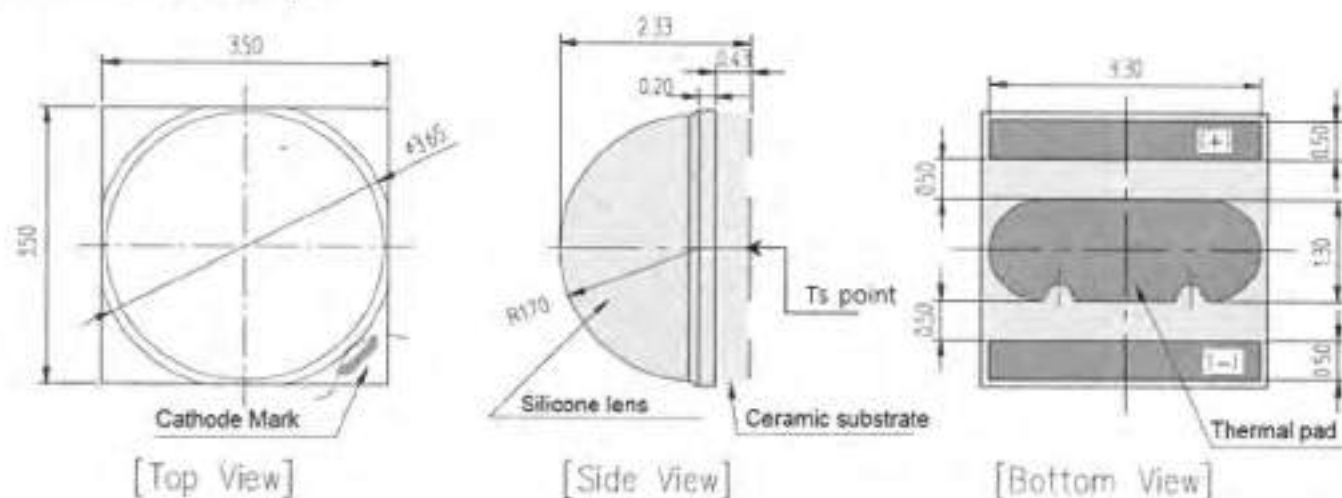
3.5%

13. TM-21-11 Report : Projecting Long Term Lumen Maintenance of LED Light Source

Table 1: Report at each LM-80 Test Condition

Description of LED Light Source Tested (manufacturer, model, catalog number)					
Test Condition 1 - 55°C Case Temp		Test Condition 2 - 85°C Case Temp		Test Condition 3 - 105°C Case Temp	
Sample size	20	Sample size	20	Sample size	20
Number of failures	0	Number of failures	0	Number of failures	0
DUT drive current used in the test (mA)	1 000	DUT drive current used in the test (mA)	1 000	DUT drive current used in the test (mA)	1 000
Test duration (hours)	17,000	Test duration (hours)	17,000	Test duration (hours)	17,000
Test duration used for projection (hour to hour)	8,000 - 17,000	Test duration used for projection (hour to hour)	8,000 - 17,000	Test duration used for projection (hour to hour)	8,000 - 17,000
Tested case temperature (°C)	55	Tested case temperature (°C)	85	Tested case temperature (°C)	105
α	1.667E-07	α	1.484E-07	α	6.010E-07
B	0.984	B	0.981	B	0.975
Reported L90(17k) (hours)	>102000	Reported L90(17k) (hours)	>102000	Reported L90(17k) (hours)	>102000

14. Dimension of samples



15. Cover models

*****END OF TEST REPORT*****