

LM-80 Test Report

NVSL219B

Issue Date:	December 21, 2011	Revision Date:	October 17, 2012
Test Initiation Date:	August 4, 2011	Test Completion Date:	October 5, 2012
Test Duration:	10,000 hours	Report Number:	SQETMLH17005

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: NVSL219B (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	99.3%	0.0022	> 60100 hours
2	55°C	> 50°C	1200 mA	97.9%	0.0025	> 60100 hours
3	85°C	> 80°C	700 mA	97.5%	0.0025	> 60000 hours
4	85°C	> 80°C	1200 mA	94.8%	0.0031	> 60000 hours
5	105°C	> 100°C	700 mA	95.5%	0.0027	> 60100 hours
6	105°C	> 100°C	1000 mA	93.7%	0.0035	> 60100 hours

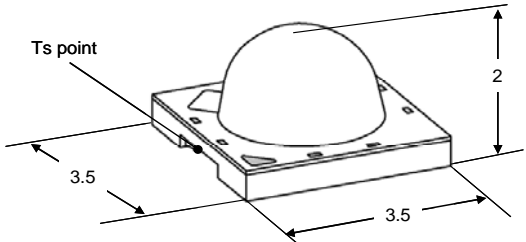
Approved Signatory:



 Hitoshi TOHYAMA, Lab Manager

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

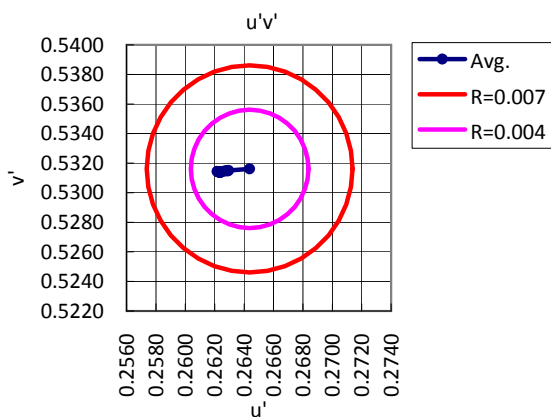
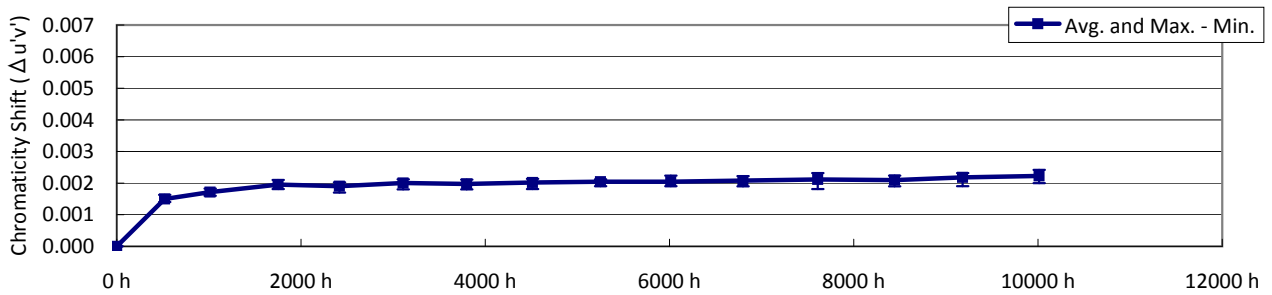
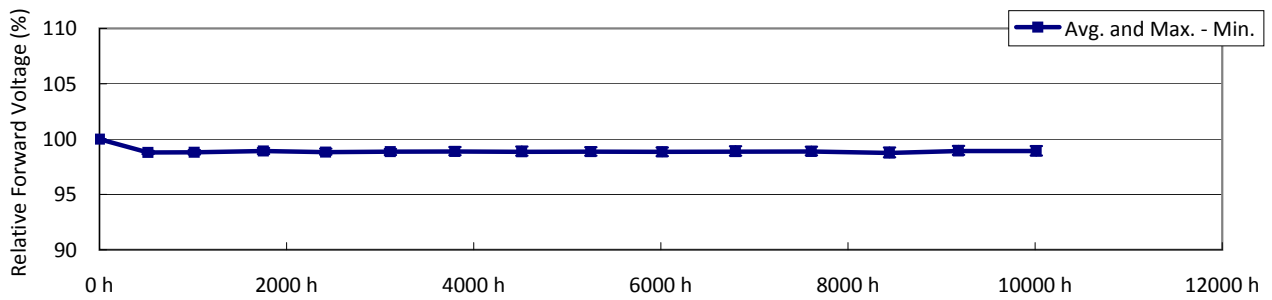
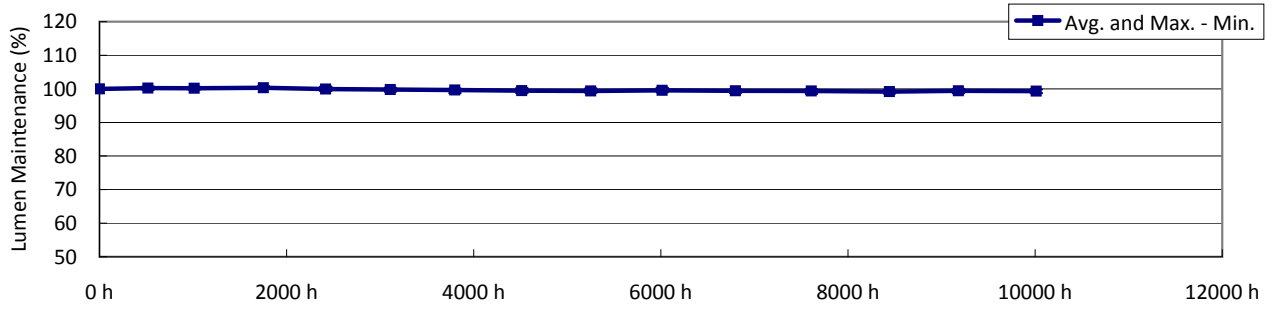
IES LM-80-08 Test Report Requirement :

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]	57.0 °C
Actual Ambient Temperature [T_A]	56.5 °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]	57.0 °C
Actual Ambient Temperature [T _A]	56.5 °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	195	3.22	2614	0.472	0.420	0.266	0.533						
2	195	3.25	2605	0.473	0.422	0.266	0.534						
3	192	3.27	2578	0.476	0.422	0.267	0.534						
4	191	3.25	2620	0.472	0.421	0.265	0.533						
5	189	3.25	2533	0.481	0.424	0.270	0.536						
6	197	3.24	2657	0.467	0.418	0.264	0.531						
7	197	3.25	2678	0.465	0.418	0.263	0.531						
8	194	3.28	2662	0.466	0.417	0.264	0.531						
9	196	3.32	2694	0.463	0.416	0.262	0.530						
10	197	3.28	2649	0.468	0.418	0.264	0.531						
11	196	3.24	2706	0.462	0.415	0.262	0.529						
12	199	3.22	2669	0.466	0.417	0.263	0.531						
13	197	3.24	2639	0.469	0.418	0.265	0.532						
14	194	3.23	2637	0.469	0.419	0.265	0.532						
15	192	3.21	2617	0.473	0.423	0.265	0.534						
16	198	3.27	2679	0.464	0.415	0.263	0.530						
17	196	3.25	2671	0.465	0.417	0.263	0.530						
18	195	3.26	2676	0.465	0.416	0.263	0.530						
19	198	3.26	2691	0.464	0.417	0.262	0.530						
20	196	3.25	2615	0.472	0.421	0.266	0.533						
21	195	3.22	2675	0.466	0.419	0.263	0.531						
22	195	3.27	2645	0.467	0.416	0.265	0.531						
23	197	3.30	2718	0.462	0.416	0.261	0.530						
24	196	3.24	2593	0.474	0.421	0.267	0.533						
n	24	24	24	24	24	24	24						
Avg.	195	3.25	2647	0.468	0.419	0.264	0.532						
Med.	196	3.25	2653	0.467	0.418	0.264	0.531						
σ	2.3	0.026	43.8	0.0048	0.0026	0.0020	0.0016						
Min.	189	3.21	2533	0.462	0.415	0.261	0.529						
Max.	199	3.32	2718	0.481	0.424	0.270	0.536						

Data Set 1 : 55°C, 700 mA

Actual Case Temperature [T _s]	57.0 °C
Actual Ambient Temperature [T _A]	56.5 °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	519 h	1013 h	1752 h	2417 h	3109 h	3798 h	4513 h	5251 h	6014 h	6797 h	7609 h	8443 h	9181 h	10012 h
1	100.0	100.3	100.4	100.5	99.8	100.2	99.9	99.9	99.8	99.9	99.6	99.7	99.4	99.7	99.6
2	100.0	100.2	100.1	100.3	100.0	100.1	100.0	99.4	99.5	99.7	99.6	99.5	99.3	99.6	99.4
3	100.0	100.6	100.2	100.6	100.5	100.0	100.1	99.4	99.4	99.7	99.5	99.6	99.3	99.5	99.4
4	100.0	100.7	100.5	100.6	100.3	99.7	99.8	99.3	99.3	99.5	99.3	99.4	99.1	99.3	99.1
5	100.0	100.4	100.3	100.4	99.7	99.4	99.3	99.1	99.1	99.3	99.1	99.1	98.8	98.7	98.9
6	100.0	100.3	100.3	100.4	99.6	99.9	99.7	99.7	99.6	99.7	99.3	99.4	99.1	99.4	99.2
7	100.0	100.0	100.0	100.2	99.5	99.7	99.6	99.4	99.3	99.0	99.3	99.2	98.9	99.2	99.1
8	100.0	100.1	100.0	100.3	99.9	100.0	99.7	99.3	99.3	99.5	99.5	99.5	99.3	99.6	99.4
9	100.0	100.6	100.6	100.8	100.7	100.1	100.0	99.8	99.7	99.8	99.8	99.9	99.6	99.9	99.7
10	100.0	100.3	100.2	100.3	100.0	99.5	99.4	99.2	99.1	99.2	99.2	98.5	99.0	99.3	99.1
11	100.0	100.3	100.2	100.1	99.6	99.2	99.2	99.2	99.1	99.2	99.0	99.0	98.8	99.1	98.9
12	100.0	100.6	100.5	100.7	100.1	100.3	100.1	100.2	100.1	100.3	99.8	99.9	99.5	99.8	99.7
13	100.0	100.1	100.1	100.3	99.7	99.9	99.9	99.7	99.5	99.6	99.5	99.4	99.2	99.5	99.3
14	100.0	99.7	100.4	100.5	100.3	100.2	100.0	99.7	99.5	99.7	99.8	99.5	99.6	100.0	99.9
15	100.0	99.7	100.4	100.4	100.4	99.9	99.7	99.5	99.4	99.5	99.6	99.7	99.4	99.6	99.5
16	100.0	100.1	100.1	100.2	100.0	99.7	98.7	99.3	99.1	99.4	99.4	99.4	99.1	99.0	99.1
17	100.0	99.8	99.7	100.0	99.5	99.2	99.1	99.0	98.9	99.0	98.8	98.8	98.6	98.7	98.7
18	100.0	100.2	100.1	100.3	99.7	99.9	100.0	99.9	99.2	99.1	99.5	99.2	99.2	99.5	99.4
19	100.0	100.1	100.0	100.1	99.6	99.8	99.9	99.6	99.5	99.7	99.5	99.4	99.2	99.5	99.4
20	100.0	100.1	100.1	100.0	99.9	99.9	99.7	99.4	99.3	99.6	99.5	99.5	99.3	99.6	99.4
21	100.0	100.1	100.4	100.4	100.3	100.0	99.8	99.5	99.5	99.7	99.6	99.6	99.5	99.6	99.6
22	100.0	100.1	100.0	100.1	99.9	99.3	99.2	98.8	99.1	99.3	99.2	99.2	98.9	99.0	99.0
23	100.0	100.1	100.0	100.1	99.8	99.4	99.3	99.2	99.2	99.5	99.2	99.2	98.9	99.2	99.0
24	100.0	100.3	100.1	100.2	99.4	99.8	99.9	99.7	99.7	99.8	99.5	99.5	99.3	99.6	99.4
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	100.2	100.2	100.3	99.9	99.8	99.7	99.5	99.4	99.5	99.4	99.4	99.2	99.4	99.3
Med.	100.0	100.2	100.2	100.3	99.9	99.9	99.7	99.4	99.4	99.6	99.5	99.4	99.2	99.5	99.4
σ	0.00	0.27	0.21	0.21	0.34	0.32	0.36	0.32	0.28	0.32	0.25	0.32	0.27	0.34	0.29
Min.	100.0	99.7	99.7	100.0	99.4	99.2	98.7	98.8	98.9	99.0	98.8	98.5	98.6	98.7	98.7
Max.	100.0	100.7	100.6	100.8	100.7	100.3	100.1	100.2	100.1	100.3	99.8	99.9	99.6	100.0	99.9

TM-21 Projection

Time	4513 h	5251 h	6014 h	6797 h	7609 h	8443 h	9181 h	10012 h							
ln(Avg.)	-0.0053	-0.0063	-0.0046	-0.0058	-0.0062	-0.0083	-0.0059	-0.0070							

Test duration used	4513 h	to	10012 h
B	0.9962		
α	3.2532E-07		
R ²	0.3325		
Calculated L ₇₀ (10K)	1080000	hours	
Reported L ₇₀ (10K)	> 60100	hours	

Curve-fit equation:

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

Lumen maintenance life equation:

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

Data Set 1 : 55°C, 700 mA

Actual Case Temperature [T _s]	57.0 °C
Actual Ambient Temperature [T _A]	56.5 °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	519 h	1013 h	1752 h	2417 h	3109 h	3798 h	4513 h	5251 h	6014 h	6797 h	7609 h	8443 h	9181 h	10012 h
1	100.0	98.8	98.7	98.8	98.6	98.7	98.7	98.6	98.7	98.6	98.7	98.7	98.6	98.7	98.7
2	100.0	98.8	98.7	98.9	98.7	98.8	98.8	98.8	98.8	98.8	98.8	98.8	98.7	98.9	98.9
3	100.0	98.7	98.8	98.9	98.8	98.9	98.9	98.8	98.9	98.9	98.9	98.9	98.7	98.9	98.9
4	100.0	98.9	99.0	99.1	99.0	99.1	99.1	99.0	99.0	99.0	99.0	99.1	98.9	99.1	99.1
5	100.0	98.8	98.9	98.9	98.8	98.9	98.9	98.8	98.8	98.8	98.8	98.9	98.7	98.9	98.9
6	100.0	98.8	98.9	98.9	98.8	98.8	98.8	98.8	98.9	98.8	98.9	98.9	98.7	98.9	98.9
7	100.0	98.9	99.0	99.2	99.0	99.1	99.1	99.1	99.1	99.1	99.1	99.2	99.0	99.2	99.2
8	100.0	98.7	98.7	98.8	98.6	98.7	98.6	98.6	98.6	98.6	98.6	98.7	98.5	98.7	98.7
9	100.0	98.7	98.6	98.7	98.6	98.6	98.5	98.5	98.5	98.5	98.5	98.5	98.4	98.6	98.5
10	100.0	98.8	98.8	98.9	98.8	98.8	98.9	98.9	98.9	98.8	98.8	98.9	98.7	98.9	98.9
11	100.0	98.7	98.7	99.2	99.1	99.1	99.1	99.1	99.1	99.1	99.0	99.1	98.9	99.1	99.1
12	100.0	98.9	98.8	98.9	98.8	98.8	98.8	98.8	98.8	98.8	98.8	98.8	98.6	98.9	98.8
13	100.0	98.8	98.8	98.9	98.8	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.8	99.0	99.0
14	100.0	98.8	98.8	98.8	98.8	98.8	98.8	98.8	98.8	98.8	98.8	98.8	98.7	98.8	98.8
15	100.0	98.9	98.8	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.8	99.0	99.0
16	100.0	98.8	98.8	98.9	98.8	98.9	98.9	98.8	98.9	98.9	98.9	98.9	98.8	98.9	98.9
17	100.0	98.8	99.0	99.1	98.9	99.0	99.3	99.3	99.3	99.2	99.4	99.3	99.2	99.4	99.4
18	100.0	98.7	98.6	98.7	98.6	98.6	98.6	98.6	98.6	98.6	98.6	98.6	98.5	98.7	98.7
19	100.0	98.8	98.8	98.9	98.8	98.8	98.8	98.8	98.9	98.9	98.9	98.9	98.8	98.9	99.0
20	100.0	98.8	98.9	99.0	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.8	99.0	99.0
21	100.0	98.9	98.9	98.9	98.8	98.9	98.9	98.8	98.8	98.9	98.9	98.8	98.7	98.9	98.9
22	100.0	98.7	98.7	98.8	98.7	98.8	98.8	98.8	98.8	98.8	98.8	98.8	98.7	98.8	98.9
23	100.0	98.9	98.9	99.1	99.0	99.0	99.1	99.0	99.0	99.1	99.1	99.0	98.9	99.1	99.1
24	100.0	98.8	98.8	98.9	98.8	98.9	98.9	98.9	98.8	98.9	98.9	98.9	98.8	99.0	99.0
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	98.8	98.8	98.9	98.8	98.9	98.9	98.8	98.9	98.8	98.9	98.9	98.7	98.9	98.9
Med.	100.0	98.8	98.8	98.9	98.8	98.9	98.9	98.8	98.9	98.9	98.9	98.9	98.7	98.9	98.9
σ	0.00	0.08	0.10	0.13	0.13	0.14	0.17	0.17	0.18	0.17	0.18	0.17	0.18	0.18	0.18
Min.	100.0	98.7	98.6	98.7	98.6	98.6	98.5	98.5	98.5	98.5	98.5	98.5	98.4	98.6	98.5
Max.	100.0	98.9	99.0	99.2	99.1	99.1	99.3	99.3	99.3	99.2	99.4	99.3	99.2	99.4	99.4

Data Set 1 : 55°C, 700 mA

Actual Case Temperature [T _s]	57.0 °C
Actual Ambient Temperature [T _A]	56.5 °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

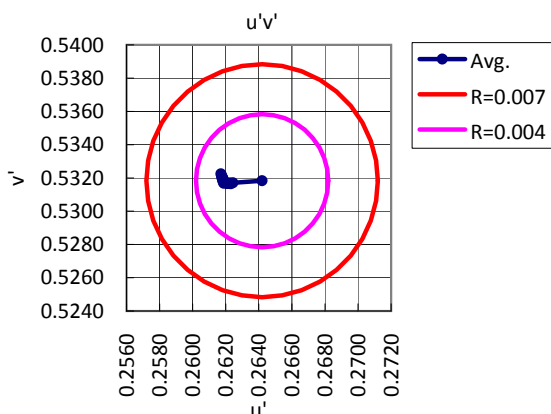
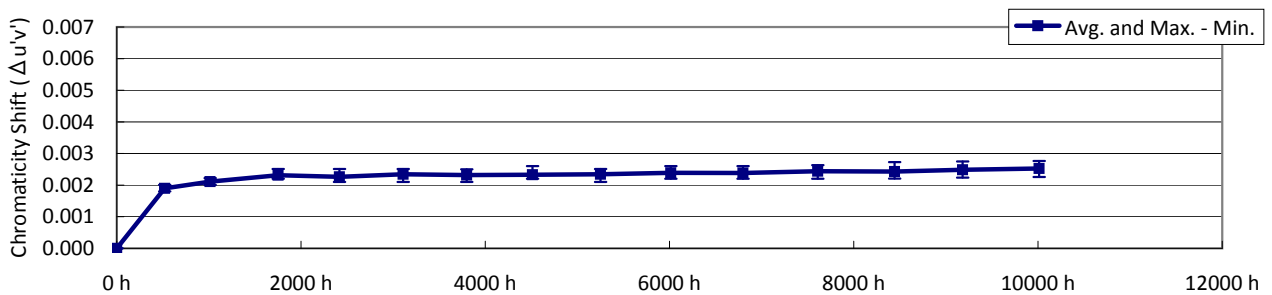
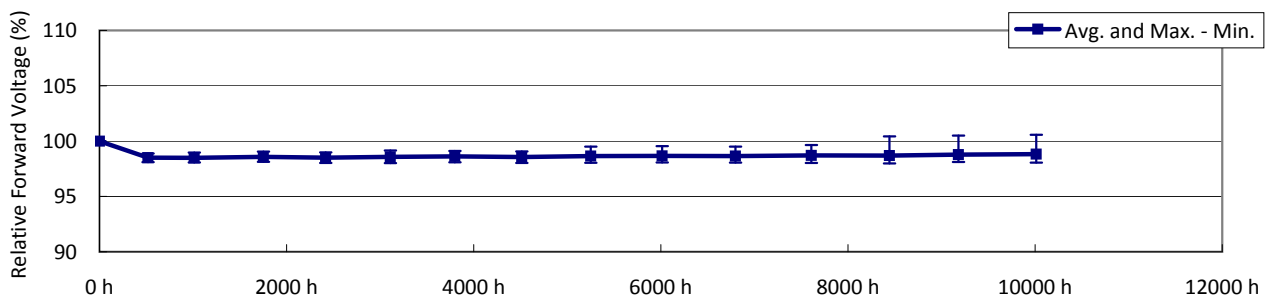
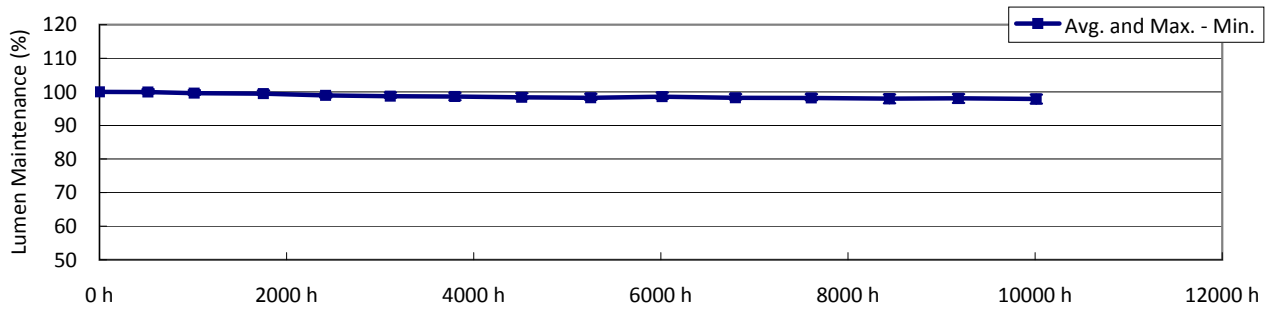
LED No.	Chromaticity Shift Δu'v'														
	0 h	519 h	1013 h	1752 h	2417 h	3109 h	3798 h	4513 h	5251 h	6014 h	6797 h	7609 h	8443 h	9181 h	10012 h
1	0.0000	0.0014	0.0016	0.0019	0.0018	0.0020	0.0020	0.0020	0.0021	0.0020	0.0021	0.0021	0.0021	0.0022	0.0022
2	0.0000	0.0014	0.0016	0.0019	0.0019	0.0020	0.0019	0.0019	0.0020	0.0020	0.0020	0.0021	0.0020	0.0022	0.0021
3	0.0000	0.0016	0.0018	0.0020	0.0020	0.0020	0.0019	0.0021	0.0021	0.0021	0.0021	0.0022	0.0022	0.0023	0.0023
4	0.0000	0.0016	0.0018	0.0020	0.0019	0.0021	0.0020	0.0021	0.0021	0.0021	0.0021	0.0022	0.0022	0.0022	0.0023
5	0.0000	0.0015	0.0017	0.0019	0.0017	0.0018	0.0018	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0020	0.0020
6	0.0000	0.0015	0.0017	0.0019	0.0019	0.0019	0.0020	0.0020	0.0020	0.0020	0.0020	0.0021	0.0020	0.0021	0.0022
7	0.0000	0.0015	0.0017	0.0019	0.0019	0.0020	0.0020	0.0020	0.0020	0.0019	0.0021	0.0021	0.0020	0.0021	0.0022
8	0.0000	0.0015	0.0017	0.0019	0.0019	0.0020	0.0020	0.0020	0.0020	0.0020	0.0021	0.0021	0.0021	0.0022	0.0022
9	0.0000	0.0016	0.0018	0.0020	0.0020	0.0021	0.0020	0.0021	0.0021	0.0022	0.0022	0.0022	0.0022	0.0023	0.0023
10	0.0000	0.0015	0.0017	0.0019	0.0019	0.0020	0.0020	0.0020	0.0020	0.0020	0.0021	0.0020	0.0021	0.0022	0.0022
11	0.0000	0.0015	0.0017	0.0019	0.0018	0.0019	0.0019	0.0019	0.0020	0.0019	0.0019	0.0020	0.0019	0.0020	0.0021
12	0.0000	0.0015	0.0017	0.0019	0.0019	0.0020	0.0019	0.0020	0.0020	0.0020	0.0021	0.0021	0.0021	0.0022	0.0022
13	0.0000	0.0014	0.0017	0.0020	0.0019	0.0021	0.0020	0.0020	0.0021	0.0021	0.0021	0.0021	0.0021	0.0022	0.0022
14	0.0000	0.0014	0.0017	0.0020	0.0019	0.0020	0.0020	0.0020	0.0020	0.0021	0.0021	0.0022	0.0022	0.0022	0.0023
15	0.0000	0.0015	0.0018	0.0020	0.0020	0.0021	0.0021	0.0021	0.0021	0.0021	0.0022	0.0023	0.0022	0.0023	0.0023
16	0.0000	0.0015	0.0017	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0021	0.0021	0.0022	0.0021	0.0022	0.0022
17	0.0000	0.0014	0.0016	0.0018	0.0018	0.0018	0.0018	0.0018	0.0019	0.0019	0.0019	0.0018	0.0019	0.0019	0.0020
18	0.0000	0.0015	0.0017	0.0019	0.0018	0.0020	0.0019	0.0020	0.0020	0.0019	0.0020	0.0020	0.0020	0.0021	0.0022
19	0.0000	0.0014	0.0016	0.0019	0.0018	0.0019	0.0019	0.0019	0.0020	0.0019	0.0020	0.0020	0.0020	0.0021	0.0022
20	0.0000	0.0015	0.0018	0.0019	0.0020	0.0021	0.0021	0.0021	0.0021	0.0022	0.0022	0.0023	0.0022	0.0023	0.0024
21	0.0000	0.0015	0.0018	0.0020	0.0020	0.0021	0.0021	0.0021	0.0021	0.0021	0.0022	0.0022	0.0022	0.0023	0.0024
22	0.0000	0.0015	0.0017	0.0020	0.0019	0.0020	0.0020	0.0020	0.0021	0.0021	0.0021	0.0022	0.0021	0.0022	0.0023
23	0.0000	0.0015	0.0017	0.0019	0.0018	0.0019	0.0019	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0021	0.0021
24	0.0000	0.0015	0.0017	0.0020	0.0019	0.0020	0.0020	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0022	0.0023
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	0.0000	0.0015	0.0017	0.0020	0.0019	0.0020	0.0020	0.0020	0.0020	0.0020	0.0021	0.0021	0.0021	0.0022	0.0022
Med.	0.0000	0.0015	0.0017	0.0019	0.0019	0.0020	0.0020	0.0020	0.0020	0.0020	0.0021	0.0021	0.0021	0.0022	0.0022
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	0.0017	0.0018	0.0018	0.0018	0.0019	0.0019	0.0019	0.0018	0.0019	0.0019	0.0020
Max.	0.0000	0.0016	0.0018	0.0021	0.0020	0.0021	0.0021	0.0021	0.0021	0.0022	0.0022	0.0023	0.0022	0.0023	0.0024

Data Set 2 : 55°C, 1200 mA

Actual Case Temperature [T_S]	62.1 °C
Actual Ambient Temperature [T_A]	61.5 °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]	62.1 °C
Actual Ambient Temperature [T _A]	61.5 °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	306	3.48	2626	0.471	0.421	0.265	0.533						
2	298	3.57	2538	0.480	0.424	0.269	0.535						
3	310	3.50	2634	0.470	0.420	0.265	0.532						
4	308	3.56	2692	0.464	0.418	0.262	0.531						
5	313	3.49	2702	0.463	0.416	0.262	0.530						
6	308	3.50	2719	0.463	0.419	0.261	0.531						
7	315	3.48	2680	0.465	0.418	0.263	0.531						
8	310	3.48	2681	0.464	0.416	0.263	0.530						
9	307	3.51	2694	0.464	0.417	0.262	0.531						
10	297	3.51	2534	0.480	0.424	0.270	0.535						
11	307	3.52	2675	0.466	0.419	0.263	0.531						
12	311	3.49	2726	0.461	0.416	0.261	0.530						
13	303	3.56	2698	0.464	0.418	0.262	0.531						
14	294	3.46	2515	0.482	0.425	0.271	0.536						
15	304	3.47	2721	0.461	0.415	0.261	0.529						
16	294	3.52	2513	0.483	0.425	0.271	0.536						
17	306	3.60	2696	0.463	0.416	0.262	0.530						
18	305	3.55	2653	0.468	0.418	0.264	0.531						
19	304	3.48	2666	0.466	0.416	0.264	0.530						
20	292	3.57	2555	0.479	0.425	0.269	0.535						
21	313	3.53	2731	0.460	0.416	0.261	0.529						
22	307	3.57	2617	0.473	0.423	0.265	0.534						
23	306	3.59	2679	0.465	0.417	0.263	0.530						
24	300	3.58	2669	0.466	0.418	0.263	0.531						
n	24	24	24	24	24	24	24						
Avg.	305	3.52	2651	0.468	0.419	0.264	0.532						
Med.	306	3.52	2677	0.466	0.418	0.263	0.531						
σ	6.3	0.043	69.4	0.0072	0.0033	0.0032	0.0023						
Min.	292	3.46	2513	0.460	0.415	0.261	0.529						
Max.	315	3.60	2731	0.483	0.425	0.271	0.536						

Data Set 2 : 55°C, 1200 mA

Actual Case Temperature [T _s]	62.1 °C
Actual Ambient Temperature [T _A]	61.5 °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	519 h	1013 h	1752 h	2417 h	3109 h	3798 h	4513 h	5251 h	6014 h	6797 h	7609 h	8443 h	9181 h	10012 h
1	100.0	100.8	100.5	100.4	99.6	99.8	99.7	99.6	99.4	99.8	99.3	99.3	99.2	99.3	99.2
2	100.0	100.1	99.7	99.8	99.1	99.2	99.0	98.6	98.7	98.7	98.6	98.5	98.6	98.6	98.5
3	100.0	100.0	99.6	99.6	99.2	98.8	98.6	98.4	98.0	98.5	98.3	98.3	98.2	98.3	98.1
4	100.0	99.6	99.5	99.1	98.9	98.2	98.2	97.9	97.6	98.2	97.9	97.9	97.8	97.9	97.6
5	100.0	100.0	99.6	99.5	98.9	98.4	98.3	98.2	98.1	98.2	98.1	98.1	97.9	98.0	97.8
6	100.0	100.0	99.7	99.5	98.8	98.3	98.3	98.2	98.0	98.1	98.3	97.7	97.5	97.5	97.3
7	100.0	99.8	99.6	99.5	98.7	98.9	98.7	98.5	98.2	98.4	98.0	98.1	97.8	98.0	97.9
8	100.0	99.8	99.5	99.4	98.9	98.9	98.5	98.3	98.2	98.5	98.3	98.3	98.1	98.2	98.1
9	100.0	100.0	99.6	99.5	99.2	98.7	98.5	98.2	98.1	98.2	98.0	98.0	97.7	97.8	97.7
10	100.0	100.1	99.7	99.5	99.0	98.3	98.3	98.0	97.9	98.3	97.9	98.0	97.8	97.9	97.7
11	100.0	100.1	99.6	99.6	99.0	98.5	98.5	98.2	98.1	98.4	98.1	98.0	97.9	98.1	97.9
12	100.0	100.0	99.7	99.5	98.8	98.9	98.8	98.7	98.5	98.8	98.2	98.2	98.0	98.0	97.9
13	100.0	99.4	99.2	99.1	98.4	98.6	98.7	98.4	98.0	98.6	98.1	98.2	97.9	98.1	98.0
14	100.0	99.9	99.5	99.3	98.3	98.8	98.5	98.1	98.1	98.4	98.2	97.9	98.1	98.1	97.9
15	100.0	99.9	99.5	99.3	99.2	98.6	98.5	98.1	98.0	98.4	98.3	98.2	98.1	98.2	98.0
16	100.0	100.2	99.9	99.6	99.3	98.5	98.5	98.2	98.2	98.5	98.2	98.3	98.1	98.2	98.0
17	100.0	100.5	100.1	100.0	98.9	98.9	98.9	98.9	98.8	98.9	98.6	98.4	98.4	98.5	98.3
18	100.0	99.7	99.3	99.3	98.5	98.7	98.7	98.7	98.4	98.9	98.1	98.1	98.0	98.1	98.0
19	100.0	99.7	99.5	99.4	98.8	99.0	98.9	98.8	98.7	98.9	98.4	98.6	98.3	98.4	98.2
20	100.0	99.5	99.3	99.1	98.7	98.8	98.6	98.3	98.2	98.5	98.2	98.2	98.1	98.2	98.1
21	100.0	99.6	99.4	99.1	98.9	98.2	98.5	97.9	97.7	97.9	97.7	97.5	96.6	96.7	96.5
22	100.0	100.2	99.9	99.7	99.2	98.7	98.7	98.3	98.3	98.6	98.2	98.4	98.0	98.2	98.0
23	100.0	100.0	99.7	99.6	98.9	98.4	97.5	98.2	98.0	98.2	97.8	98.0	97.6	97.7	97.5
24	100.0	99.7	99.1	99.2	98.6	98.2	98.6	98.5	98.3	98.6	97.9	98.1	97.8	97.7	97.6
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	99.9	99.6	99.5	98.9	98.7	98.6	98.4	98.2	98.5	98.2	98.2	98.0	98.1	97.9
Med.	100.0	100.0	99.6	99.5	98.9	98.7	98.5	98.3	98.1	98.5	98.2	98.2	98.0	98.1	97.9
σ	0.00	0.29	0.29	0.31	0.30	0.35	0.38	0.37	0.38	0.38	0.32	0.34	0.46	0.45	0.47
Min.	100.0	99.4	99.1	99.1	98.3	98.2	97.5	97.9	97.6	97.9	97.7	97.5	96.6	96.7	96.5
Max.	100.0	100.8	100.5	100.4	99.6	99.8	99.7	99.6	99.4	99.8	99.3	99.3	99.2	99.3	99.2

TM-21 Projection

Time	4513 h	5251 h	6014 h	6797 h	7609 h	8443 h	9181 h	10012 h							
ln(Avg.)	-0.0163	-0.0179	-0.0148	-0.0181	-0.0184	-0.0205	-0.0195	-0.0212							

Test duration used	4513 h	to	10012 h
B	0.9883		
α	9.0276E-07		
R ²	0.6869		
Calculated L ₇₀ (10K)	382000	hours	
Reported L ₇₀ (10K)	> 60100	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]	62.1 °C
Actual Ambient Temperature [T _A]	61.5 °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	519 h	1013 h	1752 h	2417 h	3109 h	3798 h	4513 h	5251 h	6014 h	6797 h	7609 h	8443 h	9181 h	10012 h
1	100.0	98.5	98.5	98.6	98.5	98.6	98.5	98.5	98.5	98.6	98.6	98.6	98.5	98.6	98.7
2	100.0	98.3	98.3	98.4	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.4	98.4
3	100.0	98.3	98.2	98.4	98.3	98.3	98.3	98.2	98.3	98.3	98.2	98.3	98.3	98.3	98.4
4	100.0	98.5	98.5	98.6	98.5	98.6	98.6	98.6	98.6	98.6	98.6	98.6	98.6	98.7	98.7
5	100.0	98.7	98.7	98.8	98.8	98.8	98.8	98.8	98.9	98.8	98.9	98.9	98.9	99.0	99.0
6	100.0	98.6	98.5	98.6	98.4	99.1	99.1	99.0	99.0	99.0	98.4	99.1	99.0	99.1	99.1
7	100.0	98.7	98.7	98.8	98.8	98.9	99.0	99.0	99.3	99.3	99.3	99.3	99.3	99.4	99.4
8	100.0	98.4	98.4	98.5	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.3	98.5	98.5
9	100.0	98.5	98.4	98.5	98.4	98.4	98.5	98.4	98.5	98.4	98.5	98.5	98.5	98.5	98.6
10	100.0	98.5	98.5	98.5	98.5	98.5	98.6	98.5	98.5	98.5	98.5	98.5	98.5	98.6	98.6
11	100.0	98.5	98.5	98.5	98.5	98.5	98.6	98.5	98.5	98.6	98.7	98.8	98.8	98.7	98.8
12	100.0	98.6	98.6	98.7	98.6	98.6	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.8	98.8
13	100.0	98.3	98.3	98.4	98.3	98.3	98.4	98.3	98.4	98.4	98.4	98.4	98.4	98.5	98.6
14	100.0	98.8	98.7	98.8	98.7	98.8	98.9	98.8	98.9	99.1	99.0	99.4	99.1	99.1	99.2
15	100.0	98.3	98.3	98.3	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.3	98.3
16	100.0	98.3	98.3	98.3	98.2	98.3	98.3	98.2	98.2	98.2	98.3	98.2	98.2	98.3	98.3
17	100.0	98.1	98.1	98.1	98.0	98.0	98.1	98.0	98.0	98.1	98.1	98.0	98.0	98.1	98.1
18	100.0	98.6	98.6	98.6	98.6	98.6	98.6	98.6	98.6	98.6	98.6	98.6	98.6	98.7	98.7
19	100.0	98.7	98.7	98.8	98.8	98.8	98.8	98.8	98.8	98.8	98.8	98.9	98.8	98.9	99.0
20	100.0	98.2	98.2	98.2	98.2	98.2	98.3	98.2	98.2	98.2	98.2	98.3	98.2	98.3	98.3
21	100.0	98.7	99.0	99.1	99.0	99.1	99.0	99.1	99.5	99.5	99.5	99.6	100.4	100.5	100.6
22	100.0	98.7	98.6	98.8	98.7	98.7	98.8	98.7	98.8	98.8	98.8	98.8	98.8	98.8	98.9
23	100.0	98.4	98.4	98.7	98.7	98.8	98.9	98.9	99.3	99.5	99.5	99.5	99.5	99.5	99.6
24	100.0	98.9	98.8	98.9	98.9	98.8	98.9	98.8	98.9	98.9	98.9	98.9	98.9	99.0	99.1
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	98.5	98.5	98.6	98.5	98.6	98.6	98.6	98.6	98.7	98.6	98.7	98.7	98.8	98.8
Med.	100.0	98.5	98.5	98.6	98.5	98.6	98.6	98.5	98.6	98.6	98.6	98.6	98.6	98.7	98.7
σ	0.00	0.19	0.22	0.23	0.25	0.29	0.29	0.29	0.38	0.40	0.39	0.44	0.52	0.51	0.53
Min.	100.0	98.1	98.1	98.1	98.0	98.0	98.1	98.0	98.0	98.1	98.1	98.0	98.0	98.1	98.1
Max.	100.0	98.9	99.0	99.1	99.0	99.1	99.1	99.1	99.5	99.5	99.5	99.6	100.4	100.5	100.6

Data Set 2 : 55°C, 1200 mA

Actual Case Temperature [T _s]	62.1 °C
Actual Ambient Temperature [T _A]	61.5 °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

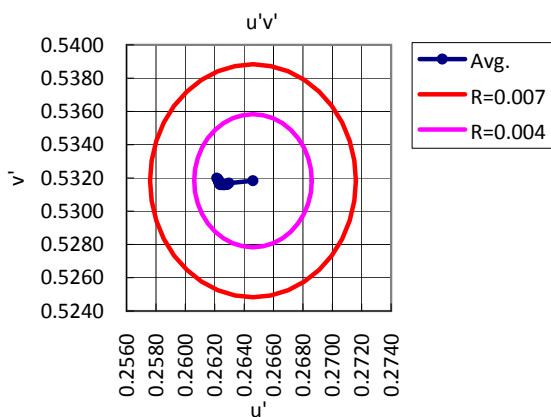
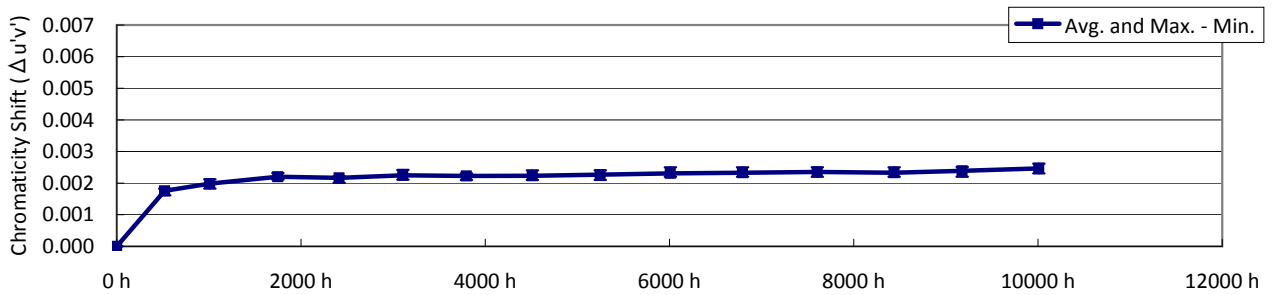
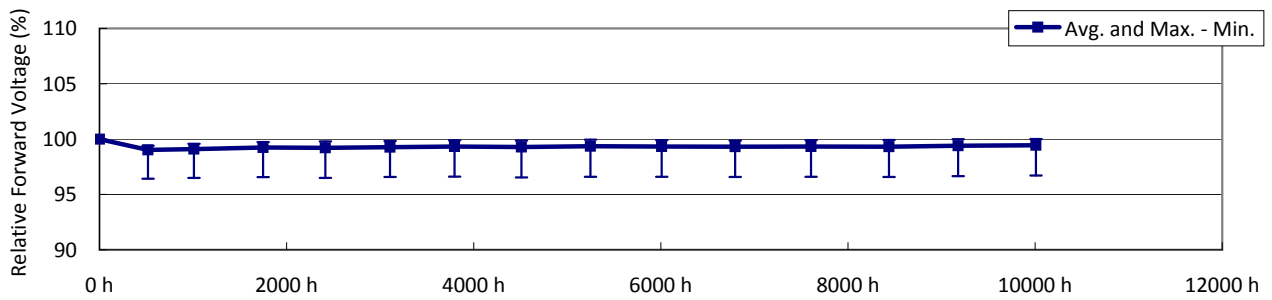
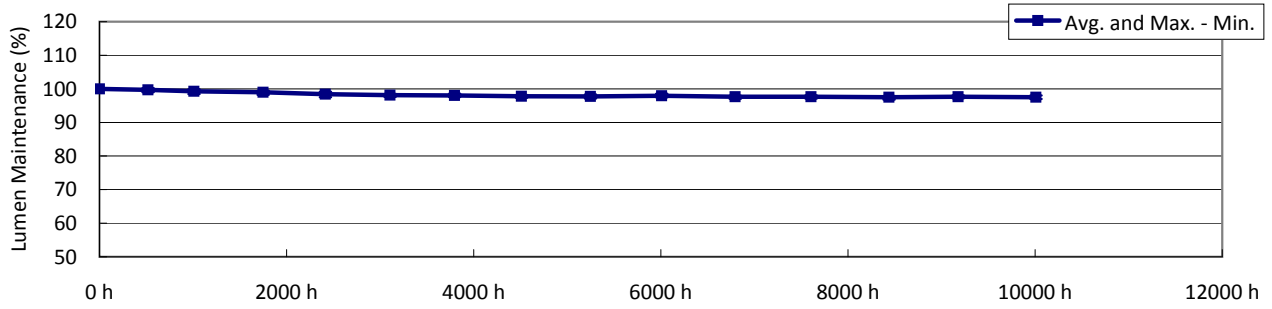
LED No.	Chromaticity Shift Δu'v'														
	0 h	519 h	1013 h	1752 h	2417 h	3109 h	3798 h	4513 h	5251 h	6014 h	6797 h	7609 h	8443 h	9181 h	10012 h
1	0.0000	0.0019	0.0022	0.0023	0.0023	0.0024	0.0024	0.0024	0.0025	0.0025	0.0025	0.0025	0.0025	0.0026	0.0026
2	0.0000	0.0019	0.0021	0.0023	0.0024	0.0025	0.0024	0.0024	0.0024	0.0025	0.0025	0.0025	0.0025	0.0025	0.0026
3	0.0000	0.0018	0.0021	0.0023	0.0022	0.0024	0.0023	0.0023	0.0023	0.0023	0.0024	0.0024	0.0024	0.0025	0.0025
4	0.0000	0.0018	0.0021	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023	0.0023	0.0023	0.0023	0.0024	0.0024
5	0.0000	0.0018	0.0020	0.0022	0.0021	0.0022	0.0022	0.0022	0.0022	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023
6	0.0000	0.0018	0.0020	0.0022	0.0021	0.0022	0.0021	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023
7	0.0000	0.0018	0.0020	0.0022	0.0022	0.0022	0.0022	0.0022	0.0021	0.0022	0.0022	0.0023	0.0022	0.0023	0.0023
8	0.0000	0.0019	0.0020	0.0023	0.0023	0.0024	0.0023	0.0023	0.0024	0.0024	0.0024	0.0025	0.0024	0.0025	0.0025
9	0.0000	0.0020	0.0022	0.0024	0.0024	0.0025	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0025	0.0026
10	0.0000	0.0019	0.0021	0.0024	0.0023	0.0024	0.0023	0.0023	0.0023	0.0024	0.0024	0.0025	0.0025	0.0025	0.0026
11	0.0000	0.0018	0.0021	0.0023	0.0021	0.0021	0.0023	0.0023	0.0022	0.0023	0.0022	0.0022	0.0022	0.0023	0.0024
12	0.0000	0.0019	0.0021	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023	0.0022	0.0023	0.0022	0.0023	0.0024
13	0.0000	0.0019	0.0021	0.0023	0.0023	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0025	0.0024	0.0025	0.0025
14	0.0000	0.0020	0.0022	0.0024	0.0023	0.0025	0.0025	0.0025	0.0025	0.0025	0.0026	0.0026	0.0026	0.0026	0.0027
15	0.0000	0.0019	0.0021	0.0023	0.0023	0.0024	0.0024	0.0023	0.0024	0.0024	0.0024	0.0025	0.0025	0.0025	0.0025
16	0.0000	0.0020	0.0022	0.0025	0.0025	0.0025	0.0025	0.0026	0.0025	0.0026	0.0026	0.0026	0.0026	0.0027	0.0027
17	0.0000	0.0020	0.0022	0.0024	0.0023	0.0023	0.0024	0.0024	0.0024	0.0025	0.0024	0.0024	0.0025	0.0025	0.0025
18	0.0000	0.0019	0.0021	0.0023	0.0022	0.0023	0.0023	0.0023	0.0024	0.0024	0.0024	0.0025	0.0024	0.0025	0.0025
19	0.0000	0.0018	0.0020	0.0022	0.0022	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023	0.0024	0.0024	0.0024	0.0025
20	0.0000	0.0019	0.0021	0.0024	0.0024	0.0025	0.0024	0.0024	0.0025	0.0025	0.0025	0.0026	0.0026	0.0026	0.0027
21	0.0000	0.0019	0.0022	0.0024	0.0023	0.0025	0.0024	0.0024	0.0025	0.0025	0.0025	0.0026	0.0027	0.0027	0.0028
22	0.0000	0.0020	0.0021	0.0024	0.0023	0.0024	0.0023	0.0023	0.0024	0.0024	0.0024	0.0025	0.0025	0.0025	0.0025
23	0.0000	0.0019	0.0021	0.0023	0.0022	0.0023	0.0022	0.0023	0.0023	0.0024	0.0023	0.0024	0.0023	0.0024	0.0025
24	0.0000	0.0018	0.0020	0.0022	0.0021	0.0021	0.0022	0.0022	0.0022	0.0023	0.0023	0.0024	0.0024	0.0024	0.0025
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	0.0000	0.0019	0.0021	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023	0.0024	0.0024	0.0024	0.0024	0.0025	0.0025
Med.	0.0000	0.0019	0.0021	0.0023	0.0023	0.0024	0.0023	0.0023	0.0024	0.0024	0.0024	0.0025	0.0024	0.0025	0.0025
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	0.0018	0.0020	0.0022	0.0021	0.0021	0.0021	0.0022	0.0021	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023
Max.	0.0000	0.0020	0.0022	0.0025	0.0025	0.0025	0.0025	0.0026	0.0025	0.0026	0.0026	0.0026	0.0027	0.0027	0.0028

Data Set 3 : 85°C, 700 mA

Actual Case Temperature [T _S]	86.2 °C
Actual Ambient Temperature [T _A]	85.6 °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]	85.6 °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	195	3.26	2638	0.469	0.418	0.265	0.531						
2	191	3.23	2536	0.480	0.423	0.270	0.535						
3	192	3.26	2610	0.473	0.421	0.266	0.533						
4	192	3.27	2625	0.471	0.420	0.265	0.532						
5	196	3.22	2604	0.473	0.422	0.266	0.533						
6	195	3.22	2631	0.470	0.419	0.265	0.532						
7	196	3.22	2683	0.465	0.417	0.263	0.531						
8	192	3.25	2691	0.464	0.417	0.262	0.531						
9	196	3.29	2657	0.467	0.418	0.264	0.531						
10	199	3.24	2676	0.466	0.418	0.263	0.531						
11	191	3.22	2567	0.477	0.422	0.268	0.534						
12	191	3.27	2675	0.467	0.419	0.263	0.532						
13	190	3.32	2655	0.467	0.417	0.264	0.531						
14	198	3.21	2690	0.464	0.416	0.262	0.530						
15	197	3.26	2649	0.469	0.420	0.264	0.532						
16	197	3.23	2678	0.465	0.416	0.263	0.530						
17	198	3.25	2675	0.465	0.417	0.263	0.530						
18	195	3.31	2654	0.467	0.418	0.264	0.531						
19	196	3.21	2692	0.464	0.417	0.262	0.531						
20	190	3.27	2578	0.475	0.421	0.268	0.533						
21	197	3.28	2692	0.464	0.418	0.262	0.531						
22	193	3.30	2636	0.469	0.419	0.265	0.532						
23	195	3.23	2674	0.465	0.417	0.263	0.530						
24	189	3.24	2532	0.480	0.423	0.270	0.535						
n	24	24	24	24	24	24	24						
Avg.	194	3.25	2642	0.469	0.419	0.265	0.532						
Med.	195	3.25	2655	0.467	0.418	0.264	0.531						
σ	3.0	0.031	48.3	0.0049	0.0022	0.0022	0.0015						
Min.	189	3.21	2532	0.464	0.416	0.262	0.530						
Max.	199	3.32	2692	0.480	0.423	0.270	0.535						

Data Set 3 : 85°C, 700 mA

Actual Case Temperature [T _s]	86.2 °C
Actual Ambient Temperature [T _A]	85.6 °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	519 h	1009 h	1748 h	2414 h	3105 h	3795 h	4510 h	5247 h	6009 h	6793 h	7604 h	8438 h	9177 h	10008 h
1	100.0	99.5	99.2	98.8	98.1	98.2	98.1	97.8	97.9	98.2	97.8	97.8	97.6	97.9	97.8
2	100.0	100.2	99.9	99.5	99.0	98.5	98.4	98.1	97.9	98.1	97.9	97.8	97.7	97.9	97.6
3	100.0	99.8	99.6	99.4	98.9	98.5	98.3	98.0	97.9	98.2	97.9	98.0	97.8	98.0	97.9
4	100.0	100.0	99.4	99.1	98.6	98.0	97.9	97.7	97.7	97.9	97.7	97.6	97.5	97.7	97.4
5	100.0	99.9	99.3	99.1	98.5	98.0	97.8	97.7	97.6	97.8	97.4	97.5	97.3	97.5	97.3
6	100.0	100.0	99.6	99.3	98.5	98.5	98.5	98.2	98.3	98.5	98.0	98.1	97.9	98.1	97.9
7	100.0	99.6	99.3	98.9	98.2	98.3	98.3	98.2	98.0	98.1	97.8	97.7	97.5	97.8	97.6
8	100.0	99.6	99.2	98.9	98.5	98.3	98.3	97.9	97.9	98.2	98.0	98.0	97.8	98.1	98.0
9	100.0	99.7	99.4	99.1	98.9	98.3	98.2	97.8	97.7	98.0	98.0	97.9	97.8	98.0	97.9
10	100.0	100.1	99.8	99.4	99.1	98.4	98.3	98.0	98.0	98.2	97.9	97.9	97.7	97.7	97.6
11	100.0	99.6	99.0	98.8	98.4	97.9	97.8	97.7	97.6	97.8	97.5	97.5	97.3	97.5	97.3
12	100.0	99.2	98.9	98.6	97.9	97.9	97.9	97.8	97.5	97.7	97.3	97.3	97.0	97.2	97.1
13	100.0	99.0	98.4	98.2	97.5	97.6	97.5	97.4	97.1	97.4	97.1	97.1	96.8	97.2	97.0
14	100.0	99.7	99.2	99.0	98.4	98.4	98.1	97.9	97.9	98.0	97.8	97.7	97.7	97.9	97.6
15	100.0	99.9	99.5	99.2	98.8	98.3	98.2	97.9	97.9	98.1	97.8	97.7	97.6	97.8	97.7
16	100.0	99.9	99.4	99.2	98.9	98.3	98.1	98.0	97.9	98.0	97.9	97.8	97.6	97.5	97.7
17	100.0	99.7	99.2	99.1	98.4	97.9	97.8	97.3	97.7	97.7	97.5	97.5	97.3	97.6	97.4
18	100.0	99.2	98.8	98.5	97.9	98.0	98.0	97.6	97.7	98.0	97.5	97.5	97.3	97.6	97.4
19	100.0	99.7	99.3	99.0	98.2	98.3	98.2	98.2	98.1	98.2	97.8	97.8	97.6	97.8	97.7
20	100.0	99.5	99.0	98.8	98.2	98.1	97.9	97.6	97.6	97.6	97.3	97.3	97.5	97.6	97.3
21	100.0	99.7	99.3	99.1	98.7	98.2	98.1	97.6	97.6	97.8	97.6	97.5	97.5	97.6	97.5
22	100.0	99.8	99.4	99.0	98.6	97.9	97.8	97.6	97.5	97.7	97.4	97.5	97.3	97.5	97.2
23	100.0	99.5	99.1	98.9	98.2	97.7	97.7	97.6	97.5	97.6	97.4	97.4	97.2	97.4	97.1
24	100.0	99.5	99.0	98.8	97.8	97.9	97.8	97.9	97.8	97.9	97.5	97.4	97.3	97.5	97.3
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	99.7	99.3	99.0	98.4	98.1	98.0	97.8	97.8	98.0	97.7	97.6	97.5	97.7	97.5
Med.	100.0	99.7	99.3	99.0	98.4	98.2	98.1	97.8	97.7	98.0	97.7	97.6	97.5	97.6	97.5
σ	0.00	0.29	0.31	0.29	0.42	0.25	0.26	0.24	0.25	0.25	0.26	0.24	0.27	0.25	0.29
Min.	100.0	99.0	98.4	98.2	97.5	97.6	97.5	97.3	97.1	97.4	97.1	97.1	96.8	97.2	97.0
Max.	100.0	100.2	99.9	99.5	99.1	98.5	98.5	98.2	98.3	98.5	98.0	98.1	97.9	98.1	98.0

TM-21 Projection

Time	4510 h	5247 h	6009 h	6793 h	7604 h	8438 h	9177 h	10008 h							
ln(Avg.)	-0.0221	-0.0227	-0.0207	-0.0238	-0.0239	-0.0255	-0.0235	-0.0253							

Test duration used	4510 h	to	10008 h
B	0.9813		
α	6.2712E-07		
R ²	0.5733		
Calculated L ₇₀ (10K)	539000	hours	
Reported L ₇₀ (10K)	> 60000	hours	

Curve-fit equation:

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

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]	85.6 °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	519 h	1009 h	1748 h	2414 h	3105 h	3795 h	4510 h	5247 h	6009 h	6793 h	7604 h	8438 h	9177 h	10008 h
1	100.0	99.4	99.4	99.6	99.6	99.7	99.7	99.6	99.8	99.7	99.7	99.7	99.7	99.7	99.8
2	100.0	96.4	96.5	96.6	96.5	96.6	96.6	96.5	96.6	96.6	96.6	96.6	96.6	96.6	96.7
3	100.0	99.3	99.4	99.6	99.5	99.6	99.7	99.6	99.7	99.7	99.7	99.7	99.7	99.7	99.8
4	100.0	99.2	99.2	99.4	99.4	99.5	99.5	99.4	99.5	99.5	99.5	99.5	99.5	99.6	99.7
5	100.0	99.2	99.4	99.6	99.6	99.7	99.8	99.8	99.9	99.8	99.8	99.8	99.8	99.9	100.0
6	100.0	99.2	99.2	99.3	99.3	99.3	99.4	99.3	99.4	99.3	99.3	99.4	99.3	99.5	99.5
7	100.0	99.2	99.0	99.1	99.0	99.2	99.2	99.4	99.4	99.4	99.3	99.4	99.3	99.5	99.5
8	100.0	98.9	99.2	99.4	99.3	99.5	99.6	99.5	99.6	99.5	99.5	99.6	99.5	99.6	99.6
9	100.0	99.1	99.1	99.2	99.2	99.2	99.3	99.2	99.3	99.3	99.3	99.3	99.2	99.3	99.4
10	100.0	99.4	99.5	99.6	99.6	99.6	99.7	99.6	99.7	99.7	99.7	99.7	99.7	99.8	99.9
11	100.0	99.1	99.2	99.3	99.4	99.4	99.5	99.4	99.5	99.5	99.5	99.5	99.4	99.5	99.6
12	100.0	99.1	99.2	99.4	99.3	99.3	99.3	99.3	99.4	99.3	99.3	99.3	99.3	99.4	99.5
13	100.0	98.8	98.8	98.9	98.8	98.9	98.9	98.8	98.9	98.8	98.8	98.8	98.8	98.9	98.9
14	100.0	99.1	99.1	99.2	99.2	99.3	99.3	99.2	99.3	99.3	99.3	99.3	99.3	99.4	99.4
15	100.0	99.4	99.5	99.6	99.7	99.8	99.9	99.8	99.9	99.9	99.9	99.9	99.8	100.0	100.0
16	100.0	99.1	99.2	99.4	99.4	99.4	99.5	99.4	99.5	99.5	99.5	99.5	99.5	99.5	99.6
17	100.0	99.4	99.5	99.7	99.7	99.8	99.9	99.8	99.9	99.9	99.8	99.9	99.8	99.9	100.0
18	100.0	99.0	99.0	99.1	99.1	99.2	99.2	99.1	99.2	99.2	99.2	99.2	99.2	99.3	99.4
19	100.0	99.0	99.1	99.1	99.1	99.2	99.2	99.2	99.2	99.1	99.1	99.2	99.2	99.2	99.2
20	100.0	98.9	99.0	99.1	99.0	99.0	99.0	99.0	99.1	99.0	99.0	99.0	99.0	99.0	99.1
21	100.0	99.4	99.6	99.7	99.8	99.8	99.9	99.9	100.0	99.9	99.9	99.9	99.9	100.0	100.0
22	100.0	99.0	99.0	99.1	99.0	99.1	99.1	99.0	99.1	99.1	99.0	99.1	99.0	99.1	99.2
23	100.0	99.1	99.1	99.1	99.1	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.3	99.3
24	100.0	99.2	99.3	99.5	99.5	99.5	99.6	99.5	99.7	99.6	99.6	99.6	99.6	99.7	99.7
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	99.0	99.1	99.2	99.2	99.3	99.3	99.3	99.4	99.3	99.3	99.3	99.3	99.4	99.4
Med.	100.0	99.1	99.2	99.4	99.3	99.3	99.4	99.4	99.5	99.4	99.4	99.4	99.4	99.5	99.6
σ	0.00	0.58	0.59	0.62	0.63	0.63	0.65	0.65	0.66	0.65	0.65	0.65	0.65	0.65	0.65
Min.	100.0	96.4	96.5	96.6	96.5	96.6	96.6	96.5	96.6	96.6	96.6	96.6	96.6	96.6	96.7
Max.	100.0	99.4	99.6	99.7	99.8	99.8	99.9	99.9	100.0	99.9	99.9	99.9	99.9	100.0	100.0

Data Set 3 : 85°C, 700 mA

Actual Case Temperature [T _s]	86.2 °C
Actual Ambient Temperature [T _A]	85.6 °C
Drive Current [I _F]	700 mA
Measurement Current	700 mA

NOTES:

T_s and T_A were measured during initial setup.

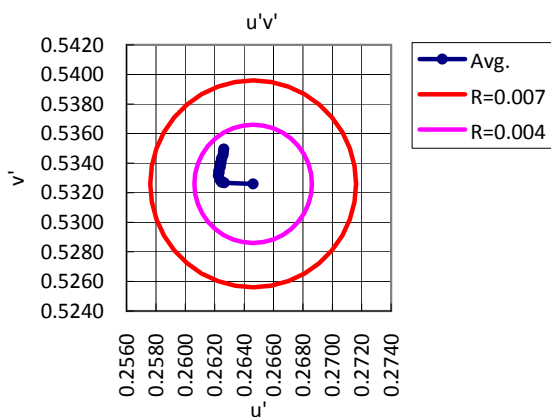
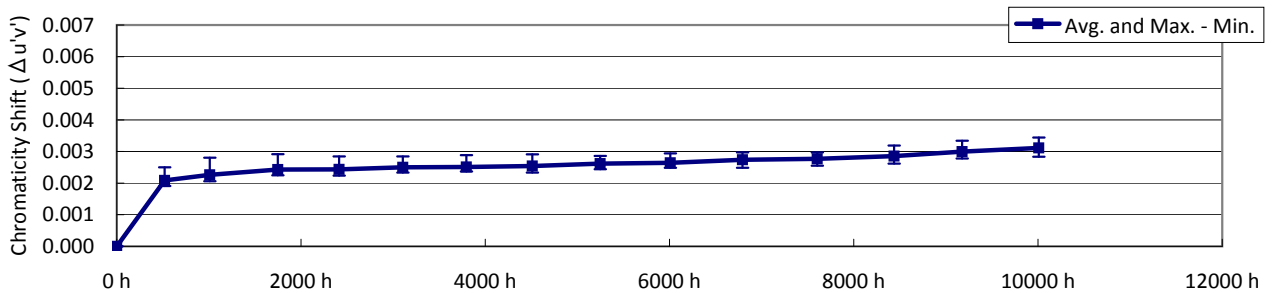
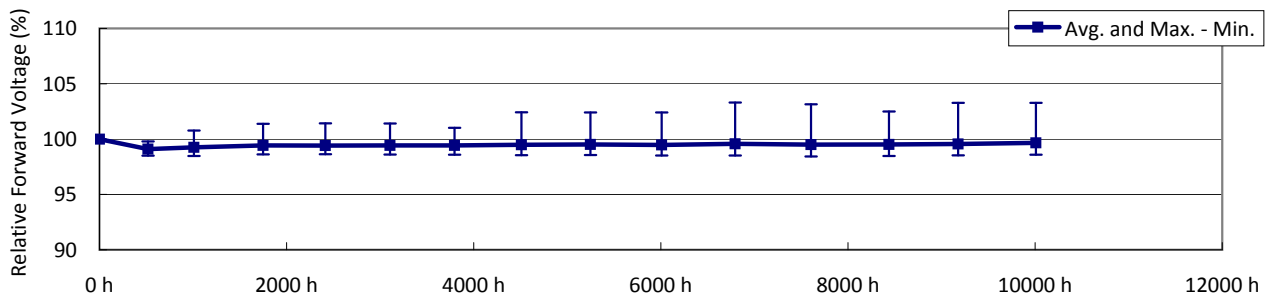
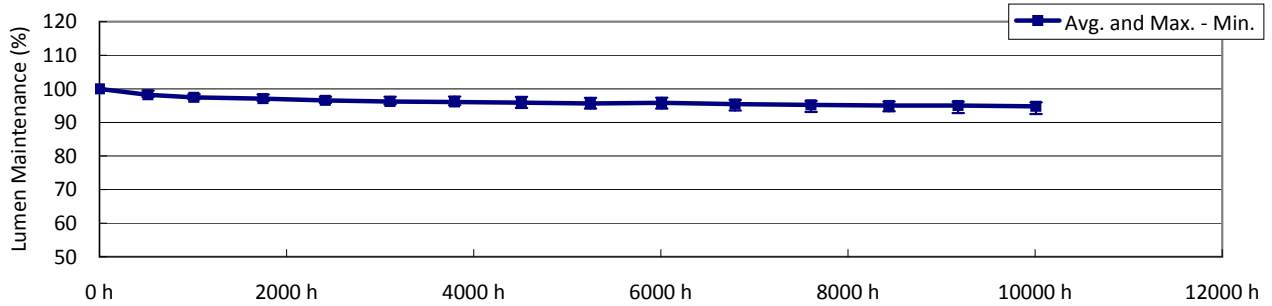
TABLE 3-4
Chromaticity Shift

LED No.	Chromaticity Shift Δu'v'														
	0 h	519 h	1009 h	1748 h	2414 h	3105 h	3795 h	4510 h	5247 h	6009 h	6793 h	7604 h	8438 h	9177 h	10008 h
1	0.0000	0.0017	0.0020	0.0022	0.0022	0.0023	0.0022	0.0023	0.0023	0.0024	0.0024	0.0024	0.0024	0.0025	0.0025
2	0.0000	0.0017	0.0020	0.0022	0.0022	0.0023	0.0023	0.0023	0.0023	0.0023	0.0024	0.0024	0.0023	0.0024	0.0025
3	0.0000	0.0018	0.0021	0.0023	0.0022	0.0023	0.0023	0.0023	0.0024	0.0024	0.0024	0.0024	0.0024	0.0025	0.0025
4	0.0000	0.0018	0.0020	0.0023	0.0022	0.0023	0.0022	0.0023	0.0023	0.0023	0.0024	0.0024	0.0024	0.0025	0.0025
5	0.0000	0.0018	0.0020	0.0022	0.0021	0.0022	0.0021	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023	0.0023
6	0.0000	0.0018	0.0020	0.0023	0.0022	0.0022	0.0023	0.0022	0.0023	0.0024	0.0024	0.0024	0.0024	0.0025	0.0025
7	0.0000	0.0017	0.0019	0.0021	0.0021	0.0022	0.0022	0.0021	0.0022	0.0022	0.0022	0.0023	0.0022	0.0023	0.0024
8	0.0000	0.0017	0.0018	0.0021	0.0021	0.0022	0.0022	0.0022	0.0022	0.0023	0.0023	0.0024	0.0023	0.0024	0.0025
9	0.0000	0.0018	0.0020	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023	0.0024	0.0024	0.0024	0.0024	0.0026
10	0.0000	0.0018	0.0020	0.0022	0.0022	0.0023	0.0023	0.0022	0.0023	0.0023	0.0023	0.0024	0.0023	0.0024	0.0025
11	0.0000	0.0017	0.0019	0.0022	0.0021	0.0022	0.0022	0.0022	0.0023	0.0023	0.0022	0.0023	0.0023	0.0023	0.0024
12	0.0000	0.0016	0.0019	0.0021	0.0021	0.0021	0.0022	0.0021	0.0021	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023
13	0.0000	0.0017	0.0019	0.0021	0.0022	0.0022	0.0022	0.0022	0.0023	0.0023	0.0024	0.0024	0.0023	0.0024	0.0025
14	0.0000	0.0017	0.0019	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023	0.0023	0.0024	0.0024	0.0024	0.0025	0.0025
15	0.0000	0.0018	0.0020	0.0022	0.0022	0.0024	0.0023	0.0023	0.0023	0.0023	0.0024	0.0024	0.0024	0.0025	0.0025
16	0.0000	0.0018	0.0020	0.0022	0.0022	0.0023	0.0022	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023	0.0024
17	0.0000	0.0017	0.0020	0.0022	0.0021	0.0022	0.0022	0.0022	0.0022	0.0023	0.0022	0.0023	0.0023	0.0023	0.0024
18	0.0000	0.0017	0.0019	0.0021	0.0021	0.0021	0.0022	0.0021	0.0022	0.0022	0.0022	0.0023	0.0022	0.0023	0.0024
19	0.0000	0.0017	0.0019	0.0021	0.0021	0.0022	0.0022	0.0022	0.0022	0.0023	0.0023	0.0023	0.0023	0.0024	0.0024
20	0.0000	0.0018	0.0020	0.0022	0.0022	0.0024	0.0023	0.0024	0.0024	0.0025	0.0025	0.0025	0.0025	0.0025	0.0026
21	0.0000	0.0018	0.0020	0.0022	0.0022	0.0023	0.0022	0.0023	0.0023	0.0023	0.0024	0.0024	0.0024	0.0024	0.0025
22	0.0000	0.0018	0.0021	0.0022	0.0022	0.0023	0.0023	0.0022	0.0023	0.0023	0.0024	0.0024	0.0024	0.0024	0.0025
23	0.0000	0.0017	0.0019	0.0022	0.0020	0.0021	0.0021	0.0021	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023
24	0.0000	0.0017	0.0020	0.0022	0.0021	0.0022	0.0022	0.0023	0.0023	0.0023	0.0023	0.0023	0.0024	0.0024	0.0025
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	0.0000	0.0018	0.0020	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023	0.0023	0.0023	0.0024	0.0023	0.0024	0.0025
Med.	0.0000	0.0017	0.0020	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023	0.0023	0.0024	0.0024	0.0023	0.0024	0.0025
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	0.0016	0.0018	0.0021	0.0020	0.0021	0.0021	0.0021	0.0021	0.0022	0.0022	0.0022	0.0022	0.0022	0.0023
Max.	0.0000	0.0018	0.0021	0.0023	0.0022	0.0024	0.0023	0.0024	0.0024	0.0025	0.0025	0.0025	0.0025	0.0025	0.0026

Data Set 4 : 85°C, 1200 mA

Actual Case Temperature [T _S]	90.6 °C
Actual Ambient Temperature [T _A]	90.3 °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]	90.6 °C
Actual Ambient Temperature [T _A]	90.3 °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	297	3.49	2526	0.481	0.425	0.270	0.536						
2	317	3.48	2742	0.461	0.418	0.260	0.531						
3	307	3.52	2679	0.467	0.421	0.263	0.532						
4	310	3.50	2710	0.462	0.416	0.262	0.530						
5	307	3.48	2671	0.467	0.420	0.263	0.532						
6	304	3.52	2664	0.468	0.420	0.263	0.532						
7	298	3.52	2609	0.473	0.421	0.266	0.533						
8	315	3.49	2707	0.464	0.419	0.261	0.531						
9	296	3.49	2514	0.483	0.425	0.271	0.536						
10	298	3.50	2589	0.475	0.422	0.267	0.534						
11	307	3.48	2629	0.471	0.421	0.265	0.533						
12	300	3.56	2563	0.478	0.424	0.268	0.535						
13	307	3.55	2672	0.466	0.418	0.263	0.531						
14	303	3.47	2617	0.472	0.422	0.266	0.533						
15	303	3.60	2691	0.464	0.417	0.262	0.531						
16	307	3.47	2693	0.465	0.418	0.262	0.531						
17	291	3.47	2457	0.490	0.428	0.274	0.538						
18	306	3.46	2654	0.468	0.419	0.264	0.532						
19	309	3.52	2707	0.462	0.415	0.262	0.529						
20	306	3.52	2618	0.473	0.422	0.265	0.534						
21	310	3.45	2654	0.469	0.421	0.264	0.533						
22	309	3.48	2669	0.467	0.420	0.263	0.532						
23	300	3.47	2598	0.473	0.421	0.267	0.533						
24	310	3.53	2722	0.462	0.416	0.261	0.530						
n	24	24	24	24	24	24	24						
Avg.	305	3.50	2640	0.470	0.421	0.265	0.533						
Med.	306	3.49	2659	0.468	0.420	0.264	0.532						
σ	6.1	0.035	71.2	0.0073	0.0030	0.0034	0.0022						
Min.	291	3.45	2457	0.461	0.415	0.260	0.529						
Max.	317	3.60	2742	0.490	0.428	0.274	0.538						

Data Set 4 : 85°C, 1200 mA

Actual Case Temperature [T _s]	90.6 °C
Actual Ambient Temperature [T _A]	90.3 °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	519 h	1009 h	1748 h	2414 h	3105 h	3795 h	4510 h	5247 h	6009 h	6793 h	7604 h	8438 h	9177 h	10008 h
1	100.0	98.2	97.2	97.0	96.3	96.1	96.1	96.0	95.7	96.0	95.7	95.2	95.2	95.2	95.0
2	100.0	98.0	97.4	97.1	96.6	96.4	96.3	96.0	95.5	95.9	96.0	95.5	95.4	95.4	95.2
3	100.0	98.0	97.1	96.4	95.8	95.7	95.6	94.3	94.1	94.1	93.5	93.1	93.3	92.8	92.5
4	100.0	98.7	98.2	97.7	97.2	96.9	96.5	96.4	96.4	96.5	96.5	96.2	95.9	96.0	95.7
5	100.0	98.8	98.1	97.8	97.2	96.6	96.5	96.5	96.2	96.4	96.4	96.0	95.7	95.8	95.5
6	100.0	98.6	97.8	97.6	96.7	96.7	96.8	96.8	96.4	96.7	96.4	96.0	95.7	95.7	95.5
7	100.0	97.6	96.9	96.6	95.8	95.9	95.7	95.5	95.3	95.4	95.0	94.8	94.5	94.6	94.4
8	100.0	98.2	97.7	97.4	96.8	96.3	96.5	96.2	96.1	96.2	95.9	95.7	95.5	95.6	95.4
9	100.0	98.3	97.5	97.1	96.8	96.2	96.0	95.6	95.5	95.7	95.3	95.1	94.9	94.8	94.8
10	100.0	98.0	97.2	96.9	96.5	95.7	95.7	95.4	95.3	95.4	95.0	94.6	94.6	94.5	94.2
11	100.0	97.9	97.2	96.4	96.1	95.6	95.5	95.4	95.1	95.3	94.9	94.7	94.5	94.5	94.2
12	100.0	97.9	97.2	96.8	96.0	95.9	95.9	95.8	95.5	95.7	95.1	94.9	94.6	94.6	94.3
13	100.0	98.0	97.3	97.0	96.2	96.2	96.1	96.0	95.7	95.8	95.4	95.2	95.0	95.0	94.7
14	100.0	98.0	97.3	96.9	96.4	96.2	95.9	95.6	95.4	95.5	95.3	95.0	94.8	94.2	94.5
15	100.0	98.3	97.7	97.3	97.0	96.5	96.2	95.9	95.6	95.8	95.6	95.4	95.2	95.2	94.9
16	100.0	98.3	97.5	97.0	96.7	96.0	95.7	95.6	95.4	95.5	95.4	94.7	94.6	94.5	94.1
17	100.0	98.2	97.4	97.0	96.1	95.6	95.4	95.3	95.2	95.4	95.0	94.7	94.6	94.7	94.4
18	100.0	98.1	97.2	96.9	96.1	96.2	96.2	96.2	96.0	96.1	94.6	95.3	95.0	95.0	94.8
19	100.0	98.1	97.5	97.2	96.3	96.6	96.4	96.3	96.1	96.3	95.9	95.6	95.5	95.5	95.3
20	100.0	97.7	96.9	96.4	96.0	95.9	95.6	95.3	95.0	95.2	94.8	94.8	94.4	94.6	94.2
21	100.0	98.5	97.6	97.0	97.0	96.2	96.2	95.9	95.7	95.9	95.8	95.6	95.4	95.4	95.2
22	100.0	98.8	98.3	98.0	97.6	97.0	96.8	96.6	96.4	96.6	96.5	96.2	96.0	96.0	95.7
23	100.0	97.9	96.9	96.7	96.0	95.4	95.1	95.2	94.5	95.1	94.7	94.5	94.2	94.4	94.0
24	100.0	99.5	98.4	98.3	97.6	97.7	97.7	97.6	97.3	97.4	96.7	96.4	96.2	96.2	96.0
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	98.2	97.5	97.1	96.5	96.2	96.1	95.9	95.6	95.8	95.5	95.2	95.0	95.0	94.8
Med.	100.0	98.1	97.4	97.0	96.4	96.2	96.1	95.9	95.6	95.8	95.4	95.2	95.0	95.0	94.8
σ	0.00	0.41	0.44	0.49	0.54	0.52	0.56	0.66	0.67	0.66	0.74	0.72	0.66	0.74	0.76
Min.	100.0	97.6	96.9	96.4	95.8	95.4	95.1	94.3	94.1	94.1	93.5	93.1	93.3	92.8	92.5
Max.	100.0	99.5	98.4	98.3	97.6	97.7	97.7	97.6	97.3	97.4	96.7	96.4	96.2	96.2	96.0

TM-21 Projection

Time	4510 h	5247 h	6009 h	6793 h	7604 h	8438 h	9177 h	10008 h							
ln(Avg.)	-0.0419	-0.0445	-0.0425	-0.0464	-0.0491	-0.0509	-0.0512	-0.0537							

Test duration used	4510 h	to	10008 h
B	0.9686		
α	2.1689E-06		
R ²	0.9334		
Calculated L ₇₀ (10K)	150000	hours	
Reported L ₇₀ (10K)	> 60000	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]	90.6 °C
Actual Ambient Temperature [T _A]	90.3 °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	519 h	1009 h	1748 h	2414 h	3105 h	3795 h	4510 h	5247 h	6009 h	6793 h	7604 h	8438 h	9177 h	10008 h
1	100.0	98.7	98.8	98.9	98.8	98.9	98.8	98.8	98.8	98.8	98.9	98.8	98.8	98.9	98.9
2	100.0	99.4	99.4	99.6	99.5	99.6	99.6	99.5	99.6	99.5	99.6	99.5	99.5	99.6	99.6
3	100.0	99.8	100.8	101.4	101.4	101.4	101.0	102.4	102.4	102.4	103.3	103.1	102.5	103.3	103.3
4	100.0	99.3	99.4	99.6	99.5	99.6	99.6	99.6	99.6	99.6	99.7	99.5	99.5	99.6	99.7
5	100.0	99.0	99.2	99.3	99.3	99.3	99.4	99.3	99.4	99.3	99.4	99.3	99.3	99.4	99.4
6	100.0	98.6	98.7	98.8	98.7	98.8	98.8	98.8	98.8	98.7	98.8	98.7	98.7	98.8	98.9
7	100.0	99.0	99.1	99.2	99.2	99.2	99.2	99.1	99.2	99.1	99.1	99.0	99.1	99.2	99.2
8	100.0	99.1	99.2	99.4	99.4	99.4	99.4	99.4	99.4	99.3	99.4	99.3	99.3	99.4	99.5
9	100.0	99.4	99.6	99.7	99.7	99.7	99.7	99.6	99.7	99.6	99.6	99.6	99.6	99.7	99.7
10	100.0	99.2	99.4	99.6	99.5	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.7	99.9
11	100.0	99.0	99.2	99.3	99.3	99.4	99.3	99.3	99.3	99.3	99.3	99.2	99.3	99.4	99.4
12	100.0	99.2	99.3	99.4	99.4	99.5	99.5	99.4	99.4	99.4	99.4	99.3	99.3	99.5	99.5
13	100.0	99.2	99.3	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.4	99.4	99.5	99.5
14	100.0	98.8	98.9	99.0	99.0	99.0	99.0	99.0	99.0	98.9	99.0	98.9	98.9	99.0	99.0
15	100.0	98.5	98.5	98.6	98.6	98.6	98.6	98.5	98.6	98.5	98.5	98.4	98.5	98.5	98.6
16	100.0	99.0	99.2	99.4	99.5	99.5	99.5	99.5	99.5	99.5	99.6	99.9	99.9	100.0	100.1
17	100.0	98.9	98.9	99.0	99.1	99.1	99.1	99.0	99.1	99.0	99.0	99.0	99.0	99.1	99.1
18	100.0	99.1	99.2	99.3	99.3	99.3	99.3	99.3	99.4	99.4	99.4	99.5	99.7	99.4	99.6
19	100.0	99.1	99.2	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.3	99.4	99.4	99.5
20	100.0	99.3	99.9	100.1	100.0	100.1	100.1	100.0	100.1	100.0	100.0	99.9	100.0	100.0	100.1
21	100.0	99.0	99.1	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.1	99.2	99.2	99.3
22	100.0	99.3	99.4	99.5	99.5	99.5	99.6	99.6	99.6	99.5	99.6	99.5	99.5	99.6	99.6
23	100.0	98.9	98.8	99.0	98.9	98.9	98.9	98.9	99.0	98.9	99.2	99.1	99.1	98.7	99.1
24	100.0	99.3	99.6	99.8	99.9	99.8	100.3	100.6	100.8	100.8	101.2	101.2	101.2	100.8	101.3
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	99.1	99.3	99.4	99.4	99.4	99.4	99.5	99.5	99.5	99.6	99.5	99.5	99.6	99.7
Med.	100.0	99.1	99.2	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.3	99.4	99.4	99.5
σ	0.00	0.28	0.45	0.53	0.54	0.54	0.51	0.75	0.76	0.78	0.94	0.94	0.83	0.92	0.93
Min.	100.0	98.5	98.5	98.6	98.6	98.6	98.6	98.5	98.6	98.5	98.5	98.4	98.5	98.5	98.6
Max.	100.0	99.8	100.8	101.4	101.4	101.4	101.0	102.4	102.4	102.4	103.3	103.1	102.5	103.3	103.3

Data Set 4 : 85°C, 1200 mA

Actual Case Temperature [T _s]	90.6 °C
Actual Ambient Temperature [T _A]	90.3 °C
Drive Current [I _F]	1200 mA
Measurement Current	1200 mA

NOTES:

T_s and T_A were measured during initial setup.

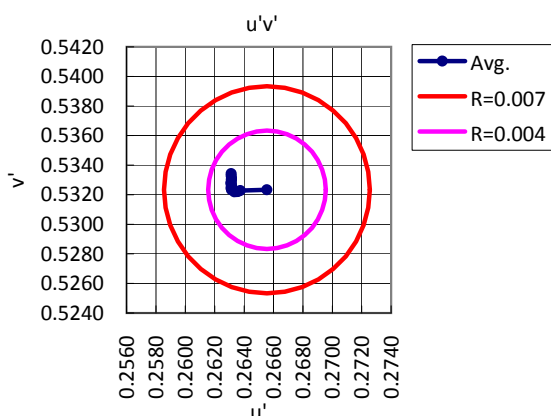
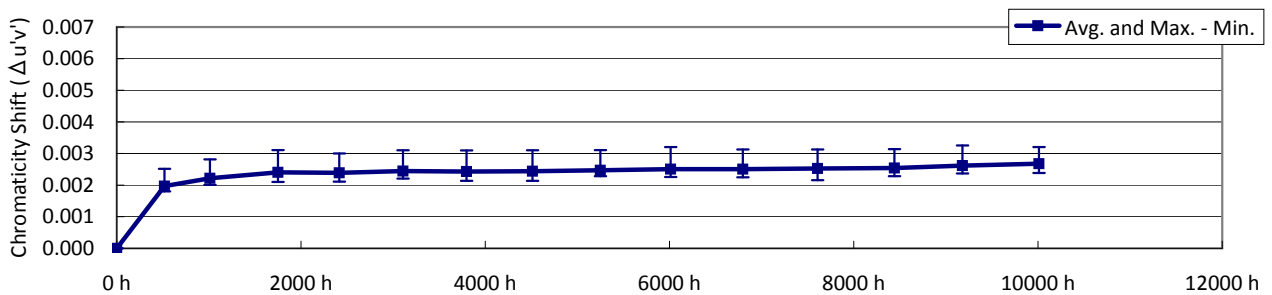
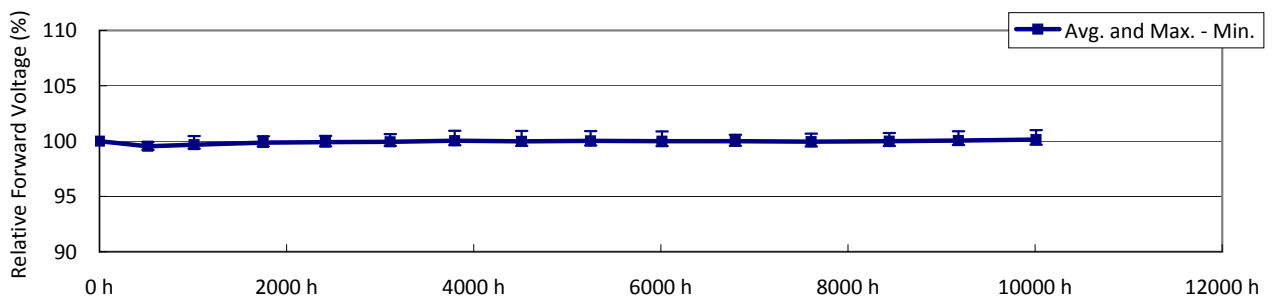
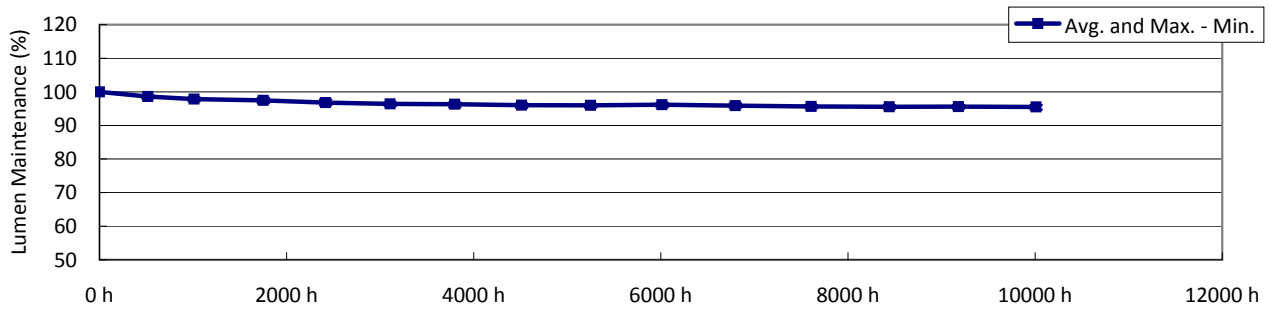
TABLE 4-4
Chromaticity Shift

LED No.	Chromaticity Shift Δu'v'														
	0 h	519 h	1009 h	1748 h	2414 h	3105 h	3795 h	4510 h	5247 h	6009 h	6793 h	7604 h	8438 h	9177 h	10008 h
1	0.0000	0.0020	0.0022	0.0024	0.0025	0.0025	0.0024	0.0025	0.0025	0.0025	0.0026	0.0026	0.0027	0.0028	0.0028
2	0.0000	0.0020	0.0021	0.0024	0.0023	0.0025	0.0025	0.0026	0.0026	0.0027	0.0028	0.0029	0.0030	0.0031	0.0032
3	0.0000	0.0019	0.0021	0.0022	0.0022	0.0023	0.0024	0.0023	0.0025	0.0025	0.0027	0.0027	0.0030	0.0031	0.0034
4	0.0000	0.0021	0.0023	0.0025	0.0025	0.0025	0.0025	0.0025	0.0026	0.0026	0.0027	0.0028	0.0028	0.0029	0.0031
5	0.0000	0.0021	0.0023	0.0025	0.0025	0.0025	0.0026	0.0026	0.0026	0.0027	0.0027	0.0029	0.0029	0.0030	0.0031
6	0.0000	0.0022	0.0024	0.0025	0.0025	0.0025	0.0026	0.0027	0.0027	0.0028	0.0029	0.0029	0.0029	0.0030	0.0032
7	0.0000	0.0020	0.0022	0.0024	0.0024	0.0026	0.0025	0.0026	0.0026	0.0026	0.0027	0.0028	0.0028	0.0030	0.0031
8	0.0000	0.0020	0.0022	0.0024	0.0024	0.0025	0.0025	0.0025	0.0026	0.0026	0.0028	0.0027	0.0029	0.0030	0.0032
9	0.0000	0.0024	0.0025	0.0027	0.0027	0.0028	0.0027	0.0028	0.0028	0.0027	0.0028	0.0029	0.0029	0.0030	0.0030
10	0.0000	0.0021	0.0022	0.0024	0.0024	0.0025	0.0025	0.0024	0.0025	0.0025	0.0026	0.0027	0.0027	0.0028	0.0030
11	0.0000	0.0020	0.0021	0.0023	0.0024	0.0025	0.0025	0.0025	0.0026	0.0026	0.0028	0.0027	0.0028	0.0031	0.0031
12	0.0000	0.0020	0.0022	0.0024	0.0024	0.0024	0.0025	0.0024	0.0026	0.0026	0.0026	0.0027	0.0028	0.0029	0.0029
13	0.0000	0.0020	0.0021	0.0023	0.0023	0.0025	0.0024	0.0026	0.0027	0.0028	0.0028	0.0029	0.0030	0.0032	0.0033
14	0.0000	0.0021	0.0022	0.0024	0.0025	0.0025	0.0026	0.0026	0.0026	0.0027	0.0028	0.0028	0.0030	0.0031	0.0032
15	0.0000	0.0021	0.0023	0.0025	0.0026	0.0026	0.0027	0.0027	0.0029	0.0028	0.0030	0.0030	0.0032	0.0033	0.0034
16	0.0000	0.0021	0.0022	0.0024	0.0024	0.0024	0.0025	0.0025	0.0026	0.0026	0.0028	0.0028	0.0030	0.0031	0.0033
17	0.0000	0.0025	0.0028	0.0029	0.0028	0.0028	0.0029	0.0029	0.0028	0.0029	0.0029	0.0029	0.0028	0.0030	0.0030
18	0.0000	0.0019	0.0021	0.0023	0.0023	0.0024	0.0024	0.0024	0.0026	0.0026	0.0027	0.0028	0.0029	0.0031	0.0032
19	0.0000	0.0020	0.0022	0.0024	0.0024	0.0025	0.0025	0.0025	0.0026	0.0026	0.0028	0.0028	0.0029	0.0030	0.0032
20	0.0000	0.0020	0.0021	0.0023	0.0023	0.0025	0.0024	0.0024	0.0025	0.0025	0.0026	0.0027	0.0028	0.0029	0.0031
21	0.0000	0.0022	0.0024	0.0025	0.0025	0.0025	0.0026	0.0025	0.0026	0.0027	0.0027	0.0027	0.0028	0.0029	0.0029
22	0.0000	0.0021	0.0023	0.0024	0.0024	0.0024	0.0024	0.0024	0.0025	0.0025	0.0026	0.0026	0.0026	0.0028	0.0029
23	0.0000	0.0020	0.0022	0.0023	0.0023	0.0023	0.0024	0.0024	0.0024	0.0025	0.0025	0.0025	0.0026	0.0028	0.0029
24	0.0000	0.0021	0.0022	0.0024	0.0024	0.0025	0.0025	0.0025	0.0026	0.0026	0.0027	0.0028	0.0028	0.0030	0.0032
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	0.0025	0.0025	0.0025	0.0026	0.0026	0.0027	0.0028	0.0029	0.0030	0.0031
Med.	0.0000	0.0021	0.0022	0.0024	0.0024	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	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002
Min.	0.0000	0.0019	0.0021	0.0022	0.0022	0.0023	0.0024	0.0023	0.0024	0.0025	0.0025	0.0025	0.0026	0.0028	0.0028
Max.	0.0000	0.0025	0.0028	0.0029	0.0028	0.0028	0.0029	0.0029	0.0029	0.0029	0.0030	0.0030	0.0032	0.0033	0.0034

Data Set 5 : 105°C, 700 mA

Actual Case Temperature [T _S]	107.9 °C
Actual Ambient Temperature [T _A]	106.0 °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]	107.9 °C
Actual Ambient Temperature [T _A]	106.0 °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	3.25	2679	0.466	0.418	0.263	0.531					
2	196	3.28	2634	0.468	0.417	0.265	0.531					
3	194	3.28	2650	0.468	0.418	0.264	0.531					
4	190	3.24	2521	0.481	0.424	0.270	0.535					
5	196	3.24	2661	0.466	0.416	0.264	0.530					
6	193	3.24	2634	0.468	0.417	0.265	0.531					
7	190	3.23	2558	0.477	0.422	0.269	0.534					
8	199	3.22	2662	0.468	0.419	0.264	0.532					
9	196	3.22	2689	0.464	0.417	0.262	0.530					
10	187	3.23	2478	0.486	0.425	0.273	0.537					
11	196	3.23	2691	0.464	0.417	0.262	0.531					
12	194	3.29	2640	0.468	0.418	0.265	0.531					
13	197	3.28	2658	0.467	0.417	0.264	0.531					
14	194	3.26	2629	0.470	0.420	0.265	0.532					
15	194	3.26	2598	0.474	0.422	0.267	0.534					
16	192	3.25	2607	0.472	0.420	0.266	0.533					
17	191	3.25	2585	0.475	0.422	0.267	0.534					
18	187	3.27	2488	0.485	0.425	0.272	0.537					
19	193	3.24	2645	0.470	0.421	0.264	0.533					
20	193	3.26	2660	0.467	0.418	0.264	0.531					
21	201	3.21	2699	0.464	0.418	0.262	0.531					
22	191	3.24	2559	0.477	0.422	0.268	0.534					
23	198	3.25	2665	0.466	0.416	0.264	0.530					
24	193	3.24	2638	0.469	0.419	0.265	0.532					
n	24	24	24	24	24	24	24					
Avg.	194	3.25	2622	0.471	0.420	0.266	0.532					
Med.	194	3.24	2639	0.468	0.418	0.265	0.532					
σ	3.6	0.021	61.6	0.0064	0.0028	0.0029	0.0020					
Min.	187	3.21	2478	0.464	0.416	0.262	0.530					
Max.	201	3.29	2699	0.486	0.425	0.273	0.537					

Data Set 5 : 105°C, 700 mA

Actual Case Temperature [T _s]	107.9 °C
Actual Ambient Temperature [T _A]	106.0 °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	517 h	1011 h	1750 h	2416 h	3107 h	3797 h	4512 h	5249 h	6012 h	6796 h	7607 h	8441 h	9180 h	10011 h
1	100.0	98.8	98.1	97.6	96.9	96.8	96.8	96.5	96.3	96.6	96.2	96.0	96.0	95.4	96.0
2	100.0	98.6	97.9	97.1	96.5	96.4	96.3	96.0	95.9	96.0	95.8	95.6	95.6	95.6	95.0
3	100.0	98.7	98.1	97.7	97.4	96.9	96.7	96.5	96.3	96.5	96.3	96.2	96.1	96.1	96.0
4	100.0	98.3	97.7	97.1	96.7	96.0	95.9	95.8	95.7	95.7	95.5	95.4	95.3	95.3	95.2
5	100.0	98.6	97.9	97.4	96.8	96.1	96.0	96.0	95.9	96.0	95.7	95.7	95.3	95.6	95.5
6	100.0	98.0	97.2	96.7	96.0	95.9	95.9	95.6	95.7	95.8	95.2	95.1	95.0	95.1	94.9
7	100.0	98.4	97.8	97.3	96.4	96.6	96.5	96.0	96.1	96.4	96.0	95.8	95.7	95.9	95.8
8	100.0	98.7	98.0	97.6	97.0	96.8	96.7	96.3	96.2	96.5	96.2	96.0	95.9	96.1	96.1
9	100.0	98.8	98.0	97.7	97.3	96.7	96.5	96.2	96.2	96.3	96.2	96.0	95.9	96.0	95.9
10	100.0	98.7	98.1	97.7	97.1	96.4	96.2	96.0	96.0	96.1	95.9	95.8	95.6	95.7	95.6
11	100.0	98.7	98.0	97.6	96.9	96.4	96.4	95.9	96.0	96.1	95.9	95.3	95.6	95.7	95.6
12	100.0	98.6	98.0	97.6	96.7	96.8	96.9	96.6	96.5	96.7	96.2	96.0	96.0	96.1	96.0
13	100.0	98.8	98.1	97.5	96.7	96.7	96.6	96.5	96.3	96.4	96.0	96.0	95.7	95.9	95.7
14	100.0	98.6	97.7	97.3	96.8	96.5	96.4	95.9	96.0	96.1	95.8	95.7	95.6	95.7	95.6
15	100.0	98.6	97.9	97.4	97.0	96.5	96.2	95.8	95.8	96.0	95.5	95.3	95.2	95.2	95.2
16	100.0	98.5	97.8	97.3	96.7	96.0	95.9	95.6	95.5	95.7	95.4	95.3	95.1	95.1	94.9
17	100.0	98.8	98.0	97.6	96.3	96.3	96.3	96.2	96.0	96.1	95.8	95.6	95.5	95.5	95.4
18	100.0	98.3	97.7	97.2	96.2	96.2	96.2	96.0	95.9	96.1	95.4	95.4	95.2	95.2	95.2
19	100.0	98.6	97.8	97.5	96.7	96.5	96.6	96.3	96.2	96.3	95.9	95.8	95.7	95.8	95.7
20	100.0	98.5	97.8	98.0	97.2	96.8	96.7	96.1	96.3	96.5	96.5	96.1	96.1	95.9	96.1
21	100.0	99.1	98.3	98.2	97.8	97.0	96.8	96.3	96.3	96.5	96.6	96.1	96.1	96.1	96.0
22	100.0	98.4	97.3	97.3	96.7	95.8	95.4	95.2	95.3	95.4	95.5	95.0	94.9	94.9	94.7
23	100.0	98.6	97.8	97.4	96.7	96.1	96.0	95.8	95.7	95.8	95.6	95.4	95.2	95.3	95.1
24	100.0	98.5	97.6	97.2	96.3	96.1	96.2	96.1	96.0	96.1	95.6	95.5	95.3	95.4	95.3
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	98.6	97.9	97.5	96.8	96.4	96.3	96.0	96.0	96.2	95.9	95.7	95.6	95.6	95.5
Med.	100.0	98.6	97.9	97.5	96.7	96.4	96.3	96.0	96.0	96.1	95.8	95.7	95.6	95.6	95.6
σ	0.00	0.22	0.25	0.32	0.40	0.34	0.37	0.33	0.30	0.32	0.37	0.34	0.36	0.36	0.43
Min.	100.0	98.0	97.2	96.7	96.0	95.8	95.4	95.2	95.3	95.4	95.2	95.0	94.9	94.9	94.7
Max.	100.0	99.1	98.3	98.2	97.8	97.0	96.8	96.3	96.3	96.5	96.6	96.1	96.1	96.1	96.0

TM-21 Projection

Time	4512 h	5249 h	6012 h	6796 h	7607 h	8441 h	9180 h	10011 h							
ln(Avg.)	-0.0404	-0.0410	-0.0392	-0.0422	-0.0442	-0.0454	-0.0449	-0.0459							

Test duration used	4512 h	to	10011 h
B	0.9663		
α	1.1919E-06		
R ²	0.8189		
Calculated L ₇₀ (10K)	270000	hours	
Reported L ₇₀ (10K)	> 60100	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]	107.9 °C
Actual Ambient Temperature [T _A]	106.0 °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	517 h	1011 h	1750 h	2416 h	3107 h	3797 h	4512 h	5249 h	6012 h	6796 h	7607 h	8441 h	9180 h	10011 h
1	100.0	99.7	99.9	100.1	100.2	100.2	100.3	100.3	100.3	100.3	100.3	100.2	100.2	100.3	100.4
2	100.0	99.3	99.4	99.5	99.5	99.6	99.6	99.6	99.6	99.5	99.6	99.5	99.6	99.6	100.3
3	100.0	99.4	99.6	99.7	99.8	99.8	99.8	99.8	99.9	99.8	99.8	99.7	99.8	99.8	99.9
4	100.0	99.6	99.8	100.0	100.1	100.1	100.2	100.1	100.2	100.1	100.1	100.1	100.1	100.2	100.2
5	100.0	99.3	99.4	99.5	99.6	99.6	99.6	99.6	99.7	99.6	99.6	99.6	99.6	99.6	99.7
6	100.0	99.8	99.9	100.0	100.1	100.0	100.1	100.1	100.1	100.1	100.1	100.0	100.1	100.1	100.2
7	100.0	99.6	99.7	99.9	100.0	100.0	100.1	100.1	100.1	100.1	100.1	100.0	100.1	100.1	100.2
8	100.0	99.6	99.7	99.9	99.9	100.0	100.0	100.0	100.1	100.1	100.0	100.0	100.0	100.1	100.1
9	100.0	99.3	99.4	99.6	99.6	99.6	99.7	99.6	99.6	99.7	99.6	99.6	99.6	99.7	99.7
10	100.0	99.5	99.6	99.8	99.8	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	100.0	100.0
11	100.0	99.7	99.9	100.2	100.2	100.3	100.4	100.3	100.4	100.4	100.4	100.3	100.3	100.4	100.5
12	100.0	99.5	99.6	99.8	99.8	99.9	100.0	99.9	99.9	99.9	99.9	99.8	99.9	100.0	100.0
13	100.0	99.8	99.8	100.0	100.0	100.0	100.1	100.0	100.0	100.0	100.0	99.9	100.0	100.0	100.0
14	100.0	99.3	99.4	99.5	99.5	99.6	99.7	99.6	99.7	99.6	99.6	99.6	99.6	99.7	99.7
15	100.0	99.7	99.8	100.0	100.1	100.1	100.2	100.1	100.2	100.2	100.4	100.6	100.7	100.8	100.8
16	100.0	99.4	99.4	99.6	99.6	99.6	99.7	99.6	99.7	99.7	99.6	99.6	99.6	99.7	99.7
17	100.0	99.5	99.6	99.9	99.9	99.9	100.0	100.0	100.0	100.0	100.0	99.9	100.0	100.0	100.1
18	100.0	99.6	99.7	100.1	100.2	100.3	100.5	100.4	100.5	100.4	100.4	100.4	100.4	100.5	100.6
19	100.0	99.7	99.9	100.1	100.1	100.2	100.3	100.2	100.3	100.3	100.3	100.2	100.3	100.3	100.3
20	100.0	99.2	99.3	99.5	99.8	99.8	99.9	99.8	99.9	99.8	99.8	99.8	99.8	99.9	100.0
21	100.0	99.4	99.5	99.7	99.8	99.7	99.9	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.9
22	100.0	99.9	100.5	100.4	100.5	100.6	100.9	100.9	100.9	100.9	100.6	100.7	100.7	100.9	101.0
23	100.0	99.4	99.5	99.6	99.7	99.7	99.8	99.7	99.8	99.7	99.7	99.7	99.7	99.8	99.8
24	100.0	99.6	99.8	100.0	100.1	100.1	100.2	100.1	100.2	100.2	100.2	100.1	100.2	100.2	100.3
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	99.5	99.7	99.9	99.9	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.1	100.1
Med.	100.0	99.5	99.7	99.9	99.9	100.0	100.0	100.0	100.0	100.0	100.0	99.9	100.0	100.0	100.1
σ	0.00	0.19	0.25	0.25	0.26	0.28	0.31	0.32	0.32	0.32	0.30	0.32	0.33	0.34	0.34
Min.	100.0	99.2	99.3	99.5	99.5	99.6	99.6	99.6	99.6	99.5	99.6	99.5	99.6	99.6	99.7
Max.	100.0	99.9	100.5	100.4	100.5	100.6	100.9	100.9	100.9	100.9	100.6	100.7	100.7	100.9	101.0

Data Set 5 : 105°C, 700 mA

Actual Case Temperature [T _s]	107.9 °C
Actual Ambient Temperature [T _A]	106.0 °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

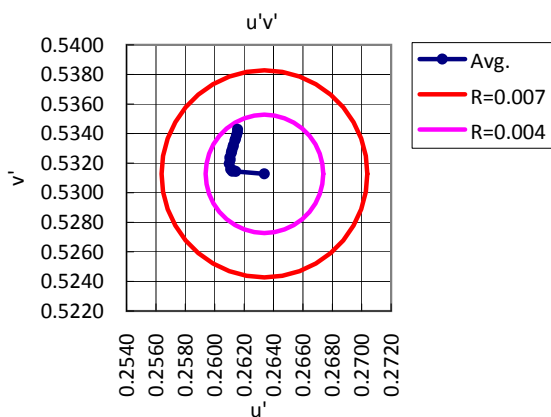
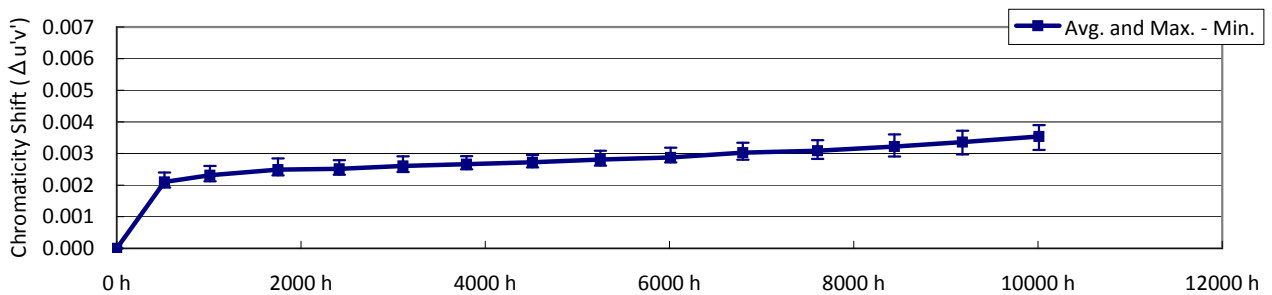
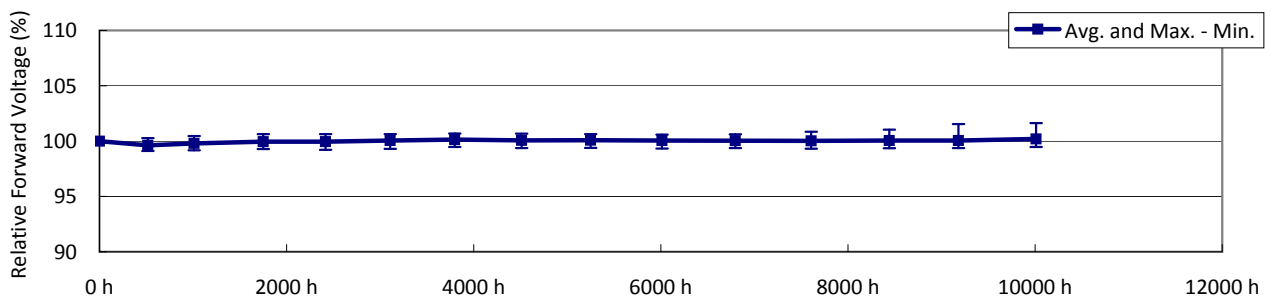
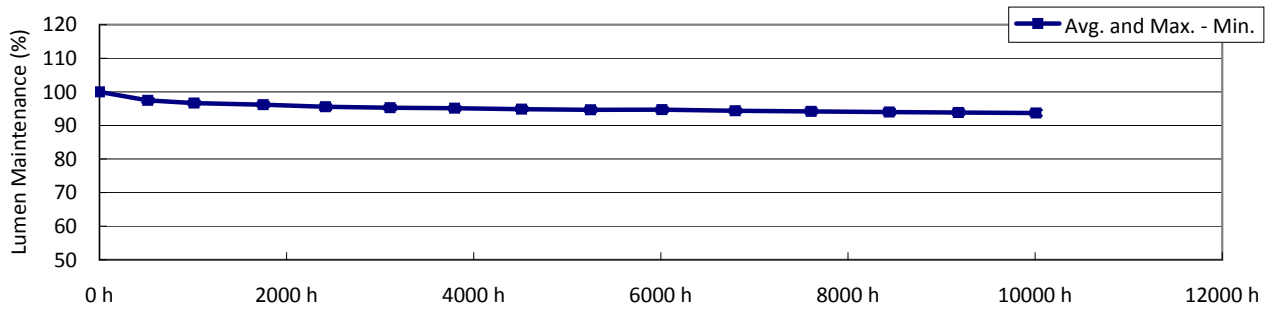
LED No.	Chromaticity Shift Δu'v'														
	0 h	517 h	1011 h	1750 h	2416 h	3107 h	3797 h	4512 h	5249 h	6012 h	6796 h	7607 h	8441 h	9180 h	10011 h
1	0.0000	0.0020	0.0022	0.0023	0.0024	0.0024	0.0024	0.0024	0.0025	0.0024	0.0025	0.0025	0.0025	0.0025	0.0026
2	0.0000	0.0019	0.0022	0.0023	0.0023	0.0024	0.0023	0.0023	0.0024	0.0024	0.0024	0.0024	0.0025	0.0025	0.0026
3	0.0000	0.0021	0.0023	0.0025	0.0025	0.0026	0.0026	0.0026	0.0026	0.0026	0.0027	0.0028	0.0027	0.0028	0.0028
4	0.0000	0.0019	0.0022	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0025	0.0025	0.0025	0.0025	0.0026
5	0.0000	0.0019	0.0021	0.0023	0.0023	0.0022	0.0023	0.0023	0.0024	0.0025	0.0023	0.0024	0.0024	0.0025	0.0026
6	0.0000	0.0019	0.0021	0.0023	0.0022	0.0023	0.0023	0.0023	0.0023	0.0024	0.0024	0.0025	0.0025	0.0025	0.0026
7	0.0000	0.0021	0.0023	0.0025	0.0026	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0028	0.0029	0.0029
8	0.0000	0.0018	0.0020	0.0023	0.0022	0.0024	0.0023	0.0023	0.0023	0.0023	0.0024	0.0024	0.0024	0.0026	0.0026
9	0.0000	0.0020	0.0022	0.0025	0.0025	0.0026	0.0025	0.0026	0.0025	0.0026	0.0026	0.0026	0.0027	0.0028	0.0028
10	0.0000	0.0022	0.0025	0.0027	0.0027	0.0028	0.0027	0.0027	0.0028	0.0029	0.0029	0.0028	0.0028	0.0030	0.0030
11	0.0000	0.0018	0.0020	0.0021	0.0021	0.0022	0.0021	0.0021	0.0023	0.0023	0.0022	0.0022	0.0023	0.0024	0.0024
12	0.0000	0.0018	0.0021	0.0023	0.0023	0.0023	0.0023	0.0023	0.0024	0.0024	0.0024	0.0024	0.0024	0.0026	0.0026
13	0.0000	0.0019	0.0021	0.0023	0.0023	0.0024	0.0023	0.0023	0.0023	0.0023	0.0024	0.0024	0.0024	0.0025	0.0025
14	0.0000	0.0020	0.0022	0.0024	0.0024	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0026	0.0026	0.0027	0.0028
15	0.0000	0.0019	0.0022	0.0024	0.0024	0.0024	0.0024	0.0024	0.0025	0.0025	0.0024	0.0025	0.0025	0.0025	0.0027
16	0.0000	0.0020	0.0022	0.0024	0.0023	0.0024	0.0023	0.0023	0.0024	0.0025	0.0024	0.0024	0.0025	0.0025	0.0025
17	0.0000	0.0019	0.0022	0.0023	0.0022	0.0023	0.0023	0.0023	0.0024	0.0024	0.0023	0.0023	0.0024	0.0024	0.0025
18	0.0000	0.0025	0.0028	0.0031	0.0030	0.0031	0.0031	0.0031	0.0031	0.0032	0.0031	0.0031	0.0031	0.0033	0.0032
19	0.0000	0.0019	0.0021	0.0023	0.0023	0.0023	0.0023	0.0023	0.0024	0.0024	0.0024	0.0024	0.0025	0.0025	0.0026
20	0.0000	0.0019	0.0021	0.0023	0.0023	0.0023	0.0023	0.0024	0.0024	0.0024	0.0024	0.0025	0.0025	0.0025	0.0027
21	0.0000	0.0019	0.0022	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0025	0.0025	0.0025	0.0025	0.0027
22	0.0000	0.0020	0.0022	0.0024	0.0024	0.0024	0.0024	0.0024	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0026
23	0.0000	0.0019	0.0022	0.0024	0.0023	0.0023	0.0023	0.0023	0.0024	0.0025	0.0024	0.0024	0.0024	0.0025	0.0025
24	0.0000	0.0020	0.0023	0.0025	0.0024	0.0025	0.0025	0.0025	0.0025	0.0026	0.0026	0.0026	0.0026	0.0028	0.0027
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	0.0024	0.0024	0.0024	0.0024	0.0025	0.0025	0.0025	0.0025	0.0025	0.0026	0.0027
Med.	0.0000	0.0019	0.0022	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0025	0.0025	0.0025	0.0026
σ	0.0000	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Min.	0.0000	0.0018	0.0020	0.0021	0.0021	0.0022	0.0021	0.0021	0.0023	0.0023	0.0022	0.0022	0.0023	0.0024	0.0024
Max.	0.0000	0.0025	0.0028	0.0031	0.0030	0.0031	0.0031	0.0031	0.0031	0.0032	0.0031	0.0031	0.0031	0.0033	0.0032

Data Set 6 : 105°C, 1000 mA

Actual Case Temperature [T_S]	110.1 °C
Actual Ambient Temperature [T_A]	108.0 °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]	110.1 °C
Actual Ambient Temperature [T _A]	108.0 °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	262	3.48	2667	0.467	0.419	0.263	0.532						
2	263	3.47	2673	0.466	0.418	0.263	0.531						
3	271	3.42	2722	0.461	0.416	0.261	0.530						
4	259	3.37	2701	0.464	0.418	0.262	0.531						
5	264	3.39	2664	0.467	0.419	0.263	0.531						
6	264	3.37	2687	0.465	0.419	0.262	0.531						
7	268	3.40	2684	0.465	0.418	0.263	0.531						
8	264	3.46	2701	0.462	0.415	0.262	0.529						
9	263	3.41	2703	0.464	0.419	0.262	0.531						
10	264	3.42	2651	0.468	0.419	0.264	0.532						
11	263	3.37	2683	0.465	0.417	0.263	0.531						
12	262	3.48	2719	0.461	0.415	0.261	0.529						
13	255	3.42	2513	0.482	0.424	0.271	0.536						
14	263	3.45	2705	0.463	0.416	0.262	0.530						
15	265	3.44	2713	0.461	0.414	0.262	0.529						
16	260	3.43	2645	0.470	0.421	0.264	0.533						
17	266	3.43	2710	0.462	0.415	0.262	0.529						
18	264	3.38	2697	0.465	0.419	0.262	0.531						
19	259	3.37	2597	0.474	0.421	0.267	0.533						
20	266	3.46	2692	0.463	0.415	0.262	0.530						
21	264	3.46	2648	0.468	0.417	0.264	0.531						
22	265	3.44	2683	0.465	0.418	0.263	0.531						
23	257	3.43	2552	0.479	0.424	0.269	0.535						
24	255	3.37	2623	0.472	0.422	0.265	0.533						
n	24	24	24	24	24	24	24						
Avg.	263	3.42	2668	0.467	0.418	0.263	0.531						
Med.	264	3.42	2683	0.465	0.418	0.263	0.531						
σ	3.8	0.037	52.2	0.0055	0.0027	0.0024	0.0018						
Min.	255	3.37	2513	0.461	0.414	0.261	0.529						
Max.	271	3.48	2722	0.482	0.424	0.271	0.536						

Data Set 6 : 105°C, 1000 mA

Actual Case Temperature [T _s]	110.1 °C
Actual Ambient Temperature [T _A]	108.0 °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	517 h	1011 h	1750 h	2416 h	3107 h	3797 h	4512 h	5249 h	6012 h	6796 h	7607 h	8441 h	9180 h	10011 h
1	100.0	97.4	96.5	96.0	95.3	95.5	95.2	95.3	94.8	94.7	94.4	94.2	93.9	93.9	93.6
2	100.0	97.8	97.1	96.6	96.2	96.0	95.7	95.7	95.1	95.1	94.9	94.6	94.6	94.6	94.3
3	100.0	97.5	96.5	96.1	95.9	95.4	95.0	94.9	94.5	94.5	94.4	94.2	94.0	93.1	93.3
4	100.0	97.9	97.0	96.7	96.3	95.6	95.2	95.2	94.6	94.7	94.5	94.4	94.3	94.2	94.0
5	100.0	97.2	96.2	95.8	95.0	94.6	94.5	94.4	94.0	93.9	93.7	93.5	93.3	93.2	92.9
6	100.0	97.5	96.5	96.0	95.4	95.3	95.3	95.3	94.7	94.8	94.3	94.1	93.8	93.8	93.4
7	100.0	97.5	96.8	96.3	95.4	95.6	95.5	95.1	95.0	95.1	94.7	94.5	94.3	94.3	93.9
8	100.0	97.5	96.7	96.4	95.6	95.6	95.4	94.8	94.9	94.9	94.5	94.4	94.3	94.3	94.1
9	100.0	97.9	96.9	96.5	96.0	95.5	95.2	94.5	94.6	94.5	94.4	94.1	94.0	93.8	93.7
10	100.0	97.5	96.7	95.7	95.6	95.1	94.8	94.4	94.5	94.6	94.3	94.1	94.0	93.9	93.6
11	100.0	97.3	96.5	96.2	95.5	95.1	95.1	94.8	94.8	94.8	94.3	94.3	94.1	94.0	93.8
12	100.0	96.8	96.0	95.6	94.7	94.8	94.8	94.4	94.2	94.3	93.7	93.5	93.2	93.1	92.9
13	100.0	96.9	96.1	95.6	94.8	94.7	94.8	94.4	94.3	94.4	93.8	93.7	93.7	93.6	93.4
14	100.0	97.5	96.8	96.3	95.6	95.0	94.8	94.2	94.3	94.3	94.0	93.8	93.7	93.5	93.3
15	100.0	97.4	96.8	96.4	96.1	95.2	95.2	95.0	94.8	94.9	94.7	94.5	94.4	94.2	94.1
16	100.0	97.4	96.6	95.8	95.3	94.7	94.4	94.3	94.2	94.1	93.9	93.8	93.5	93.3	93.1
17	100.0	98.1	97.4	96.9	96.2	95.8	95.6	95.5	95.4	95.4	95.1	95.0	94.9	94.7	94.6
18	100.0	97.3	96.4	95.9	95.2	95.2	95.2	94.9	94.7	94.8	94.2	93.9	93.2	93.4	93.5
19	100.0	97.5	96.6	96.1	95.4	95.5	95.4	95.1	95.0	95.1	94.6	94.5	94.2	94.1	94.1
20	100.0	97.6	96.8	96.4	95.9	95.6	95.4	95.1	95.1	95.2	94.9	94.7	94.6	94.5	94.3
21	100.0	97.7	96.9	96.3	96.2	95.6	95.4	94.9	94.7	94.9	94.6	94.4	94.2	94.1	94.0
22	100.0	97.5	96.8	96.3	96.0	95.3	95.1	94.4	94.7	94.7	94.4	94.3	94.0	93.9	93.7
23	100.0	97.3	96.3	95.8	95.0	94.5	94.4	94.3	94.0	94.1	93.7	93.6	93.4	93.3	93.1
24	100.0	97.1	96.3	95.9	95.2	95.2	95.3	95.1	94.9	95.0	94.3	94.2	94.0	93.8	93.7
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	97.5	96.6	96.2	95.6	95.3	95.1	94.8	94.6	94.7	94.3	94.2	94.0	93.9	93.7
Med.	100.0	97.5	96.7	96.2	95.5	95.3	95.2	94.9	94.7	94.8	94.4	94.2	94.0	93.9	93.7
σ	0.00	0.29	0.32	0.35	0.47	0.39	0.36	0.41	0.36	0.38	0.39	0.38	0.44	0.47	0.45
Min.	100.0	96.8	96.0	95.6	94.7	94.5	94.4	94.2	94.0	93.9	93.7	93.5	93.2	93.1	92.9
Max.	100.0	98.1	97.4	96.9	96.3	96.0	95.7	95.7	95.4	95.4	95.1	95.0	94.9	94.7	94.6

TM-21 Projection

Time	4512 h	5249 h	6012 h	6796 h	7607 h	8441 h	9180 h	10011 h							
ln(Avg.)	-0.0531	-0.0550	-0.0545	-0.0583	-0.0600	-0.0621	-0.0633	-0.0652							

Test duration used	4512 h	to	10011 h
B	0.9585		
α	2.2880E-06		
R ²	0.9742		
Calculated L ₇₀ (10K)	137000	hours	
Reported L ₇₀ (10K)	> 60100	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]	110.1 °C
Actual Ambient Temperature [T _A]	108.0 °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	517 h	1011 h	1750 h	2416 h	3107 h	3797 h	4512 h	5249 h	6012 h	6796 h	7607 h	8441 h	9180 h	10011 h
1	100.0	99.8	100.0	100.1	100.1	100.1	100.2	100.1	100.1	100.0	100.0	100.0	100.0	100.0	100.1
2	100.0	99.6	99.7	99.9	100.0	100.0	100.0	100.0	100.0	99.9	99.9	99.9	99.9	99.9	100.0
3	100.0	100.2	100.5	100.6	100.6	100.6	100.7	100.7	100.6	100.6	100.6	100.6	100.6	101.5	101.6
4	100.0	99.5	99.7	99.7	99.7	100.0	100.3	100.3	100.3	100.2	100.3	100.2	100.1	99.9	100.4
5	100.0	100.0	100.1	100.4	100.4	100.4	100.5	100.5	100.4	100.3	100.4	100.4	100.3	100.3	100.4
6	100.0	99.7	99.8	100.0	100.1	100.0	100.1	100.1	100.1	100.1	100.1	100.0	100.0	100.1	100.2
7	100.0	99.9	100.1	100.3	100.3	100.4	100.5	100.3	100.3	100.3	100.3	100.2	100.3	100.3	100.4
8	100.0	99.6	99.7	99.9	99.8	99.9	100.0	99.8	99.9	99.9	99.8	99.8	99.9	99.8	99.9
9	100.0	99.1	99.2	99.3	99.2	99.3	99.6	99.9	99.9	100.0	99.9	99.8	99.9	100.0	100.0
10	100.0	99.6	99.7	99.9	99.8	100.0	100.0	99.9	99.9	99.9	99.9	99.9	99.9	99.9	100.0
11	100.0	99.8	100.3	100.5	100.1	100.4	100.6	100.4	100.5	100.4	100.4	100.4	100.4	100.5	100.5
12	100.0	100.3	100.3	100.4	100.3	100.4	100.4	100.3	100.3	100.3	100.3	100.2	100.3	100.3	100.4
13	100.0	99.7	99.8	100.0	100.0	100.1	100.1	100.0	100.0	100.0	99.9	99.9	99.9	99.8	100.0
14	100.0	99.2	99.3	99.4	99.7	100.4	100.5	100.4	100.4	100.4	100.3	100.3	100.3	100.3	100.4
15	100.0	99.3	99.4	99.5	99.5	99.5	99.5	99.4	99.5	99.4	99.4	99.4	99.4	99.4	99.5
16	100.0	99.5	99.7	99.9	100.0	100.2	100.3	100.2	100.2	100.2	100.2	100.1	100.2	100.1	100.3
17	100.0	99.7	99.8	100.0	100.0	100.1	100.2	100.0	100.1	100.0	100.0	100.0	100.1	100.0	100.1
18	100.0	99.9	100.2	100.3	100.3	100.3	100.4	100.3	100.4	100.4	100.6	100.8	101.0	100.3	100.9
19	100.0	99.3	99.5	99.6	99.6	99.6	99.7	99.5	99.6	99.6	99.5	99.5	99.5	99.6	99.6
20	100.0	99.5	99.6	99.8	99.8	99.8	99.9	99.8	99.9	99.8	99.8	99.8	99.8	99.8	99.9
21	100.0	99.4	99.6	99.7	99.6	99.7	99.8	99.7	99.7	99.6	99.6	99.6	99.6	99.6	99.7
22	100.0	99.6	99.7	99.9	99.8	99.8	99.9	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.9
23	100.0	99.5	99.8	100.4	100.5	100.6	100.6	100.5	100.5	100.6	100.5	100.4	100.5	100.5	100.7
24	100.0	99.3	99.4	99.4	99.5	99.4	99.5	99.4	99.4	99.3	99.4	99.3	99.4	99.4	99.5
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	100.0	99.6	99.8	100.0	99.9	100.0	100.1	100.1	100.1	100.0	100.0	100.0	100.1	100.0	100.2
Med.	100.0	99.6	99.7	99.9	100.0	100.1	100.2	100.1	100.1	100.0	100.0	100.0	100.0	100.0	100.1
σ	0.00	0.29	0.33	0.36	0.35	0.36	0.35	0.35	0.34	0.34	0.35	0.38	0.39	0.45	0.47
Min.	100.0	99.1	99.2	99.3	99.2	99.3	99.5	99.4	99.4	99.3	99.4	99.3	99.4	99.4	99.5
Max.	100.0	100.3	100.5	100.6	100.6	100.6	100.7	100.7	100.6	100.6	100.6	100.8	101.0	101.5	101.6

Data Set 6 : 105°C, 1000 mA

Actual Case Temperature [T _s]	110.1 °C
Actual Ambient Temperature [T _A]	108.0 °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	517 h	1011 h	1750 h	2416 h	3107 h	3797 h	4512 h	5249 h	6012 h	6796 h	7607 h	8441 h	9180 h	10011 h
1	0.0000	0.0021	0.0023	0.0025	0.0026	0.0027	0.0027	0.0029	0.0029	0.0030	0.0031	0.0032	0.0033	0.0036	0.0036
2	0.0000	0.0020	0.0022	0.0024	0.0025	0.0025	0.0027	0.0028	0.0028	0.0028	0.0030	0.0031	0.0032	0.0034	0.0036
3	0.0000	0.0021	0.0023	0.0024	0.0025	0.0026	0.0027	0.0028	0.0028	0.0029	0.0031	0.0031	0.0033	0.0035	0.0038
4	0.0000	0.0021	0.0024	0.0025	0.0026	0.0027	0.0027	0.0029	0.0029	0.0030	0.0030	0.0032	0.0033	0.0036	0.0036
5	0.0000	0.0019	0.0022	0.0024	0.0023	0.0024	0.0025	0.0027	0.0028	0.0029	0.0031	0.0031	0.0033	0.0035	0.0037
6	0.0000	0.0020	0.0022	0.0023	0.0023	0.0024	0.0026	0.0027	0.0027	0.0028	0.0029	0.0030	0.0031	0.0034	0.0035
7	0.0000	0.0021	0.0023	0.0024	0.0025	0.0025	0.0026	0.0027	0.0028	0.0028	0.0030	0.0030	0.0031	0.0033	0.0035
8	0.0000	0.0019	0.0021	0.0023	0.0025	0.0025	0.0026	0.0026	0.0028	0.0029	0.0031	0.0031	0.0032	0.0034	0.0035
9	0.0000	0.0024	0.0026	0.0028	0.0028	0.0029	0.0029	0.0030	0.0031	0.0031	0.0032	0.0032	0.0033	0.0035	0.0037
10	0.0000	0.0021	0.0023	0.0024	0.0025	0.0025	0.0026	0.0026	0.0028	0.0028	0.0030	0.0030	0.0031	0.0032	0.0034
11	0.0000	0.0020	0.0021	0.0023	0.0023	0.0024	0.0025	0.0026	0.0026	0.0028	0.0029	0.0029	0.0031	0.0032	0.0034
12	0.0000	0.0020	0.0022	0.0024	0.0024	0.0025	0.0026	0.0027	0.0029	0.0030	0.0032	0.0033	0.0034	0.0036	0.0038
13	0.0000	0.0023	0.0025	0.0026	0.0027	0.0027	0.0027	0.0027	0.0027	0.0028	0.0028	0.0029	0.0029	0.0030	0.0031
14	0.0000	0.0020	0.0022	0.0024	0.0025	0.0028	0.0029	0.0029	0.0030	0.0032	0.0033	0.0034	0.0036	0.0037	0.0039
15	0.0000	0.0020	0.0022	0.0024	0.0024	0.0025	0.0026	0.0027	0.0028	0.0028	0.0031	0.0031	0.0032	0.0034	0.0037
16	0.0000	0.0023	0.0025	0.0027	0.0027	0.0027	0.0028	0.0027	0.0029	0.0029	0.0031	0.0032	0.0033	0.0034	0.0035
17	0.0000	0.0021	0.0023	0.0025	0.0025	0.0024	0.0026	0.0026	0.0027	0.0028	0.0030	0.0030	0.0031	0.0032	0.0034
18	0.0000	0.0020	0.0022	0.0024	0.0024	0.0026	0.0026	0.0026	0.0028	0.0028	0.0031	0.0031	0.0033	0.0034	0.0036
19	0.0000	0.0020	0.0022	0.0025	0.0024	0.0025	0.0025	0.0026	0.0027	0.0027	0.0028	0.0028	0.0030	0.0031	0.0032
20	0.0000	0.0021	0.0022	0.0025	0.0026	0.0026	0.0026	0.0027	0.0028	0.0029	0.0030	0.0032	0.0033	0.0034	0.0036
21	0.0000	0.0022	0.0024	0.0026	0.0026	0.0027	0.0026	0.0027	0.0028	0.0029	0.0030	0.0031	0.0033	0.0034	0.0036
22	0.0000	0.0020	0.0022	0.0025	0.0025	0.0025	0.0026	0.0026	0.0028	0.0028	0.0029	0.0031	0.0032	0.0033	0.0034
23	0.0000	0.0023	0.0026	0.0028	0.0028	0.0029	0.0029	0.0029	0.0029	0.0030	0.0029	0.0030	0.0031	0.0032	0.0033
24	0.0000	0.0021	0.0024	0.0026	0.0025	0.0027	0.0027	0.0026	0.0027	0.0028	0.0029	0.0030	0.0031	0.0032	0.0034
n	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Avg.	0.0000	0.0021	0.0023	0.0025	0.0025	0.0026	0.0027	0.0027	0.0028	0.0029	0.0030	0.0031	0.0032	0.0034	0.0035
Med.	0.0000	0.0021	0.0023	0.0025	0.0025	0.0026	0.0026	0.0027	0.0028	0.0028	0.0030	0.0031	0.0032	0.0034	0.0035
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	0.0002	0.0002
Min.	0.0000	0.0019	0.0021	0.0023	0.0023	0.0024	0.0025	0.0026	0.0026	0.0027	0.0028	0.0028	0.0029	0.0030	0.0031
Max.	0.0000	0.0024	0.0026	0.0028	0.0028	0.0029	0.0029	0.0030	0.0031	0.0032	0.0033	0.0034	0.0036	0.0037	0.0039