

LM-80 Test Report

NVSL119B

Issue Date: May 29, 2012	Revision Date: October 17, 2012
Test Initiation Date: August 4, 2011	Test Completion Date: October 9, 2012
Test Duration: 10,000 hours	Report Number: SQETMLH16003

Customer Information:

Company Name: Nichia Corporation
 Address: 491-100, Oka, Kaminaka-cho, Anan-shi, Tokushima, 774-8601, JAPAN

Description of Test Samples:

Classification: LED Package
 Model Name: Warm White LED
 Model Number: NVSL119B (Nominal CCT: 2700K)

Test Summary:

Data Set	Case Temperature [T _s]	Ambient Temperature [T _A]	Drive Current [I _F]	Lumen Maintenance at 10,000 hours	Chromaticity Shift (Δu'v') at 10,000 hours	TM-21 Projection L ₇₀ (10K)
1	55°C	> 50°C	700 mA	98.9%	0.0022	> 60600 hours
2	55°C	> 50°C	1200 mA	97.3%	0.0023	> 60600 hours
3	85°C	> 80°C	700 mA	97.4%	0.0023	> 60500 hours
4	85°C	> 80°C	1200 mA	93.6%	0.0031	> 60500 hours
5	105°C	> 100°C	700 mA	95.5%	0.0027	> 60500 hours
6	105°C	> 100°C	1000 mA	93.3%	0.0038	> 60500 hours

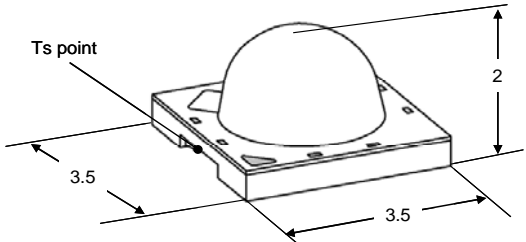
Approved Signatory:



Hitoshi TOHYAMA, Lab Manager

Nichia Corporation LED Testing Laboratory
 491-100, Oka, Kaminaka-cho, Anan-shi, Tokushima, 774-8601, JAPAN

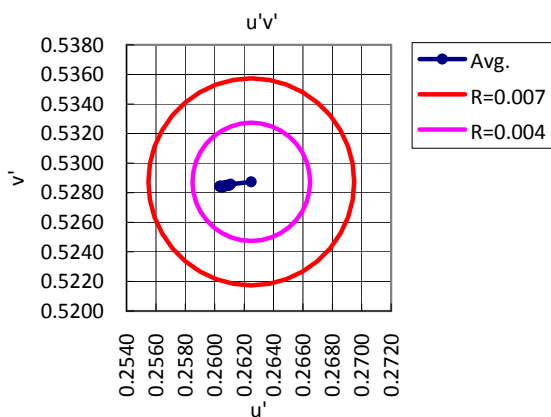
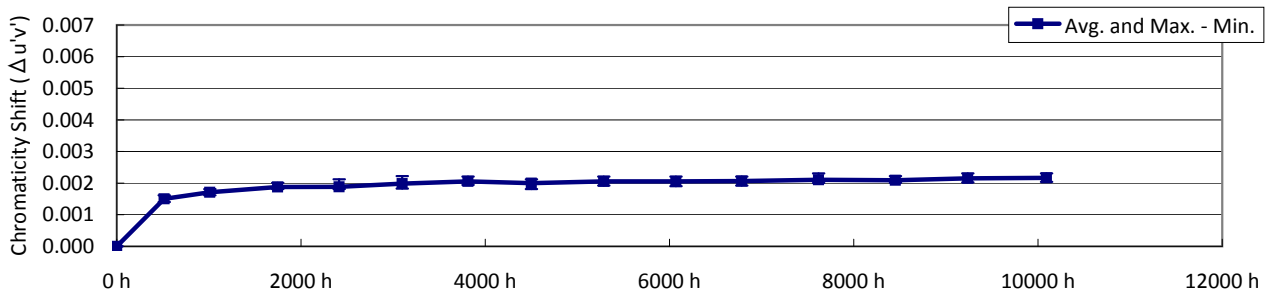
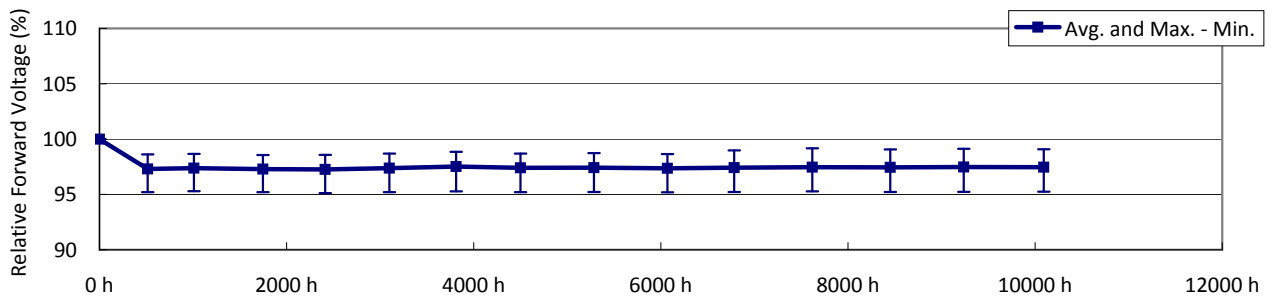
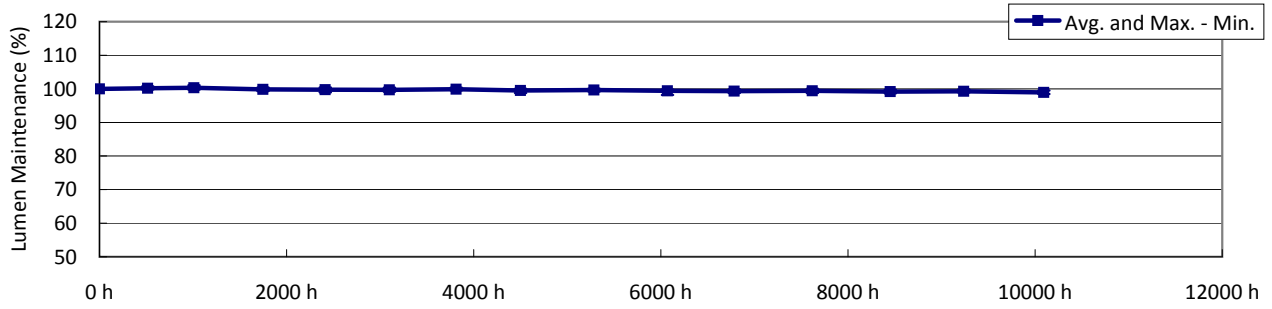
IES LM-80-08 Test Report Requirement :

1. **Number of LED light sources tested**
See tables.
 2. **Description of LED light sources**
See Description of Test Samples
 3. **Description of auxiliary equipment**
Active cooling life test system
Consisting of small boxes, in which each box contains a reliability test board, and a water-cooled heat sink or a heater to control device temperature.
LED Tester
Consisting of an integrating sphere, a programmable current-source meter, and a spectroradiometer.
 4. **Operating cycle**
Constant direct current (DC).
 5. **Ambient conditions including airflow, temperature, and relative humidity**
Ambient Temperature (T_A) : See tables
Ambient temperature is the temperature of the air at a distance of 1.5 mm above the reliability test board.
Air flow : < 0.1m/s
Relative Humidity : < 45%
 6. **Case temperature (test point temperature)**
See tables.
For the case temperature (T_S) measurement point, see the figure below.
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7. **Drive current of the LED light sources during lifetime test**
See tables.
 8. **Initial luminous flux and forward voltage at photometric measurement current**
See tables.
 9. **Lumen maintenance data for each individual LED light source along with median value, standard deviation, minimum and maximum lumen maintenance value for all of the LED light sources.**
See tables.
 10. **Observation of LED light sources failures including the failure conditions and time of failure.**
No failure observed
 11. **LED light source monitoring interval**
See tables.
 12. **Photometric measurement uncertainty**
Flux measurement: 4.8% (k=2)
Lumen maintenance: 1.8% (k=2)
 13. **Chromaticity shift reported over the measurement time.**
See tables.

Data Set 1 : 55°C, 700 mA

Actual Case Temperature [T_S]	56.9 °C
Actual Ambient Temperature [T_A]	56.3 °C
Drive Current [I_F]	700 mA
Measurement Current	700 mA

NOTES:
 T_S and T_A were measured during initial setup.



Data Set 1 : 55°C, 700 mA

Actual Case Temperature [T _S]	56.9 °C
Actual Ambient Temperature [T _A]	56.3 °C
Drive Current [I _F]	700 mA
Measurement Current	700 mA

NOTES:

 T_S and T_A were measured during initial setup.

TABLE 1-1
 Initial Characteristics

LED No.	Luminous flux	Forward voltage	CCT	CIE1931		CIE1976							
	Φ _V [lm]	V _F [V]	T _{CP} [K]	x	y	u'	v'						
1	197	3.26	2688	0.463	0.414	0.263	0.529						
2	196	3.28	2655	0.466	0.416	0.264	0.530						
3	199	3.31	2785	0.452	0.408	0.259	0.525						
4	196	3.26	2621	0.469	0.416	0.266	0.531						
5	195	3.27	2650	0.467	0.417	0.264	0.531						
6	200	3.29	2705	0.462	0.415	0.262	0.529						
7	197	3.29	2784	0.453	0.409	0.259	0.526						
8	198	3.28	2737	0.459	0.413	0.261	0.528						
9	197	3.30	2734	0.457	0.409	0.261	0.526						
10	200	3.29	2770	0.454	0.409	0.259	0.526						
11	196	3.28	2675	0.464	0.414	0.263	0.529						
12	202	3.26	2805	0.450	0.405	0.258	0.524						
13	197	3.24	2627	0.468	0.416	0.266	0.531						
14	199	3.29	2727	0.458	0.411	0.261	0.527						
15	201	3.29	2727	0.459	0.413	0.261	0.528						
16	198	3.25	2657	0.467	0.418	0.264	0.531						
17	196	3.27	2635	0.469	0.418	0.265	0.531						
18	196	3.28	2630	0.468	0.416	0.265	0.531						
19	200	3.27	2732	0.458	0.411	0.261	0.527						
20	193	3.23	2549	0.477	0.420	0.269	0.533						
21	201	3.24	2746	0.457	0.411	0.260	0.527						
22	194	3.29	2665	0.465	0.415	0.264	0.530						
23	196	3.27	2739	0.458	0.412	0.261	0.527						
24	199	3.28	2669	0.465	0.417	0.263	0.530						
n	24	24	24	24	24	24	24						
Avg.	198	3.27	2696	0.462	0.413	0.262	0.529						
Med.	197	3.28	2697	0.462	0.414	0.262	0.529						
σ	2.3	0.020	63.2	0.0065	0.0037	0.0027	0.0023						
Min.	193	3.23	2549	0.450	0.405	0.258	0.524						
Max.	202	3.31	2805	0.477	0.420	0.269	0.533						

Data Set 1 : 55°C, 700 mA

Actual Case Temperature [T _s]	56.9 °C
Actual Ambient Temperature [T _A]	56.3 °C
Drive Current [I _F]	700 mA
Measurement Current	700 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 1-2
Lumen Maintenance

LED No.	Lumen Maintenance % (Normalized to 100% at 0 hours)														
	0 h	515 h	1009 h	1747 h	2413 h	3099 h	3812 h	4500 h	5285 h	6070 h	6783 h	7618 h	8451 h	9237 h	10092 h
1	100.0	100.6	100.8	100.3	100.4	100.2	99.9	99.8	100.1	99.8	99.8	99.9	99.6	99.8	99.0
2	100.0	100.3	100.5	100.0	100.4	99.9	99.9	99.5	99.7	99.4	99.3	99.5	99.2	99.3	98.9
3	100.0	100.2	100.4	100.1	100.3	99.8	99.9	99.6	99.8	99.5	99.5	99.7	99.4	99.5	99.2
4	100.0	100.1	100.3	100.0	99.7	99.6	99.9	99.7	99.7	99.5	99.4	99.6	99.3	99.4	99.0
5	100.0	100.3	100.3	99.9	99.2	99.6	100.3	99.5	99.9	99.8	99.6	99.6	99.3	99.5	99.1
6	100.0	99.9	100.0	99.5	98.9	99.5	100.0	99.4	99.6	99.5	99.4	99.4	99.2	99.2	99.0
7	100.0	100.2	100.4	99.8	99.8	99.9	99.8	99.5	99.5	99.3	99.4	99.3	99.2	99.4	98.9
8	100.0	100.1	100.5	99.8	99.9	99.7	99.6	99.4	99.4	99.0	99.2	99.1	99.0	99.1	98.7
9	100.0	100.1	100.2	99.7	99.7	99.4	99.5	99.3	99.4	99.1	98.8	99.1	99.0	99.0	98.7
10	100.0	99.8	99.8	99.4	99.2	99.1	99.5	99.1	99.3	99.1	99.0	98.8	98.8	98.9	98.7
11	100.0	99.9	99.9	99.6	99.1	99.4	99.7	99.4	99.6	99.5	99.2	99.1	99.1	99.2	98.9
12	100.0	100.3	99.8	99.9	99.7	99.8	100.1	99.6	99.8	99.6	99.5	99.3	99.3	99.5	99.1
13	100.0	100.2	100.3	99.8	99.9	99.8	99.9	99.5	99.4	99.3	99.3	99.3	99.0	99.2	98.8
14	100.0	100.5	100.7	100.1	100.3	99.9	100.1	99.7	99.8	99.4	99.7	99.6	99.4	99.5	99.1
15	100.0	100.2	100.2	99.8	99.9	99.5	99.7	99.2	99.4	99.1	99.1	99.3	98.9	99.1	98.7
16	100.0	100.0	99.9	99.6	99.4	99.4	99.7	99.4	99.5	99.3	99.0	98.9	99.0	99.2	98.8
17	100.0	100.1	100.1	99.6	99.2	99.5	99.9	98.8	99.6	99.3	98.8	99.0	98.6	98.9	98.5
18	100.0	99.8	99.8	99.3	99.1	99.4	99.8	99.1	99.2	98.2	98.7	99.1	98.8	98.9	98.6
19	100.0	100.4	100.8	100.2	100.3	100.4	100.4	100.1	100.0	99.8	99.9	100.0	99.7	99.8	99.5
20	100.0	100.7	101.1	100.4	100.4	100.2	100.0	99.7	99.7	99.5	99.5	99.7	99.3	99.4	99.0
21	100.0	100.2	100.5	100.0	100.0	99.7	99.8	99.7	99.6	99.3	99.4	99.6	99.2	99.2	99.0
22	100.0	100.4	100.3	99.9	99.8	99.6	99.7	99.6	99.6	99.4	99.3	99.5	99.1	99.1	98.8
23	100.0	100.2	100.3	99.9	99.6	99.7	100.2	99.7	99.9	99.7	99.4	99.6	99.4	99.5	99.1
24	100.0	100.3	100.4	100.0	99.9	100.1	100.3	99.8	100.0	99.8	99.6	99.8	99.5	99.5	99.3
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	100.2	100.3	99.9	99.8	99.7	99.9	99.5	99.6	99.4	99.3	99.4	99.2	99.3	98.9
Med.	100.0	100.2	100.3	99.9	99.8	99.7	99.9	99.5	99.6	99.4	99.4	99.4	99.2	99.3	99.0
σ	0.00	0.23	0.34	0.27	0.46	0.30	0.25	0.27	0.23	0.35	0.31	0.33	0.26	0.25	0.23
Min.	100.0	99.8	99.8	99.3	98.9	99.1	99.5	98.8	99.2	98.2	98.7	98.8	98.6	98.9	98.5
Max.	100.0	100.7	101.1	100.4	100.4	100.4	100.4	100.1	100.1	99.8	99.9	100.0	99.7	99.8	99.5

TM-21 Projection

Time	4500 h	5285 h	6070 h	6783 h	7618 h	8451 h	9237 h	10092 h							
ln(Avg.)	-0.0049	-0.0036	-0.0061	-0.0067	-0.0060	-0.0082	-0.0071	-0.0107							

Test duration used	4500 h	to	10092 h
B	1.0003		
α	9.5352E-07		
R ²	0.7596		
Calculated L ₇₀ (10K)	374000	hours	
Reported L ₇₀ (10K)	> 60600	hours	

Curve-fit equation:

$$\Phi(t) = B \exp(-at)$$

Lumen maintenance life equation:

$$L_{70} = \ln(B/0.7)/\alpha$$

Data Set 1 : 55°C, 700 mA

Actual Case Temperature [T _s]	56.9 °C
Actual Ambient Temperature [T _A]	56.3 °C
Drive Current [I _F]	700 mA
Measurement Current	700 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 1-3
Forward Voltage

LED No.	Relative Forward Voltage % (Normalized to 100% at 0 hours)														
	0 h	515 h	1009 h	1747 h	2413 h	3099 h	3812 h	4500 h	5285 h	6070 h	6783 h	7618 h	8451 h	9237 h	10092 h
1	100.0	97.1	97.2	97.2	97.2	97.4	97.5	97.4	97.4	97.4	97.4	97.5	97.4	97.4	97.4
2	100.0	97.3	97.3	97.2	97.3	97.3	97.5	97.4	97.4	97.4	97.4	97.4	97.4	97.4	97.4
3	100.0	96.9	97.0	97.0	96.9	96.9	97.1	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0
4	100.0	97.2	97.1	97.1	97.1	97.1	97.3	97.1	97.2	97.1	97.2	97.2	97.1	97.2	97.1
5	100.0	97.1	97.1	97.1	97.1	97.1	97.3	97.2	97.2	97.2	97.2	97.2	97.2	97.2	97.2
6	100.0	97.2	97.2	97.1	97.2	97.2	97.3	97.3	97.3	97.2	97.3	97.3	97.3	97.3	97.3
7	100.0	97.2	97.3	97.2	97.1	97.2	97.4	97.3	97.3	97.2	97.2	97.2	97.3	97.3	97.2
8	100.0	97.2	97.4	97.2	97.2	97.3	97.5	97.4	97.4	97.3	97.3	97.3	97.4	97.4	97.4
9	100.0	96.5	96.6	96.5	96.5	96.6	96.7	96.6	96.6	96.6	96.6	96.5	96.6	96.6	96.6
10	100.0	96.9	97.0	97.0	96.9	97.1	97.3	97.1	97.1	97.0	97.1	97.1	97.1	97.2	97.2
11	100.0	96.8	96.9	96.8	96.8	96.9	97.1	97.0	97.0	96.9	97.0	96.9	97.0	97.0	97.0
12	100.0	97.3	97.3	97.3	97.2	97.3	97.5	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3
13	100.0	98.6	98.6	98.5	98.5	98.6	98.8	98.7	98.7	98.6	99.0	99.2	99.1	99.1	99.1
14	100.0	98.6	98.6	98.4	98.4	98.5	98.7	98.5	98.5	98.4	98.5	98.5	98.5	98.5	98.5
15	100.0	97.4	97.6	97.5	97.5	97.7	97.9	97.8	97.8	97.8	97.8	98.0	97.9	98.0	98.1
16	100.0	98.6	98.7	98.5	98.5	98.6	98.7	98.6	98.6	98.5	98.6	98.6	98.6	98.6	98.6
17	100.0	96.9	97.0	97.0	96.9	97.2	97.3	97.3	97.3	97.3	97.4	97.7	97.6	97.6	97.6
18	100.0	98.6	98.7	98.6	98.6	98.7	98.8	98.7	98.7	98.7	98.7	98.8	98.7	98.8	98.7
19	100.0	98.5	98.5	98.5	98.4	98.5	98.6	98.5	98.5	98.4	98.5	98.5	98.5	98.5	98.5
20	100.0	96.3	96.3	96.2	96.2	96.3	96.5	96.3	96.3	96.3	96.3	96.4	96.4	96.4	96.3
21	100.0	98.6	98.6	98.5	98.5	98.6	98.7	98.6	98.6	98.5	98.6	98.6	98.6	98.6	98.6
22	100.0	95.2	95.3	95.2	95.1	95.2	95.3	95.2	95.2	95.2	95.2	95.3	95.2	95.2	95.3
23	100.0	96.5	96.6	96.5	96.4	96.5	96.5	96.4	96.4	96.4	96.4	96.5	96.5	96.5	96.5
24	100.0	97.0	97.1	97.0	97.0	97.1	97.2	97.1	97.1	97.1	97.1	97.2	97.1	97.1	97.1
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	97.3	97.4	97.3	97.3	97.4	97.5	97.4	97.4	97.4	97.4	97.5	97.4	97.5	97.5
Med.	100.0	97.2	97.2	97.1	97.1	97.2	97.3	97.3	97.3	97.2	97.3	97.3	97.3	97.3	97.3
σ	0.00	0.87	0.86	0.84	0.85	0.86	0.87	0.86	0.86	0.85	0.88	0.90	0.88	0.89	0.88
Min.	100.0	95.2	95.3	95.2	95.1	95.2	95.3	95.2	95.2	95.2	95.2	95.3	95.2	95.2	95.3
Max.	100.0	98.6	98.7	98.6	98.6	98.7	98.8	98.7	98.7	98.7	99.0	99.2	99.1	99.1	99.1

Data Set 1 : 55°C, 700 mA

Actual Case Temperature [T _s]	56.9 °C
Actual Ambient Temperature [T _A]	56.3 °C
Drive Current [I _F]	700 mA
Measurement Current	700 mA

NOTES:

T_s and T_A were measured during initial setup.

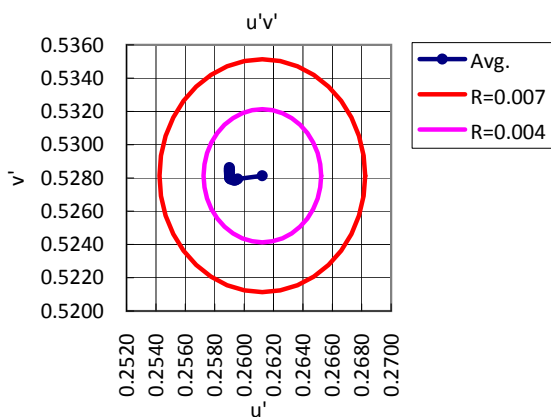
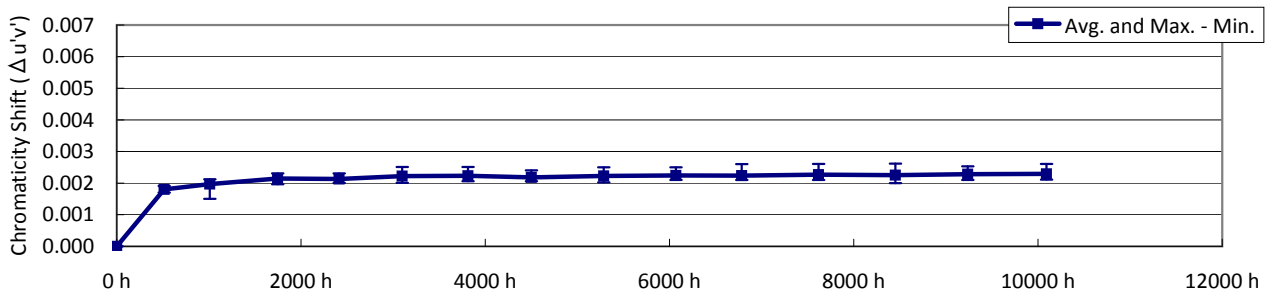
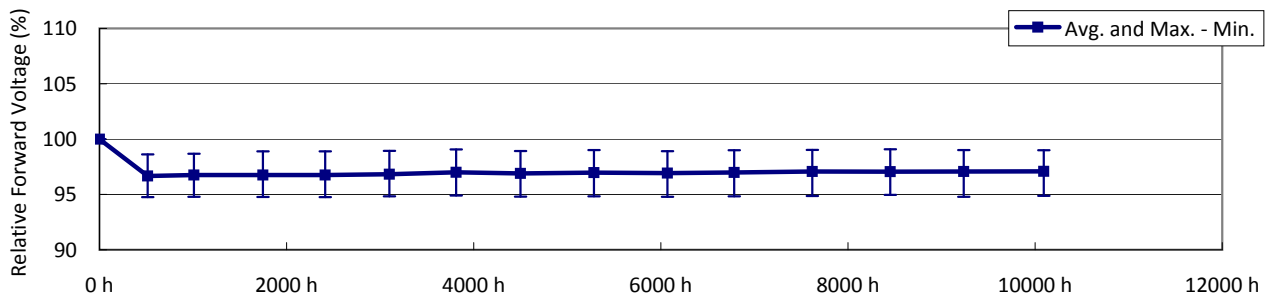
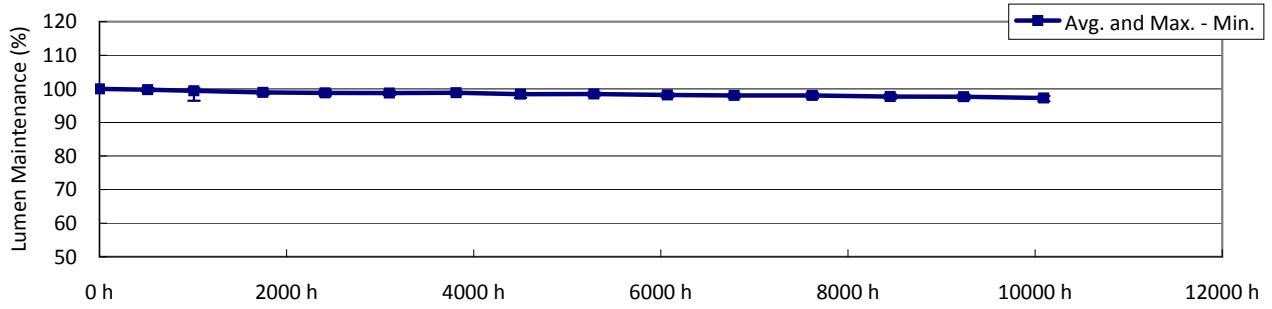
TABLE 1-4
Chromaticity Shift

LED No.	Chromaticity Shift Δu'v'														
	0 h	515 h	1009 h	1747 h	2413 h	3099 h	3812 h	4500 h	5285 h	6070 h	6783 h	7618 h	8451 h	9237 h	10092 h
1	0.0000	0.0016	0.0018	0.0019	0.0020	0.0020	0.0020	0.0020	0.0020	0.0021	0.0021	0.0022	0.0022	0.0022	0.0021
2	0.0000	0.0015	0.0018	0.0019	0.0019	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0021	0.0021	0.0021
3	0.0000	0.0015	0.0017	0.0018	0.0018	0.0019	0.0019	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0021	0.0020
4	0.0000	0.0015	0.0017	0.0019	0.0018	0.0019	0.0020	0.0020	0.0020	0.0021	0.0020	0.0021	0.0020	0.0021	0.0021
5	0.0000	0.0015	0.0017	0.0018	0.0018	0.0019	0.0020	0.0019	0.0020	0.0020	0.0020	0.0021	0.0021	0.0021	0.0022
6	0.0000	0.0014	0.0016	0.0018	0.0018	0.0019	0.0020	0.0019	0.0019	0.0019	0.0020	0.0021	0.0020	0.0021	0.0021
7	0.0000	0.0015	0.0017	0.0018	0.0020	0.0021	0.0022	0.0021	0.0020	0.0020	0.0021	0.0021	0.0022	0.0023	0.0023
8	0.0000	0.0015	0.0017	0.0018	0.0018	0.0019	0.0020	0.0019	0.0020	0.0020	0.0020	0.0020	0.0021	0.0021	0.0021
9	0.0000	0.0015	0.0017	0.0019	0.0018	0.0019	0.0021	0.0020	0.0021	0.0020	0.0020	0.0021	0.0021	0.0021	0.0021
10	0.0000	0.0015	0.0017	0.0019	0.0018	0.0019	0.0021	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0021
11	0.0000	0.0015	0.0017	0.0018	0.0019	0.0020	0.0020	0.0020	0.0020	0.0020	0.0021	0.0021	0.0021	0.0022	0.0022
12	0.0000	0.0015	0.0017	0.0018	0.0019	0.0020	0.0020	0.0020	0.0021	0.0019	0.0021	0.0020	0.0021	0.0022	0.0022
13	0.0000	0.0015	0.0017	0.0019	0.0020	0.0021	0.0021	0.0020	0.0021	0.0021	0.0021	0.0021	0.0021	0.0022	0.0022
14	0.0000	0.0015	0.0017	0.0018	0.0019	0.0021	0.0021	0.0020	0.0021	0.0021	0.0021	0.0021	0.0021	0.0022	0.0022
15	0.0000	0.0015	0.0017	0.0018	0.0018	0.0019	0.0020	0.0019	0.0020	0.0020	0.0020	0.0020	0.0020	0.0021	0.0021
16	0.0000	0.0015	0.0017	0.0019	0.0018	0.0019	0.0020	0.0020	0.0021	0.0021	0.0020	0.0020	0.0020	0.0021	0.0021
17	0.0000	0.0014	0.0016	0.0018	0.0018	0.0019	0.0020	0.0018	0.0020	0.0020	0.0020	0.0021	0.0020	0.0021	0.0021
18	0.0000	0.0015	0.0017	0.0019	0.0019	0.0020	0.0020	0.0020	0.0020	0.0019	0.0021	0.0021	0.0021	0.0021	0.0022
19	0.0000	0.0015	0.0016	0.0019	0.0018	0.0020	0.0021	0.0020	0.0021	0.0021	0.0021	0.0022	0.0021	0.0022	0.0022
20	0.0000	0.0016	0.0018	0.0020	0.0021	0.0022	0.0022	0.0021	0.0022	0.0022	0.0022	0.0023	0.0022	0.0023	0.0023
21	0.0000	0.0014	0.0017	0.0019	0.0018	0.0019	0.0020	0.0019	0.0020	0.0020	0.0020	0.0020	0.0020	0.0021	0.0021
22	0.0000	0.0015	0.0016	0.0018	0.0018	0.0018	0.0020	0.0019	0.0020	0.0021	0.0019	0.0020	0.0020	0.0020	0.0021
23	0.0000	0.0014	0.0016	0.0018	0.0018	0.0019	0.0020	0.0020	0.0020	0.0020	0.0021	0.0021	0.0020	0.0021	0.0021
24	0.0000	0.0014	0.0017	0.0019	0.0019	0.0020	0.0021	0.0020	0.0020	0.0021	0.0021	0.0021	0.0021	0.0021	0.0022
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	0.0000	0.0015	0.0017	0.0019	0.0019	0.0020	0.0021	0.0020	0.0021	0.0021	0.0021	0.0021	0.0021	0.0022	0.0022
Med.	0.0000	0.0015	0.0017	0.0019	0.0018	0.0019	0.0020	0.0020	0.0020	0.0020	0.0020	0.0021	0.0021	0.0021	0.0021
σ	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Min.	0.0000	0.0014	0.0016	0.0018	0.0018	0.0018	0.0019	0.0018	0.0019	0.0019	0.0019	0.0020	0.0020	0.0020	0.0020
Max.	0.0000	0.0016	0.0018	0.0020	0.0021	0.0022	0.0022	0.0021	0.0022	0.0022	0.0022	0.0023	0.0022	0.0023	0.0023

Data Set 2 : 55°C, 1200 mA

Actual Case Temperature [T _S]	63.7 °C
Actual Ambient Temperature [T _A]	63.2 °C
Drive Current [I _F]	1200 mA
Measurement Current	1200 mA

NOTES:
T_S and T_A were measured during initial setup.



Data Set 2 : 55°C, 1200 mA

Actual Case Temperature [T _S]	63.7 °C
Actual Ambient Temperature [T _A]	63.2 °C
Drive Current [I _F]	1200 mA
Measurement Current	1200 mA

NOTES:

 T_S and T_A were measured during initial setup.

TABLE 2-1
 Initial Characteristics

LED No.	Luminous flux	Forward voltage	CCT	CIE1931		CIE1976							
	Φ _V [lm]	V _F [V]	T _{CP} [K]	x	y	u'	v'						
1	308	3.60	2686	0.463	0.415	0.263	0.529						
2	319	3.60	2873	0.445	0.405	0.255	0.523						
3	309	3.55	2669	0.464	0.415	0.264	0.530						
4	307	3.56	2745	0.457	0.412	0.260	0.527						
5	323	3.51	2958	0.436	0.396	0.253	0.518						
6	313	3.51	2739	0.458	0.412	0.261	0.527						
7	315	3.54	2743	0.456	0.408	0.261	0.526						
8	309	3.53	2630	0.470	0.419	0.265	0.532						
9	309	3.59	2755	0.455	0.409	0.260	0.526						
10	308	3.57	2669	0.464	0.414	0.264	0.529						
11	314	3.54	2792	0.452	0.408	0.259	0.525						
12	309	3.55	2669	0.465	0.416	0.263	0.530						
13	307	3.61	2680	0.465	0.418	0.263	0.531						
14	309	3.51	2682	0.463	0.415	0.263	0.529						
15	316	3.56	2758	0.457	0.413	0.260	0.528						
16	319	3.54	2790	0.455	0.413	0.258	0.527						
17	309	3.63	2684	0.463	0.414	0.263	0.529						
18	308	3.49	2631	0.469	0.418	0.265	0.532						
19	306	3.52	2610	0.472	0.420	0.266	0.533						
20	318	3.56	2759	0.457	0.412	0.260	0.528						
21	319	3.56	2812	0.452	0.410	0.258	0.526						
22	315	3.52	2731	0.460	0.414	0.261	0.529						
23	312	3.61	2728	0.460	0.414	0.261	0.529						
24	307	3.53	2624	0.470	0.418	0.266	0.532						
n	24	24	24	24	24	24	24						
Avg.	312	3.55	2726	0.459	0.413	0.261	0.528						
Med.	309	3.55	2729	0.460	0.414	0.261	0.529						
σ	4.9	0.037	82.0	0.0083	0.0051	0.0032	0.0032						
Min.	306	3.49	2610	0.436	0.396	0.253	0.518						
Max.	323	3.63	2958	0.472	0.420	0.266	0.533						

Data Set 2 : 55°C, 1200 mA

Actual Case Temperature [T _s]	63.7 °C
Actual Ambient Temperature [T _A]	63.2 °C
Drive Current [I _F]	1200 mA
Measurement Current	1200 mA

NOTES:
T_s and T_A were measured during initial setup.

TABLE 2-2
Lumen Maintenance

LED No.	Lumen Maintenance % (Normalized to 100% at 0 hours)														
	0 h	515 h	1009 h	1747 h	2413 h	3099 h	3812 h	4500 h	5285 h	6070 h	6783 h	7618 h	8451 h	9237 h	10092 h
1	100.0	99.8	99.6	99.1	98.9	99.2	99.1	98.7	98.7	98.4	98.5	98.4	98.0	98.0	97.6
2	100.0	99.9	99.4	98.9	98.9	99.0	98.6	98.4	98.3	98.0	98.0	98.0	97.5	97.6	97.1
3	100.0	99.9	99.7	99.2	99.2	98.7	98.8	98.6	98.6	98.3	98.3	98.4	98.0	98.0	97.7
4	100.0	99.7	99.6	98.8	98.6	98.6	98.9	98.5	98.6	98.3	98.1	98.1	97.6	97.3	96.7
5	100.0	100.3	100.2	99.4	99.0	98.8	99.2	98.7	98.9	98.7	98.4	98.3	97.8	97.9	97.6
6	100.0	99.5	96.5	98.3	98.1	98.6	98.9	98.3	98.4	98.3	98.0	97.9	97.6	97.5	97.3
7	100.0	100.1	99.9	99.2	99.1	99.2	99.2	98.7	98.9	98.5	98.4	98.5	98.2	98.2	97.8
8	100.0	100.1	100.1	99.3	99.3	99.0	98.4	98.0	98.1	97.7	97.7	97.7	97.4	97.4	96.9
9	100.0	99.6	99.4	98.7	98.7	98.4	98.5	98.1	98.2	97.8	97.7	97.9	97.5	97.5	97.1
10	100.0	99.4	99.1	98.5	98.4	98.1	98.3	98.0	98.1	97.8	97.6	97.5	97.2	97.2	96.9
11	100.0	99.4	99.1	98.5	98.2	98.4	98.8	98.4	98.5	98.2	97.8	97.8	97.4	97.5	97.0
12	100.0	99.7	99.4	98.9	98.6	98.9	99.0	98.1	97.8	98.3	98.1	98.0	97.8	97.8	97.4
13	100.0	99.6	99.7	98.8	98.8	98.7	98.8	98.3	98.4	98.0	97.9	98.0	97.7	97.7	97.3
14	100.0	100.0	100.2	99.1	99.4	98.9	99.0	98.6	98.4	98.1	98.0	98.0	97.8	97.8	97.3
15	100.0	100.1	100.1	99.3	99.3	98.9	99.0	98.8	98.8	98.1	98.2	98.2	98.0	97.9	97.7
16	100.0	99.6	99.4	98.7	98.4	98.5	98.7	98.3	98.4	98.0	97.8	97.9	97.6	97.4	97.1
17	100.0	99.2	98.9	98.5	97.9	98.4	98.8	98.2	98.4	97.9	97.5	97.1	97.0	96.7	96.3
18	100.0	99.8	98.4	98.8	98.5	98.6	98.7	97.3	97.9	97.5	97.4	97.4	97.2	97.0	96.5
19	100.0	99.9	99.7	98.9	99.0	99.0	99.0	98.6	98.5	98.4	98.4	98.5	98.0	98.2	97.8
20	100.0	100.2	100.2	99.4	99.6	99.3	99.1	98.8	98.9	98.6	98.6	98.8	98.4	98.3	97.9
21	100.0	100.0	99.9	99.3	99.3	98.8	98.9	98.5	98.6	98.3	98.2	98.3	97.8	97.8	97.5
22	100.0	99.9	99.7	99.2	99.0	98.9	99.1	98.8	99.0	98.4	98.4	98.3	98.0	98.0	97.7
23	100.0	99.2	99.0	98.5	98.1	98.4	98.9	98.4	98.5	98.1	97.7	97.6	97.4	97.4	96.8
24	100.0	99.5	99.3	98.7	98.5	98.7	98.9	98.4	98.5	98.1	97.9	97.7	97.6	97.5	97.1
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	99.8	99.4	98.9	98.8	98.8	98.9	98.4	98.5	98.2	98.0	98.0	97.7	97.7	97.3
Med.	100.0	99.8	99.6	98.9	98.9	98.8	98.9	98.4	98.5	98.2	98.0	98.0	97.7	97.7	97.3
σ	0.00	0.30	0.78	0.33	0.47	0.29	0.24	0.34	0.30	0.30	0.33	0.40	0.34	0.39	0.44
Min.	100.0	99.2	96.5	98.3	97.9	98.1	98.3	97.3	97.8	97.5	97.4	97.1	97.0	96.7	96.3
Max.	100.0	100.3	100.2	99.4	99.6	99.3	99.2	98.8	99.0	98.7	98.6	98.8	98.4	98.3	97.9

TM-21 Projection

Time	4500 h	5285 h	6070 h	6783 h	7618 h	8451 h	9237 h	10092 h							
ln(Avg.)	-0.0161	-0.0153	-0.0185	-0.0199	-0.0200	-0.0233	-0.0237	-0.0279							

Test duration used	4500 h	to	10092 h
B	0.9945		
α	2.0831E-06		
R ²	0.9377		
Calculated L ₇₀ (10K)	169000	hours	
Reported L ₇₀ (10K)	> 60600	hours	

Curve-fit equation:
 $\Phi(t) = B \exp(-\alpha t)$

Lumen maintenance life equation:
 $L_{70} = \ln(B/0.7) / \alpha$

Data Set 2 : 55°C, 1200 mA

Actual Case Temperature [T _s]	63.7 °C
Actual Ambient Temperature [T _A]	63.2 °C
Drive Current [I _F]	1200 mA
Measurement Current	1200 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 2-3
Forward Voltage

LED No.	Relative Forward Voltage % (Normalized to 100% at 0 hours)														
	0 h	515 h	1009 h	1747 h	2413 h	3099 h	3812 h	4500 h	5285 h	6070 h	6783 h	7618 h	8451 h	9237 h	10092 h
1	100.0	96.1	96.1	96.0	96.0	96.1	96.2	96.1	96.0	96.1	96.1	96.2	96.1	96.1	96.2
2	100.0	96.5	97.3	97.3	97.3	96.7	97.5	97.4	97.4	97.4	97.5	97.5	97.4	97.4	97.5
3	100.0	95.2	95.2	95.2	95.2	95.2	95.3	95.2	95.2	95.2	95.3	95.3	95.3	95.2	95.3
4	100.0	96.4	96.5	96.5	96.5	96.5	96.7	96.6	96.7	96.7	96.9	97.0	97.0	97.4	97.5
5	100.0	95.8	95.9	95.8	95.9	96.3	96.6	96.5	96.5	96.6	96.5	96.6	96.5	96.5	96.6
6	100.0	96.8	96.9	96.9	96.9	96.9	97.0	96.9	97.0	97.0	97.0	97.0	97.0	97.0	97.0
7	100.0	96.6	96.6	96.6	96.7	96.7	96.8	96.7	96.8	96.7	96.8	96.8	96.8	96.8	96.8
8	100.0	96.3	96.3	96.4	96.4	96.5	97.1	97.0	97.1	97.0	97.0	97.1	97.0	97.1	97.1
9	100.0	96.5	96.6	96.6	96.6	96.6	96.7	96.6	96.7	96.6	96.6	96.7	96.7	96.7	96.7
10	100.0	95.2	95.2	95.2	95.1	95.2	95.4	95.2	95.3	95.2	95.2	95.3	95.3	95.3	95.3
11	100.0	96.1	96.2	96.2	96.1	96.2	96.3	96.2	96.3	96.2	96.2	96.3	96.2	96.3	96.3
12	100.0	95.5	95.6	95.6	95.6	95.6	95.7	95.6	95.7	95.6	95.6	95.6	95.6	95.6	95.6
13	100.0	94.8	94.8	94.8	94.8	94.8	94.9	94.8	94.8	94.8	94.8	94.9	95.0	94.8	94.9
14	100.0	98.2	98.2	98.2	98.2	98.2	98.4	98.4	98.7	98.8	98.8	98.9	98.9	98.8	98.8
15	100.0	98.1	98.2	98.1	98.1	98.2	98.3	98.1	98.2	98.1	98.1	98.2	98.2	98.2	98.2
16	100.0	98.6	98.7	98.9	98.9	98.9	99.1	98.9	99.0	98.9	99.0	99.0	99.1	99.0	99.0
17	100.0	96.3	96.4	96.4	96.4	96.5	96.7	96.5	96.6	96.6	97.0	98.0	98.2	98.1	98.0
18	100.0	95.8	96.0	96.1	96.2	96.5	96.6	97.1	97.1	97.1	97.1	97.1	97.2	97.1	97.2
19	100.0	98.2	98.3	98.2	98.2	98.3	98.3	98.2	98.3	98.2	98.3	98.3	98.2	98.3	98.3
20	100.0	98.4	98.5	98.5	98.5	98.6	98.7	98.6	98.6	98.5	98.6	98.6	98.6	98.6	98.6
21	100.0	98.2	98.2	98.2	98.1	98.2	98.4	98.2	98.3	98.2	98.2	98.3	98.2	98.3	98.2
22	100.0	98.2	98.2	98.2	98.2	98.3	98.3	98.3	98.3	98.2	98.3	98.3	98.3	98.3	98.3
23	100.0	96.1	96.3	96.2	96.3	96.3	96.5	96.4	96.4	96.3	96.4	96.5	96.4	96.5	96.5
24	100.0	96.0	96.1	95.8	96.1	96.2	96.3	96.2	96.3	96.2	96.3	96.3	96.2	96.3	96.3
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	96.7	96.8	96.7	96.8	96.8	97.0	96.9	97.0	96.9	97.0	97.1	97.1	97.1	97.1
Med.	100.0	96.4	96.4	96.5	96.4	96.5	96.7	96.7	96.7	96.7	96.9	97.0	97.0	97.0	97.0
σ	0.00	1.16	1.16	1.19	1.17	1.15	1.14	1.15	1.17	1.17	1.17	1.19	1.20	1.20	1.18
Min.	100.0	94.8	94.8	94.8	94.8	94.8	94.9	94.8	94.8	94.8	94.8	94.9	95.0	94.8	94.9
Max.	100.0	98.6	98.7	98.9	98.9	98.9	99.1	98.9	99.0	98.9	99.0	99.0	99.1	99.0	99.0

Data Set 2 : 55°C, 1200 mA

Actual Case Temperature [T _s]	63.7 °C
Actual Ambient Temperature [T _A]	63.2 °C
Drive Current [I _F]	1200 mA
Measurement Current	1200 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 2-4
Chromaticity Shift

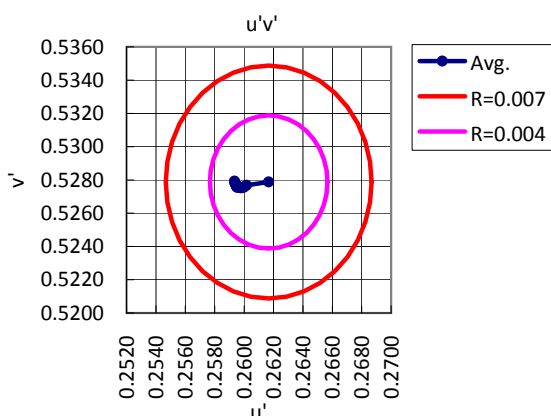
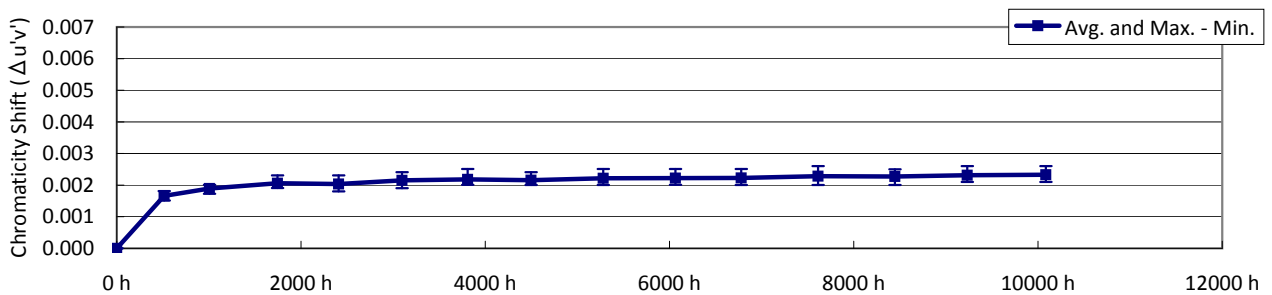
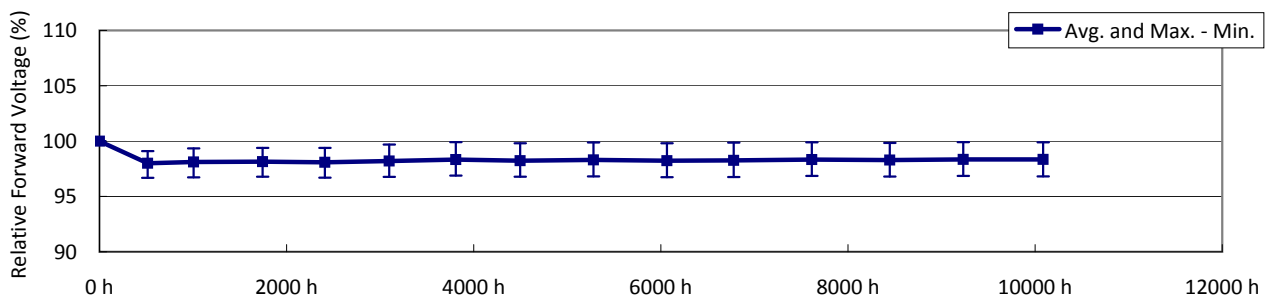
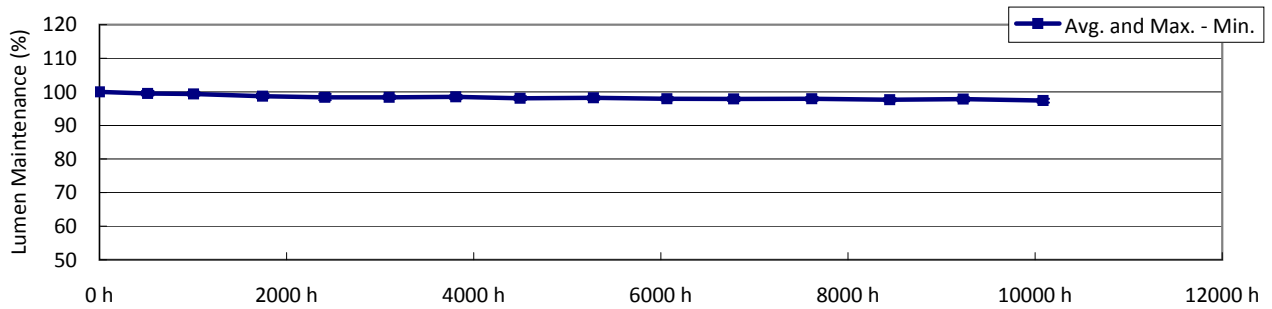
LED No.	Chromaticity Shift Δu'v'														
	0 h	515 h	1009 h	1747 h	2413 h	3099 h	3812 h	4500 h	5285 h	6070 h	6783 h	7618 h	8451 h	9237 h	10092 h
1	0.0000	0.0019	0.0020	0.0022	0.0021	0.0022	0.0022	0.0022	0.0023	0.0023	0.0023	0.0023	0.0022	0.0023	0.0023
2	0.0000	0.0017	0.0019	0.0020	0.0020	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0022	0.0022
3	0.0000	0.0017	0.0019	0.0021	0.0020	0.0021	0.0021	0.0021	0.0022	0.0022	0.0022	0.0022	0.0021	0.0022	0.0022
4	0.0000	0.0017	0.0019	0.0020	0.0020	0.0020	0.0021	0.0021	0.0022	0.0022	0.0021	0.0022	0.0021	0.0022	0.0021
5	0.0000	0.0018	0.0020	0.0020	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0020	0.0021	0.0021
6	0.0000	0.0017	0.0015	0.0021	0.0021	0.0022	0.0022	0.0021	0.0022	0.0022	0.0023	0.0023	0.0022	0.0023	0.0023
7	0.0000	0.0018	0.0020	0.0022	0.0022	0.0023	0.0023	0.0022	0.0022	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023
8	0.0000	0.0017	0.0019	0.0021	0.0021	0.0022	0.0021	0.0021	0.0021	0.0021	0.0021	0.0022	0.0021	0.0022	0.0022
9	0.0000	0.0018	0.0020	0.0021	0.0021	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023
10	0.0000	0.0018	0.0020	0.0021	0.0021	0.0021	0.0022	0.0021	0.0021	0.0022	0.0021	0.0021	0.0021	0.0021	0.0021
11	0.0000	0.0018	0.0019	0.0021	0.0021	0.0022	0.0022	0.0022	0.0022	0.0021	0.0022	0.0022	0.0022	0.0023	0.0023
12	0.0000	0.0018	0.0019	0.0021	0.0021	0.0022	0.0022	0.0021	0.0020	0.0021	0.0022	0.0022	0.0022	0.0023	0.0022
13	0.0000	0.0019	0.0021	0.0023	0.0023	0.0024	0.0024	0.0023	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024
14	0.0000	0.0018	0.0020	0.0022	0.0022	0.0023	0.0023	0.0022	0.0022	0.0022	0.0022	0.0023	0.0023	0.0023	0.0023
15	0.0000	0.0018	0.0021	0.0022	0.0022	0.0023	0.0023	0.0023	0.0023	0.0023	0.0022	0.0023	0.0023	0.0023	0.0024
16	0.0000	0.0018	0.0020	0.0022	0.0021	0.0022	0.0022	0.0022	0.0022	0.0022	0.0021	0.0022	0.0022	0.0023	0.0022
17	0.0000	0.0017	0.0019	0.0021	0.0021	0.0022	0.0022	0.0021	0.0022	0.0022	0.0021	0.0023	0.0023	0.0023	0.0023
18	0.0000	0.0019	0.0019	0.0022	0.0022	0.0024	0.0024	0.0024	0.0025	0.0025	0.0026	0.0026	0.0026	0.0025	0.0025
19	0.0000	0.0019	0.0021	0.0023	0.0023	0.0025	0.0025	0.0024	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0026
20	0.0000	0.0018	0.0020	0.0022	0.0022	0.0023	0.0023	0.0022	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023	0.0024
21	0.0000	0.0018	0.0020	0.0022	0.0021	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023	0.0023
22	0.0000	0.0018	0.0020	0.0021	0.0021	0.0021	0.0023	0.0022	0.0022	0.0023	0.0022	0.0022	0.0022	0.0022	0.0023
23	0.0000	0.0018	0.0019	0.0021	0.0021	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023	0.0023	0.0023	0.0023
24	0.0000	0.0017	0.0019	0.0021	0.0021	0.0022	0.0022	0.0021	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023	0.0023
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	0.0000	0.0018	0.0020	0.0021	0.0021	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023	0.0023	0.0023	0.0023
Med.	0.0000	0.0018	0.0020	0.0021	0.0021	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023	0.0023
σ	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Min.	0.0000	0.0017	0.0015	0.0020	0.0020	0.0020	0.0021	0.0021	0.0020	0.0021	0.0021	0.0021	0.0020	0.0021	0.0021
Max.	0.0000	0.0019	0.0021	0.0023	0.0023	0.0025	0.0025	0.0024	0.0025	0.0025	0.0026	0.0026	0.0026	0.0025	0.0026

Data Set 3 : 85°C, 700 mA

Actual Case Temperature [T_S]	86.2 °C
Actual Ambient Temperature [T_A]	84.6 °C
Drive Current [I_F]	700 mA
Measurement Current	700 mA

NOTES:

T_S and T_A were measured during initial setup.



Data Set 3 : 85°C, 700 mA

Actual Case Temperature [T _S]	86.2 °C
Actual Ambient Temperature [T _A]	84.6 °C
Drive Current [I _F]	700 mA
Measurement Current	700 mA

NOTES:

 T_S and T_A were measured during initial setup.

TABLE 3-1
 Initial Characteristics

LED No.	Luminous flux	Forward voltage	CCT	CIE1931		CIE1976							
	Φ _V [lm]	V _F [V]	T _{CP} [K]	x	y	u'	v'						
1	199	3.29	2760	0.454	0.407	0.260	0.525						
2	199	3.23	2682	0.463	0.414	0.263	0.529						
3	202	3.28	2838	0.446	0.403	0.257	0.522						
4	196	3.31	2654	0.466	0.415	0.264	0.530						
5	196	3.27	2759	0.455	0.409	0.260	0.526						
6	193	3.31	2646	0.467	0.416	0.265	0.530						
7	199	3.27	2766	0.455	0.411	0.260	0.527						
8	194	3.23	2593	0.474	0.420	0.267	0.533						
9	201	3.27	2808	0.450	0.406	0.258	0.524						
10	198	3.27	2671	0.464	0.414	0.264	0.529						
11	201	3.28	2812	0.450	0.406	0.258	0.524						
12	200	3.23	2709	0.460	0.412	0.262	0.528						
13	192	3.21	2543	0.479	0.423	0.269	0.535						
14	197	3.28	2658	0.466	0.417	0.264	0.531						
15	201	3.27	2754	0.454	0.408	0.260	0.525						
16	199	3.28	2713	0.461	0.414	0.262	0.529						
17	202	3.26	2745	0.458	0.413	0.260	0.528						
18	202	3.24	2744	0.457	0.411	0.260	0.527						
19	196	3.32	2577	0.474	0.419	0.268	0.533						
20	202	3.28	2757	0.456	0.410	0.260	0.527						
21	201	3.29	2735	0.458	0.412	0.261	0.528						
22	202	3.27	2763	0.456	0.411	0.260	0.527						
23	202	3.26	2759	0.455	0.410	0.260	0.526						
24	202	3.25	2774	0.454	0.409	0.259	0.526						
n	24	24	24	24	24	24	24						
Avg.	199	3.27	2718	0.460	0.412	0.262	0.528						
Med.	200	3.27	2744	0.457	0.412	0.260	0.527						
σ	3.1	0.027	75.5	0.0081	0.0049	0.0031	0.0030						
Min.	192	3.21	2543	0.446	0.403	0.257	0.522						
Max.	202	3.32	2838	0.479	0.423	0.269	0.535						

Data Set 3 : 85°C, 700 mA

Actual Case Temperature [T _s]	86.2 °C
Actual Ambient Temperature [T _A]	84.6 °C
Drive Current [I _F]	700 mA
Measurement Current	700 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 3-2
Lumen Maintenance

LED No.	Lumen Maintenance % (Normalized to 100% at 0 hours)														
	0 h	515 h	1006 h	1744 h	2409 h	3096 h	3809 h	4497 h	5280 h	6065 h	6778 h	7613 h	8446 h	9232 h	10086 h
1	100.0	99.6	99.4	98.8	98.6	98.7	98.7	98.3	98.3	98.0	98.1	98.2	97.9	98.0	97.6
2	100.0	100.2	99.9	99.2	99.2	98.9	98.9	98.3	98.4	98.1	98.2	98.2	97.9	98.0	97.6
3	100.0	100.3	100.0	99.5	99.3	98.9	98.9	98.6	98.6	98.4	98.4	98.5	98.1	98.1	97.8
4	100.0	99.6	99.4	98.8	98.3	98.4	98.6	98.3	98.3	98.1	98.0	98.1	97.7	97.7	97.5
5	100.0	99.4	99.4	98.8	98.2	98.5	99.0	98.7	98.7	98.5	98.2	98.3	97.9	98.0	97.7
6	100.0	99.0	99.1	98.6	98.1	98.5	98.7	98.3	98.4	98.1	98.0	98.0	97.7	97.8	97.2
7	100.0	99.6	99.5	98.8	98.6	98.6	98.6	98.3	98.4	98.3	98.2	98.3	98.1	98.1	97.9
8	100.0	99.7	99.8	98.9	98.5	98.1	98.0	97.6	97.7	97.5	97.3	97.5	97.2	97.2	96.9
9	100.0	99.9	99.8	99.1	98.9	98.5	98.7	98.4	98.5	98.3	98.2	98.3	98.0	98.0	97.7
10	100.0	99.6	99.2	98.7	98.3	98.2	98.5	98.0	98.2	97.9	97.8	97.9	97.6	97.6	97.3
11	100.0	99.4	99.1	98.7	98.0	98.5	98.8	98.2	98.5	98.1	98.0	98.1	97.8	98.0	97.6
12	100.0	99.2	99.1	98.5	98.1	98.4	98.6	98.0	98.2	97.9	97.8	97.9	97.6	98.4	97.4
13	100.0	99.6	99.3	98.5	98.2	98.1	98.2	97.6	97.8	97.4	97.4	97.4	97.2	97.4	96.8
14	100.0	100.0	99.9	99.2	98.9	98.7	98.9	98.3	98.7	98.2	98.3	98.4	98.1	98.4	97.9
15	100.0	99.6	99.3	98.7	98.5	98.0	98.2	97.8	98.0	97.5	97.6	97.8	97.4	97.6	97.2
16	100.0	99.3	99.0	98.3	97.9	97.9	98.1	97.7	97.9	97.6	97.5	97.6	97.3	97.5	97.1
17	100.0	99.3	99.3	98.6	97.9	98.2	98.5	98.0	98.1	97.8	97.5	97.6	97.4	97.7	97.3
18	100.0	99.5	99.3	98.6	98.2	98.6	97.8	98.2	98.3	98.2	98.0	98.0	97.8	98.1	97.7
19	100.0	98.9	99.1	98.3	98.2	98.3	98.2	97.6	97.9	97.5	97.6	97.5	97.2	97.5	97.2
20	100.0	99.3	99.6	98.7	98.7	98.5	98.3	97.8	98.1	97.7	97.8	97.8	97.6	97.7	97.4
21	100.0	99.3	99.3	98.6	98.5	98.1	98.1	97.8	97.9	97.5	97.6	97.8	97.4	97.5	97.2
22	100.0	99.5	99.3	98.5	98.2	98.3	98.5	98.2	98.3	98.0	97.9	98.1	97.8	97.9	97.5
23	100.0	99.0	98.9	98.1	97.5	97.9	98.4	98.0	98.0	97.8	97.6	97.6	97.3	97.5	97.1
24	100.0	99.5	99.4	98.8	98.3	98.4	98.8	98.3	98.4	98.2	97.9	98.0	97.8	97.9	97.6
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	99.5	99.4	98.7	98.4	98.4	98.5	98.1	98.2	97.9	97.9	97.9	97.7	97.8	97.4
Med.	100.0	99.5	99.3	98.7	98.3	98.4	98.5	98.2	98.3	98.0	97.9	98.0	97.7	97.9	97.4
σ	0.00	0.35	0.29	0.31	0.43	0.29	0.32	0.31	0.28	0.31	0.30	0.31	0.30	0.31	0.31
Min.	100.0	98.9	98.9	98.1	97.5	97.9	97.8	97.6	97.7	97.4	97.3	97.4	97.2	97.2	96.8
Max.	100.0	100.3	100.0	99.5	99.3	98.9	99.0	98.7	98.7	98.5	98.4	98.5	98.1	98.4	97.9

TM-21 Projection

Time	4497 h	5280 h	6065 h	6778 h	7613 h	8446 h	9232 h	10086 h							
ln(Avg.)	-0.0192	-0.0179	-0.0209	-0.0215	-0.0208	-0.0238	-0.0220	-0.0260							

Test duration used	4497 h	to	10086 h
B	0.9869		
α	1.1475E-06		
R ²	0.7762		
Calculated L ₇₀ (10K)	299000	hours	
Reported L ₇₀ (10K)	> 60500	hours	

Curve-fit equation:

$$\Phi(t) = B \exp(-\alpha t)$$

Lumen maintenance life equation:

$$L_{70} = \ln(B/0.7) / \alpha$$

Data Set 3 : 85°C, 700 mA

Actual Case Temperature [T _s]	86.2 °C
Actual Ambient Temperature [T _A]	84.6 °C
Drive Current [I _F]	700 mA
Measurement Current	700 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 3-3
Forward Voltage

LED No.	Relative Forward Voltage % (Normalized to 100% at 0 hours)														
	0 h	515 h	1006 h	1744 h	2409 h	3096 h	3809 h	4497 h	5280 h	6065 h	6778 h	7613 h	8446 h	9232 h	10086 h
1	100.0	97.5	97.6	97.7	97.6	97.7	97.9	97.8	97.8	97.7	97.8	97.8	97.9	97.9	97.9
2	100.0	97.5	97.7	97.7	97.7	97.8	97.8	97.8	97.8	97.8	97.8	97.9	97.8	97.9	97.9
3	100.0	96.7	96.7	96.8	96.7	96.8	96.9	96.8	96.8	96.7	96.8	96.9	96.8	96.8	96.8
4	100.0	97.7	97.8	97.8	97.8	97.9	98.0	97.9	97.9	97.9	98.0	98.1	98.0	98.0	98.0
5	100.0	97.4	97.4	97.5	97.4	97.5	97.7	97.5	97.6	97.5	97.5	97.6	97.5	97.6	97.6
6	100.0	97.1	97.1	97.3	97.1	97.2	97.4	97.2	97.2	97.2	97.3	97.3	97.3	97.3	97.3
7	100.0	97.5	97.6	97.7	97.6	97.7	97.8	97.8	97.9	97.7	97.8	97.8	97.8	97.9	97.9
8	100.0	98.0	98.0	98.0	98.3	98.4	98.9	98.8	98.9	98.9	98.9	99.0	99.0	99.0	99.3
9	100.0	97.2	97.3	97.3	97.2	97.3	97.4	97.3	97.4	97.3	97.3	97.4	97.4	97.4	97.4
10	100.0	97.6	97.7	97.7	97.6	97.8	97.9	97.8	97.8	97.8	97.8	97.9	97.9	97.9	97.9
11	100.0	97.0	97.1	97.2	97.1	97.2	97.3	97.2	97.3	97.2	97.2	97.3	97.2	97.3	97.3
12	100.0	97.5	97.6	97.6	97.6	97.7	97.8	97.7	97.8	97.7	97.7	97.8	97.8	97.9	97.8
13	100.0	97.0	97.1	97.1	97.1	97.2	97.3	97.2	97.3	97.2	97.3	97.3	97.3	97.3	97.3
14	100.0	98.9	99.1	99.1	99.1	99.2	99.4	99.2	99.3	99.2	99.3	99.3	99.3	99.3	99.3
15	100.0	98.8	99.0	99.0	98.9	99.0	99.1	99.0	99.0	99.0	99.0	99.1	99.0	99.1	99.1
16	100.0	98.9	98.9	98.9	98.8	98.9	99.0	98.9	99.0	98.9	98.9	98.9	98.9	98.9	98.9
17	100.0	99.1	99.3	99.4	99.4	99.7	99.9	99.8	99.9	99.8	99.9	99.9	99.8	99.9	99.9
18	100.0	98.9	99.0	99.0	99.0	99.1	99.1	99.0	99.1	99.0	99.0	99.1	99.1	99.2	99.2
19	100.0	97.4	97.5	97.6	97.5	97.7	97.8	97.6	97.7	97.7	97.7	97.8	97.7	97.8	97.8
20	100.0	98.9	99.1	99.1	99.0	99.1	99.2	99.1	99.1	99.1	99.1	99.2	99.1	99.2	99.2
21	100.0	98.8	98.9	98.9	98.9	99.0	99.1	98.9	99.0	99.0	98.9	99.0	99.0	99.0	99.0
22	100.0	98.9	99.0	99.0	98.9	99.0	99.1	99.0	99.1	99.0	99.0	99.1	99.0	99.1	99.1
23	100.0	98.8	98.9	99.0	98.9	99.0	99.1	99.0	99.1	99.0	99.0	99.1	99.0	99.2	99.1
24	100.0	98.9	99.1	99.1	99.1	99.2	99.2	99.2	99.2	99.1	99.2	99.2	99.2	99.2	99.2
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	98.0	98.1	98.1	98.1	98.2	98.3	98.2	98.3	98.2	98.3	98.3	98.3	98.3	98.3
Med.	100.0	97.6	97.8	97.8	97.7	97.8	97.9	97.9	97.9	97.8	97.9	98.0	97.9	98.0	98.0
σ	0.00	0.81	0.84	0.83	0.84	0.85	0.86	0.85	0.87	0.86	0.86	0.85	0.85	0.85	0.87
Min.	100.0	96.7	96.7	96.8	96.7	96.8	96.9	96.8	96.8	96.7	96.8	96.9	96.8	96.8	96.8
Max.	100.0	99.1	99.3	99.4	99.4	99.7	99.9	99.8	99.9	99.8	99.9	99.9	99.8	99.9	99.9

Data Set 3 : 85°C, 700 mA

Actual Case Temperature [T _s]	86.2 °C
Actual Ambient Temperature [T _A]	84.6 °C
Drive Current [I _F]	700 mA
Measurement Current	700 mA

NOTES:

T_s and T_A were measured during initial setup.

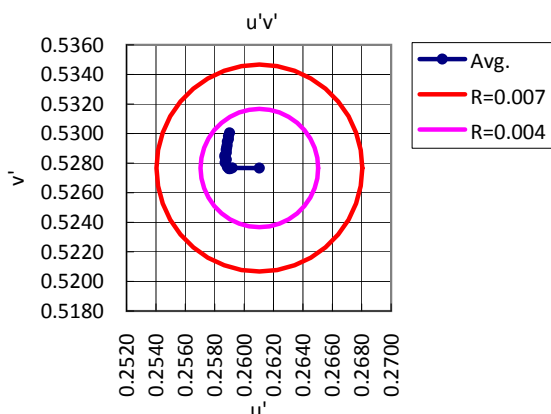
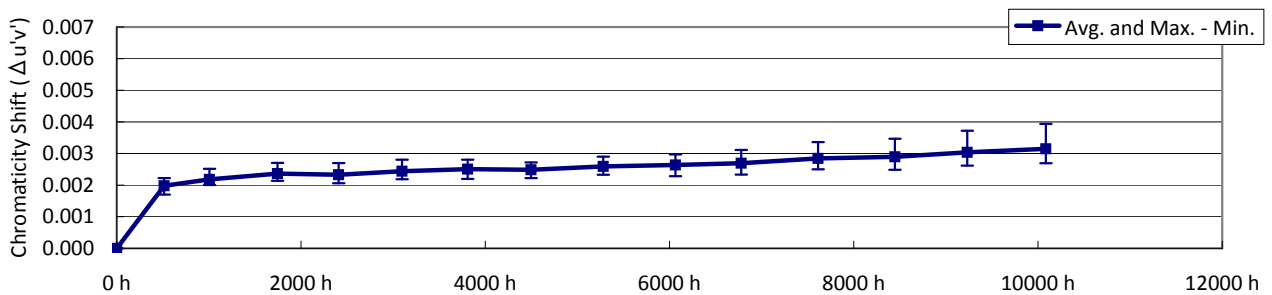
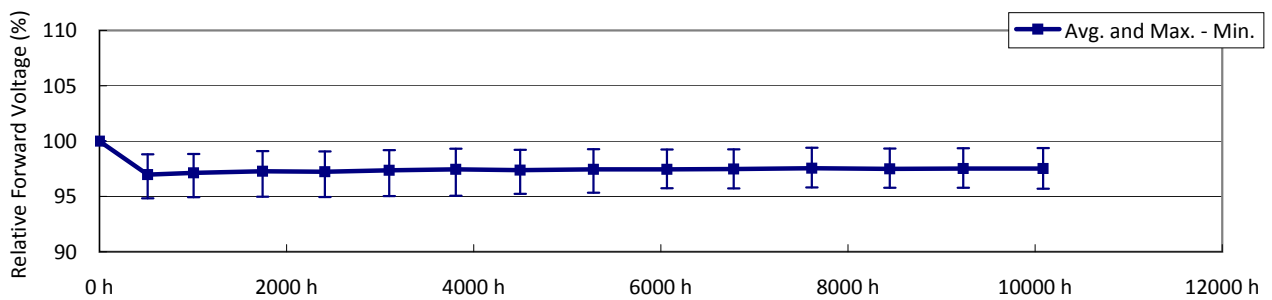
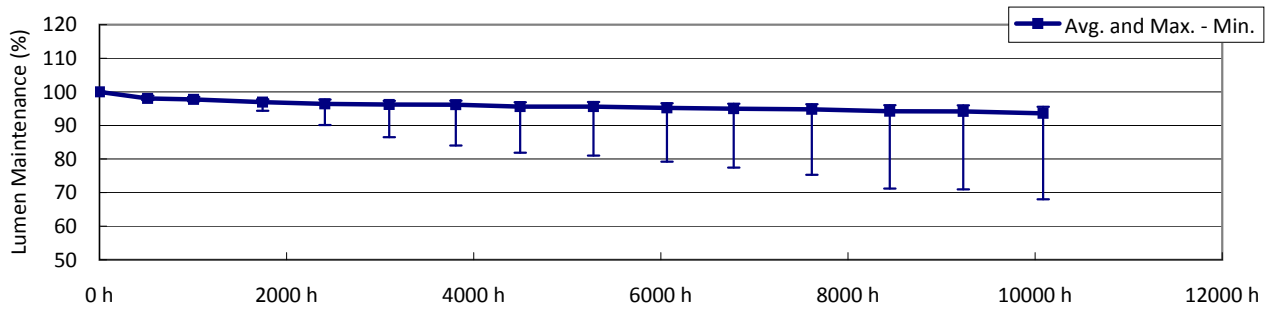
TABLE 3-4
Chromaticity Shift

LED No.	Chromaticity Shift Δu'v'														
	0 h	515 h	1006 h	1744 h	2409 h	3096 h	3809 h	4497 h	5280 h	6065 h	6778 h	7613 h	8446 h	9232 h	10086 h
1	0.0000	0.0017	0.0019	0.0021	0.0021	0.0022	0.0022	0.0022	0.0023	0.0023	0.0023	0.0024	0.0023	0.0024	0.0024
2	0.0000	0.0017	0.0019	0.0021	0.0021	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023	0.0023	0.0023	0.0023	0.0023
3	0.0000	0.0016	0.0019	0.0019	0.0019	0.0019	0.0019	0.0020	0.0020	0.0021	0.0021	0.0020	0.0020	0.0021	0.0021
4	0.0000	0.0016	0.0018	0.0019	0.0018	0.0019	0.0019	0.0020	0.0020	0.0021	0.0021	0.0020	0.0020	0.0021	0.0021
5	0.0000	0.0015	0.0017	0.0019	0.0019	0.0020	0.0020	0.0020	0.0021	0.0021	0.0021	0.0021	0.0022	0.0022	0.0022
6	0.0000	0.0017	0.0019	0.0022	0.0021	0.0023	0.0023	0.0023	0.0023	0.0023	0.0024	0.0024	0.0024	0.0025	0.0024
7	0.0000	0.0016	0.0018	0.0020	0.0020	0.0022	0.0021	0.0021	0.0022	0.0022	0.0022	0.0023	0.0023	0.0023	0.0024
8	0.0000	0.0015	0.0018	0.0020	0.0020	0.0021	0.0021	0.0020	0.0020	0.0020	0.0021	0.0021	0.0021	0.0021	0.0022
9	0.0000	0.0016	0.0019	0.0021	0.0020	0.0021	0.0022	0.0021	0.0022	0.0021	0.0021	0.0022	0.0022	0.0022	0.0022
10	0.0000	0.0017	0.0019	0.0020	0.0019	0.0020	0.0021	0.0021	0.0021	0.0021	0.0020	0.0022	0.0021	0.0021	0.0022
11	0.0000	0.0016	0.0019	0.0020	0.0021	0.0022	0.0022	0.0021	0.0022	0.0022	0.0022	0.0023	0.0023	0.0023	0.0023
12	0.0000	0.0016	0.0019	0.0021	0.0021	0.0022	0.0021	0.0022	0.0022	0.0022	0.0022	0.0023	0.0023	0.0025	0.0024
13	0.0000	0.0018	0.0020	0.0023	0.0023	0.0024	0.0025	0.0024	0.0025	0.0025	0.0025	0.0026	0.0025	0.0026	0.0026
14	0.0000	0.0017	0.0019	0.0021	0.0021	0.0023	0.0023	0.0022	0.0023	0.0023	0.0024	0.0025	0.0024	0.0025	0.0025
15	0.0000	0.0017	0.0019	0.0020	0.0020	0.0021	0.0021	0.0021	0.0022	0.0022	0.0021	0.0022	0.0022	0.0022	0.0022
16	0.0000	0.0016	0.0018	0.0019	0.0019	0.0020	0.0021	0.0020	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023
17	0.0000	0.0016	0.0019	0.0020	0.0021	0.0023	0.0023	0.0022	0.0023	0.0023	0.0023	0.0024	0.0024	0.0024	0.0024
18	0.0000	0.0016	0.0019	0.0020	0.0020	0.0022	0.0021	0.0022	0.0022	0.0022	0.0023	0.0024	0.0023	0.0024	0.0024
19	0.0000	0.0016	0.0019	0.0021	0.0021	0.0022	0.0023	0.0022	0.0023	0.0024	0.0024	0.0024	0.0024	0.0025	0.0025
20	0.0000	0.0017	0.0019	0.0021	0.0021	0.0022	0.0022	0.0022	0.0023	0.0023	0.0023	0.0024	0.0024	0.0024	0.0024
21	0.0000	0.0016	0.0018	0.0020	0.0019	0.0020	0.0021	0.0021	0.0021	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022
22	0.0000	0.0017	0.0019	0.0021	0.0020	0.0021	0.0022	0.0022	0.0023	0.0023	0.0022	0.0023	0.0023	0.0023	0.0024
23	0.0000	0.0015	0.0018	0.0019	0.0019	0.0020	0.0021	0.0021	0.0021	0.0021	0.0021	0.0022	0.0022	0.0023	0.0023
24	0.0000	0.0017	0.0019	0.0021	0.0020	0.0021	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023	0.0023	0.0023	0.0024
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	0.0000	0.0017	0.0019	0.0021	0.0020	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023	0.0023	0.0023	0.0023
Med.	0.0000	0.0016	0.0019	0.0020	0.0020	0.0021	0.0021	0.0022	0.0022	0.0022	0.0022	0.0023	0.0023	0.0023	0.0024
σ	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Min.	0.0000	0.0015	0.0017	0.0019	0.0018	0.0019	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0021	0.0021
Max.	0.0000	0.0018	0.0020	0.0023	0.0023	0.0024	0.0025	0.0024	0.0025	0.0025	0.0025	0.0026	0.0025	0.0026	0.0026

Data Set 4 : 85°C, 1200 mA

Actual Case Temperature [T _S]	91.0 °C
Actual Ambient Temperature [T _A]	91.0 °C
Drive Current [I _F]	1200 mA
Measurement Current	1200 mA

NOTES:
T_S and T_A were measured during initial setup.



Data Set 4 : 85°C, 1200 mA

Actual Case Temperature [T _S]	91.0 °C
Actual Ambient Temperature [T _A]	91.0 °C
Drive Current [I _F]	1200 mA
Measurement Current	1200 mA

NOTES:

 T_S and T_A were measured during initial setup.

TABLE 4-1
Initial Characteristics

LED No.	Luminous flux	Forward voltage	CCT	CIE1931		CIE1976							
	Φ _V [lm]	V _F [V]	T _{CP} [K]	x	y	u'	v'						
1	316	3.61	2811	0.449	0.404	0.258	0.523						
2	315	3.61	2805	0.451	0.407	0.258	0.524						
3	319	3.58	2861	0.446	0.405	0.256	0.523						
4	318	3.47	2805	0.452	0.409	0.258	0.525						
5	303	3.53	2711	0.460	0.412	0.262	0.528						
6	314	3.57	2821	0.448	0.404	0.258	0.523						
7	311	3.61	2778	0.453	0.407	0.259	0.525						
8	317	3.52	2760	0.457	0.412	0.260	0.527						
9	316	3.48	2821	0.448	0.404	0.258	0.523						
10	319	3.57	2865	0.444	0.403	0.256	0.522						
11	319	3.52	2810	0.451	0.409	0.258	0.525						
12	315	3.60	2851	0.446	0.404	0.256	0.523						
13	303	3.58	2611	0.472	0.420	0.266	0.533						
14	301	3.55	2556	0.477	0.421	0.269	0.534						
15	310	3.55	2734	0.459	0.413	0.261	0.528						
16	312	3.47	2627	0.470	0.419	0.265	0.532						
17	305	3.55	2608	0.472	0.420	0.266	0.533						
18	317	3.52	2773	0.456	0.413	0.259	0.528						
19	315	3.60	2727	0.460	0.414	0.261	0.529						
20	306	3.58	2662	0.466	0.416	0.264	0.530						
21	314	3.52	2765	0.458	0.415	0.259	0.529						
22	310	3.55	2619	0.471	0.419	0.266	0.532						
23	304	3.60	2614	0.471	0.419	0.266	0.532						
24	308	3.55	2602	0.472	0.419	0.266	0.532						
n	24	24	24	24	24	24	24						
Avg.	312	3.55	2733	0.459	0.412	0.261	0.528						
Med.	314	3.55	2762	0.457	0.413	0.259	0.528						
σ	5.6	0.043	96.5	0.0102	0.0063	0.0039	0.0039						
Min.	301	3.47	2556	0.444	0.403	0.256	0.522						
Max.	319	3.61	2865	0.477	0.421	0.269	0.534						

Data Set 4 : 85°C, 1200 mA

Actual Case Temperature [T _s]	91.0 °C
Actual Ambient Temperature [T _A]	91.0 °C
Drive Current [I _F]	1200 mA
Measurement Current	1200 mA

NOTES:

 T_s and T_A were measured during initial setup.

TABLE 4-2
 Lumen Maintenance

LED No.	Lumen Maintenance % (Normalized to 100% at 0 hours)														
	0 h	515 h	1006 h	1744 h	2409 h	3096 h	3809 h	4497 h	5280 h	6065 h	6778 h	7613 h	8446 h	9232 h	10086 h
1	100.0	98.4	98.3	97.6	97.2	97.2	97.0	96.6	96.6	96.4	96.3	96.1	95.8	95.7	95.3
2	100.0	98.3	97.9	94.4	90.1	86.5	84.0	81.9	81.0	79.2	77.5	75.3	71.2	71.0	68.0
3	100.0	98.4	98.2	97.6	97.3	96.8	96.9	96.5	96.5	96.3	96.2	96.2	95.8	95.7	95.3
4	100.0	98.3	97.5	97.6	97.0	97.1	97.1	96.9	96.7	96.6	96.4	96.3	96.0	96.0	95.6
5	100.0	97.7	97.3	97.0	96.1	96.4	96.5	96.1	96.2	95.8	95.4	95.3	94.9	94.9	94.5
6	100.0	98.4	98.0	97.5	96.9	97.3	97.3	96.9	97.0	96.5	96.1	96.0	95.6	95.5	95.2
7	100.0	98.0	98.2	97.4	97.3	97.1	97.0	96.6	96.6	96.2	96.3	96.1	95.7	95.7	95.2
8	100.0	98.7	98.5	97.8	97.7	97.2	97.2	96.8	96.8	96.3	96.4	96.2	95.9	95.8	95.3
9	100.0	98.8	98.4	97.8	97.6	97.0	97.1	96.7	96.8	96.3	96.4	96.3	95.9	95.8	95.4
10	100.0	98.2	97.9	97.2	96.9	96.8	96.9	96.6	96.6	96.3	96.1	96.1	95.6	95.6	95.1
11	100.0	98.2	98.1	97.2	96.6	97.1	97.4	96.7	96.8	96.6	96.1	96.1	95.7	95.3	95.1
12	100.0	98.1	97.8	97.0	96.6	96.8	96.8	96.0	95.6	95.4	95.0	94.9	94.5	94.4	94.0
13	100.0	97.8	97.3	96.5	96.3	96.3	96.1	95.5	95.5	95.2	95.2	95.0	94.6	94.3	94.0
14	100.0	97.8	97.6	96.8	96.8	96.4	96.1	95.6	95.7	95.2	95.4	95.3	94.9	94.8	94.3
15	100.0	97.8	97.6	96.9	96.8	96.4	96.4	96.0	96.0	95.7	95.7	95.7	95.3	95.3	94.7
16	100.0	98.0	97.6	96.8	96.3	96.3	96.4	95.7	95.9	95.5	95.3	95.3	94.8	94.7	94.3
17	100.0	97.7	97.3	96.7	95.9	96.4	96.8	96.3	96.3	96.0	95.6	95.6	95.2	95.2	94.7
18	100.0	97.9	97.6	96.9	96.5	96.8	97.1	96.5	96.5	96.3	96.1	96.0	95.6	95.6	95.0
19	100.0	97.9	97.6	96.7	96.5	96.6	96.4	95.8	95.8	95.4	95.3	95.1	94.7	94.6	94.1
20	100.0	97.8	97.5	96.8	96.5	96.3	96.1	95.6	95.9	95.3	95.3	95.2	94.8	94.7	94.1
21	100.0	98.0	97.6	97.0	96.9	96.6	96.6	96.3	96.4	96.0	96.0	96.0	95.6	95.6	95.1
22	100.0	97.9	97.4	96.6	96.3	96.2	96.3	96.0	95.8	95.6	95.4	95.3	94.8	94.7	94.3
23	100.0	97.6	97.2	96.4	95.7	95.9	96.2	95.7	95.5	95.4	94.9	94.7	94.3	94.2	93.8
24	100.0	97.7	97.2	96.1	95.7	96.0	96.1	95.5	95.5	95.3	95.0	94.9	94.5	94.4	94.1
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	98.1	97.7	96.9	96.4	96.2	96.2	95.6	95.6	95.2	95.0	94.8	94.2	94.2	93.6
Med.	100.0	98.0	97.6	96.9	96.6	96.6	96.7	96.2	96.3	95.9	95.7	95.6	95.3	95.2	94.7
σ	0.00	0.33	0.39	0.70	1.44	2.11	2.61	2.97	3.14	3.43	3.76	4.18	4.93	4.96	5.47
Min.	100.0	97.6	97.2	94.4	90.1	86.5	84.0	81.9	81.0	79.2	77.5	75.3	71.2	71.0	68.0
Max.	100.0	98.8	98.5	97.8	97.7	97.3	97.4	96.9	97.0	96.6	96.4	96.3	96.0	96.0	95.6

TM-21 Projection

Time	4497 h	5280 h	6065 h	6778 h	7613 h	8446 h	9232 h	10086 h							
ln(Avg.)	-0.0448	-0.0451	-0.0492	-0.0517	-0.0535	-0.0593	-0.0602	-0.0661							

Test duration used	4497 h	to	10086 h
B	0.9745		
α	3.8426E-06		
R ²	0.9729		
Calculated L ₇₀ (10K)	86100	hours	
Reported L ₇₀ (10K)	> 60500	hours	

Curve-fit equation:

$$\Phi(t) = B \exp(-\alpha t)$$

Lumen maintenance life equation:

$$L_{70} = \ln(B/0.7) / \alpha$$

Data Set 4 : 85°C, 1200 mA

Actual Case Temperature [T _s]	91.0 °C
Actual Ambient Temperature [T _A]	91.0 °C
Drive Current [I _F]	1200 mA
Measurement Current	1200 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 4-3
Forward Voltage

LED No.	Relative Forward Voltage % (Normalized to 100% at 0 hours)														
	0 h	515 h	1006 h	1744 h	2409 h	3096 h	3809 h	4497 h	5280 h	6065 h	6778 h	7613 h	8446 h	9232 h	10086 h
1	100.0	96.7	96.9	97.0	96.9	97.0	97.1	97.1	97.1	97.1	97.1	97.2	97.2	97.1	97.2
2	100.0	96.8	96.9	96.8	96.4	96.3	96.1	95.9	95.9	96.1	96.7	96.6	96.1	96.0	95.7
3	100.0	96.0	96.2	96.3	96.2	96.3	96.4	96.3	96.3	96.3	96.3	96.4	96.3	96.4	96.4
4	100.0	97.4	97.6	97.8	97.7	97.8	97.9	97.8	97.9	97.9	97.9	97.9	97.9	97.9	97.9
5	100.0	97.1	97.4	97.4	97.3	97.9	97.9	97.9	98.0	97.9	97.9	98.0	98.0	98.0	98.0
6	100.0	94.8	94.9	95.0	94.9	95.0	95.1	95.2	95.3	95.7	95.7	95.8	95.8	95.8	95.8
7	100.0	96.6	96.8	96.9	96.9	97.0	97.0	97.0	97.1	97.0	97.0	97.1	97.1	97.1	97.1
8	100.0	97.4	98.1	98.2	98.2	98.2	98.4	98.3	98.4	98.3	98.3	98.4	98.4	98.5	98.5
9	100.0	97.2	97.3	97.4	97.4	97.4	97.6	97.5	97.5	97.5	97.5	97.6	97.5	97.6	97.6
10	100.0	96.7	96.8	96.9	96.8	96.9	97.0	96.9	97.0	97.0	97.0	97.1	97.1	97.1	97.1
11	100.0	97.1	97.3	97.4	97.4	97.5	97.6	97.5	97.6	97.6	97.6	97.7	97.6	97.7	97.7
12	100.0	95.0	95.0	95.1	95.1	95.4	95.4	95.5	96.2	96.1	96.1	96.2	96.2	96.2	96.2
13	100.0	96.3	96.4	96.5	96.5	96.7	96.8	96.6	96.7	96.7	96.7	96.8	96.7	96.8	96.8
14	100.0	96.5	96.5	96.8	96.7	96.9	97.0	96.9	96.9	96.9	96.9	97.0	97.0	97.0	97.0
15	100.0	98.6	98.7	98.8	98.7	98.8	98.9	98.7	98.8	98.7	98.7	98.8	98.8	98.7	98.8
16	100.0	96.4	96.6	96.7	96.8	97.1	97.2	97.1	97.2	97.1	97.1	97.2	97.2	97.2	97.2
17	100.0	98.8	98.8	99.0	98.9	99.0	99.1	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0
18	100.0	98.7	98.8	98.9	98.8	98.9	99.0	98.8	98.9	98.8	98.9	98.9	98.9	98.9	98.9
19	100.0	96.5	96.6	96.8	96.9	97.1	97.4	97.3	97.4	97.3	97.3	97.4	97.4	97.4	97.4
20	100.0	97.5	97.7	97.9	98.0	98.1	98.2	98.1	98.1	98.1	98.1	98.2	98.3	98.3	98.3
21	100.0	98.7	98.8	98.9	98.8	98.9	99.0	98.9	98.9	98.8	98.9	98.9	98.8	98.9	98.9
22	100.0	96.9	97.0	97.2	97.2	97.3	97.4	97.3	97.4	97.3	97.4	97.4	97.4	97.4	97.5
23	100.0	95.7	95.8	95.9	95.9	95.9	96.1	95.9	96.0	96.0	96.0	96.1	96.0	96.1	96.1
24	100.0	97.6	98.3	99.1	99.1	99.2	99.3	99.2	99.3	99.2	99.3	99.4	99.3	99.4	99.4
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	97.0	97.1	97.3	97.2	97.4	97.4	97.4	97.4	97.4	97.5	97.6	97.5	97.5	97.5
Med.	100.0	96.8	97.0	97.1	97.0	97.2	97.4	97.3	97.4	97.3	97.3	97.4	97.4	97.4	97.4
σ	0.00	1.06	1.09	1.14	1.14	1.13	1.15	1.12	1.08	1.02	1.00	1.00	1.03	1.03	1.05
Min.	100.0	94.8	94.9	95.0	94.9	95.0	95.1	95.2	95.3	95.7	95.7	95.8	95.8	95.8	95.7
Max.	100.0	98.8	98.8	99.1	99.1	99.2	99.3	99.2	99.3	99.2	99.3	99.4	99.3	99.4	99.4

Data Set 4 : 85°C, 1200 mA

Actual Case Temperature [T _s]	91.0 °C
Actual Ambient Temperature [T _A]	91.0 °C
Drive Current [I _F]	1200 mA
Measurement Current	1200 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 4-4
Chromaticity Shift

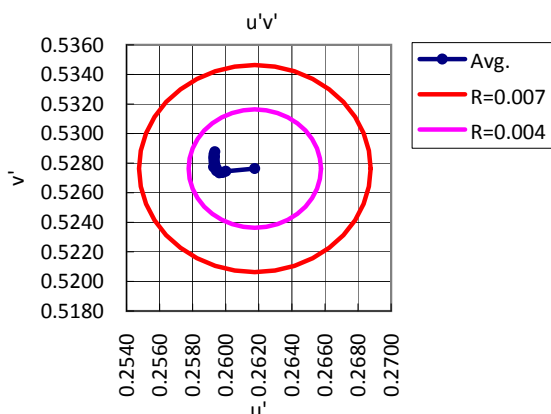
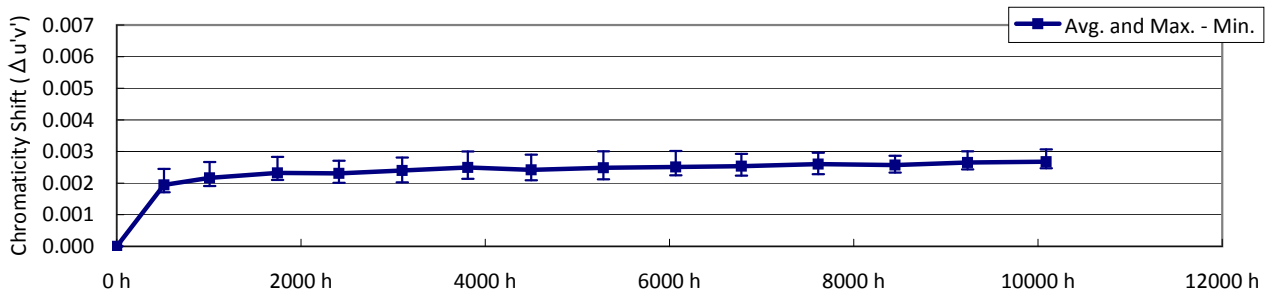
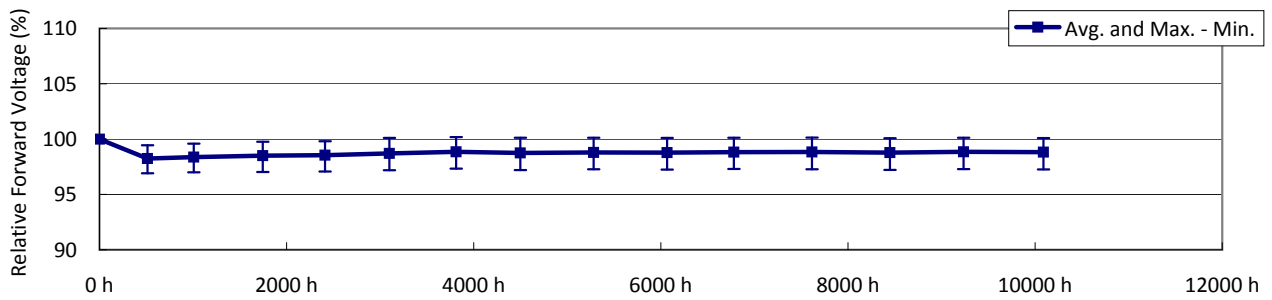
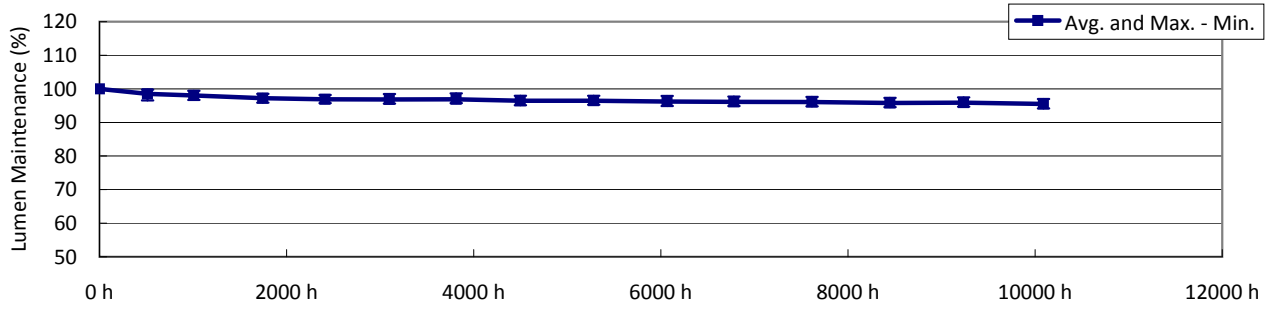
LED No.	Chromaticity Shift Δu'v'														
	0 h	515 h	1006 h	1744 h	2409 h	3096 h	3809 h	4497 h	5280 h	6065 h	6778 h	7613 h	8446 h	9232 h	10086 h
1	0.0000	0.0020	0.0022	0.0025	0.0024	0.0026	0.0026	0.0026	0.0027	0.0028	0.0028	0.0030	0.0032	0.0033	0.0036
2	0.0000	0.0019	0.0021	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023	0.0025	0.0026	0.0027	0.0029	0.0030	0.0031
3	0.0000	0.0020	0.0022	0.0024	0.0023	0.0024	0.0025	0.0025	0.0026	0.0026	0.0027	0.0028	0.0028	0.0030	0.0031
4	0.0000	0.0020	0.0021	0.0023	0.0022	0.0023	0.0024	0.0024	0.0024	0.0025	0.0024	0.0025	0.0026	0.0027	0.0027
5	0.0000	0.0017	0.0020	0.0022	0.0021	0.0022	0.0023	0.0022	0.0023	0.0024	0.0024	0.0025	0.0026	0.0028	0.0028
6	0.0000	0.0020	0.0021	0.0023	0.0024	0.0024	0.0026	0.0025	0.0026	0.0027	0.0028	0.0029	0.0030	0.0031	0.0033
7	0.0000	0.0020	0.0022	0.0024	0.0024	0.0026	0.0026	0.0026	0.0027	0.0028	0.0029	0.0031	0.0032	0.0033	0.0035
8	0.0000	0.0020	0.0022	0.0024	0.0025	0.0025	0.0025	0.0025	0.0027	0.0027	0.0028	0.0029	0.0030	0.0031	0.0032
9	0.0000	0.0020	0.0021	0.0023	0.0022	0.0023	0.0023	0.0023	0.0024	0.0026	0.0026	0.0028	0.0028	0.0030	0.0031
10	0.0000	0.0019	0.0021	0.0023	0.0022	0.0023	0.0024	0.0024	0.0027	0.0026	0.0028	0.0030	0.0031	0.0033	0.0035
11	0.0000	0.0019	0.0021	0.0024	0.0022	0.0024	0.0025	0.0025	0.0026	0.0027	0.0028	0.0030	0.0030	0.0033	0.0034
12	0.0000	0.0019	0.0021	0.0023	0.0023	0.0025	0.0026	0.0027	0.0029	0.0030	0.0031	0.0034	0.0035	0.0037	0.0039
13	0.0000	0.0021	0.0023	0.0024	0.0024	0.0025	0.0025	0.0025	0.0026	0.0026	0.0026	0.0028	0.0028	0.0029	0.0030
14	0.0000	0.0022	0.0025	0.0027	0.0027	0.0028	0.0028	0.0027	0.0028	0.0027	0.0028	0.0028	0.0029	0.0029	0.0029
15	0.0000	0.0020	0.0023	0.0025	0.0025	0.0025	0.0027	0.0026	0.0027	0.0026	0.0027	0.0029	0.0030	0.0030	0.0032
16	0.0000	0.0021	0.0023	0.0025	0.0024	0.0025	0.0027	0.0025	0.0027	0.0027	0.0027	0.0028	0.0027	0.0029	0.0029
17	0.0000	0.0020	0.0022	0.0024	0.0025	0.0025	0.0025	0.0025	0.0026	0.0026	0.0026	0.0027	0.0027	0.0028	0.0029
18	0.0000	0.0020	0.0022	0.0023	0.0023	0.0025	0.0024	0.0025	0.0026	0.0027	0.0027	0.0029	0.0029	0.0030	0.0031
19	0.0000	0.0019	0.0021	0.0023	0.0022	0.0024	0.0025	0.0025	0.0025	0.0026	0.0028	0.0029	0.0031	0.0032	0.0033
20	0.0000	0.0021	0.0023	0.0024	0.0024	0.0026	0.0026	0.0026	0.0027	0.0027	0.0028	0.0030	0.0030	0.0031	0.0033
21	0.0000	0.0019	0.0022	0.0023	0.0023	0.0024	0.0025	0.0025	0.0025	0.0026	0.0026	0.0027	0.0027	0.0029	0.0030
22	0.0000	0.0018	0.0020	0.0021	0.0021	0.0022	0.0022	0.0023	0.0023	0.0023	0.0023	0.0025	0.0025	0.0026	0.0027
23	0.0000	0.0020	0.0022	0.0023	0.0024	0.0025	0.0025	0.0025	0.0026	0.0026	0.0026	0.0028	0.0028	0.0029	0.0030
24	0.0000	0.0020	0.0022	0.0024	0.0024	0.0025	0.0026	0.0025	0.0026	0.0026	0.0026	0.0027	0.0027	0.0028	0.0030
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	0.0000	0.0020	0.0022	0.0024	0.0023	0.0024	0.0025	0.0025	0.0026	0.0026	0.0027	0.0028	0.0029	0.0030	0.0031
Med.	0.0000	0.0020	0.0022	0.0023	0.0023	0.0025	0.0025	0.0025	0.0026	0.0026	0.0027	0.0028	0.0029	0.0030	0.0031
σ	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002	0.0003
Min.	0.0000	0.0017	0.0020	0.0021	0.0021	0.0022	0.0022	0.0022	0.0023	0.0023	0.0023	0.0025	0.0025	0.0026	0.0027
Max.	0.0000	0.0022	0.0025	0.0027	0.0027	0.0028	0.0028	0.0027	0.0029	0.0030	0.0031	0.0034	0.0035	0.0037	0.0039

Data Set 5 : 105°C, 700 mA

Actual Case Temperature [T _S]	107.8 °C
Actual Ambient Temperature [T _A]	106.1 °C
Drive Current [I _F]	700 mA
Measurement Current	700 mA

NOTES:

T_S and T_A were measured during initial setup.



Data Set 5 : 105°C, 700 mA

Actual Case Temperature [T _S]	107.8 °C
Actual Ambient Temperature [T _A]	106.1 °C
Drive Current [I _F]	700 mA
Measurement Current	700 mA

NOTES:

T_S and T_A were measured during initial setup.

TABLE 5-1
Initial Characteristics

LED No.	Luminous flux	Forward voltage	CCT	CIE1931		CIE1976							
	Φ _V [lm]	V _F [V]	T _{CP} [K]	x	y	u'	v'						
1	199	3.30	2763	0.453	0.406	0.260	0.524						
2	200	3.29	2795	0.451	0.407	0.259	0.525						
3	201	3.30	2791	0.451	0.405	0.259	0.524						
4	198	3.29	2757	0.453	0.406	0.260	0.524						
5	195	3.30	2695	0.461	0.413	0.263	0.528						
6	201	3.26	2787	0.453	0.409	0.259	0.526						
7	197	3.29	2772	0.454	0.409	0.259	0.526						
8	200	3.26	2786	0.452	0.408	0.259	0.525						
9	197	3.25	2719	0.459	0.412	0.262	0.528						
10	197	3.23	2699	0.460	0.410	0.263	0.527						
11	194	3.27	2592	0.472	0.418	0.267	0.532						
12	201	3.27	2806	0.451	0.407	0.258	0.525						
13	197	3.25	2621	0.470	0.419	0.266	0.532						
14	201	3.29	2763	0.454	0.409	0.260	0.526						
15	194	3.28	2594	0.472	0.417	0.267	0.532						
16	200	3.29	2749	0.458	0.413	0.260	0.528						
17	194	3.30	2569	0.475	0.420	0.268	0.533						
18	201	3.27	2758	0.455	0.409	0.260	0.526						
19	198	3.30	2725	0.458	0.410	0.261	0.527						
20	202	3.28	2755	0.457	0.412	0.260	0.527						
21	203	3.27	2766	0.456	0.412	0.259	0.527						
22	198	3.32	2719	0.459	0.412	0.262	0.528						
23	194	3.29	2605	0.471	0.418	0.266	0.532						
24	196	3.26	2612	0.471	0.418	0.266	0.532						
n	24	24	24	24	24	24	24						
Avg.	198	3.28	2717	0.459	0.412	0.262	0.528						
Med.	198	3.28	2752	0.457	0.411	0.260	0.527						
σ	2.8	0.020	75.5	0.0079	0.0046	0.0032	0.0029						
Min.	194	3.23	2569	0.451	0.405	0.258	0.524						
Max.	203	3.32	2806	0.475	0.420	0.268	0.533						

Data Set 5 : 105°C, 700 mA

Actual Case Temperature [T _s]	107.8 °C
Actual Ambient Temperature [T _A]	106.1 °C
Drive Current [I _F]	700 mA
Measurement Current	700 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 5-2
Lumen Maintenance

LED No.	Lumen Maintenance % (Normalized to 100% at 0 hours)														
	0 h	513 h	1008 h	1745 h	2411 h	3098 h	3811 h	4498 h	5282 h	6067 h	6781 h	7615 h	8449 h	9235 h	10089 h
1	100.0	98.7	98.5	97.7	97.6	97.5	97.5	96.9	97.0	96.7	96.7	96.7	96.4	96.4	96.1
2	100.0	98.2	98.1	97.0	97.1	96.6	96.7	96.2	96.2	96.1	96.0	96.1	95.7	95.7	95.4
3	100.0	98.9	98.7	97.8	97.7	97.0	97.2	96.8	96.8	96.5	96.5	96.6	96.1	96.1	95.9
4	100.0	98.8	98.0	97.7	97.3	97.1	97.3	97.0	97.0	96.5	96.5	96.4	96.1	96.2	95.7
5	100.0	99.2	98.8	98.1	97.4	97.9	98.1	97.7	97.8	97.3	97.3	97.0	96.8	97.0	96.5
6	100.0	98.3	97.9	97.3	96.7	97.1	97.1	96.7	96.7	96.4	96.3	96.0	95.9	96.0	95.6
7	100.0	98.8	98.3	97.5	97.3	97.4	97.0	96.7	96.7	96.4	96.4	96.3	96.0	96.1	95.7
8	100.0	98.8	98.2	97.3	97.2	97.1	96.9	96.5	96.6	96.1	96.1	96.1	95.6	95.8	95.4
9	100.0	98.6	98.0	97.1	97.0	96.7	96.7	96.3	96.3	95.9	95.9	95.9	95.5	95.6	95.2
10	100.0	98.5	98.0	97.0	96.8	96.8	97.0	96.5	96.4	96.3	96.1	96.1	95.8	95.9	95.4
11	100.0	98.5	98.2	97.3	96.6	97.1	97.3	96.7	96.6	96.7	96.5	96.4	96.1	96.3	95.7
12	100.0	99.7	99.4	98.5	98.2	98.5	98.6	97.9	97.9	97.9	97.7	97.6	97.3	97.5	97.0
13	100.0	98.3	97.7	96.7	96.5	96.5	96.4	95.9	96.0	95.8	95.9	95.8	95.6	95.7	95.3
14	100.0	98.7	98.3	97.3	97.1	96.6	96.6	96.3	96.3	96.2	96.0	96.0	95.8	95.9	95.4
15	100.0	98.2	97.5	96.3	96.0	95.6	95.8	95.5	95.5	95.3	95.1	95.2	94.9	95.0	94.6
16	100.0	98.5	97.7	97.0	96.4	96.5	96.6	96.2	96.2	96.0	95.9	95.9	95.5	95.5	95.3
17	100.0	98.1	97.5	96.7	96.0	96.5	96.6	96.1	96.1	95.9	95.7	95.7	95.2	95.5	95.1
18	100.0	98.3	97.7	96.9	96.4	96.8	96.9	96.3	96.4	96.3	96.2	96.1	95.9	96.1	95.7
19	100.0	96.5	96.7	95.9	95.7	95.7	95.7	95.1	95.3	94.9	94.9	94.8	94.6	94.7	94.2
20	100.0	98.7	98.1	97.5	97.4	97.0	97.0	96.4	96.7	96.3	96.3	96.3	96.1	96.2	95.8
21	100.0	98.8	98.3	97.6	97.4	96.9	97.1	96.7	96.8	96.5	96.5	96.5	96.2	96.2	96.0
22	100.0	98.6	98.1	97.3	96.8	96.7	96.8	96.4	96.3	96.2	96.0	95.9	95.5	95.6	95.2
23	100.0	97.6	97.4	96.7	95.9	96.2	96.5	96.0	95.8	95.9	95.6	95.5	95.3	95.3	95.0
24	100.0	98.3	97.7	96.8	96.3	96.5	96.6	95.9	95.9	95.8	95.6	95.5	95.2	95.3	94.9
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	98.5	98.0	97.2	96.9	96.8	96.9	96.4	96.5	96.2	96.2	96.1	95.8	95.9	95.5
Med.	100.0	98.6	98.0	97.3	96.9	96.8	96.9	96.4	96.4	96.2	96.1	96.1	95.8	95.9	95.4
σ	0.00	0.59	0.54	0.57	0.63	0.61	0.62	0.61	0.62	0.60	0.61	0.58	0.58	0.59	0.59
Min.	100.0	96.5	96.7	95.9	95.7	95.6	95.7	95.1	95.3	94.9	94.9	94.8	94.6	94.7	94.2
Max.	100.0	99.7	99.4	98.5	98.2	98.5	98.6	97.9	97.9	97.9	97.7	97.6	97.3	97.5	97.0

TM-21 Projection

Time	4498 h	5282 h	6067 h	6781 h	7615 h	8449 h	9235 h	10089 h							
ln(Avg.)	-0.0362	-0.0360	-0.0383	-0.0393	-0.0398	-0.0431	-0.0420	-0.0460							

Test duration used	4498 h	to	10089 h
B	0.9727		
α	1.7036E-06		
R ²	0.9224		
Calculated L ₇₀ (10K)	193000	hours	
Reported L ₇₀ (10K)	> 60500	hours	

Curve-fit equation:

$$\Phi(t) = B \exp(-\alpha t)$$

Lumen maintenance life equation:

$$L_{70} = \ln(B/0.7) / \alpha$$

Data Set 5 : 105°C, 700 mA

Actual Case Temperature [T _s]	107.8 °C
Actual Ambient Temperature [T _A]	106.1 °C
Drive Current [I _F]	700 mA
Measurement Current	700 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 5-3
Forward Voltage

LED No.	Relative Forward Voltage % (Normalized to 100% at 0 hours)														
	0 h	513 h	1008 h	1745 h	2411 h	3098 h	3811 h	4498 h	5282 h	6067 h	6781 h	7615 h	8449 h	9235 h	10089 h
1	100.0	98.0	98.2	98.3	98.4	98.5	98.6	98.6	98.6	98.5	98.6	98.6	98.6	98.6	98.6
2	100.0	98.1	98.4	98.7	98.8	98.9	99.0	98.9	99.0	98.9	99.0	99.0	99.0	99.0	99.1
3	100.0	97.7	97.8	97.9	97.9	98.0	98.1	98.0	98.1	98.0	98.1	98.2	98.1	98.2	98.2
4	100.0	97.9	98.2	98.2	98.4	98.9	99.0	98.9	99.0	98.9	99.1	99.0	99.0	99.1	99.0
5	100.0	97.9	98.1	98.1	98.2	98.3	98.5	98.3	98.4	98.4	98.4	98.5	98.4	98.5	98.5
6	100.0	97.7	97.8	98.0	98.0	98.0	98.1	98.1	98.1	98.1	98.2	98.2	98.2	98.2	98.2
7	100.0	97.9	97.9	98.0	98.0	98.2	98.3	98.2	98.3	98.3	98.3	98.3	98.2	98.3	98.3
8	100.0	96.9	97.0	97.0	97.1	97.2	97.3	97.2	97.3	97.2	97.3	97.3	97.2	97.3	97.3
9	100.0	97.2	97.3	97.3	97.3	97.5	97.6	97.5	97.6	97.6	97.5	97.6	97.5	97.6	97.6
10	100.0	97.7	97.8	97.9	98.0	98.4	98.8	98.6	98.7	98.7	98.7	98.7	98.7	98.8	98.8
11	100.0	97.9	98.0	98.1	98.2	98.4	98.6	98.4	98.5	98.5	98.5	98.6	98.5	98.6	98.5
12	100.0	98.1	98.2	98.3	98.3	98.5	98.7	98.6	98.6	98.6	98.7	98.7	98.6	98.7	98.7
13	100.0	99.3	99.4	99.6	99.6	99.8	99.9	99.8	99.8	99.8	99.8	99.8	99.7	99.8	99.8
14	100.0	99.2	99.3	99.4	99.4	99.6	99.6	99.5	99.5	99.6	99.5	99.5	99.5	99.6	99.5
15	100.0	99.1	99.3	99.4	99.3	99.4	99.5	99.4	99.5	99.4	99.5	99.4	99.4	99.5	99.4
16	100.0	99.2	99.3	99.5	99.4	99.5	99.6	99.5	99.5	99.5	99.5	99.5	99.4	99.5	99.5
17	100.0	98.2	98.5	98.7	98.8	99.0	99.1	99.1	99.1	99.2	99.2	99.2	99.2	99.3	99.2
18	100.0	99.2	99.3	99.5	99.4	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6
19	100.0	98.1	98.3	98.3	98.3	98.5	98.6	98.5	98.6	98.5	98.5	98.6	98.5	98.6	98.6
20	100.0	99.3	99.6	99.8	99.8	99.9	100.1	99.9	100.0	100.0	100.0	100.0	99.9	100.0	99.9
21	100.0	99.4	99.6	99.7	99.8	99.9	100.0	99.9	100.0	100.0	100.0	100.0	99.9	100.0	100.0
22	100.0	97.1	97.2	97.4	97.4	97.5	97.6	97.5	97.5	97.6	97.6	97.6	97.6	97.7	97.6
23	100.0	99.1	99.2	99.4	99.8	100.1	100.2	100.1	100.1	100.1	100.1	100.1	100.1	100.1	100.1
24	100.0	97.4	97.4	97.6	97.6	97.7	97.8	97.7	97.8	97.7	97.8	97.8	97.8	97.9	97.8
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	98.2	98.4	98.5	98.5	98.7	98.8	98.8	98.8	98.8	98.8	98.8	98.8	98.8	98.8
Med.	100.0	98.0	98.2	98.3	98.4	98.5	98.7	98.6	98.6	98.7	98.7	98.7	98.7	98.7	98.7
σ	0.00	0.79	0.81	0.84	0.85	0.86	0.84	0.85	0.83	0.84	0.83	0.82	0.81	0.82	0.81
Min.	100.0	96.9	97.0	97.0	97.1	97.2	97.3	97.2	97.3	97.2	97.3	97.3	97.2	97.3	97.3
Max.	100.0	99.4	99.6	99.8	99.8	100.1	100.2	100.1	100.1	100.1	100.1	100.1	100.1	100.1	100.1

Data Set 5 : 105°C, 700 mA

Actual Case Temperature [T _s]	107.8 °C
Actual Ambient Temperature [T _A]	106.1 °C
Drive Current [I _F]	700 mA
Measurement Current	700 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 5-4
Chromaticity Shift

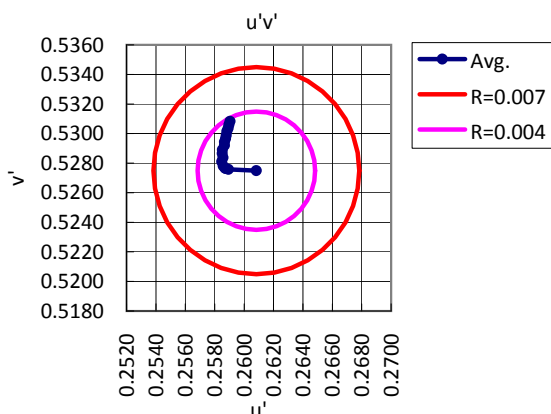
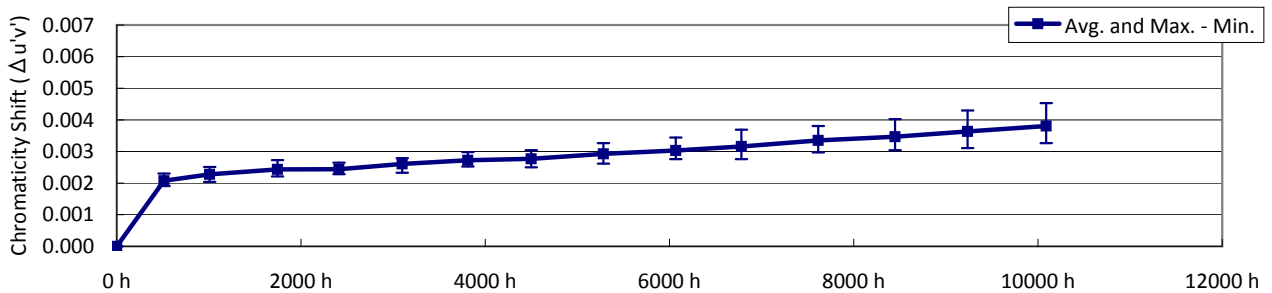
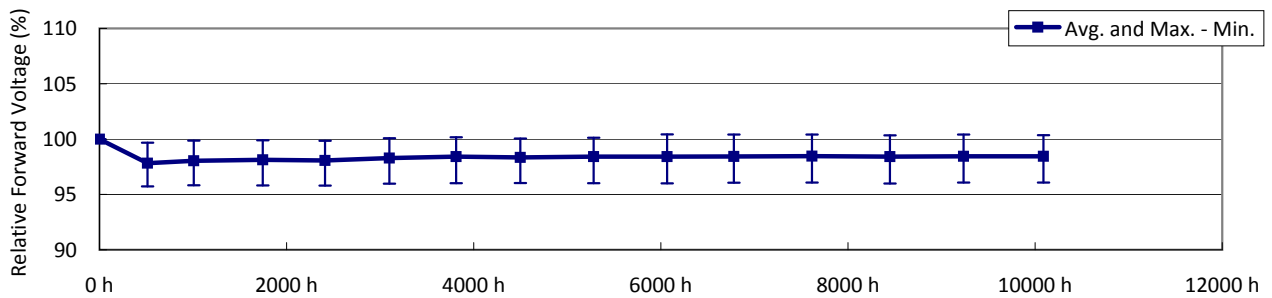
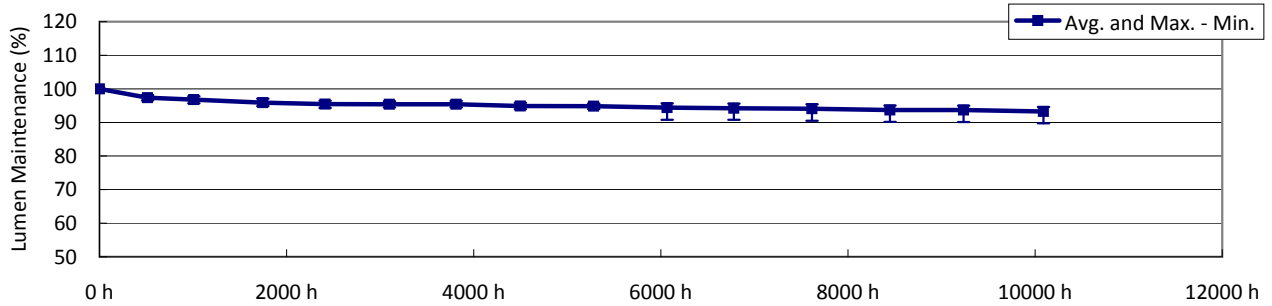
LED No.	Chromaticity Shift Δu'v'														
	0 h	513 h	1008 h	1745 h	2411 h	3098 h	3811 h	4498 h	5282 h	6067 h	6781 h	7615 h	8449 h	9235 h	10089 h
1	0.0000	0.0018	0.0020	0.0023	0.0022	0.0023	0.0024	0.0023	0.0024	0.0025	0.0024	0.0025	0.0025	0.0027	0.0026
2	0.0000	0.0019	0.0020	0.0022	0.0022	0.0022	0.0023	0.0023	0.0023	0.0024	0.0024	0.0025	0.0025	0.0026	0.0027
3	0.0000	0.0017	0.0019	0.0021	0.0020	0.0020	0.0021	0.0021	0.0021	0.0022	0.0022	0.0023	0.0023	0.0024	0.0025
4	0.0000	0.0019	0.0021	0.0023	0.0022	0.0021	0.0023	0.0023	0.0023	0.0024	0.0025	0.0026	0.0026	0.0026	0.0027
5	0.0000	0.0019	0.0021	0.0023	0.0023	0.0023	0.0024	0.0023	0.0024	0.0025	0.0025	0.0025	0.0025	0.0026	0.0025
6	0.0000	0.0019	0.0021	0.0023	0.0023	0.0024	0.0025	0.0024	0.0025	0.0025	0.0026	0.0026	0.0026	0.0027	0.0026
7	0.0000	0.0019	0.0021	0.0022	0.0023	0.0025	0.0024	0.0024	0.0024	0.0025	0.0026	0.0026	0.0025	0.0027	0.0027
8	0.0000	0.0021	0.0023	0.0023	0.0024	0.0025	0.0025	0.0024	0.0025	0.0025	0.0025	0.0026	0.0026	0.0027	0.0028
9	0.0000	0.0019	0.0021	0.0023	0.0023	0.0023	0.0024	0.0023	0.0024	0.0025	0.0024	0.0025	0.0024	0.0026	0.0026
10	0.0000	0.0019	0.0022	0.0023	0.0023	0.0023	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0026	0.0026
11	0.0000	0.0021	0.0023	0.0024	0.0024	0.0026	0.0027	0.0026	0.0026	0.0026	0.0027	0.0028	0.0027	0.0028	0.0028
12	0.0000	0.0021	0.0023	0.0025	0.0024	0.0025	0.0026	0.0025	0.0026	0.0026	0.0026	0.0026	0.0027	0.0027	0.0028
13	0.0000	0.0019	0.0021	0.0023	0.0023	0.0025	0.0025	0.0024	0.0025	0.0025	0.0025	0.0027	0.0027	0.0027	0.0027
14	0.0000	0.0018	0.0020	0.0022	0.0022	0.0023	0.0024	0.0023	0.0024	0.0024	0.0025	0.0025	0.0025	0.0025	0.0026
15	0.0000	0.0020	0.0022	0.0024	0.0024	0.0025	0.0026	0.0025	0.0025	0.0025	0.0025	0.0027	0.0026	0.0026	0.0027
16	0.0000	0.0019	0.0021	0.0023	0.0022	0.0022	0.0024	0.0023	0.0024	0.0024	0.0024	0.0025	0.0024	0.0025	0.0026
17	0.0000	0.0020	0.0023	0.0025	0.0025	0.0026	0.0028	0.0026	0.0027	0.0027	0.0027	0.0028	0.0028	0.0029	0.0029
18	0.0000	0.0018	0.0020	0.0022	0.0022	0.0024	0.0024	0.0023	0.0024	0.0025	0.0025	0.0026	0.0026	0.0027	0.0026
19	0.0000	0.0019	0.0023	0.0024	0.0024	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0028	0.0027	0.0028	0.0028
20	0.0000	0.0019	0.0021	0.0022	0.0022	0.0023	0.0024	0.0023	0.0023	0.0024	0.0025	0.0025	0.0024	0.0025	0.0025
21	0.0000	0.0019	0.0021	0.0022	0.0022	0.0023	0.0024	0.0023	0.0024	0.0024	0.0024	0.0025	0.0024	0.0024	0.0025
22	0.0000	0.0025	0.0027	0.0028	0.0027	0.0028	0.0030	0.0029	0.0030	0.0030	0.0029	0.0030	0.0029	0.0030	0.0031
23	0.0000	0.0018	0.0022	0.0023	0.0024	0.0025	0.0026	0.0025	0.0026	0.0026	0.0026	0.0026	0.0026	0.0027	0.0027
24	0.0000	0.0019	0.0022	0.0024	0.0023	0.0025	0.0025	0.0025	0.0025	0.0025	0.0026	0.0027	0.0027	0.0028	0.0027
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	0.0000	0.0019	0.0022	0.0023	0.0023	0.0024	0.0025	0.0024	0.0025	0.0025	0.0025	0.0026	0.0026	0.0027	0.0027
Med.	0.0000	0.0019	0.0021	0.0023	0.0023	0.0024	0.0025	0.0024	0.0025	0.0025	0.0025	0.0026	0.0026	0.0027	0.0027
σ	0.0000	0.0001	0.0001	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
Min.	0.0000	0.0017	0.0019	0.0021	0.0020	0.0020	0.0021	0.0021	0.0021	0.0022	0.0022	0.0023	0.0023	0.0024	0.0025
Max.	0.0000	0.0025	0.0027	0.0028	0.0027	0.0028	0.0030	0.0029	0.0030	0.0030	0.0029	0.0030	0.0029	0.0030	0.0031

Data Set 6 : 105°C, 1000 mA

Actual Case Temperature [T_S]	110.8 °C
Actual Ambient Temperature [T_A]	106.6 °C
Drive Current [I_F]	1000 mA
Measurement Current	1000 mA

NOTES:

T_S and T_A were measured during initial setup.



Data Set 6 : 105°C, 1000 mA

Actual Case Temperature [T _S]	110.8 °C
Actual Ambient Temperature [T _A]	106.6 °C
Drive Current [I _F]	1000 mA
Measurement Current	1000 mA

NOTES:

 T_S and T_A were measured during initial setup.

TABLE 6-1
 Initial Characteristics

LED No.	Luminous flux	Forward voltage	CCT	CIE1931		CIE1976							
	Φ _V [lm]	V _F [V]	T _{CP} [K]	x	y	u'	v'						
1	270	3.40	2764	0.455	0.409	0.260	0.526						
2	269	3.48	2792	0.451	0.406	0.259	0.524						
3	271	3.48	2806	0.451	0.407	0.258	0.525						
4	273	3.50	2848	0.447	0.406	0.256	0.524						
5	272	3.47	2829	0.447	0.403	0.258	0.522						
6	267	3.44	2658	0.468	0.419	0.264	0.532						
7	270	3.49	2763	0.455	0.409	0.260	0.526						
8	265	3.47	2660	0.467	0.417	0.264	0.531						
9	269	3.45	2836	0.447	0.404	0.257	0.523						
10	271	3.48	2771	0.454	0.408	0.260	0.525						
11	272	3.44	2864	0.445	0.403	0.256	0.522						
12	270	3.51	2848	0.447	0.405	0.257	0.523						
13	268	3.46	2731	0.458	0.412	0.261	0.527						
14	262	3.41	2596	0.473	0.419	0.267	0.533						
15	262	3.44	2629	0.470	0.420	0.265	0.532						
16	265	3.44	2657	0.467	0.418	0.264	0.531						
17	264	3.49	2590	0.474	0.421	0.267	0.533						
18	269	3.45	2701	0.462	0.415	0.262	0.529						
19	271	3.53	2791	0.453	0.409	0.259	0.526						
20	272	3.45	2771	0.456	0.412	0.259	0.527						
21	265	3.50	2669	0.464	0.414	0.264	0.529						
22	270	3.46	2719	0.461	0.415	0.261	0.529						
23	264	3.43	2644	0.468	0.418	0.265	0.532						
24	270	3.43	2756	0.457	0.412	0.260	0.527						
n	24	24	24	24	24	24	24						
Avg.	268	3.46	2737	0.458	0.412	0.261	0.527						
Med.	269	3.46	2760	0.456	0.412	0.260	0.527						
σ	3.4	0.032	83.6	0.0090	0.0058	0.0033	0.0035						
Min.	262	3.40	2590	0.445	0.403	0.256	0.522						
Max.	273	3.53	2864	0.474	0.421	0.267	0.533						

Data Set 6 : 105°C, 1000 mA

Actual Case Temperature [T _s]	110.8 °C
Actual Ambient Temperature [T _A]	106.6 °C
Drive Current [I _F]	1000 mA
Measurement Current	1000 mA

NOTES:
T_s and T_A were measured during initial setup.

TABLE 6-2
Lumen Maintenance

LED No.	Lumen Maintenance % (Normalized to 100% at 0 hours)														
	0 h	513 h	1008 h	1745 h	2411 h	3098 h	3811 h	4498 h	5282 h	6067 h	6781 h	7615 h	8449 h	9235 h	10089 h
1	100.0	98.2	97.8	97.1	96.5	96.3	96.4	95.8	95.6	95.7	95.6	95.4	95.1	95.0	94.6
2	100.0	97.8	97.5	96.8	96.2	95.7	95.9	95.3	95.0	90.8	90.8	90.5	90.2	90.1	89.7
3	100.0	97.9	97.5	97.0	96.3	95.7	95.9	95.5	95.2	95.1	94.9	94.8	94.3	94.2	93.8
4	100.0	97.6	97.0	96.5	95.6	95.5	95.6	95.1	95.1	94.9	94.5	94.5	94.1	94.0	93.7
5	100.0	97.6	97.0	96.3	95.6	95.8	95.9	95.5	95.6	95.3	94.8	94.9	94.4	94.5	94.1
6	100.0	97.6	96.9	96.1	95.5	95.6	95.6	95.1	95.0	94.8	94.5	94.4	94.1	94.0	93.6
7	100.0	97.2	96.6	95.5	95.3	95.3	95.0	94.5	94.0	94.0	93.7	93.4	93.1	93.1	92.7
8	100.0	97.8	97.3	96.2	96.1	95.7	95.5	95.0	95.1	94.8	94.6	94.6	94.2	94.2	93.7
9	100.0	98.1	97.5	96.5	96.3	95.9	95.9	95.4	95.4	95.1	94.9	94.9	94.5	94.4	94.0
10	100.0	97.4	96.9	96.0	95.5	95.4	95.6	95.2	95.1	94.6	94.5	94.4	94.0	94.0	93.5
11	100.0	96.9	96.3	95.4	94.7	94.9	95.2	94.8	94.6	94.3	93.9	93.7	93.2	93.2	92.8
12	100.0	97.4	96.6	95.7	95.3	95.4	95.4	95.0	94.8	94.6	94.2	94.1	93.7	93.7	93.3
13	100.0	97.4	97.0	96.0	95.7	95.6	95.5	94.9	94.9	94.6	94.5	94.4	93.9	93.9	93.5
14	100.0	96.7	96.3	95.1	95.0	94.5	94.6	94.1	94.2	93.9	93.8	93.7	93.4	93.4	92.9
15	100.0	97.1	96.5	95.4	95.2	94.8	94.8	93.9	94.4	94.2	94.0	94.0	93.6	93.6	93.2
16	100.0	96.6	95.7	94.8	94.4	94.5	94.5	94.2	94.1	93.8	93.6	93.5	93.1	93.1	92.7
17	100.0	97.0	95.9	95.1	94.3	94.8	94.7	94.3	94.0	93.8	93.3	93.2	92.7	92.7	92.2
18	100.0	97.7	96.9	96.1	95.6	95.9	95.5	94.8	94.8	94.5	94.2	94.0	93.6	93.7	93.1
19	100.0	97.1	96.5	95.4	95.1	95.0	95.0	94.4	94.3	94.0	93.9	93.7	93.3	93.3	92.9
20	100.0	97.5	97.2	96.2	96.1	95.7	95.9	95.4	95.4	95.0	94.9	94.8	94.5	94.4	94.0
21	100.0	97.1	96.5	95.5	95.2	94.7	94.8	94.3	94.2	93.8	93.6	93.5	93.1	93.0	92.6
22	100.0	97.0	96.5	95.6	95.3	95.4	95.5	95.0	94.9	94.7	94.5	94.4	93.9	93.9	93.6
23	100.0	96.9	96.4	95.4	94.8	95.5	95.5	95.0	95.0	95.0	94.6	94.6	94.1	94.3	93.8
24	100.0	97.2	96.6	95.7	95.3	95.7	95.7	95.2	95.2	95.1	94.9	94.8	94.5	94.5	94.1
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	97.4	96.8	95.9	95.5	95.4	95.4	94.9	94.8	94.4	94.2	94.1	93.7	93.7	93.3
Med.	100.0	97.4	96.7	95.8	95.4	95.5	95.5	95.0	94.9	94.6	94.5	94.4	93.9	93.9	93.5
σ	0.00	0.43	0.52	0.61	0.59	0.49	0.49	0.51	0.50	0.94	0.91	0.96	0.95	0.95	0.96
Min.	100.0	96.6	95.7	94.8	94.3	94.5	94.5	93.9	94.0	90.8	90.8	90.5	90.2	90.1	89.7
Max.	100.0	98.2	97.8	97.1	96.5	96.3	96.4	95.8	95.6	95.7	95.6	95.4	95.1	95.0	94.6

TM-21 Projection

Time	4498 h	5282 h	6067 h	6781 h	7615 h	8449 h	9235 h	10089 h							
ln(Avg.)	-0.0523	-0.0531	-0.0573	-0.0597	-0.0609	-0.0652	-0.0653	-0.0699							

Test duration used	4498 h	to	10089 h
B	0.9628		
α	3.1179E-06		
R ²	0.9770		
Calculated L ₇₀ (10K)	102000	hours	
Reported L ₇₀ (10K)	> 60500	hours	

Curve-fit equation:
 $\Phi(t) = B \exp(-\alpha t)$

Lumen maintenance life equation:
 $L_{70} = \ln(B/0.7) / \alpha$

Data Set 6 : 105°C, 1000 mA

Actual Case Temperature [T _s]	110.8 °C
Actual Ambient Temperature [T _A]	106.6 °C
Drive Current [I _F]	1000 mA
Measurement Current	1000 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 6-3
Forward Voltage

LED No.	Relative Forward Voltage % (Normalized to 100% at 0 hours)														
	0 h	513 h	1008 h	1745 h	2411 h	3098 h	3811 h	4498 h	5282 h	6067 h	6781 h	7615 h	8449 h	9235 h	10089 h
1	100.0	97.6	97.7	98.0	97.8	97.9	98.1	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0
2	100.0	97.3	97.5	97.7	97.6	97.7	97.8	97.7	97.7	97.8	97.7	97.8	97.8	97.8	97.8
3	100.0	97.2	97.4	97.7	97.5	97.6	97.7	97.7	97.7	97.7	97.7	97.7	97.7	97.7	97.7
4	100.0	97.7	98.0	98.3	98.0	98.2	98.3	98.2	98.2	98.2	98.2	98.3	98.2	98.3	98.3
5	100.0	96.1	96.2	96.4	96.2	96.3	96.5	96.4	96.4	96.4	96.4	96.5	96.4	96.4	96.5
6	100.0	97.6	97.8	98.1	97.9	98.0	98.2	98.0	98.1	98.1	98.1	98.2	98.1	98.1	98.1
7	100.0	97.2	97.4	97.4	97.4	97.7	97.8	97.8	98.7	98.4	98.7	98.7	98.7	98.7	98.7
8	100.0	97.0	97.1	97.2	97.1	97.4	97.4	97.4	97.4	97.4	97.4	97.5	97.4	97.5	97.5
9	100.0	96.0	96.1	96.1	96.1	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3
10	100.0	97.9	98.2	98.2	98.2	98.4	98.5	98.4	98.5	98.4	98.5	98.5	98.5	98.5	98.5
11	100.0	98.3	98.8	98.8	98.8	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.0	99.1	99.1
12	100.0	95.7	95.8	95.8	95.8	96.0	96.0	96.0	96.0	96.0	96.1	96.1	96.0	96.1	96.1
13	100.0	98.2	98.6	98.8	99.1	99.8	99.9	99.8	99.9	99.9	99.9	99.9	99.9	99.9	99.9
14	100.0	99.1	99.3	99.2	99.2	99.4	99.4	99.4	99.3	99.4	99.3	99.3	99.3	99.3	99.3
15	100.0	99.1	99.2	99.2	99.1	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.2	99.2	99.3
16	100.0	99.7	99.9	99.9	99.7	99.9	100.0	99.9	99.9	99.9	99.9	99.9	99.8	99.9	99.8
17	100.0	98.2	98.8	98.8	98.8	99.1	99.2	99.2	99.2	99.2	99.3	99.3	99.3	99.3	99.3
18	100.0	97.1	97.3	97.3	97.3	97.6	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.5	98.5
19	100.0	96.6	96.8	96.8	96.8	97.0	97.1	97.1	97.1	97.1	97.1	97.1	97.1	97.2	97.2
20	100.0	99.2	99.3	99.3	99.3	99.5	99.5	99.5	99.4	99.5	99.4	99.4	99.3	99.4	99.4
21	100.0	97.1	97.3	97.4	97.4	97.6	97.7	97.7	97.7	97.7	97.7	97.8	97.7	97.8	97.8
22	100.0	99.4	99.6	99.6	99.6	99.8	99.9	99.8	100.1	100.4	100.4	100.4	100.3	100.4	100.4
23	100.0	99.6	99.8	99.8	99.8	100.1	100.2	100.1	100.1	100.1	100.0	100.0	100.0	100.0	100.0
24	100.0	99.1	99.2	99.2	99.2	99.4	99.4	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	97.8	98.0	98.1	98.1	98.3	98.4	98.3	98.4	98.4	98.4	98.5	98.4	98.4	98.4
Med.	100.0	97.7	97.9	98.2	98.0	98.1	98.3	98.3	98.4	98.4	98.4	98.5	98.4	98.5	98.5
σ	0.00	1.16	1.20	1.18	1.19	1.23	1.20	1.20	1.21	1.22	1.22	1.20	1.20	1.20	1.19
Min.	100.0	95.7	95.8	95.8	95.8	96.0	96.0	96.0	96.0	96.0	96.1	96.1	96.0	96.1	96.1
Max.	100.0	99.7	99.9	99.9	99.8	100.1	100.2	100.1	100.1	100.4	100.4	100.4	100.3	100.4	100.4

Data Set 6 : 105°C, 1000 mA

Actual Case Temperature [T _s]	110.8 °C
Actual Ambient Temperature [T _A]	106.6 °C
Drive Current [I _F]	1000 mA
Measurement Current	1000 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 6-4
Chromaticity Shift

LED No.	Chromaticity Shift Δu'v'														
	0 h	513 h	1008 h	1745 h	2411 h	3098 h	3811 h	4498 h	5282 h	6067 h	6781 h	7615 h	8449 h	9235 h	10089 h
1	0.0000	0.0023	0.0025	0.0027	0.0026	0.0028	0.0029	0.0029	0.0030	0.0030	0.0031	0.0033	0.0033	0.0034	0.0036
2	0.0000	0.0019	0.0021	0.0024	0.0024	0.0026	0.0027	0.0028	0.0031	0.0033	0.0035	0.0037	0.0040	0.0042	0.0044
3	0.0000	0.0020	0.0022	0.0024	0.0024	0.0025	0.0027	0.0028	0.0030	0.0031	0.0032	0.0036	0.0037	0.0039	0.0041
4	0.0000	0.0022	0.0024	0.0026	0.0025	0.0027	0.0028	0.0029	0.0032	0.0033	0.0034	0.0036	0.0038	0.0039	0.0042
5	0.0000	0.0020	0.0021	0.0025	0.0025	0.0026	0.0027	0.0028	0.0030	0.0032	0.0033	0.0036	0.0037	0.0039	0.0042
6	0.0000	0.0019	0.0021	0.0024	0.0023	0.0023	0.0026	0.0025	0.0026	0.0028	0.0028	0.0030	0.0031	0.0031	0.0033
7	0.0000	0.0021	0.0022	0.0024	0.0025	0.0027	0.0028	0.0029	0.0030	0.0031	0.0033	0.0036	0.0038	0.0039	0.0040
8	0.0000	0.0022	0.0025	0.0026	0.0026	0.0028	0.0028	0.0028	0.0029	0.0030	0.0031	0.0033	0.0033	0.0034	0.0035
9	0.0000	0.0020	0.0022	0.0023	0.0023	0.0025	0.0026	0.0027	0.0028	0.0029	0.0031	0.0033	0.0035	0.0037	0.0039
10	0.0000	0.0021	0.0022	0.0024	0.0023	0.0025	0.0027	0.0028	0.0030	0.0031	0.0033	0.0035	0.0037	0.0039	0.0041
11	0.0000	0.0020	0.0023	0.0024	0.0025	0.0027	0.0030	0.0030	0.0033	0.0034	0.0037	0.0038	0.0040	0.0043	0.0045
12	0.0000	0.0019	0.0020	0.0022	0.0024	0.0026	0.0028	0.0029	0.0031	0.0033	0.0036	0.0037	0.0040	0.0042	0.0044
13	0.0000	0.0022	0.0024	0.0024	0.0025	0.0027	0.0028	0.0027	0.0029	0.0030	0.0031	0.0033	0.0034	0.0036	0.0039
14	0.0000	0.0021	0.0023	0.0024	0.0025	0.0027	0.0027	0.0027	0.0028	0.0028	0.0029	0.0030	0.0030	0.0031	0.0033
15	0.0000	0.0022	0.0024	0.0025	0.0024	0.0026	0.0027	0.0026	0.0027	0.0028	0.0028	0.0030	0.0030	0.0032	0.0033
16	0.0000	0.0021	0.0023	0.0024	0.0023	0.0025	0.0026	0.0026	0.0027	0.0028	0.0029	0.0031	0.0031	0.0032	0.0034
17	0.0000	0.0020	0.0021	0.0022	0.0023	0.0025	0.0025	0.0026	0.0026	0.0028	0.0028	0.0030	0.0031	0.0032	0.0034
18	0.0000	0.0021	0.0023	0.0025	0.0025	0.0027	0.0027	0.0026	0.0028	0.0030	0.0031	0.0033	0.0034	0.0036	0.0038
19	0.0000	0.0020	0.0023	0.0024	0.0025	0.0027	0.0028	0.0029	0.0030	0.0032	0.0033	0.0036	0.0036	0.0038	0.0040
20	0.0000	0.0021	0.0023	0.0025	0.0025	0.0026	0.0027	0.0027	0.0029	0.0030	0.0030	0.0033	0.0034	0.0036	0.0037
21	0.0000	0.0021	0.0024	0.0024	0.0024	0.0026	0.0027	0.0028	0.0030	0.0031	0.0032	0.0034	0.0035	0.0038	0.0039
22	0.0000	0.0020	0.0022	0.0024	0.0023	0.0025	0.0026	0.0027	0.0028	0.0029	0.0030	0.0032	0.0033	0.0035	0.0035
23	0.0000	0.0022	0.0024	0.0025	0.0026	0.0028	0.0028	0.0029	0.0029	0.0029	0.0030	0.0031	0.0032	0.0033	0.0033
24	0.0000	0.0019	0.0022	0.0023	0.0023	0.0025	0.0026	0.0028	0.0029	0.0030	0.0030	0.0033	0.0034	0.0035	0.0036
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	0.0000	0.0021	0.0023	0.0024	0.0024	0.0026	0.0027	0.0028	0.0029	0.0030	0.0032	0.0033	0.0035	0.0036	0.0038
Med.	0.0000	0.0021	0.0023	0.0024	0.0024	0.0026	0.0027	0.0028	0.0029	0.0030	0.0031	0.0033	0.0034	0.0036	0.0038
σ	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0002	0.0002	0.0003	0.0003	0.0004	0.0004
Min.	0.0000	0.0019	0.0020	0.0022	0.0023	0.0023	0.0025	0.0025	0.0026	0.0028	0.0028	0.0030	0.0030	0.0031	0.0033
Max.	0.0000	0.0023	0.0025	0.0027	0.0026	0.0028	0.0030	0.0030	0.0033	0.0034	0.0037	0.0038	0.0040	0.0043	0.0045