Test Report

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

Report no. : SLED-20-064
Testing start date : 2018.12.31
Testing completion date : 2020.03.20
Report issued date : 2020.06.17
Report revised date : -

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.

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■ 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 ◐.

■ Revision History ■

Date	Revision History	Writer	
		Drawn	Approved
2020.06.17	Rev.0 : New Version	K.Y.KWAK	D.S.PARK

■ Test Summary ■

Life test condition			Summary of result		
Test condition	Current (mA)	Case temperature (℃)	Test duration (h)	Average lumen maintenance (%)	Maximum chromaticity shift (△u'v')
1	150	55.1	10 000	97.0	0.001 6
2	150	85.0	10 000	96.4	0.002 0
3	150	105.0	10 000	93.3	0.004 2

1. Number of the sample

- 20 Packages tested at actual case temperature 55.1 ℃
- 20 Packages tested at actual case temperature 85.0 ℃
- 20 Packages tested at actual case temperature 105.0 ℃

※ 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 : SPMWH3326FP3GAV0S0
- Product series : LM302Z+ (SPMWH*326FP*******)
- Sample manufacturer : Samsung Electronics
- Sample Type : LED Package
- Package dimension : (3.0 × 3.0) ㎜
- Minimum die spacing : 0.2 ㎜
- CCT / CRI (Nominal) : 3 000 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 : 150 ㎃
- Typical voltage : 6.07 V
- Total input power : 0.91 W
- Average current density per LED die : 402 ㎃/㎟
- Average power density per LED die : 1.22 W/㎟

* LED packages are driven with a constant direct current.

5) Test duration : 10 000 h

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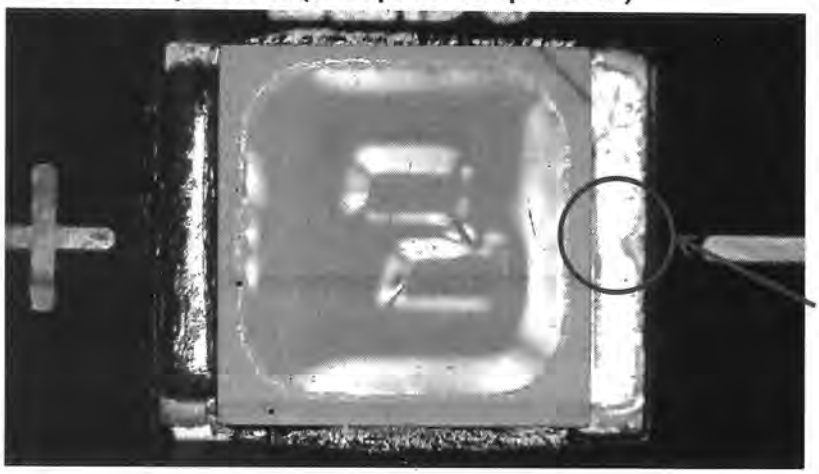
5. Ambient conditions including airflow, temperature and relative humidity

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 : Contorlled to -2 ℃
- Surrounding air temperature : Contorlled to -5 ℃
- Relative humidity : < 65 % R.H.

6. Case temperature (Test point temperature)



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

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9.1 Test condition 1 **55 ℃**

Drive Current **150 mA**

Measurement Current **150 mA**

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	121.9	6.109	99.7	99.2	98.9	98.7	98.4	98.0	98.1
2	121.5	6.136	99.6	99.5	98.8	98.6	98.2	97.8	97.8
3	123.1	6.059	100.0	99.7	99.5	99.1	98.5	98.1	97.9
4	121.6	6.046	99.6	99.4	98.6	98.4	98.1	97.8	97.6
5	119.5	6.029	99.9	99.4	99.2	99.1	98.9	98.7	98.4
6	121.1	6.063	99.7	99.5	99.1	98.8	98.6	98.5	98.0
7	121.7	6.034	99.6	99.4	99.3	98.8	98.3	97.9	97.5
8	122.9	6.080	99.7	99.2	99.0	98.4	98.2	97.9	98.0
9	121.3	6.111	99.7	99.6	99.3	98.8	98.5	98.3	98.1
10	119.6	6.064	99.5	99.3	99.0	98.7	98.5	98.0	97.7
11	124.0	6.039	99.8	99.7	99.4	99.2	98.9	98.5	98.5
12	121.7	6.085	99.6	99.1	98.6	98.3	97.9	97.8	97.7
13	124.1	6.077	99.8	99.5	98.9	98.9	98.7	98.6	98.3
14	121.2	6.050	99.7	99.1	98.7	98.3	98.0	97.6	97.5
15	124.1	6.054	99.8	99.5	98.9	98.6	98.4	97.8	97.6
16	120.2	6.043	99.7	99.5	99.0	98.6	98.6	98.2	98.0
17	122.5	6.064	99.7	99.5	99.2	98.9	98.7	98.4	97.9
18	122.0	6.040	99.6	99.1	98.7	98.6	98.3	98.0	97.6
19	123.1	6.086	99.7	99.5	98.9	98.6	98.3	98.3	98.1
20	119.7	6.045	99.6	99.4	99.0	98.7	98.1	97.7	97.7
Mean	121.8	6.07	99.7	99.4	99.0	98.7	98.4	98.1	97.9
Median	121.7	6.06	99.7	99.5	99.0	98.7	98.4	98.0	97.9
std.dev	1.4	0.03	0.1	0.2	0.3	0.3	0.3	0.3	0.3
Max	124.1	6.14	100.0	99.7	99.5	99.2	98.9	98.7	98.5
Min	119.5	6.03	99.5	99.1	98.6	98.3	97.9	97.6	97.5

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9.1 Test condition 1 **55 ℃**

Drive Current **150 mA**

Measurement Current **150 mA**

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	97.8	97.7	97.4	97.3					
2	97.7	97.5	97.2	96.9					
3	97.7	97.3	97.1	97.0					
4	97.4	97.4	97.3	97.1					
5	98.2	97.9	97.4	97.4					
6	97.7	97.6	97.3	97.1					
7	97.4	97.2	97.0	96.7					
8	97.7	97.6	97.5	97.3					
9	97.8	97.4	97.2	96.9					
10	97.4	96.9	97.0	96.7					
11	97.6	97.4	97.2	96.8					
12	97.7	97.5	97.3	97.1					
13	97.8	97.7	97.5	97.3					
14	97.3	97.1	97.0	96.8					
15	97.4	97.1	96.8	96.7					
16	97.5	97.3	97.2	97.3					
17	97.5	97.4	97.2	96.9					
18	97.2	97.1	96.8	96.6					
19	97.8	97.6	97.3	97.1					
20	97.5	97.3	97.2	97.1					
Mean	97.6	97.4	97.2	97.0					
Median	97.6	97.4	97.2	97.0					
std.dev	0.2	0.2	0.2	0.2					
Max	98.2	97.9	97.5	97.4					
Min	97.2	96.9	96.8	96.6					

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9.1 Test condition 1 **55 ℃**

Drive Current **150 mA**

Measurement Current **150 mA**

No.	u'	v'	Chromaticity Shift (△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	0.248 0	0.519 9	0.000 3	0.000 5	0.000 4	0.000 5	0.000 6	0.000 7	0.000 9
2	0.248 8	0.520 9	0.000 1	0.000 1	0.000 2	0.000 4	0.000 5	0.000 6	0.000 7
3	0.247 8	0.521 6	0.000 2	0.000 3	0.000 4	0.000 7	0.000 6	0.000 7	0.000 8
4	0.249 8	0.520 0	0.000 2	0.000 2	0.000 3	0.000 4	0.000 7	0.000 7	0.000 8
5	0.251 4	0.521 0	0.000 2	0.000 3	0.000 4	0.000 5	0.000 6	0.000 7	0.000 9
6	0.250 0	0.520 7	0.000 3	0.000 3	0.000 5	0.000 5	0.000 6	0.000 6	0.000 7
7	0.247 0	0.520 9	0.000 2	0.000 3	0.000 1	0.000 3	0.000 5	0.000 6	0.000 7
8	0.249 6	0.519 4	0.000 2	0.000 2	0.000 3	0.000 4	0.000 6	0.000 6	0.000 7
9	0.248 3	0.520 1	0.000 2	0.000 3	0.000 5	0.000 6	0.000 8	0.000 8	0.000 8
10	0.251 7	0.520 3	0.000 2	0.000 2	0.000 4	0.000 5	0.000 5	0.000 5	0.000 6
11	0.248 0	0.520 7	0.000 1	0.000 2	0.000 4	0.000 6	0.000 8	0.000 9	0.001 0
12	0.247 7	0.522 1	0.000 3	0.000 5	0.000 5	0.000 5	0.000 6	0.000 7	0.000 8
13	0.248 2	0.521 7	0.000 2	0.000 2	0.000 3	0.000 6	0.000 7	0.000 7	0.000 8
14	0.249 2	0.521 5	0.000 1	0.000 1	0.000 4	0.000 5	0.000 6	0.000 7	0.000 7
15	0.249 6	0.521 0	0.000 1	0.000 0	0.000 1	0.000 3	0.000 4	0.000 5	0.000 7
16	0.249 6	0.520 4	0.000 1	0.000 2	0.000 5	0.000 7	0.000 8	0.000 9	0.001 0
17	0.252 3	0.519 4	0.000 1	0.000 2	0.000 3	0.000 4	0.000 7	0.000 8	0.000 8
18	0.253 1	0.519 5	0.000 2	0.000 2	0.000 5	0.000 7	0.000 9	0.000 9	0.000 9
19	0.250 6	0.522 2	0.000 3	0.000 4	0.000 4	0.000 6	0.000 7	0.000 8	0.000 9
20	0.249 2	0.519 7	0.000 1	0.000 2	0.000 4	0.000 5	0.000 7	0.000 6	0.000 7
Mean	0.249 5	0.520 6	0.000 2	0.000 2	0.000 4	0.000 5	0.000 6	0.000 7	0.000 8
Median	0.249 4	0.520 7	0.000 2	0.000 2	0.000 4	0.000 5	0.000 6	0.000 7	0.000 8
std.dev	0.001 6	0.000 9	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1
Max	0.253 1	0.522 2	0.000 3	0.000 5	0.000 5	0.000 7	0.000 9	0.000 9	0.001 0
Min	0.247 0	0.519 4	0.000 1	0.000 0	0.000 1	0.000 3	0.000 4	0.000 5	0.000 6

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9.1 Test condition 1 **55 ℃**

Drive Current **150 mA**

Measurement Current **150 mA**

No.	Chromaticity Shift (△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 0	0.001 2	0.001 4	0.001 5					
2	0.000 8	0.000 9	0.001 0	0.001 2					
3	0.000 9	0.001 1	0.001 3	0.001 4					
4	0.000 9	0.001 1	0.001 1	0.001 3					
5	0.001 0	0.001 2	0.001 2	0.001 4					
6	0.000 9	0.001 0	0.001 1	0.001 3					
7	0.000 8	0.001 1	0.001 1	0.001 3					
8	0.000 8	0.000 9	0.001 0	0.001 1					
9	0.000 9	0.001 1	0.001 2	0.001 4					
10	0.000 7	0.000 9	0.001 0	0.001 2					
11	0.001 1	0.001 2	0.001 4	0.001 4					
12	0.000 9	0.001 0	0.001 1	0.001 2					
13	0.000 9	0.001 1	0.001 1	0.001 2					
14	0.000 8	0.001 0	0.001 0	0.001 1					
15	0.000 8	0.001 0	0.001 1	0.001 2					
16	0.001 1	0.001 2	0.001 3	0.001 5					
17	0.000 9	0.001 2	0.001 2	0.001 3					
18	0.001 1	0.001 3	0.001 5	0.001 6					
19	0.000 9	0.001 0	0.001 1	0.001 3					
20	0.000 9	0.000 9	0.001 0	0.001 2					
Mean	0.000 9	0.001 1	0.001 2	0.001 3					
Median	0.000 9	0.001 1	0.001 1	0.001 3					
std.dev	0.000 1	0.000 1	0.000 1	0.000 1					
Max	0.001 1	0.001 3	0.001 5	0.001 6					
Min	0.000 7	0.000 9	0.001 0	0.001 1					

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9.1 Test condition 1 **55 ℃**

Drive Current **150 mA**

Measurement Current **150 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	3 079	3 085	3 086	3 084	3 081	3 080	3 082	3 081
2	3 052	3 053	3 052	3 051	3 052	3 052	3 054	3 053
3	3 071	3 076	3 077	3 078	3 082	3 078	3 073	3 071
4	3 031	3 034	3 033	3 032	3 036	3 037	3 031	3 024
5	2 984	2 989	2 987	2 986	2 986	2 985	2 985	2 983
6	3 022	3 028	3 028	3 030	3 029	3 025	3 023	3 024
7	3 097	3 101	3 103	3 098	3 100	3 099	3 099	3 100
8	3 042	3 046	3 042	3 042	3 041	3 041	3 039	3 039
9	3 069	3 069	3 069	3 066	3 069	3 067	3 066	3 062
10	2 982	2 986	2 984	2 984	2 984	2 983	2 982	2 978
11	3 074	3 076	3 076	3 076	3 074	3 074	3 075	3 076
12	3 071	3 078	3 078	3 074	3 070	3 070	3 070	3 065
13	3 060	3 063	3 064	3 062	3 065	3 061	3 062	3 054
14	3 036	3 037	3 036	3 036	3 037	3 031	3 029	3 027
15	3 029	3 031	3 030	3 028	3 029	3 026	3 026	3 028
16	3 035	3 036	3 037	3 038	3 041	3 040	3 041	3 040
17	2 972	2 971	2 973	2 970	2 969	2 972	2 972	2 972
18	2 952	2 956	2 956	2 960	2 962	2 964	2 959	2 958
19	2 997	3 004	3 004	3 000	3 000	3 001	3 000	2 999
20	3 049	3 051	3 052	3 053	3 056	3 056	3 054	3 052
Mean	3 035	3 038	3 038	3 037	3 038	3 037	3 036	3 034
Median	3 039	3 041	3 040	3 040	3 041	3 041	3 040	3 039
std.dev	40	40	40	40	40	39	39	39
Max	3 097	3 101	3 103	3 098	3 100	3 099	3 099	3 100
Min	2 952	2 956	2 956	2 960	2 962	2 964	2 959	2 958

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9.1 Test condition 1 **55 ℃**

Drive Current **150 mA**

Measurement Current **150 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	3 081	3 080	3 078	3 081					
2	3 053	3 050	3 046	3 045					
3	3 072	3 074	3 076	3 073					
4	3 026	3 026	3 028	3 030					
5	2 984	2 984	2 983	2 984					
6	3 020	3 019	3 020	3 021					
7	3 100	3 099	3 099	3 097					
8	3 039	3 036	3 036	3 036					
9	3 063	3 066	3 067	3 069					
10	2 979	2 981	2 980	2 979					
11	3 075	3 071	3 071	3 069					
12	3 067	3 065	3 066	3 067					
13	3 056	3 057	3 057	3 058					
14	3 031	3 029	3 031	3 033					
15	3 030	3 030	3 028	3 028					
16	3 040	3 035	3 033	3 039					
17	2 972	2 974	2 975	2 972					
18	2 962	2 962	2 963	2 963					
19	2 998	2 995	2 995	2 997					
20	3 053	3 049	3 049	3 051					
Mean	3 035	3 034	3 034	3 035					
Median	3 040	3 035	3 034	3 038					
std.dev	39	39	38	39					
Max	3 100	3 099	3 099	3 097					
Min	2 962	2 962	2 963	2 963					

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9.2 Test condition 2 **85 ℃**

Drive Current **150 mA**

Measurement Current **150 mA**

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	121.4	6.036	99.4	99.0	98.3	98.0	97.6	97.6	97.6
2	119.9	6.117	99.2	99.0	98.6	98.2	97.8	97.7	97.4
3	122.5	6.079	99.4	99.4	99.0	98.5	98.0	98.1	97.5
4	122.3	6.115	99.5	99.3	99.1	98.5	98.1	98.0	97.9
5	121.2	6.051	99.1	98.9	98.5	98.3	98.1	97.9	97.5
6	122.2	6.027	99.8	99.7	99.1	98.7	98.4	98.0	97.8
7	123.0	6.031	99.4	98.7	98.4	97.8	97.6	97.5	97.2
8	119.5	6.127	99.2	98.9	98.8	98.4	98.1	97.8	97.2
9	123.1	6.039	99.6	99.5	99.0	98.3	97.9	97.6	97.1
10	121.4	6.130	99.5	99.0	98.3	97.8	97.4	97.2	96.9
11	121.3	6.107	99.5	99.4	98.5	98.0	97.6	97.4	97.2
12	122.0	6.054	99.5	99.1	98.3	97.9	97.3	97.0	97.0
13	120.7	6.042	99.4	99.0	98.5	98.2	97.9	97.7	97.5
14	122.9	6.047	99.5	99.2	98.6	98.5	97.6	97.2	97.0
15	119.2	6.045	99.7	99.2	98.8	98.2	97.6	97.5	97.3
16	122.5	6.048	99.2	99.1	98.4	97.9	97.4	97.3	97.1
17	122.0	6.072	99.5	99.2	98.5	98.3	97.9	97.7	97.4
18	123.6	6.089	99.1	99.0	98.5	98.3	97.9	97.9	97.5
19	120.2	6.067	99.3	98.8	98.4	98.0	97.7	97.4	97.1
20	121.5	6.038	99.2	98.9	98.6	98.2	98.0	97.5	96.8
Mean	121.6	6.07	99.4	99.1	98.6	98.2	97.8	97.6	97.3
Median	121.7	6.05	99.4	99.0	98.5	98.2	97.9	97.6	97.3
std.dev	1.2	0.03	0.2	0.2	0.3	0.3	0.3	0.3	0.3
Max	123.6	6.13	99.8	99.7	99.1	98.7	98.4	98.1	97.9
Min	119.2	6.03	99.1	98.7	98.3	97.8	97.3	97.0	96.8

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9.2 Test condition 2 **85 ℃**

Drive Current **150 mA**

Measurement Current **150 mA**

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	97.3	97.0	96.8	96.6					
2	97.1	96.7	96.3	96.4					
3	97.1	97.0	96.6	96.4					
4	97.7	97.4	96.5	96.3					
5	97.1	96.9	96.7	96.4					
6	97.6	97.3	96.8	96.8					
7	97.0	96.9	96.6	96.0					
8	97.1	97.0	96.7	96.5					
9	97.0	96.8	96.6	96.4					
10	96.7	96.6	96.3	96.0					
11	97.2	97.0	96.7	96.2					
12	97.0	96.7	96.5	96.4					
13	96.9	96.8	96.6	96.5					
14	96.9	96.6	96.4	96.4					
15	97.1	96.8	96.5	96.4					
16	97.0	96.8	96.6	96.4					
17	97.2	97.1	96.9	96.7					
18	97.3	96.9	96.7	96.3					
19	97.0	96.8	96.6	96.5					
20	96.8	96.7	96.6	96.5					
Mean	97.1	96.9	96.6	96.4					
Median	97.1	96.9	96.6	96.4					
std.dev	0.2	0.2	0.2	0.2					
Max	97.7	97.4	96.9	96.8					
Min	96.7	96.6	96.3	96.0					

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9.2 Test condition 2 **85 ℃**

Drive Current **150 mA**

Measurement Current **150 mA**

No.	u'	v'	Chromaticity Shift (△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	0.251 9	0.518 8	0.000 3	0.000 2	0.000 3	0.000 4	0.000 6	0.000 8	0.001 0
2	0.250 0	0.520 3	0.000 2	0.000 3	0.000 3	0.000 4	0.000 6	0.000 7	0.000 8
3	0.249 4	0.522 0	0.000 0	0.000 2	0.000 6	0.000 7	0.000 9	0.001 2	0.001 3
4	0.247 3	0.520 3	0.000 1	0.000 3	0.000 4	0.000 5	0.000 6	0.000 8	0.000 9
5	0.248 3	0.521 2	0.000 0	0.000 2	0.000 3	0.000 4	0.000 6	0.000 8	0.001 0
6	0.248 8	0.522 3	0.000 2	0.000 2	0.000 3	0.000 5	0.000 7	0.000 8	0.000 8
7	0.248 5	0.522 6	0.000 1	0.000 1	0.000 2	0.000 3	0.000 5	0.000 6	0.000 8
8	0.252 0	0.520 4	0.000 1	0.000 2	0.000 3	0.000 5	0.000 4	0.000 6	0.000 9
9	0.249 7	0.518 6	0.000 3	0.000 1	0.000 1	0.000 3	0.000 5	0.000 7	0.000 7
10	0.249 1	0.520 1	0.000 1	0.000 1	0.000 3	0.000 4	0.000 6	0.000 7	0.000 9
11	0.249 3	0.519 4	0.000 2	0.000 2	0.000 3	0.000 4	0.000 4	0.000 6	0.000 9
12	0.249 4	0.519 1	0.000 1	0.000 2	0.000 3	0.000 4	0.000 5	0.000 6	0.000 9
13	0.249 7	0.520 8	0.000 2	0.000 3	0.000 4	0.000 5	0.000 8	0.001 0	0.001 1
14	0.251 8	0.518 3	0.000 3	0.000 3	0.000 3	0.000 5	0.000 6	0.000 8	0.001 0
15	0.249 6	0.522 2	0.000 2	0.000 3	0.000 5	0.000 7	0.000 7	0.000 8	0.000 9
16	0.246 9	0.521 8	0.000 4	0.000 6	0.000 7	0.000 7	0.000 9	0.001 1	0.001 2
17	0.248 8	0.521 9	0.000 2	0.000 2	0.000 3	0.000 5	0.000 7	0.001 0	0.001 0
18	0.252 4	0.519 3	0.000 2	0.000 1	0.000 1	0.000 2	0.000 4	0.000 7	0.000 8
19	0.249 7	0.520 9	0.000 2	0.000 2	0.000 4	0.000 5	0.000 7	0.001 0	0.001 1
20	0.250 4	0.520 2	0.000 1	0.000 2	0.000 2	0.000 3	0.000 5	0.000 8	0.000 9
Mean	0.249 6	0.520 5	0.000 2	0.000 2	0.000 3	0.000 4	0.000 6	0.000 8	0.000 9
Median	0.249 5	0.520 3	0.000 2	0.000 2	0.000 3	0.000 4	0.000 6	0.000 8	0.000 9
std.dev	0.001 5	0.001 3	0.000 1	0.000 1	0.000 1	0.000 1	0.000 1	0.000 2	0.000 1
Max	0.252 4	0.522 6	0.000 4	0.000 6	0.000 7	0.000 7	0.000 9	0.001 2	0.001 3
Min	0.246 9	0.518 3	0.000 0	0.000 1	0.000 1	0.000 2	0.000 4	0.000 6	0.000 7

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9.2 Test condition 2 **85 ℃**

Drive Current **150 mA**

Measurement Current **150 mA**

No.	Chromaticity Shift (△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 1	0.001 3	0.001 4	0.001 6					
2	0.000 9	0.001 0	0.001 3	0.001 4					
3	0.001 3	0.001 4	0.001 5	0.001 7					
4	0.001 1	0.001 3	0.001 5	0.001 9					
5	0.001 2	0.001 4	0.001 6	0.001 8					
6	0.000 9	0.001 1	0.001 2	0.001 6					
7	0.001 0	0.001 2	0.001 4	0.001 6					
8	0.001 0	0.001 2	0.001 3	0.001 3					
9	0.000 9	0.001 0	0.001 2	0.001 3					
10	0.001 1	0.001 1	0.001 3	0.001 4					
11	0.001 1	0.001 1	0.001 3	0.001 6					
12	0.001 1	0.001 1	0.001 4	0.001 5					
13	0.001 1	0.001 2	0.001 5	0.001 6					
14	0.001 2	0.001 4	0.001 6	0.002 0					
15	0.001 1	0.001 2	0.001 2	0.001 4					
16	0.001 1	0.001 3	0.001 5	0.001 6					
17	0.001 2	0.001 2	0.001 4	0.001 6					
18	0.001 0	0.001 2	0.001 3	0.001 5					
19	0.001 2	0.001 5	0.001 7	0.002 0					
20	0.001 0	0.001 2	0.001 5	0.001 6					
Mean	0.001 1	0.001 2	0.001 4	0.001 6					
Median	0.001 1	0.001 2	0.001 4	0.001 6					
std.dev	0.000 1	0.000 1	0.000 1	0.000 2					
Max	0.001 3	0.001 5	0.001 7	0.002 0					
Min	0.000 9	0.001 0	0.001 2	0.001 3					

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9.2 Test condition 2 **85 ℃**

Drive Current **150 mA**

Measurement Current **150 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	2 986	2 993	2 989	2 989	2 983	2 986	2 985	2 986
2	3 025	3 026	3 018	3 017	3 015	3 017	3 014	3 013
3	3 028	3 028	3 025	3 027	3 026	3 025	3 026	3 023
4	3 093	3 097	3 097	3 095	3 089	3 089	3 091	3 091
5	3 061	3 060	3 057	3 058	3 058	3 055	3 057	3 054
6	3 041	3 046	3 045	3 045	3 045	3 048	3 046	3 046
7	3 046	3 050	3 044	3 044	3 042	3 043	3 041	3 041
8	2 972	2 976	2 973	2 967	2 962	2 966	2 967	2 970
9	3 045	3 052	3 047	3 044	3 043	3 046	3 042	3 038
10	3 049	3 051	3 051	3 049	3 050	3 050	3 051	3 050
11	3 049	3 053	3 049	3 043	3 041	3 043	3 044	3 041
12	3 048	3 047	3 047	3 047	3 046	3 048	3 044	3 044
13	3 028	3 032	3 030	3 027	3 029	3 033	3 035	3 033
14	2 991	2 999	2 982	2 984	2 980	2 982	2 984	2 986
15	3 022	3 027	3 026	3 028	3 029	3 027	3 024	3 022
16	3 093	3 103	3 104	3 103	3 101	3 102	3 104	3 102
17	3 044	3 048	3 048	3 045	3 041	3 043	3 043	3 043
18	2 970	2 968	2 969	2 968	2 968	2 968	2 962	2 965
19	3 027	3 032	3 031	3 031	3 030	3 032	3 035	3 033
20	3 016	3 018	3 014	3 014	3 013	3 017	3 022	3 017
Mean	3 032	3 035	3 032	3 031	3 030	3 031	3 031	3 030
Median	3 035	3 039	3 038	3 037	3 035	3 038	3 038	3 036
std.dev	33	34	36	35	36	35	36	35
Max	3 093	3 103	3 104	3 103	3 101	3 102	3 104	3 102
Min	2 970	2 968	2 969	2 967	2 962	2 966	2 962	2 965

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9.2 Test condition 2 **85 ℃**

Drive Current **150 mA**

Measurement Current **150 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	2 980	2 981	2 979	2 981					
2	3 012	3 013	3 015	3 019					
3	3 020	3 022	3 023	3 027					
4	3 092	3 095	3 097	3 103					
5	3 053	3 055	3 060	3 061					
6	3 042	3 044	3 043	3 048					
7	3 041	3 038	3 043	3 046					
8	2 967	2 966	2 966	2 969					
9	3 034	3 037	3 037	3 038					
10	3 048	3 050	3 049	3 053					
11	3 043	3 039	3 042	3 046					
12	3 043	3 037	3 043	3 042					
13	3 029	3 030	3 034	3 034					
14	2 979	2 979	2 986	2 996					
15	3 018	3 014	3 015	3 019					
16	3 092	3 096	3 098	3 102					
17	3 040	3 040	3 041	3 044					
18	2 964	2 967	2 965	2 970					
19	3 029	3 033	3 036	3 043					
20	3 018	3 020	3 017	3 014					
Mean	3 027	3 028	3 029	3 033					
Median	3 031	3 035	3 036	3 040					
std.dev	35	35	36	36					
Max	3 092	3 096	3 098	3 103					
Min	2 964	2 966	2 965	2 969					

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9.3 Test condition 3 **105 ℃**

Drive Current **150 mA**

Measurement Current **150 mA**

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	120.7	6.028	99.4	98.7	98.0	97.3	96.8	96.3	95.8
2	119.8	6.107	99.5	98.7	97.9	97.2	96.9	96.2	95.7
3	123.6	6.058	99.4	98.7	98.1	97.3	97.1	96.4	96.0
4	121.5	6.091	99.5	99.1	98.1	97.4	96.9	96.0	95.4
5	119.9	6.140	99.4	98.8	97.9	96.8	96.6	95.9	95.4
6	122.8	6.044	99.3	98.5	97.8	97.2	97.0	96.5	96.1
7	121.5	6.064	99.4	98.8	97.9	97.1	96.7	96.1	95.6
8	123.8	6.031	99.3	98.5	97.6	97.0	96.5	95.8	95.5
9	122.2	6.122	99.2	98.6	98.0	97.4	97.2	96.5	95.8
10	123.3	6.030	99.5	98.8	97.8	97.3	97.0	96.2	95.5
11	119.8	6.080	99.6	98.9	98.0	97.3	97.0	96.2	95.8
12	121.5	6.043	99.3	98.7	97.4	96.9	96.6	95.8	95.5
13	119.5	6.032	99.6	98.8	98.2	97.5	97.2	96.4	95.9
14	122.7	6.039	99.2	98.6	97.8	97.2	96.9	96.0	95.4
15	122.3	6.100	99.3	98.7	97.9	97.2	97.1	96.4	96.1
16	122.7	6.063	99.3	98.7	97.9	97.1	97.1	96.6	95.9
17	122.7	6.047	99.5	98.9	98.2	97.3	96.8	96.1	95.7
18	120.7	6.069	99.4	98.4	97.6	96.9	96.8	96.1	95.7
19	119.3	6.043	99.4	98.6	97.8	97.3	96.8	96.2	95.6
20	123.3	6.093	99.5	98.7	98.1	97.1	97.0	96.3	95.8
Mean	121.7	6.07	99.4	98.7	97.9	97.2	96.9	96.2	95.7
Median	121.9	6.06	99.4	98.7	97.9	97.2	96.9	96.2	95.7
std.dev	1.5	0.03	0.1	0.2	0.2	0.2	0.2	0.2	0.2
Max	123.8	6.14	99.6	99.1	98.2	97.5	97.2	96.6	96.1
Min	119.3	6.03	99.2	98.4	97.4	96.8	96.5	95.8	95.4

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9.3 Test condition 3 **105 ℃**

Drive Current **150 mA**

Measurement Current **150 mA**

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	95.1	94.4	93.8	93.5					
2	95.0	94.4	93.6	93.1					
3	95.6	94.7	94.0	93.5					
4	94.8	94.4	93.7	93.0					
5	94.7	94.1	93.2	93.0					
6	95.6	94.8	94.1	93.4					
7	95.1	94.2	93.4	93.1					
8	94.6	94.1	93.4	93.0					
9	95.2	94.8	94.2	93.7					
10	95.0	94.6	93.9	93.3					
11	95.2	94.6	93.7	93.5					
12	94.8	94.2	93.7	93.2					
13	95.3	94.6	93.9	93.2					
14	95.0	94.4	93.7	93.3					
15	95.4	94.7	94.1	93.5					
16	95.4	94.6	94.0	93.7					
17	95.0	94.5	93.9	93.4					
18	95.1	94.5	93.7	93.0					
19	94.8	94.5	93.8	93.3					
20	95.4	94.9	94.2	93.4					
Mean	95.1	94.5	93.8	93.3					
Median	95.1	94.5	93.8	93.3					
std.dev	0.3	0.2	0.3	0.2					
Max	95.6	94.9	94.2	93.7					
Min	94.6	94.1	93.2	93.0					

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9.3 Test condition 3 **105 ℃**

Drive Current **150 mA**

Measurement Current **150 mA**

No.	u'	v'	Chromaticity Shift (△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	0.251 6	0.521 2	0.000 2	0.000 6	0.001 0	0.001 2	0.001 7	0.002 0	0.002 3
2	0.251 5	0.520 6	0.000 4	0.000 7	0.001 1	0.001 4	0.001 9	0.002 2	0.002 7
3	0.251 0	0.520 2	0.000 3	0.000 5	0.000 9	0.001 2	0.001 6	0.002 1	0.002 5
4	0.247 8	0.522 1	0.000 3	0.000 6	0.000 8	0.001 2	0.001 8	0.002 1	0.002 6
5	0.249 0	0.521 7	0.000 4	0.000 6	0.000 9	0.001 2	0.001 7	0.002 1	0.002 6
6	0.250 7	0.521 2	0.000 3	0.000 8	0.001 1	0.001 6	0.002 0	0.002 3	0.002 9
7	0.250 5	0.520 6	0.000 2	0.000 6	0.001 1	0.001 3	0.001 8	0.002 1	0.002 6
8	0.249 4	0.520 9	0.000 4	0.000 7	0.000 9	0.001 3	0.001 6	0.002 0	0.002 4
9	0.252 8	0.519 2	0.000 4	0.000 7	0.001 2	0.001 7	0.002 2	0.002 5	0.002 8
10	0.249 3	0.520 4	0.000 3	0.000 6	0.000 9	0.001 2	0.001 6	0.001 9	0.002 4
11	0.248 4	0.521 1	0.000 2	0.000 5	0.000 9	0.001 2	0.001 5	0.001 8	0.002 5
12	0.246 5	0.521 4	0.000 3	0.000 8	0.001 1	0.001 5	0.001 6	0.001 9	0.002 5
13	0.249 0	0.522 0	0.000 2	0.000 5	0.000 8	0.001 2	0.001 6	0.002 0	0.002 6
14	0.251 4	0.521 3	0.000 4	0.000 6	0.001 0	0.001 3	0.001 8	0.002 0	0.002 6
15	0.248 0	0.521 5	0.000 2	0.000 5	0.000 8	0.001 2	0.001 6	0.001 7	0.002 3
16	0.247 3	0.521 8	0.000 3	0.000 6	0.000 9	0.001 4	0.001 6	0.001 9	0.002 5
17	0.249 9	0.521 9	0.000 4	0.000 8	0.001 1	0.001 4	0.001 7	0.002 0	0.002 4
18	0.249 7	0.519 5	0.000 3	0.000 5	0.000 9	0.001 3	0.001 6	0.002 0	0.002 7
19	0.251 3	0.520 3	0.000 3	0.000 7	0.001 0	0.001 5	0.001 8	0.002 3	0.002 7
20	0.251 4	0.520 6	0.000 4	0.000 7	0.001 2	0.001 7	0.002 1	0.002 5	0.003 1
Mean	0.249 8	0.521 0	0.000 3	0.000 6	0.001 0	0.001 3	0.001 7	0.002 1	0.002 6
Median	0.249 8	0.521 1	0.000 3	0.000 6	0.001 0	0.001 3	0.001 7	0.002 0	0.002 6
std.dev	0.001 7	0.000 8	0.000 1	0.000 1	0.000 1	0.000 2	0.000 2	0.000 2	0.000 2
Max	0.252 8	0.522 1	0.000 4	0.000 8	0.001 2	0.001 7	0.002 2	0.002 5	0.003 1
Min	0.246 5	0.519 2	0.000 2	0.000 5	0.000 8	0.001 2	0.001 5	0.001 7	0.002 3

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9.3 Test condition 3 **105 ℃**

Drive Current **150 mA**

Measurement Current **150 mA**

No.	Chromaticity Shift (△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	0.002 7	0.003 1	0.003 4	0.003 7					
2	0.003 0	0.003 2	0.003 6	0.004 0					
3	0.002 8	0.003 2	0.003 5	0.003 9					
4	0.003 0	0.003 3	0.003 6	0.004 0					
5	0.003 1	0.003 5	0.003 6	0.003 8					
6	0.003 3	0.003 5	0.003 8	0.004 2					
7	0.002 9	0.003 4	0.003 8	0.004 1					
8	0.002 9	0.003 3	0.003 5	0.003 8					
9	0.003 1	0.003 3	0.003 7	0.004 1					
10	0.002 9	0.003 2	0.003 5	0.003 7					
11	0.002 8	0.003 2	0.003 3	0.003 7					
12	0.002 8	0.003 2	0.003 6	0.003 8					
13	0.002 9	0.003 1	0.003 4	0.003 6					
14	0.003 1	0.003 5	0.003 8	0.004 1					
15	0.002 7	0.003 2	0.003 5	0.003 8					
16	0.002 8	0.003 3	0.003 5	0.003 9					
17	0.002 9	0.003 0	0.003 4	0.003 9					
18	0.003 0	0.003 4	0.003 6	0.004 0					
19	0.003 2	0.003 4	0.003 8	0.004 0					
20	0.003 2	0.003 5	0.003 6	0.003 9					
Mean	0.003 0	0.003 3	0.003 6	0.003 9					
Median	0.002 9	0.003 3	0.003 6	0.003 9					
std.dev	0.000 2	0.000 1	0.000 2	0.000 2					
Max	0.003 3	0.003 5	0.003 8	0.004 2					
Min	0.002 7	0.003 0	0.003 3	0.003 6					

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9.3 Test condition 3 **105 ℃**

Drive Current **150 mA**

Measurement Current **150 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	2 977	2 977	2 972	2 981	2 979	2 977	2 977	2 970
2	2 985	2 984	2 980	2 979	2 981	2 983	2 985	2 989
3	3 000	3 001	2 998	2 998	2 999	2 999	2 997	2 999
4	3 067	3 062	3 057	3 061	3 063	3 066	3 069	3 064
5	3 039	3 045	3 041	3 039	3 033	3 034	3 035	3 041
6	3 000	2 998	2 994	2 991	2 995	2 996	2 997	3 000
7	3 009	3 008	3 006	3 008	3 008	3 008	3 005	3 009
8	3 035	3 038	3 025	3 027	3 034	3 036	3 034	3 034
9	2 962	2 963	2 962	2 962	2 966	2 969	2 969	2 971
10	3 041	3 036	3 029	3 033	3 032	3 027	3 030	3 035
11	3 060	3 058	3 053	3 057	3 059	3 053	3 049	3 055
12	3 107	3 106	3 102	3 104	3 101	3 096	3 094	3 095
13	3 038	3 036	3 031	3 034	3 035	3 033	3 035	3 041
14	2 983	2 985	2 978	2 978	2 979	2 982	2 982	2 988
15	3 068	3 067	3 059	3 060	3 062	3 058	3 063	3 063
16	3 083	3 084	3 079	3 076	3 078	3 076	3 077	3 077
17	3 015	3 014	3 005	3 010	3 012	3 009	3 010	3 010
18	3 037	3 039	3 030	3 027	3 029	3 030	3 032	3 035
19	2 990	2 986	2 982	2 985	2 986	2 987	2 991	2 994
20	2 988	2 991	2 987	2 987	2 993	2 997	2 998	3 003
Mean	3 024	3 024	3 018	3 020	3 021	3 021	3 021	3 024
Median	3 025	3 025	3 016	3 019	3 021	3 018	3 020	3 022
std.dev	40	39	38	38	37	36	36	36
Max	3 107	3 106	3 102	3 104	3 101	3 096	3 094	3 095
Min	2 962	2 963	2 962	2 962	2 966	2 969	2 969	2 970

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9.3 Test condition 3 **105 ℃**

Drive Current **150 mA**

Measurement Current **150 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	2 970	2 976	2 973	2 975					
2	2 986	2 986	2 985	2 986					
3	2 998	3 005	3 002	2 997					
4	3 065	3 064	3 064	3 064					
5	3 044	3 048	3 046	3 046					
6	3 002	3 000	2 999	3 002					
7	3 006	3 016	3 010	3 013					
8	3 031	3 034	3 033	3 034					
9	2 970	2 964	2 964	2 966					
10	3 036	3 038	3 037	3 038					
11	3 052	3 058	3 053	3 058					
12	3 097	3 101	3 101	3 098					
13	3 038	3 038	3 034	3 031					
14	2 991	2 996	2 993	2 994					
15	3 062	3 067	3 067	3 069					
16	3 076	3 078	3 078	3 079					
17	3 011	3 010	3 011	3 015					
18	3 036	3 037	3 036	3 037					
19	2 997	2 996	2 991	2 992					
20	2 996	2 996	2 993	2 989					
Mean	3 023	3 025	3 024	3 024					
Median	3 021	3 025	3 022	3 023					
std.dev	36	37	37	37					
Max	3 097	3 101	3 101	3 098					
Min	2 970	2 964	2 964	2 966					

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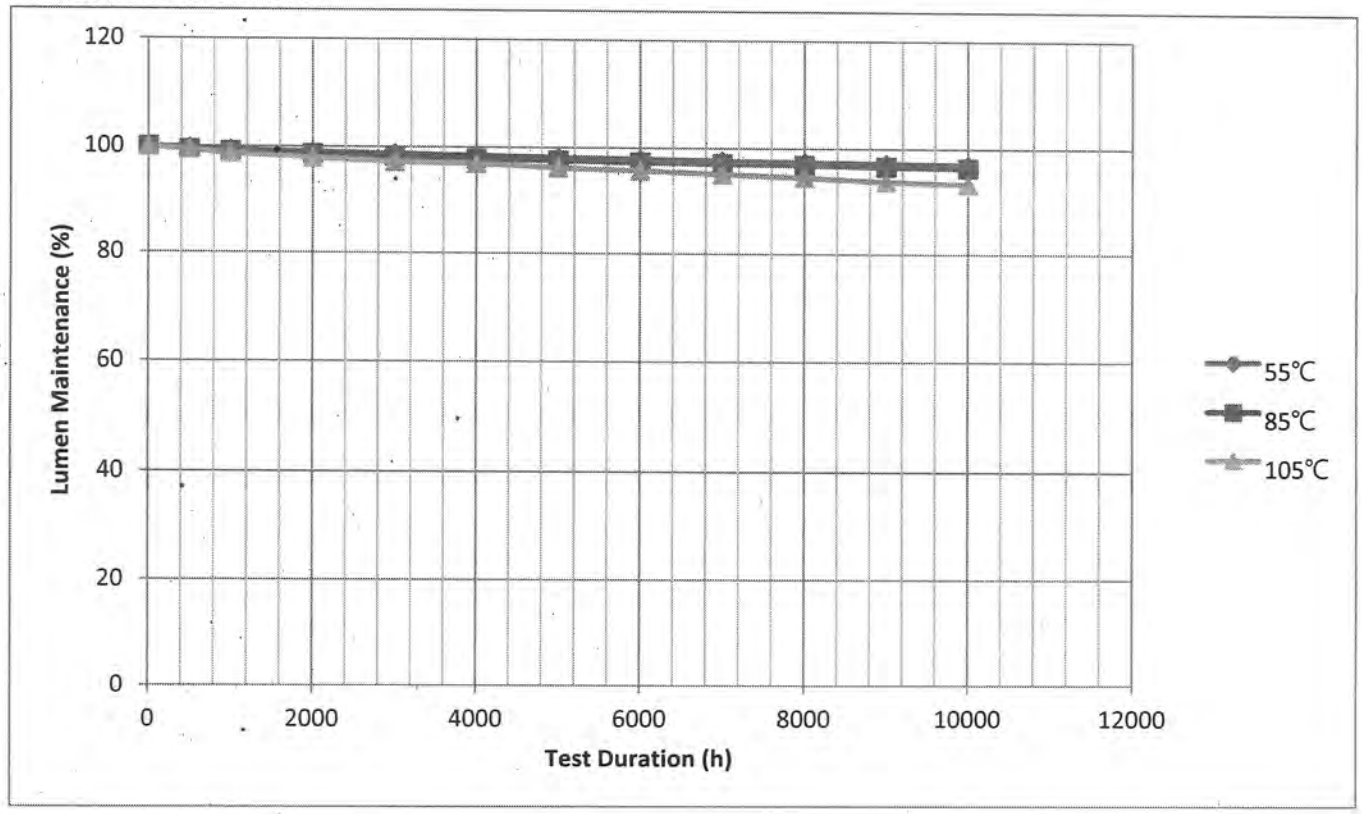
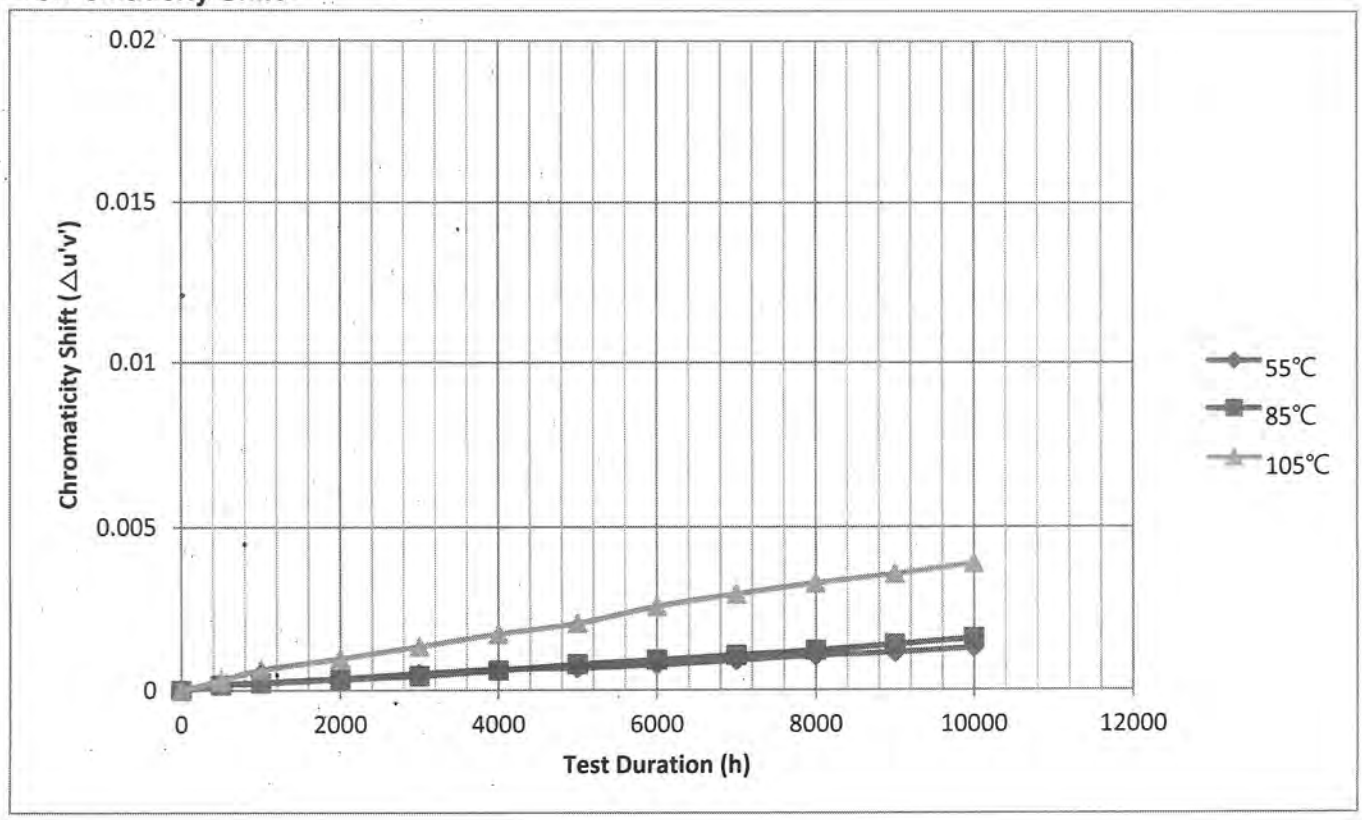
9.4 Chart

<Lumen Maintenance>



<Chromaticity Shift>



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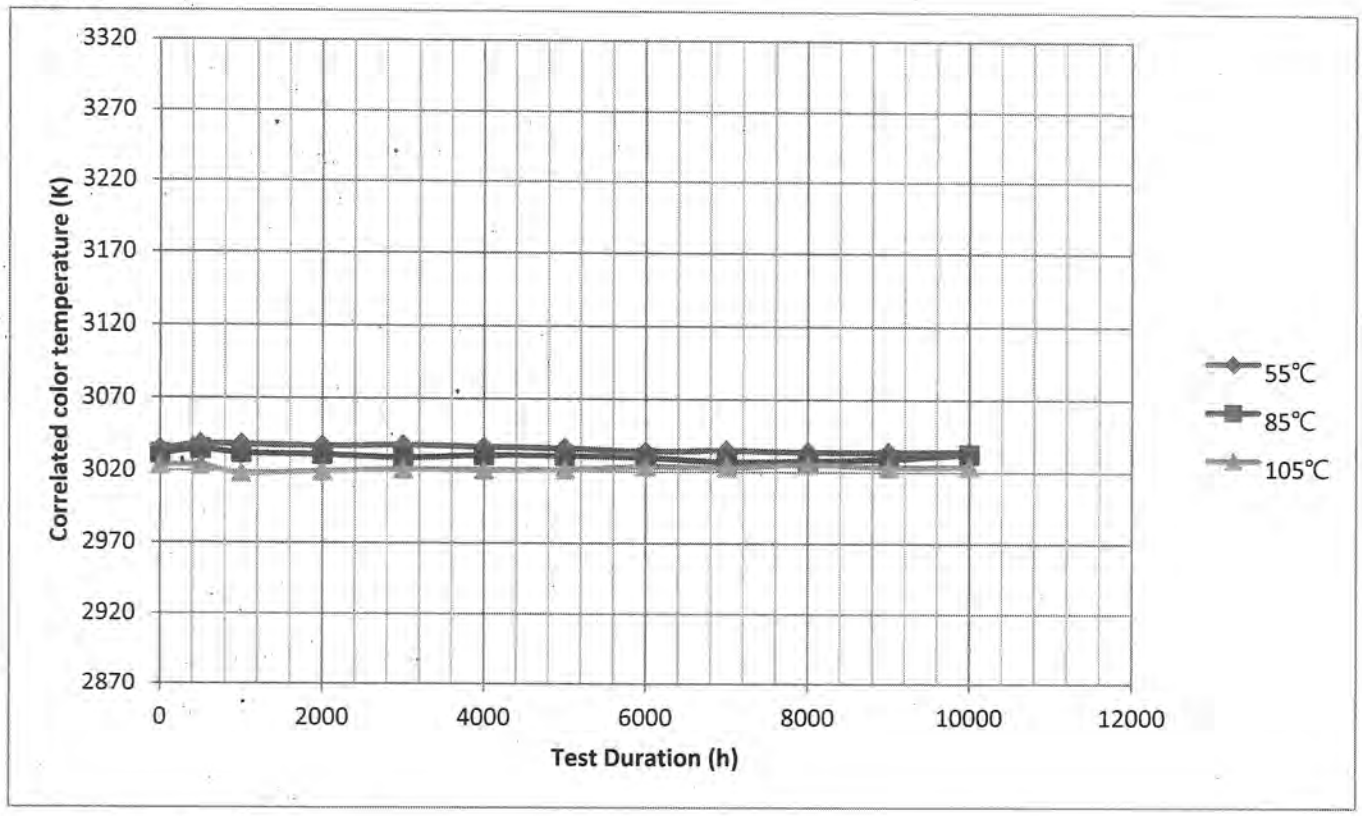
<CCT>



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

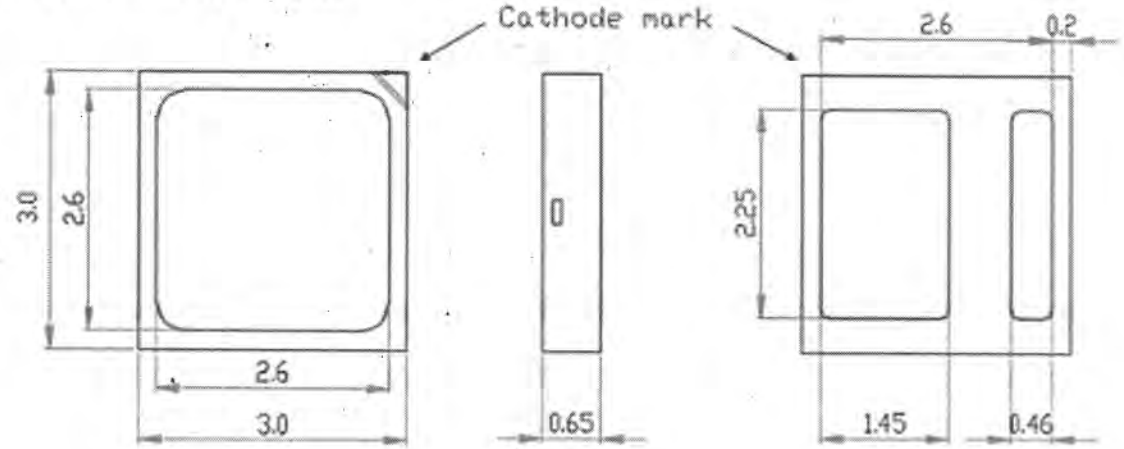
12. Photometric measurement uncertainty

3.5%

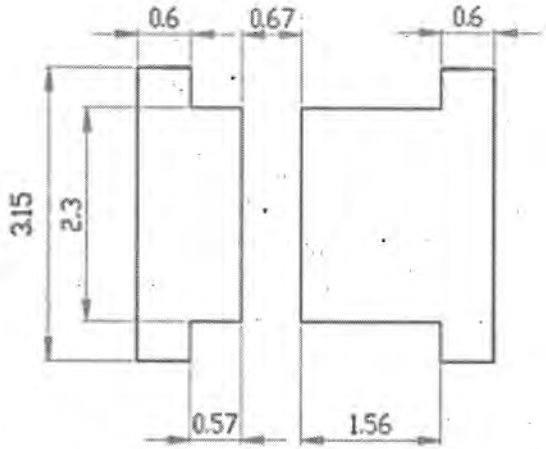
13. TM-21-11 Report : Projecting Long Term Lumen Maintenance of LED Light Source

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)	150	DUT drive current used in the test (mA)	150	DUT drive current used in the test (mA)	150
Test duration (hours)	10,000	Test duration (hours)	10,000	Test duration (hours)	10,000
Test duration used for projection (hour to hour)	5,000 - 10,000	Test duration used for projection (hour to hour)	5,000 - 10,000	Test duration used for projection (hour to hour)	5,000 - 10,000
Tested case temperature (°C)	55	Tested case temperature (°C)	85	Tested case temperature (°C)	105
α	2.285E-06	α	2.445E-06	α	6.272E-06
B	0.992	B	0.988	B	0.993
Reported L90(10k) (hours)	43,000	Reported L90(10k) (hours)	38,000	Reported L90(10k) (hours)	16,000

14. Dimension of samples



[BOTTOM VIEW]



[RECOMMENDED PCB SOLDER PAD]

Measurement unit : mm

Tolerance : ±0.1mm

15. Cover models

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