

LM-80 Test Report

Reissued with Amendment

NFSL757D

This test report is reissued to supersede Test Report No. SQETMN547004 dated January 21, 2014.

Issue Date:	July 1, 2013	Revision Date:	January 23, 2014
Test Initiation Date:	April 26, 2013	Test Completion Date:	-
Test Duration:	6,000 hours	Report Number:	SQETMN547004R

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: NFSL757D (Nominal CCT: 2700 K)

Test Summary:

Data Set	Case Temperature [T _s]	Ambient Temperature [T _A]	Drive Current [I _F]	Lumen Maintenance at 6,000 hours	Chromaticity Shift (Δu'v') at 6,000 hours	TM-21 Projection L ₇₀ (6K)
1	55 °C	> 50 °C	65 mA	98.0 %	0.0010	> 36700 hours
2	55 °C	> 50 °C	150 mA	99.3 %	0.0013	> 36700 hours
3	55 °C	> 50 °C	180 mA	99.7 %	0.0013	> 36700 hours
4	85 °C	> 80 °C	65 mA	97.0 %	0.0010	> 36700 hours
5	85 °C	> 80 °C	150 mA	97.6 %	0.0013	> 36700 hours
6	85 °C	> 80 °C	180 mA	97.9 %	0.0014	> 36700 hours
7	105 °C	> 100 °C	65 mA	94.3 %	0.0012	> 36700 hours
8	105 °C	> 100 °C	150 mA	94.8 %	0.0016	> 36700 hours
9	105 °C	> 100 °C	180 mA	95.2 %	0.0017	> 36700 hours

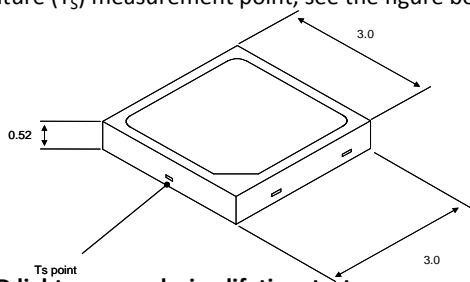
Approved Signatory:



Hitoshi TOHYAMA, Lab Manager

Nichia Corporation LED Testing Laboratory
 1-1, Tatsumi-Cho, Anan-Shi, TOKUSHIMA 774-0001, JAPAN

IES LM-80-08 Test Report Requirement :

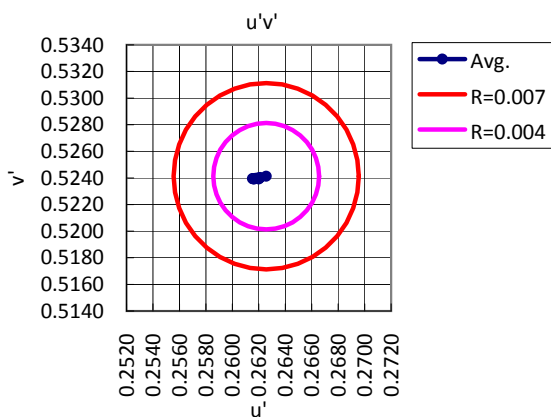
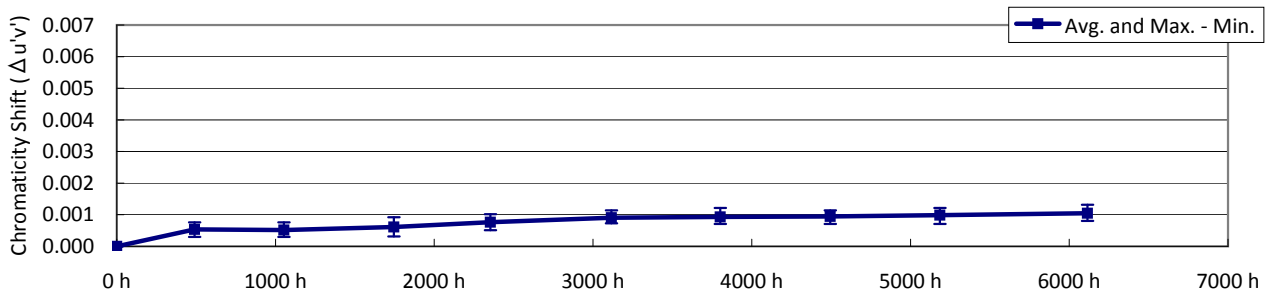
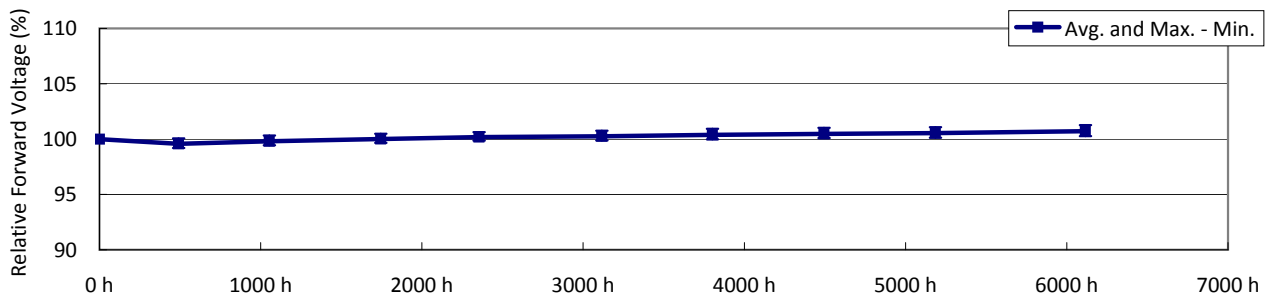
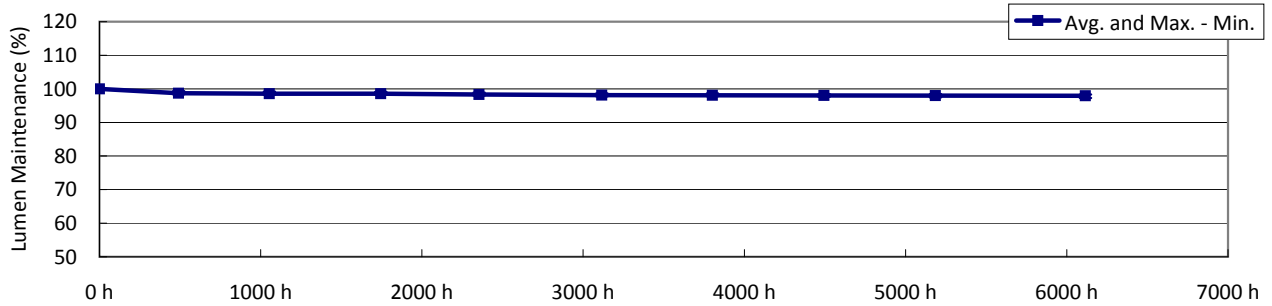
1. **Number of LED light sources tested**
See tables.
 2. **Description of LED light sources**
See Description of Test Samples
 3. **Description of auxiliary equipment**
Active cooling life test system
Consisting of small boxes, in which each box contains a reliability test board, and a water-cooled 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 : < 0.1 m/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, 65 mA

Actual Case Temperature [T_S]	55.2 °C
Actual Ambient Temperature [T_A]	54.2 °C
Drive Current [I_F]	65 mA
Measurement Current	65 mA

NOTES:

T_S and T_A were measured during initial setup.



Data Set 1 : 55 °C, 65 mA

Actual Case Temperature [T _s]	55.2 °C
Actual Ambient Temperature [T _A]	54.2 °C
Drive Current [I _F]	65 mA
Measurement Current	65 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	24.0	2.90	2593	0.471	0.416	0.267	0.531						
2	24.0	2.90	2661	0.465	0.415	0.264	0.530						
3	24.5	2.90	2853	0.442	0.396	0.257	0.519						
4	24.0	2.91	2688	0.457	0.403	0.264	0.524						
5	24.1	2.90	2707	0.459	0.410	0.262	0.527						
6	24.2	2.90	2773	0.449	0.400	0.260	0.521						
7	24.3	2.89	2663	0.466	0.416	0.264	0.530						
8	24.1	2.91	2777	0.445	0.393	0.261	0.518						
9	24.2	2.91	2776	0.448	0.399	0.260	0.521						
10	24.4	2.91	2835	0.443	0.396	0.258	0.519						
11	24.6	2.90	2733	0.456	0.408	0.261	0.526						
12	24.1	2.91	2662	0.463	0.412	0.264	0.528						
13	24.5	2.90	2840	0.443	0.397	0.258	0.520						
14	23.8	2.90	2752	0.449	0.397	0.262	0.520						
15	23.6	2.90	2589	0.468	0.410	0.268	0.528						
16	23.8	2.90	2601	0.470	0.415	0.267	0.530						
17	24.1	2.90	2735	0.452	0.401	0.262	0.523						
18	23.8	2.91	2623	0.466	0.411	0.266	0.528						
19	24.3	2.90	2754	0.449	0.398	0.261	0.521						
20	24.2	2.90	2780	0.450	0.402	0.260	0.522						
21	24.2	2.90	2804	0.443	0.392	0.260	0.517						
22	24.1	2.90	2736	0.451	0.399	0.262	0.521						
23	23.9	2.90	2765	0.448	0.397	0.261	0.520						
24	23.9	2.90	2641	0.462	0.407	0.266	0.527						
25	23.7	2.90	2658	0.461	0.407	0.265	0.526						
n	25	25	25	25	25	25	25						
Avg.	24.1	2.90	2720	0.455	0.404	0.262	0.524						
Med.	24.1	2.90	2735	0.452	0.402	0.262	0.523						
σ	0.26	0.005	78.6	0.0094	0.0077	0.0030	0.0044						
Min.	23.6	2.89	2589	0.442	0.392	0.257	0.517						
Max.	24.6	2.91	2853	0.471	0.416	0.268	0.531						

Data Set 1 : 55 °C, 65 mA

Actual Case Temperature [T _s]	55.2 °C
Actual Ambient Temperature [T _A]	54.2 °C
Drive Current [I _F]	65 mA
Measurement Current	65 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	490 h	1053 h	1745 h	2354 h	3116 h	3802 h	4494 h	5185 h	6115 h				
1	100.0	98.8	98.6	98.6	98.2	98.3	98.1	98.2	98.0	98.1				
2	100.0	98.5	98.3	98.4	98.2	98.1	97.9	98.1	98.0	98.1				
3	100.0	98.6	98.4	98.4	98.3	98.1	97.9	98.1	98.0	98.2				
4	100.0	98.6	98.3	98.4	98.3	98.0	97.9	98.1	97.8	98.2				
5	100.0	98.9	98.7	98.6	98.5	98.4	98.2	98.3	98.0	98.1				
6	100.0	98.5	98.3	98.3	98.2	98.0	98.0	98.0	97.7	97.8				
7	100.0	98.4	98.2	98.2	98.0	97.9	97.9	97.9	97.6	97.5				
8	100.0	99.0	99.0	98.9	98.5	98.5	98.5	98.4	98.1	97.9				
9	100.0	99.0	98.9	98.8	98.3	98.4	98.3	98.2	98.1	97.8				
10	100.0	98.7	98.7	98.6	98.2	98.2	98.2	98.1	98.0	97.8				
11	100.0	99.0	98.8	98.8	98.5	98.4	98.3	98.3	98.3	98.3				
12	100.0	98.7	98.6	98.5	98.3	98.1	98.1	98.1	98.1	98.2				
13	100.0	98.6	98.5	98.5	98.3	98.0	98.0	98.1	98.1	98.1				
14	100.0	98.6	98.5	98.4	98.2	98.0	97.9	97.9	97.9	97.9				
15	100.0	98.4	98.3	98.3	98.2	98.0	97.9	98.0	97.9	97.9				
16	100.0	98.5	98.3	98.2	98.1	97.8	97.8	97.8	97.7	97.6				
17	100.0	98.6	98.4	98.4	98.2	97.7	97.8	97.6	97.4	97.3				
18	100.0	99.3	99.2	99.1	98.9	98.6	98.6	98.4	98.2	98.0				
19	100.0	99.2	99.1	99.1	98.9	98.6	98.7	98.5	98.4	98.3				
20	100.0	99.0	98.9	98.9	98.6	98.3	98.3	98.2	98.1	98.0				
21	100.0	98.8	98.7	98.7	98.3	98.2	98.2	97.9	98.1	98.1				
22	100.0	98.7	98.6	98.6	98.2	98.0	98.0	97.7	98.0	98.0				
23	100.0	98.5	98.5	98.5	98.2	98.0	98.0	97.7	98.1	98.1				
24	100.0	98.5	98.3	98.4	98.1	97.9	97.9	97.6	97.9	97.9				
25	100.0	98.5	98.4	98.4	98.3	98.0	98.0	97.8	97.9	97.8				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	100.0	98.7	98.6	98.6	98.3	98.1	98.1	98.0	98.0	98.0				
Med.	100.0	98.6	98.5	98.5	98.3	98.1	98.0	98.1	98.0	98.0				
σ	0.00	0.25	0.27	0.25	0.23	0.24	0.24	0.24	0.21	0.25				
Min.	100.0	98.4	98.2	98.2	98.0	97.7	97.8	97.6	97.4	97.3				
Max.	100.0	99.3	99.2	99.1	98.9	98.6	98.7	98.5	98.4	98.3				

TM-21 Projection

Time	1745 h	2354 h	3116 h	3802 h	4494 h	5185 h	6115 h							
ln(Avg.)	-0.0145	-0.0170	-0.0188	-0.0191	-0.0198	-0.0204	-0.0207							

Test duration used	1745 h	to	6115 h
B	0.9864		
α	1.2841E-06		
R ²	0.8385		
Calculated L ₇₀ (6K)	267000	hours	
Reported L ₇₀ (6K)	> 36700	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, 65 mA

Actual Case Temperature [T _s]	55.2 °C
Actual Ambient Temperature [T _A]	54.2 °C
Drive Current [I _F]	65 mA
Measurement Current	65 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	490 h	1053 h	1745 h	2354 h	3116 h	3802 h	4494 h	5185 h	6115 h
1	100.0	100.0	100.2	100.5	100.6	100.7	100.9	100.9	101.0	101.2
2	100.0	99.9	100.2	100.3	100.4	100.5	100.7	100.7	100.7	100.9
3	100.0	99.9	100.1	100.4	100.5	100.6	100.7	100.9	100.9	101.1
4	100.0	100.1	100.3	100.5	100.6	100.8	100.9	101.0	101.1	101.3
5	100.0	100.0	100.2	100.5	100.6	100.7	100.8	100.9	101.0	101.2
6	100.0	100.0	100.2	100.4	100.5	100.7	100.8	100.8	101.0	101.1
7	100.0	99.9	100.1	100.2	100.3	100.4	100.5	100.6	100.7	100.9
8	100.0	100.0	100.2	100.4	100.6	100.7	100.9	100.9	100.9	101.2
9	100.0	99.9	100.2	100.4	100.5	100.6	100.8	100.8	101.0	101.2
10	100.0	100.0	100.2	100.4	100.6	100.7	100.8	101.0	101.0	101.2
11	100.0	99.3	99.5	99.7	100.0	100.0	100.1	100.2	100.3	100.5
12	100.0	99.3	99.5	99.8	100.0	100.0	100.1	100.3	100.3	100.5
13	100.0	99.4	99.6	99.8	99.9	100.0	100.2	100.2	100.3	100.5
14	100.0	99.3	99.5	99.8	100.0	100.0	100.1	100.3	100.3	100.5
15	100.0	99.4	99.6	99.7	99.9	99.9	100.0	100.2	100.1	100.3
16	100.0	99.2	99.4	99.7	99.9	99.9	100.0	100.1	100.2	100.3
17	100.0	99.3	99.5	99.7	100.0	100.0	100.1	100.3	100.3	100.5
18	100.0	99.3	99.5	99.7	99.9	100.0	100.1	100.2	100.3	100.5
19	100.0	99.3	99.4	99.7	99.9	99.9	100.1	100.2	100.3	100.4
20	100.0	99.2	99.5	99.7	99.9	100.0	100.1	100.1	100.3	100.4
21	100.0	99.3	99.5	99.8	100.0	100.1	100.2	100.3	100.3	100.5
22	100.0	99.3	99.6	99.8	100.0	100.1	100.2	100.3	100.4	100.5
23	100.0	99.4	99.6	99.8	99.9	100.0	100.1	100.2	100.2	100.3
24	100.0	99.3	99.6	99.8	100.0	100.0	100.2	100.3	100.3	100.5
25	100.0	99.5	99.5	99.7	99.9	99.9	100.0	100.1	100.1	100.3
n	25	25	25	25	25	25	25	25	25	25
Avg.	100.0	99.6	99.8	100.0	100.2	100.2	100.4	100.5	100.5	100.7
Med.	100.0	99.4	99.6	99.8	100.0	100.0	100.2	100.3	100.3	100.5
σ	0.00	0.32	0.34	0.34	0.29	0.34	0.35	0.32	0.35	0.36
Min.	100.0	99.2	99.4	99.7	99.9	99.9	100.0	100.1	100.1	100.3
Max.	100.0	100.1	100.3	100.5	100.6	100.8	100.9	101.0	101.1	101.3

Data Set 1 : 55 °C, 65 mA

Actual Case Temperature [T _s]	55.2 °C
Actual Ambient Temperature [T _A]	54.2 °C
Drive Current [I _F]	65 mA
Measurement Current	65 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 1-4
Chromaticity Shift

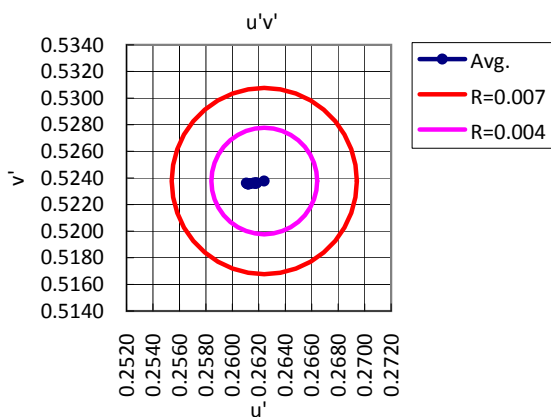
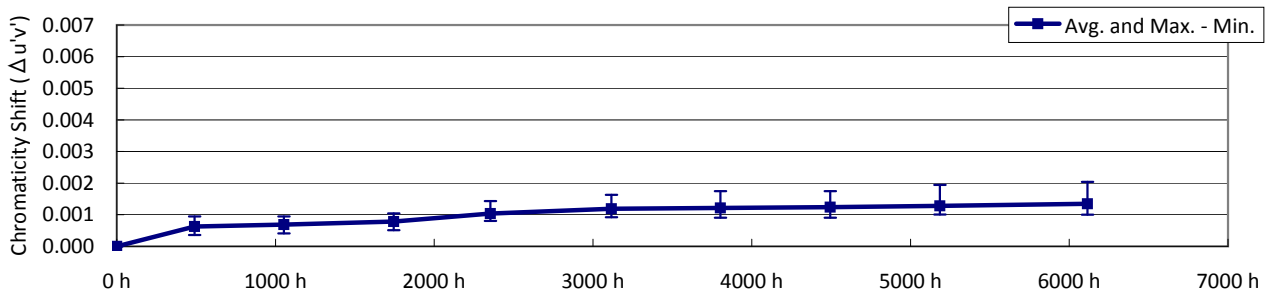
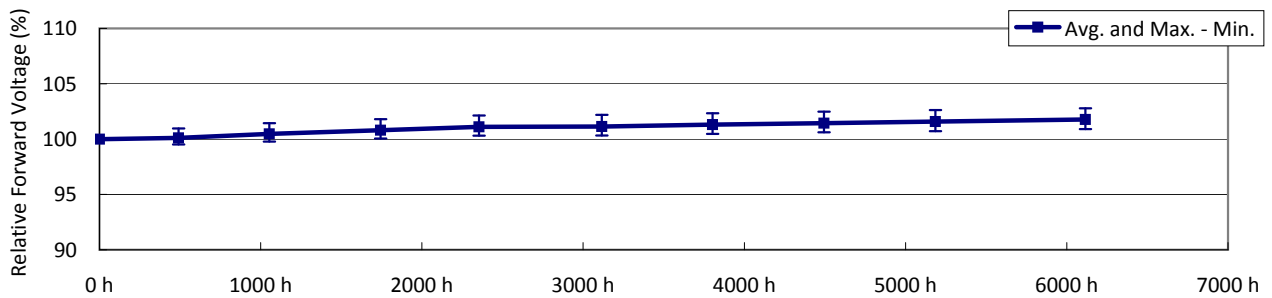
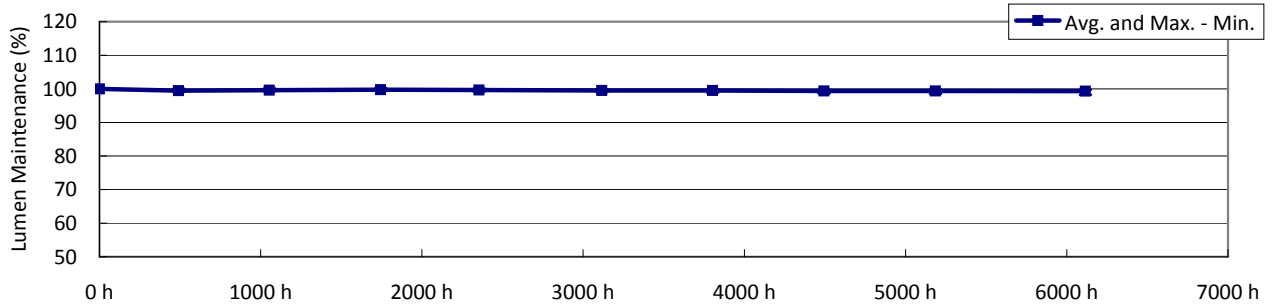
LED No.	Chromaticity Shift Δu'v'														
	0 h	490 h	1053 h	1745 h	2354 h	3116 h	3802 h	4494 h	5185 h	6115 h					
1	0.0000	0.0003	0.0003	0.0005	0.0005	0.0008	0.0008	0.0008	0.0008	0.0009					
2	0.0000	0.0004	0.0003	0.0004	0.0005	0.0007	0.0007	0.0008	0.0008	0.0008					
3	0.0000	0.0003	0.0003	0.0003	0.0005	0.0007	0.0007	0.0007	0.0008	0.0008					
4	0.0000	0.0004	0.0003	0.0005	0.0006	0.0007	0.0007	0.0007	0.0008	0.0008					
5	0.0000	0.0004	0.0004	0.0004	0.0007	0.0009	0.0008	0.0009	0.0008	0.0009					
6	0.0000	0.0004	0.0004	0.0005	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009					
7	0.0000	0.0005	0.0004	0.0005	0.0007	0.0009	0.0009	0.0009	0.0010	0.0010					
8	0.0000	0.0004	0.0004	0.0005	0.0006	0.0008	0.0007	0.0008	0.0008	0.0009					
9	0.0000	0.0003	0.0003	0.0004	0.0005	0.0007	0.0007	0.0007	0.0007	0.0008					
10	0.0000	0.0003	0.0003	0.0004	0.0006	0.0007	0.0007	0.0007	0.0008	0.0008					
11	0.0000	0.0006	0.0006	0.0007	0.0008	0.0009	0.0010	0.0010	0.0011	0.0012					
12	0.0000	0.0005	0.0005	0.0005	0.0007	0.0009	0.0009	0.0009	0.0009	0.0010					
13	0.0000	0.0005	0.0005	0.0006	0.0008	0.0009	0.0009	0.0010	0.0010	0.0011					
14	0.0000	0.0007	0.0006	0.0007	0.0009	0.0010	0.0011	0.0011	0.0011	0.0012					
15	0.0000	0.0006	0.0006	0.0006	0.0008	0.0010	0.0010	0.0011	0.0012	0.0012					
16	0.0000	0.0007	0.0007	0.0009	0.0009	0.0011	0.0012	0.0011	0.0012	0.0013					
17	0.0000	0.0008	0.0008	0.0009	0.0010	0.0009	0.0010	0.0009	0.0009	0.0011					
18	0.0000	0.0006	0.0006	0.0008	0.0009	0.0010	0.0011	0.0011	0.0011	0.0011					
19	0.0000	0.0006	0.0005	0.0006	0.0008	0.0009	0.0009	0.0010	0.0010	0.0011					
20	0.0000	0.0006	0.0006	0.0007	0.0009	0.0010	0.0011	0.0010	0.0011	0.0011					
21	0.0000	0.0005	0.0007	0.0006	0.0008	0.0009	0.0010	0.0010	0.0010	0.0011					
22	0.0000	0.0007	0.0006	0.0007	0.0009	0.0011	0.0010	0.0011	0.0011	0.0011					
23	0.0000	0.0006	0.0006	0.0007	0.0008	0.0010	0.0010	0.0010	0.0011	0.0011					
24	0.0000	0.0006	0.0006	0.0007	0.0009	0.0010	0.0011	0.0011	0.0011	0.0012					
25	0.0000	0.0007	0.0007	0.0007	0.0009	0.0010	0.0010	0.0011	0.0011	0.0012					
n	25	25	25	25	25	25	25	25	25	25					
Avg.	0.0000	0.0005	0.0005	0.0006	0.0008	0.0009	0.0009	0.0009	0.0010	0.0010					
Med.	0.0000	0.0005	0.0005	0.0006	0.0008	0.0009	0.0009	0.0010	0.0010	0.0011					
σ	0.0000	0.0001	0.0002	0.0002	0.0002	0.0001	0.0002	0.0001	0.0002	0.0002					
Min.	0.0000	0.0003	0.0003	0.0003	0.0005	0.0007	0.0007	0.0007	0.0007	0.0008					
Max.	0.0000	0.0008	0.0008	0.0009	0.0010	0.0011	0.0012	0.0011	0.0012	0.0013					

Data Set 2 : 55 °C, 150 mA

Actual Case Temperature [T _S]	57.0 °C
Actual Ambient Temperature [T _A]	55.7 °C
Drive Current [I _F]	150 mA
Measurement Current	150 mA

NOTES:

T_S and T_A were measured during initial setup.



Data Set 2 : 55 °C, 150 mA

Actual Case Temperature [T _S]	57.0 °C
Actual Ambient Temperature [T _A]	55.7 °C
Drive Current [I _F]	150 mA
Measurement Current	150 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	50.8	3.16	2672	0.460	0.408	0.264	0.526						
2	51.1	3.15	2793	0.446	0.396	0.260	0.520						
3	51.2	3.16	2848	0.441	0.393	0.258	0.518						
4	51.9	3.16	2805	0.448	0.402	0.259	0.522						
5	50.4	3.16	2644	0.461	0.406	0.266	0.526						
6	50.2	3.16	2645	0.461	0.405	0.266	0.525						
7	49.9	3.16	2753	0.447	0.394	0.262	0.519						
8	49.9	3.16	2650	0.461	0.406	0.265	0.526						
9	51.0	3.16	2786	0.445	0.394	0.260	0.519						
10	50.3	3.16	2646	0.465	0.413	0.265	0.529						
11	51.6	3.15	2692	0.459	0.408	0.263	0.526						
12	50.4	3.16	2734	0.449	0.395	0.262	0.520						
13	50.3	3.16	2663	0.462	0.409	0.264	0.527						
14	51.0	3.16	2653	0.465	0.413	0.265	0.529						
15	50.6	3.16	2687	0.458	0.405	0.264	0.525						
16	51.2	3.15	2697	0.461	0.412	0.263	0.528						
17	50.6	3.16	2765	0.448	0.397	0.261	0.520						
18	50.6	3.16	2683	0.460	0.408	0.264	0.526						
19	50.5	3.17	2747	0.452	0.402	0.261	0.523						
20	51.6	3.16	2745	0.455	0.407	0.261	0.525						
21	50.1	3.17	2601	0.470	0.416	0.267	0.531						
22	50.8	3.16	2702	0.459	0.409	0.263	0.527						
23	50.6	3.16	2779	0.445	0.394	0.261	0.518						
24	50.8	3.16	2742	0.451	0.400	0.262	0.522						
25	51.6	3.15	2694	0.459	0.407	0.263	0.526						
n	25	25	25	25	25	25	25						
Avg.	50.8	3.16	2713	0.455	0.404	0.263	0.524						
Med.	50.6	3.16	2697	0.459	0.406	0.263	0.525						
σ	0.54	0.005	61.8	0.0077	0.0068	0.0023	0.0038						
Min.	49.9	3.15	2601	0.441	0.393	0.258	0.518						
Max.	51.9	3.17	2848	0.470	0.416	0.267	0.531						

Data Set 2 : 55 °C, 150 mA

Actual Case Temperature [T _s]	57.0 °C
Actual Ambient Temperature [T _A]	55.7 °C
Drive Current [I _F]	150 mA
Measurement Current	150 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	490 h	1053 h	1744 h	2354 h	3116 h	3803 h	4494 h	5185 h	6115 h				
1	100.0	99.4	99.6	99.7	99.7	99.5	99.5	99.4	99.5	99.3				
2	100.0	99.2	99.6	99.6	99.5	99.4	99.4	99.3	99.4	99.4				
3	100.0	99.4	99.8	99.8	99.7	99.6	99.6	99.6	99.7	99.8				
4	100.0	99.1	99.4	99.3	99.4	99.2	99.2	99.3	99.3	99.4				
5	100.0	99.6	99.9	99.9	99.9	99.8	99.8	99.8	99.6	99.7				
6	100.0	99.6	99.7	99.8	99.8	99.7	99.7	99.7	99.5	99.4				
7	100.0	99.5	99.6	99.6	99.7	99.4	99.5	99.4	99.2	98.9				
8	100.0	99.7	99.9	100.0	100.0	99.7	99.8	99.6	99.5	99.2				
9	100.0	100.1	100.2	100.2	100.1	100.0	99.9	99.7	99.6	99.2				
10	100.0	99.8	100.1	100.2	100.2	99.9	99.9	99.8	99.8	99.5				
11	100.0	99.0	99.2	99.4	99.4	99.2	99.2	99.1	99.1	99.0				
12	100.0	99.4	99.6	99.7	99.7	99.5	99.5	99.5	99.5	99.5				
13	100.0	99.2	99.4	99.5	99.5	99.3	99.3	99.4	99.4	99.5				
14	100.0	99.1	99.2	99.4	99.3	99.2	99.3	99.4	99.2	99.3				
15	100.0	99.5	99.7	99.8	99.8	99.6	99.6	99.2	99.2	99.5				
16	100.0	99.6	99.7	99.8	99.8	99.6	99.6	98.9	99.2	99.2				
17	100.0	99.4	99.6	99.7	99.7	99.5	99.6	99.4	99.2	99.1				
18	100.0	99.8	99.8	99.9	99.9	99.7	99.6	99.5	99.3	99.2				
19	100.0	99.6	99.6	99.8	99.5	99.0	98.8	98.6	98.5	98.2				
20	100.0	99.3	99.5	99.6	99.5	99.4	99.3	99.2	99.2	99.1				
21	100.0	99.3	99.5	99.8	99.6	99.5	99.5	99.4	99.3	99.3				
22	100.0	99.6	99.7	99.9	99.8	99.7	99.7	99.7	99.7	99.7				
23	100.0	99.2	99.2	99.3	99.2	99.1	99.1	99.0	99.1	99.2				
24	100.0	99.7	99.7	99.9	99.8	99.7	99.7	99.6	99.7	99.7				
25	100.0	99.2	99.3	99.4	99.4	99.2	99.2	99.2	99.1	99.1				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	100.0	99.5	99.6	99.7	99.7	99.5	99.5	99.4	99.4	99.3				
Med.	100.0	99.4	99.6	99.8	99.7	99.5	99.5	99.4	99.3	99.3				
σ	0.00	0.26	0.26	0.24	0.24	0.26	0.26	0.29	0.28	0.32				
Min.	100.0	99.0	99.2	99.3	99.2	99.0	98.8	98.6	98.5	98.2				
Max.	100.0	100.1	100.2	100.2	100.2	100.0	99.9	99.8	99.8	99.8				

TM-21 Projection

Time	1744 h	2354 h	3116 h	3803 h	4494 h	5185 h	6115 h							
ln(Avg.)	-0.0027	-0.0033	-0.0050	-0.0051	-0.0062	-0.0064	-0.0071							

Test duration used	1744 h	to	6115 h
B	0.9987		
α	9.9897E-07		
R ²	0.9463		
Calculated L ₇₀ (6K)	356000	hours	
Reported L ₇₀ (6K)	> 36700	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, 150 mA

Actual Case Temperature [T _s]	57.0 °C
Actual Ambient Temperature [T _A]	55.7 °C
Drive Current [I _F]	150 mA
Measurement Current	150 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	490 h	1053 h	1744 h	2354 h	3116 h	3803 h	4494 h	5185 h	6115 h
1	100.0	100.8	101.2	101.5	101.8	101.8	102.0	102.1	102.2	102.4
2	100.0	100.6	100.9	101.2	101.5	101.4	101.6	101.8	101.8	102.0
3	100.0	100.9	101.4	101.8	102.0	102.2	102.3	102.5	102.6	102.7
4	100.0	100.6	101.0	101.2	101.5	101.5	101.6	101.7	101.9	102.1
5	100.0	101.0	101.4	101.8	102.1	102.2	102.3	102.4	102.6	102.7
6	100.0	101.0	101.4	101.8	102.1	102.2	102.3	102.5	102.6	102.8
7	100.0	100.9	101.3	101.7	102.1	102.1	102.3	102.4	102.6	102.7
8	100.0	100.8	101.1	101.5	101.8	101.8	102.0	102.1	102.3	102.4
9	100.0	100.9	101.4	101.8	102.1	102.1	102.3	102.4	102.6	102.8
10	100.0	100.9	101.4	101.7	102.0	102.0	102.3	102.4	102.6	102.8
11	100.0	99.6	99.9	100.2	100.5	100.4	100.6	100.7	100.9	101.0
12	100.0	99.6	100.0	100.3	100.7	100.6	100.9	101.0	101.2	101.4
13	100.0	99.6	100.0	100.3	100.6	100.6	100.7	100.9	101.1	101.3
14	100.0	99.5	99.8	100.1	100.4	100.3	100.5	100.6	100.8	101.0
15	100.0	99.6	100.0	100.3	100.6	100.7	100.8	101.0	101.2	101.3
16	100.0	99.7	100.0	100.3	100.7	100.7	100.9	101.0	101.2	101.4
17	100.0	99.7	100.0	100.4	100.7	100.7	100.9	101.1	101.2	101.5
18	100.0	99.6	100.0	100.4	100.7	100.7	100.9	101.1	101.2	101.5
19	100.0	99.6	100.0	100.4	100.7	100.7	100.9	101.0	101.2	101.4
20	100.0	99.5	99.8	100.1	100.3	100.3	100.5	100.6	100.7	100.9
21	100.0	99.7	100.1	100.4	100.7	100.8	101.0	101.1	101.3	101.5
22	100.0	99.6	100.0	100.3	100.6	100.7	100.9	101.0	101.2	101.3
23	100.0	99.5	99.8	100.1	100.4	100.5	100.6	100.7	100.8	101.0
24	100.0	99.6	100.0	100.4	100.6	100.7	100.9	101.0	101.2	101.4
25	100.0	99.9	99.9	100.2	100.4	100.5	100.7	100.8	100.9	101.0
n	25	25	25	25	25	25	25	25	25	25
Avg.	100.0	100.1	100.5	100.8	101.1	101.1	101.3	101.4	101.6	101.8
Med.	100.0	99.7	100.0	100.4	100.7	100.7	100.9	101.1	101.2	101.5
σ	0.00	0.62	0.66	0.68	0.69	0.70	0.70	0.68	0.69	0.69
Min.	100.0	99.5	99.8	100.1	100.3	100.3	100.5	100.6	100.7	100.9
Max.	100.0	101.0	101.4	101.8	102.1	102.2	102.3	102.5	102.6	102.8

Data Set 2 : 55 °C, 150 mA

Actual Case Temperature [T _s]	57.0 °C
Actual Ambient Temperature [T _A]	55.7 °C
Drive Current [I _F]	150 mA
Measurement Current	150 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 2-4
Chromaticity Shift

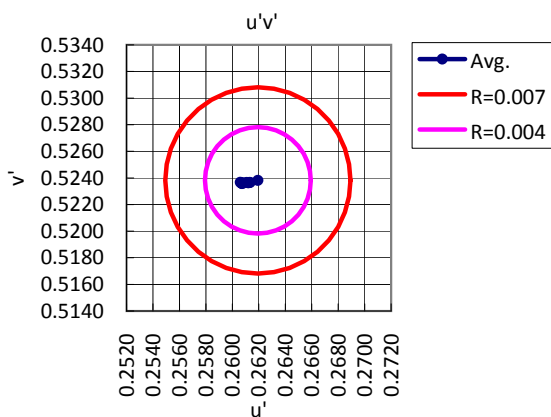
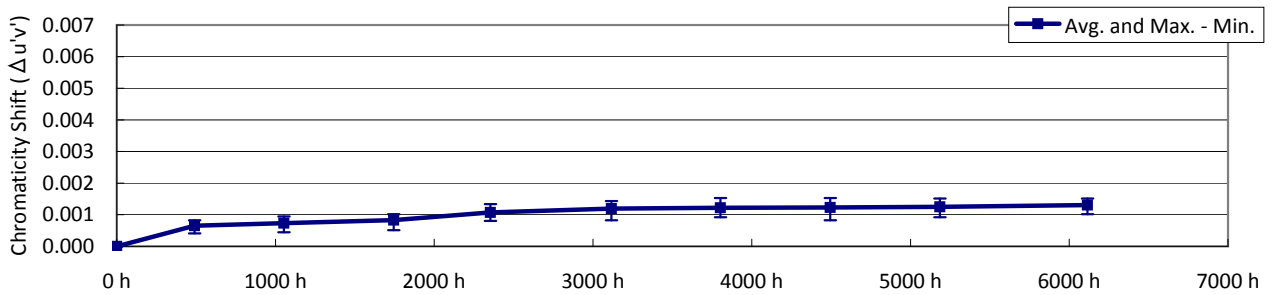
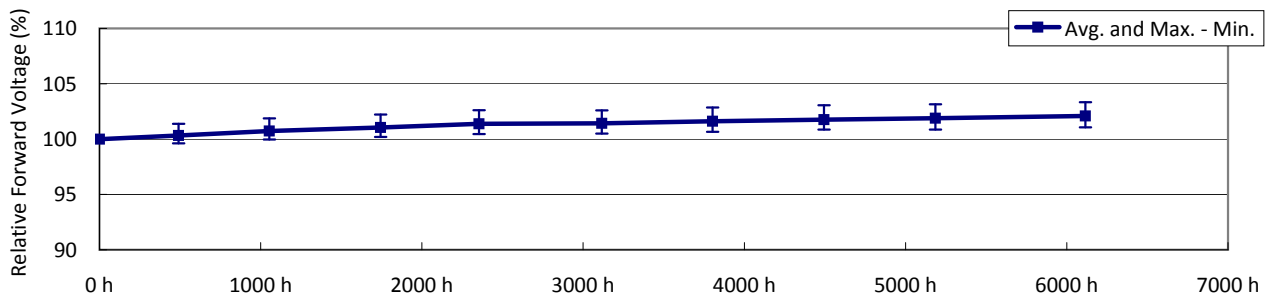
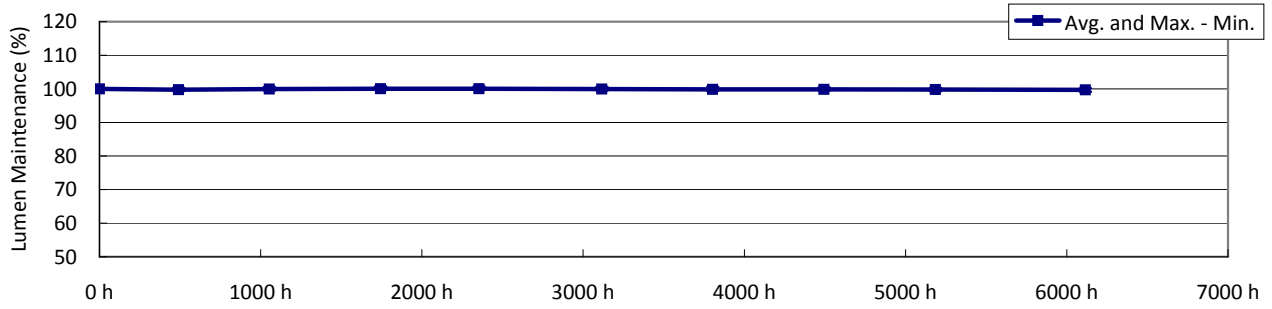
LED No.	Chromaticity Shift Δu'v'														
	0 h	490 h	1053 h	1744 h	2354 h	3116 h	3803 h	4494 h	5185 h	6115 h					
1	0.0000	0.0004	0.0005	0.0006	0.0008	0.0010	0.0010	0.0011	0.0011	0.0012					
2	0.0000	0.0004	0.0005	0.0006	0.0008	0.0009	0.0010	0.0009	0.0010	0.0011					
3	0.0000	0.0004	0.0005	0.0005	0.0008	0.0009	0.0009	0.0010	0.0010	0.0010					
4	0.0000	0.0004	0.0004	0.0005	0.0008	0.0009	0.0009	0.0009	0.0010	0.0010					
5	0.0000	0.0004	0.0005	0.0006	0.0008	0.0010	0.0010	0.0010	0.0011	0.0011					
6	0.0000	0.0007	0.0008	0.0008	0.0010	0.0012	0.0013	0.0012	0.0013	0.0014					
7	0.0000	0.0007	0.0008	0.0009	0.0010	0.0012	0.0012	0.0012	0.0013	0.0013					
8	0.0000	0.0005	0.0006	0.0007	0.0009	0.0010	0.0010	0.0011	0.0011	0.0011					
9	0.0000	0.0004	0.0005	0.0007	0.0010	0.0012	0.0013	0.0014	0.0013	0.0014					
10	0.0000	0.0004	0.0005	0.0006	0.0008	0.0009	0.0009	0.0010	0.0010	0.0011					
11	0.0000	0.0006	0.0006	0.0008	0.0011	0.0012	0.0012	0.0013	0.0014	0.0015					
12	0.0000	0.0007	0.0008	0.0009	0.0011	0.0012	0.0012	0.0013	0.0013	0.0014					
13	0.0000	0.0007	0.0008	0.0009	0.0011	0.0013	0.0013	0.0013	0.0014	0.0014					
14	0.0000	0.0007	0.0007	0.0008	0.0010	0.0011	0.0011	0.0012	0.0012	0.0013					
15	0.0000	0.0008	0.0008	0.0009	0.0012	0.0013	0.0014	0.0014	0.0012	0.0015					
16	0.0000	0.0008	0.0008	0.0009	0.0012	0.0014	0.0013	0.0012	0.0013	0.0013					
17	0.0000	0.0009	0.0009	0.0010	0.0013	0.0015	0.0014	0.0015	0.0015	0.0015					
18	0.0000	0.0007	0.0007	0.0008	0.0011	0.0013	0.0013	0.0013	0.0013	0.0014					
19	0.0000	0.0007	0.0008	0.0009	0.0014	0.0016	0.0017	0.0017	0.0019	0.0020					
20	0.0000	0.0006	0.0007	0.0008	0.0010	0.0012	0.0012	0.0013	0.0013	0.0014					
21	0.0000	0.0007	0.0008	0.0009	0.0011	0.0012	0.0013	0.0014	0.0014	0.0015					
22	0.0000	0.0007	0.0007	0.0008	0.0011	0.0012	0.0012	0.0013	0.0013	0.0014					
23	0.0000	0.0007	0.0007	0.0009	0.0010	0.0012	0.0013	0.0012	0.0013	0.0013					
24	0.0000	0.0006	0.0007	0.0008	0.0010	0.0011	0.0011	0.0012	0.0012	0.0013					
25	0.0000	0.0007	0.0007	0.0008	0.0010	0.0012	0.0013	0.0012	0.0013	0.0014					
n	25	25	25	25	25	25	25	25	25	25					
Avg.	0.0000	0.0006	0.0007	0.0008	0.0010	0.0012	0.0012	0.0012	0.0013	0.0013					
Med.	0.0000	0.0007	0.0007	0.0008	0.0010	0.0012	0.0012	0.0012	0.0013	0.0014					
σ	0.0000	0.0002	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002					
Min.	0.0000	0.0004	0.0004	0.0005	0.0008	0.0009	0.0009	0.0009	0.0010	0.0010					
Max.	0.0000	0.0009	0.0009	0.0010	0.0014	0.0016	0.0017	0.0017	0.0019	0.0020					

Data Set 3 : 55 °C, 180 mA

Actual Case Temperature [T _S]	57.5 °C
Actual Ambient Temperature [T _A]	56.3 °C
Drive Current [I _F]	180 mA
Measurement Current	180 mA

NOTES:

T_S and T_A were measured during initial setup.



Data Set 3 : 55 °C, 180 mA

Actual Case Temperature [T _s]	57.5 °C
Actual Ambient Temperature [T _A]	56.3 °C
Drive Current [I _F]	180 mA
Measurement Current	180 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	59.5	3.24	2713	0.456	0.405	0.262	0.525						
2	58.9	3.25	2769	0.449	0.400	0.260	0.522						
3	59.0	3.24	2699	0.460	0.410	0.263	0.527						
4	58.8	3.25	2717	0.454	0.402	0.263	0.523						
5	60.3	3.23	2732	0.455	0.407	0.261	0.525						
6	58.7	3.24	2808	0.443	0.392	0.260	0.517						
7	60.1	3.23	2701	0.460	0.411	0.262	0.528						
8	59.9	3.24	2849	0.439	0.391	0.258	0.517						
9	59.1	3.24	2701	0.457	0.405	0.263	0.525						
10	58.7	3.24	2768	0.452	0.406	0.260	0.524						
11	59.3	3.26	2795	0.446	0.398	0.260	0.520						
12	59.5	3.25	2731	0.457	0.410	0.261	0.527						
13	59.5	3.24	2718	0.454	0.403	0.262	0.524						
14	59.2	3.24	2714	0.455	0.404	0.263	0.524						
15	58.4	3.24	2667	0.460	0.407	0.264	0.526						
16	59.1	3.24	2620	0.472	0.422	0.265	0.533						
17	60.0	3.23	2818	0.443	0.395	0.259	0.519						
18	59.4	3.25	2735	0.451	0.398	0.262	0.521						
19	59.6	3.24	2725	0.456	0.407	0.262	0.525						
20	58.4	3.25	2795	0.443	0.392	0.260	0.518						
21	59.9	3.23	2799	0.443	0.392	0.260	0.518						
22	59.0	3.24	2614	0.472	0.421	0.266	0.533						
23	58.9	3.24	2713	0.456	0.405	0.262	0.525						
24	59.1	3.24	2651	0.464	0.412	0.265	0.528						
25	58.8	3.25	2686	0.456	0.402	0.264	0.524						
n	25	25	25	25	25	25	25						
Avg.	59.3	3.24	2730	0.454	0.404	0.262	0.524						
Med.	59.1	3.24	2718	0.455	0.405	0.262	0.524						
σ	0.52	0.006	59.9	0.0084	0.0082	0.0020	0.0044						
Min.	58.4	3.23	2614	0.439	0.391	0.258	0.517						
Max.	60.3	3.26	2849	0.472	0.422	0.266	0.533						

Data Set 3 : 55 °C, 180 mA

Actual Case Temperature [T _s]	57.5 °C
Actual Ambient Temperature [T _A]	56.3 °C
Drive Current [I _F]	180 mA
Measurement Current	180 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	490 h	1053 h	1744 h	2354 h	3116 h	3803 h	4494 h	5185 h	6115 h				
1	100.0	99.8	100.0	100.2	100.2	100.0	100.0	99.9	99.9	99.8				
2	100.0	100.0	100.3	100.4	100.3	100.0	100.0	100.0	100.2	100.2				
3	100.0	99.5	99.8	99.9	99.9	99.7	99.6	99.7	99.8	99.8				
4	100.0	99.5	99.6	99.7	99.7	99.5	99.4	99.6	99.6	99.6				
5	100.0	99.6	99.8	99.9	100.0	99.8	99.7	99.8	99.7	99.6				
6	100.0	99.5	99.7	99.7	99.8	99.6	99.6	99.8	99.5	99.3				
7	100.0	99.6	99.7	99.8	99.9	99.6	99.7	99.7	99.4	99.2				
8	100.0	99.8	100.0	100.1	100.2	100.0	100.1	100.0	99.7	99.6				
9	100.0	100.3	100.5	100.7	100.7	100.5	100.5	100.3	100.2	99.9				
10	100.0	100.3	100.6	100.7	100.7	100.6	100.6	100.4	100.3	100.2				
11	100.0	99.8	100.1	100.2	100.2	100.2	100.1	100.1	100.0	100.0				
12	100.0	99.4	99.6	99.7	99.7	99.7	99.5	99.6	99.6	99.6				
13	100.0	99.5	99.6	99.7	99.7	99.7	99.6	99.7	99.6	99.7				
14	100.0	99.9	99.9	100.0	100.0	100.0	99.9	100.0	99.9	100.0				
15	100.0	99.6	99.5	99.6	99.6	99.5	99.4	99.5	99.3	99.3				
16	100.0	99.8	99.9	100.0	100.2	100.0	99.9	100.0	99.7	99.6				
17	100.0	99.4	99.6	99.7	99.8	99.6	99.5	99.5	99.3	99.1				
18	100.0	99.9	100.2	100.3	100.3	100.2	100.1	99.9	99.8	99.5				
19	100.0	100.1	100.4	100.6	100.6	100.5	100.4	100.3	100.2	100.0				
20	100.0	99.9	100.3	100.4	100.4	100.4	100.2	100.1	100.1	100.0				
21	100.0	99.4	99.7	99.8	99.8	99.6	99.6	99.6	99.5	99.4				
22	100.0	99.5	99.7	99.9	99.9	99.8	99.7	99.7	99.9	99.9				
23	100.0	99.3	99.5	99.6	99.6	99.5	99.4	99.4	99.7	99.7				
24	100.0	99.7	99.9	100.0	100.0	99.9	99.8	99.8	100.0	99.9				
25	100.0	99.8	100.0	100.1	100.0	99.9	99.9	99.9	99.9	99.8				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	100.0	99.7	99.9	100.0	100.0	99.9	99.9	99.8	99.8	99.7				
Med.	100.0	99.7	99.9	100.0	100.0	99.9	99.8	99.8	99.8	99.7				
σ	0.00	0.28	0.31	0.34	0.32	0.34	0.34	0.27	0.29	0.29				
Min.	100.0	99.3	99.5	99.6	99.6	99.5	99.4	99.4	99.3	99.1				
Max.	100.0	100.3	100.6	100.7	100.7	100.6	100.6	100.4	100.3	100.2				

TM-21 Projection

Time	1744 h	2354 h	3116 h	3803 h	4494 h	5185 h	6115 h							
ln(Avg.)	0.0004	0.0005	-0.0008	-0.0015	-0.0015	-0.0022	-0.0029							

Test duration used	1744 h	to	6115 h
B	1.0019		
α	7.8824E-07		
R ²	0.9553		
Calculated L ₇₀ (6K)	455000	hours	
Reported L ₇₀ (6K)	> 36700	hours	

Curve-fit equation:

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

Lumen maintenance life equation:

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

Data Set 3 : 55 °C, 180 mA

Actual Case Temperature [T _s]	57.5 °C
Actual Ambient Temperature [T _A]	56.3 °C
Drive Current [I _F]	180 mA
Measurement Current	180 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	490 h	1053 h	1744 h	2354 h	3116 h	3803 h	4494 h	5185 h	6115 h
1	100.0	101.1	101.5	101.8	102.1	102.1	102.4	102.6	102.6	102.8
2	100.0	101.3	101.8	102.1	102.6	102.5	102.8	102.9	103.1	103.3
3	100.0	101.1	101.5	101.8	102.2	102.2	102.4	102.6	102.7	102.9
4	100.0	101.1	101.5	101.8	102.1	102.2	102.4	102.5	102.6	102.9
5	100.0	100.9	101.3	101.6	101.9	101.9	102.2	102.2	102.3	102.6
6	100.0	101.1	101.4	101.7	102.1	102.1	102.3	102.4	102.6	102.8
7	100.0	100.8	101.1	101.4	101.8	101.7	101.9	102.0	102.1	102.4
8	100.0	101.1	101.4	101.7	102.1	102.0	102.2	102.4	102.6	102.7
9	100.0	101.4	101.8	102.2	102.6	102.6	102.9	103.1	103.1	103.3
10	100.0	101.4	101.9	102.2	102.6	102.6	102.8	102.9	103.1	103.3
11	100.0	99.8	100.2	100.6	100.9	101.0	101.2	101.3	101.5	101.7
12	100.0	99.7	100.2	100.5	100.8	100.9	101.0	101.2	101.3	101.5
13	100.0	99.8	100.2	100.5	100.8	100.9	101.0	101.2	101.3	101.5
14	100.0	99.9	100.3	100.6	101.0	101.1	101.2	101.4	101.5	101.7
15	100.0	99.8	100.3	100.6	101.0	101.1	101.2	101.4	101.5	101.7
16	100.0	99.8	100.2	100.6	100.9	101.0	101.1	101.3	101.4	101.7
17	100.0	99.6	100.0	100.2	100.5	100.5	100.7	100.9	100.9	101.1
18	100.0	99.7	100.1	100.4	100.7	100.8	100.9	101.1	101.2	101.4
19	100.0	99.7	100.2	100.5	100.8	100.9	101.1	101.3	101.4	101.7
20	100.0	99.8	100.3	100.6	100.9	101.1	101.2	101.4	101.5	101.7
21	100.0	99.7	100.1	100.4	100.6	100.7	100.8	101.0	101.1	101.2
22	100.0	99.8	100.3	100.6	100.9	101.0	101.2	101.3	101.4	101.6
23	100.0	99.7	100.1	100.3	100.6	100.7	100.9	101.0	101.1	101.3
24	100.0	99.8	100.3	100.6	101.0	101.1	101.3	101.4	101.5	101.7
25	100.0	100.3	100.3	100.7	101.0	101.1	101.3	101.3	101.6	101.7
n	25	25	25	25	25	25	25	25	25	25
Avg.	100.0	100.3	100.7	101.0	101.4	101.4	101.6	101.8	101.9	102.1
Med.	100.0	99.8	100.3	100.6	101.0	101.1	101.2	101.4	101.5	101.7
σ	0.00	0.68	0.68	0.69	0.72	0.68	0.71	0.70	0.71	0.72
Min.	100.0	99.6	100.0	100.2	100.5	100.5	100.7	100.9	100.9	101.1
Max.	100.0	101.4	101.9	102.2	102.6	102.6	102.9	103.1	103.1	103.3

Data Set 3 : 55 °C, 180 mA

Actual Case Temperature [T _s]	57.5 °C
Actual Ambient Temperature [T _A]	56.3 °C
Drive Current [I _F]	180 mA
Measurement Current	180 mA

NOTES:

T_s and T_A were measured during initial setup.

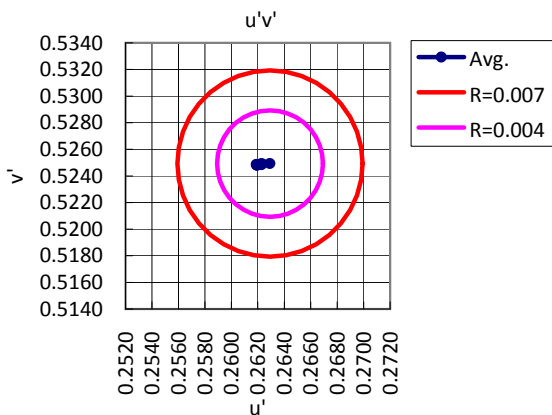
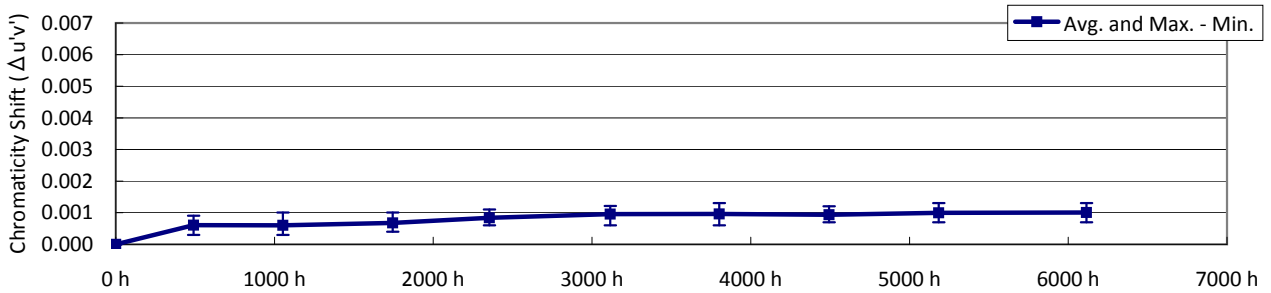
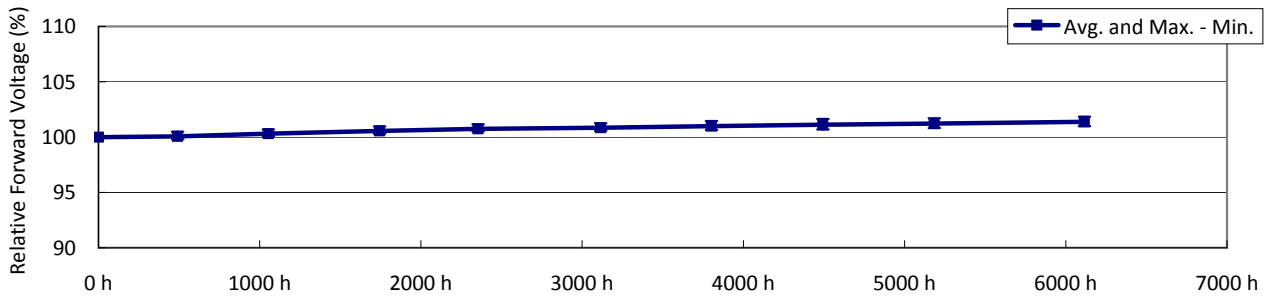
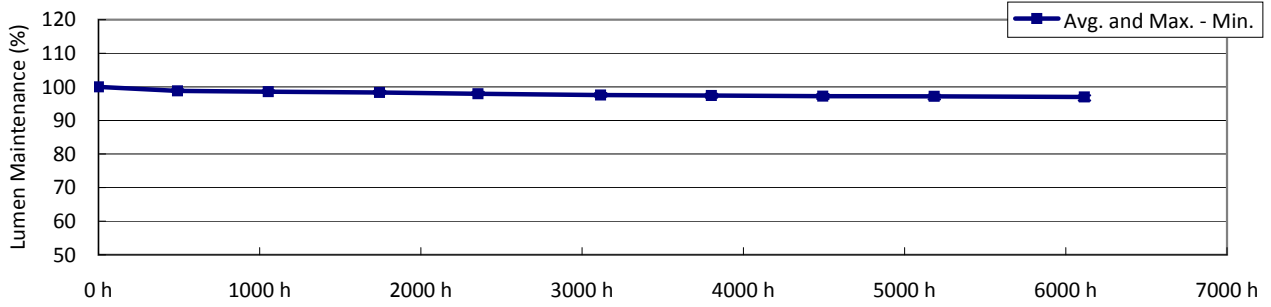
TABLE 3-4
Chromaticity Shift

LED No.	Chromaticity Shift Δu'v'														
	0 h	490 h	1053 h	1744 h	2354 h	3116 h	3803 h	4494 h	5185 h	6115 h					
1	0.0000	0.0004	0.0005	0.0005	0.0008	0.0010	0.0010	0.0010	0.0010	0.0011					
2	0.0000	0.0005	0.0006	0.0007	0.0008	0.0008	0.0009	0.0008	0.0010	0.0010					
3	0.0000	0.0004	0.0005	0.0006	0.0008	0.0009	0.0010	0.0010	0.0010	0.0011					
4	0.0000	0.0004	0.0005	0.0005	0.0009	0.0010	0.0009	0.0009	0.0009	0.0010					
5	0.0000	0.0004	0.0006	0.0006	0.0009	0.0010	0.0010	0.0010	0.0010	0.0012					
6	0.0000	0.0007	0.0008	0.0008	0.0010	0.0012	0.0012	0.0011	0.0012	0.0012					
7	0.0000	0.0005	0.0006	0.0007	0.0009	0.0011	0.0011	0.0010	0.0011	0.0011					
8	0.0000	0.0005	0.0005	0.0006	0.0009	0.0010	0.0010	0.0010	0.0010	0.0011					
9	0.0000	0.0004	0.0004	0.0006	0.0008	0.0009	0.0010	0.0010	0.0010	0.0011					
10	0.0000	0.0005	0.0005	0.0006	0.0008	0.0009	0.0010	0.0009	0.0010	0.0010					
11	0.0000	0.0007	0.0007	0.0009	0.0011	0.0013	0.0013	0.0014	0.0013	0.0014					
12	0.0000	0.0007	0.0008	0.0009	0.0011	0.0012	0.0012	0.0012	0.0012	0.0012					
13	0.0000	0.0008	0.0009	0.0010	0.0012	0.0013	0.0013	0.0014	0.0014	0.0015					
14	0.0000	0.0007	0.0008	0.0009	0.0012	0.0013	0.0013	0.0014	0.0014	0.0014					
15	0.0000	0.0008	0.0008	0.0010	0.0013	0.0014	0.0013	0.0014	0.0014	0.0015					
16	0.0000	0.0008	0.0009	0.0010	0.0012	0.0013	0.0013	0.0014	0.0014	0.0015					
17	0.0000	0.0008	0.0009	0.0010	0.0013	0.0014	0.0015	0.0015	0.0015	0.0015					
18	0.0000	0.0008	0.0009	0.0010	0.0012	0.0013	0.0014	0.0014	0.0014	0.0015					
19	0.0000	0.0007	0.0008	0.0010	0.0012	0.0013	0.0013	0.0013	0.0014	0.0014					
20	0.0000	0.0007	0.0008	0.0009	0.0012	0.0013	0.0013	0.0014	0.0014	0.0014					
21	0.0000	0.0007	0.0008	0.0009	0.0012	0.0013	0.0014	0.0014	0.0014	0.0015					
22	0.0000	0.0008	0.0008	0.0009	0.0012	0.0013	0.0013	0.0014	0.0014	0.0014					
23	0.0000	0.0007	0.0008	0.0008	0.0012	0.0012	0.0013	0.0013	0.0013	0.0014					
24	0.0000	0.0007	0.0008	0.0010	0.0011	0.0013	0.0013	0.0013	0.0013	0.0014					
25	0.0000	0.0008	0.0009	0.0010	0.0012	0.0014	0.0014	0.0014	0.0014	0.0015					
n	25	25	25	25	25	25	25	25	25	25					
Avg.	0.0000	0.0007	0.0007	0.0008	0.0011	0.0012	0.0012	0.0012	0.0012	0.0013					
Med.	0.0000	0.0007	0.0008	0.0009	0.0011	0.0013	0.0013	0.0013	0.0013	0.0014					
σ	0.0000	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002					
Min.	0.0000	0.0004	0.0004	0.0005	0.0008	0.0008	0.0009	0.0008	0.0009	0.0010					
Max.	0.0000	0.0008	0.0009	0.0010	0.0013	0.0014	0.0015	0.0015	0.0015	0.0015					

Data Set 4 : 85 °C, 65 mA

Actual Case Temperature [T_S]	84.7 °C
Actual Ambient Temperature [T_A]	83.6 °C
Drive Current [I_F]	65 mA
Measurement Current	65 mA

NOTES:
 T_S and T_A were measured during initial setup.



Data Set 4 : 85 °C, 65 mA

Actual Case Temperature [T _s]	84.7 °C
Actual Ambient Temperature [T _A]	83.6 °C
Drive Current [I _F]	65 mA
Measurement Current	65 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	24.4	2.90	2705	0.458	0.407	0.263	0.526						
2	23.6	2.90	2596	0.468	0.412	0.267	0.529						
3	23.9	2.90	2703	0.451	0.395	0.264	0.520						
4	24.2	2.89	2763	0.448	0.397	0.261	0.520						
5	24.2	2.91	2614	0.472	0.421	0.266	0.533						
6	24.4	2.90	2710	0.457	0.408	0.262	0.526						
7	24.0	2.90	2745	0.449	0.397	0.262	0.521						
8	24.2	2.91	2656	0.465	0.414	0.264	0.530						
9	24.1	2.90	2606	0.470	0.417	0.267	0.531						
10	24.1	2.90	2726	0.455	0.405	0.262	0.525						
11	24.5	2.90	2849	0.442	0.397	0.257	0.519						
12	24.0	2.90	2702	0.457	0.406	0.263	0.525						
13	24.6	2.91	2804	0.451	0.408	0.258	0.525						
14	24.2	2.90	2693	0.456	0.403	0.264	0.524						
15	24.2	2.90	2745	0.450	0.398	0.262	0.521						
16	24.2	2.90	2676	0.461	0.409	0.264	0.527						
17	24.2	2.90	2751	0.448	0.395	0.262	0.520						
18	23.8	2.89	2587	0.471	0.415	0.268	0.531						
19	23.8	2.90	2764	0.447	0.396	0.261	0.520						
20	24.1	2.90	2660	0.461	0.408	0.265	0.527						
21	24.2	2.90	2776	0.449	0.400	0.260	0.522						
22	24.2	2.90	2776	0.446	0.394	0.261	0.519						
23	24.1	2.90	2678	0.462	0.412	0.263	0.528						
24	24.4	2.90	2665	0.464	0.413	0.264	0.529						
25	23.9	2.90	2687	0.456	0.402	0.264	0.524						
n	25	25	25	25	25	25	25						
Avg.	24.1	2.90	2706	0.457	0.405	0.263	0.525						
Med.	24.2	2.90	2703	0.456	0.406	0.263	0.525						
σ	0.23	0.003	66.2	0.0085	0.0077	0.0025	0.0042						
Min.	23.6	2.89	2587	0.442	0.394	0.257	0.519						
Max.	24.6	2.91	2849	0.472	0.421	0.268	0.533						

Data Set 4 : 85 °C, 65 mA

Actual Case Temperature [T _s]	84.7 °C
Actual Ambient Temperature [T _A]	83.6 °C
Drive Current [I _F]	65 mA
Measurement Current	65 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	490 h	1053 h	1744 h	2354 h	3115 h	3802 h	4493 h	5184 h	6115 h				
1	100.0	98.8	98.6	98.3	97.9	97.6	97.4	97.4	97.3	97.1				
2	100.0	98.6	98.4	98.2	97.7	97.5	97.4	97.3	97.3	97.3				
3	100.0	98.8	98.3	98.1	97.7	97.4	97.3	97.2	97.2	97.2				
4	100.0	98.5	98.2	98.0	97.7	97.5	97.3	97.2	97.2	97.3				
5	100.0	98.8	98.4	98.1	97.8	97.6	97.4	97.3	97.1	97.2				
6	100.0	98.7	98.6	98.3	98.0	97.7	97.6	97.6	97.3	97.2				
7	100.0	98.6	98.5	98.0	97.6	97.3	97.2	97.1	96.8	96.5				
8	100.0	99.0	98.9	98.6	98.1	97.7	97.6	97.6	97.2	96.8				
9	100.0	99.0	98.8	98.6	98.2	97.7	97.7	97.6	97.3	96.9				
10	100.0	98.8	98.8	98.5	98.2	97.8	97.8	97.8	97.6	97.3				
11	100.0	98.9	98.6	98.4	97.9	97.6	97.4	97.1	97.2	97.1				
12	100.0	98.7	98.4	98.2	97.8	97.3	97.3	97.0	97.1	97.0				
13	100.0	98.6	98.4	98.1	97.7	97.3	97.2	96.9	97.1	97.1				
14	100.0	98.6	98.4	98.0	97.6	97.2	97.1	96.8	96.9	96.9				
15	100.0	98.8	98.4	98.0	97.6	97.1	96.8	96.4	96.3	95.9				
16	100.0	98.9	98.6	98.3	98.0	97.6	97.4	97.2	97.1	96.9				
17	100.0	99.0	98.7	98.4	98.1	97.7	97.5	97.3	97.1	96.8				
18	100.0	99.1	98.9	98.8	98.5	98.1	97.9	97.6	97.4	97.0				
19	100.0	99.3	98.7	98.4	97.9	97.5	97.2	96.8	96.6	96.1				
20	100.0	99.0	98.9	98.8	98.5	98.1	97.9	97.6	97.5	97.1				
21	100.0	98.7	98.7	98.4	98.1	97.8	97.6	97.4	97.5	97.4				
22	100.0	98.8	98.7	98.4	98.0	97.7	97.6	97.3	97.5	97.4				
23	100.0	98.5	98.3	98.1	97.6	97.3	97.1	96.8	97.1	96.9				
24	100.0	98.7	98.6	98.3	97.9	97.5	97.3	97.0	97.3	97.0				
25	100.0	98.9	98.5	98.2	97.8	97.5	97.4	97.2	97.3	97.1				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	100.0	98.8	98.6	98.3	97.9	97.6	97.4	97.2	97.2	97.0				
Med.	100.0	98.8	98.6	98.3	97.9	97.6	97.4	97.2	97.2	97.1				
σ	0.00	0.19	0.20	0.23	0.26	0.25	0.27	0.33	0.30	0.36				
Min.	100.0	98.5	98.2	98.0	97.6	97.1	96.8	96.4	96.3	95.9				
Max.	100.0	99.3	98.9	98.8	98.5	98.1	97.9	97.8	97.6	97.4				

TM-21 Projection

Time	1744 h	2354 h	3115 h	3802 h	4493 h	5184 h	6115 h							
ln(Avg.)	-0.0172	-0.0210	-0.0247	-0.0262	-0.0281	-0.0287	-0.0307							

Test duration used	1744 h	to	6115 h
B	0.9861		
α	2.9354E-06		
R ²	0.9261		
Calculated L ₇₀ (6K)	117000	hours	
Reported L ₇₀ (6K)	> 36700	hours	

Curve-fit equation:

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

Lumen maintenance life equation:

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

Data Set 4 : 85 °C, 65 mA

Actual Case Temperature [T _s]	84.7 °C
Actual Ambient Temperature [T _A]	83.6 °C
Drive Current [I _F]	65 mA
Measurement Current	65 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	490 h	1053 h	1744 h	2354 h	3115 h	3802 h	4493 h	5184 h	6115 h
1	100.0	100.4	100.7	100.9	101.1	101.2	101.4	101.5	101.6	101.8
2	100.0	100.3	100.5	100.7	100.8	101.0	101.1	101.3	101.3	101.5
3	100.0	100.3	100.6	100.9	101.1	101.2	101.4	101.6	101.7	101.8
4	100.0	100.3	100.5	100.7	100.9	101.0	101.1	101.3	101.3	101.5
5	100.0	100.3	100.6	100.8	101.0	101.2	101.3	101.5	101.5	101.7
6	100.0	100.3	100.5	100.7	100.8	101.0	101.1	101.2	101.2	101.4
7	100.0	100.5	100.6	101.0	101.2	101.2	101.5	101.6	101.7	101.8
8	100.0	100.4	100.7	100.9	101.1	101.2	101.4	101.5	101.7	101.8
9	100.0	100.3	100.6	100.8	101.0	101.2	101.3	101.5	101.6	101.7
10	100.0	100.2	100.6	100.7	100.9	101.0	101.1	101.2	101.3	101.4
11	100.0	99.8	100.1	100.4	100.6	100.7	100.8	100.9	101.1	101.3
12	100.0	99.9	100.2	100.4	100.7	100.8	100.9	101.0	101.1	101.3
13	100.0	99.9	100.1	100.4	100.5	100.6	100.8	100.9	101.0	101.2
14	100.0	99.9	100.1	100.4	100.6	100.7	100.9	101.0	101.1	101.2
15	100.0	99.8	100.1	100.4	100.6	100.7	100.9	100.9	101.0	101.2
16	100.0	99.8	100.1	100.3	100.6	100.7	100.8	100.9	101.1	101.3
17	100.0	99.8	100.1	100.4	100.6	100.7	100.8	100.9	101.1	101.2
18	100.0	99.9	100.1	100.4	100.5	100.6	100.7	100.8	100.8	101.0
19	100.0	100.0	100.1	100.4	100.6	100.7	100.9	101.0	101.1	101.3
20	100.0	99.9	100.1	100.4	100.6	100.6	100.8	100.8	100.9	101.0
21	100.0	99.9	100.1	100.3	100.5	100.6	100.6	100.7	100.8	101.0
22	100.0	99.8	100.1	100.4	100.5	100.6	100.8	100.9	101.0	101.2
23	100.0	99.8	100.2	100.5	100.6	100.7	100.8	101.0	101.1	101.3
24	100.0	99.9	100.2	100.4	100.6	100.7	100.8	101.0	101.1	101.3
25	100.0	100.1	100.1	100.4	100.6	100.7	100.8	100.9	101.1	101.2
n	25	25	25	25	25	25	25	25	25	25
Avg.	100.0	100.1	100.3	100.6	100.7	100.8	101.0	101.1	101.2	101.4
Med.	100.0	99.9	100.2	100.4	100.6	100.7	100.9	101.0	101.1	101.3
σ	0.00	0.24	0.24	0.23	0.22	0.24	0.26	0.29	0.27	0.27
Min.	100.0	99.8	100.1	100.3	100.5	100.6	100.6	100.7	100.8	101.0
Max.	100.0	100.5	100.7	101.0	101.2	101.2	101.5	101.6	101.7	101.8

Data Set 4 : 85 °C, 65 mA

Actual Case Temperature [T _s]	84.7 °C
Actual Ambient Temperature [T _A]	83.6 °C
Drive Current [I _F]	65 mA
Measurement Current	65 mA

NOTES:

T_s and T_A were measured during initial setup.

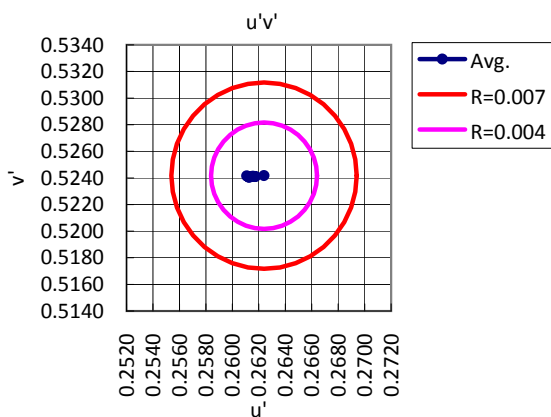
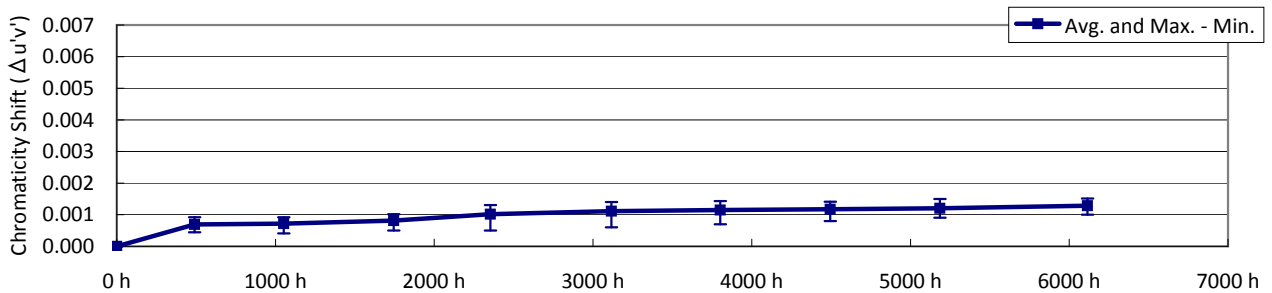
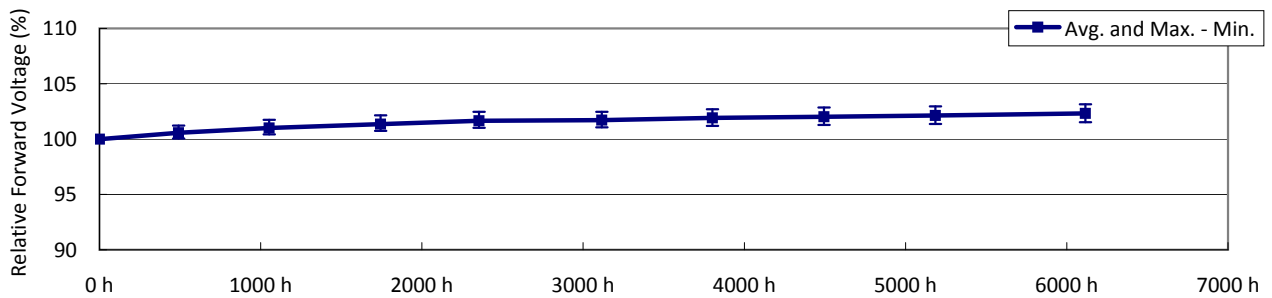
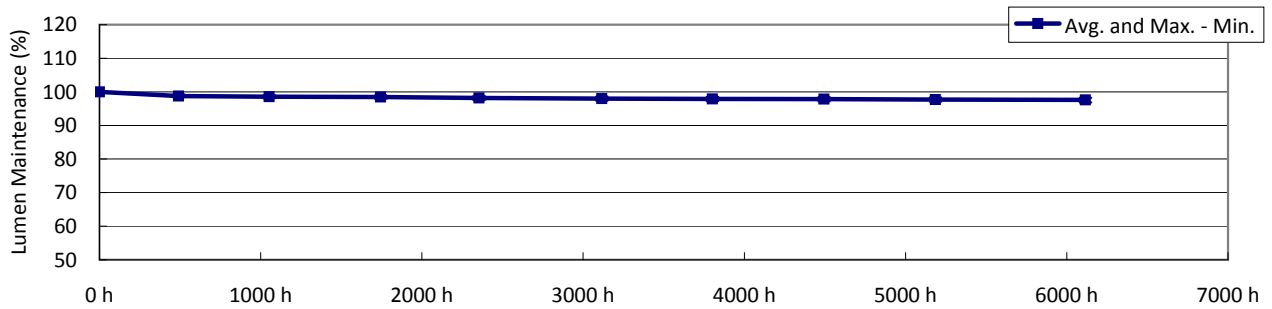
TABLE 4-4
Chromaticity Shift

LED No.	Chromaticity Shift Δu'v'														
	0 h	490 h	1053 h	1744 h	2354 h	3115 h	3802 h	4493 h	5184 h	6115 h					
1	0.0000	0.0003	0.0003	0.0004	0.0006	0.0007	0.0007	0.0007	0.0007	0.0007					
2	0.0000	0.0003	0.0004	0.0005	0.0006	0.0007	0.0007	0.0008	0.0007	0.0007					
3	0.0000	0.0004	0.0003	0.0004	0.0006	0.0007	0.0007	0.0007	0.0007	0.0007					
4	0.0000	0.0005	0.0004	0.0005	0.0007	0.0007	0.0008	0.0007	0.0008	0.0008					
5	0.0000	0.0004	0.0004	0.0004	0.0006	0.0007	0.0007	0.0007	0.0008	0.0008					
6	0.0000	0.0004	0.0004	0.0006	0.0007	0.0008	0.0008	0.0008	0.0009	0.0008					
7	0.0000	0.0006	0.0006	0.0007	0.0009	0.0010	0.0010	0.0009	0.0010	0.0010					
8	0.0000	0.0005	0.0005	0.0006	0.0008	0.0009	0.0008	0.0008	0.0009	0.0009					
9	0.0000	0.0004	0.0004	0.0005	0.0006	0.0007	0.0007	0.0007	0.0008	0.0008					
10	0.0000	0.0004	0.0003	0.0004	0.0006	0.0006	0.0006	0.0007	0.0007	0.0007					
11	0.0000	0.0007	0.0007	0.0008	0.0009	0.0010	0.0010	0.0010	0.0011	0.0011					
12	0.0000	0.0006	0.0006	0.0007	0.0009	0.0010	0.0010	0.0010	0.0010	0.0010					
13	0.0000	0.0006	0.0007	0.0007	0.0008	0.0011	0.0010	0.0009	0.0010	0.0010					
14	0.0000	0.0008	0.0007	0.0008	0.0009	0.0011	0.0010	0.0011	0.0011	0.0011					
15	0.0000	0.0008	0.0008	0.0009	0.0010	0.0011	0.0011	0.0011	0.0012	0.0012					
16	0.0000	0.0009	0.0010	0.0010	0.0011	0.0012	0.0013	0.0012	0.0013	0.0013					
17	0.0000	0.0008	0.0008	0.0009	0.0011	0.0012	0.0012	0.0011	0.0012	0.0013					
18	0.0000	0.0007	0.0007	0.0009	0.0009	0.0011	0.0011	0.0010	0.0011	0.0010					
19	0.0000	0.0007	0.0006	0.0007	0.0009	0.0010	0.0010	0.0010	0.0011	0.0011					
20	0.0000	0.0008	0.0008	0.0008	0.0010	0.0011	0.0011	0.0011	0.0011	0.0011					
21	0.0000	0.0007	0.0008	0.0007	0.0009	0.0010	0.0010	0.0009	0.0010	0.0011					
22	0.0000	0.0007	0.0007	0.0008	0.0009	0.0010	0.0011	0.0010	0.0011	0.0011					
23	0.0000	0.0006	0.0007	0.0007	0.0009	0.0011	0.0011	0.0011	0.0011	0.0012					
24	0.0000	0.0007	0.0007	0.0008	0.0010	0.0011	0.0012	0.0011	0.0012	0.0013					
25	0.0000	0.0007	0.0006	0.0007	0.0009	0.0010	0.0011	0.0011	0.0011	0.0012					
n	25	25	25	25	25	25	25	25	25	25					
Avg.	0.0000	0.0006	0.0006	0.0007	0.0008	0.0010	0.0010	0.0009	0.0010	0.0010					
Med.	0.0000	0.0006	0.0006	0.0007	0.0009	0.0010	0.0010	0.0010	0.0010	0.0010					
σ	0.0000	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002					
Min.	0.0000	0.0003	0.0003	0.0004	0.0006	0.0006	0.0006	0.0007	0.0007	0.0007					
Max.	0.0000	0.0009	0.0010	0.0010	0.0011	0.0012	0.0013	0.0012	0.0013	0.0013					

Data Set 5 : 85 °C, 150 mA

Actual Case Temperature [T _S]	86.2 °C
Actual Ambient Temperature [T _A]	84.3 °C
Drive Current [I _F]	150 mA
Measurement Current	150 mA

NOTES:
T_S and T_A were measured during initial setup.



Data Set 5 : 85 °C, 150 mA

Actual Case Temperature [T _S]	86.2 °C
Actual Ambient Temperature [T _A]	84.3 °C
Drive Current [I _F]	150 mA
Measurement Current	150 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	50.1	3.17	2601	0.466	0.409	0.267	0.528					
2	51.4	3.16	2696	0.461	0.412	0.263	0.528					
3	50.5	3.18	2794	0.445	0.396	0.260	0.519					
4	50.9	3.16	2761	0.448	0.397	0.261	0.520					
5	50.5	3.16	2645	0.462	0.408	0.265	0.527					
6	50.5	3.16	2806	0.443	0.393	0.260	0.518					
7	50.2	3.16	2630	0.464	0.409	0.266	0.527					
8	50.8	3.16	2674	0.465	0.417	0.263	0.530					
9	50.2	3.16	2766	0.448	0.397	0.261	0.520					
10	50.2	3.16	2719	0.451	0.398	0.263	0.521					
11	50.8	3.16	2702	0.460	0.411	0.262	0.528					
12	50.4	3.16	2678	0.458	0.405	0.264	0.525					
13	50.2	3.17	2758	0.449	0.398	0.261	0.521					
14	50.3	3.17	2772	0.446	0.394	0.261	0.519					
15	49.9	3.16	2682	0.457	0.403	0.264	0.524					
16	51.0	3.16	2717	0.457	0.407	0.262	0.526					
17	50.3	3.15	2617	0.469	0.416	0.266	0.531					
18	51.0	3.16	2799	0.447	0.400	0.259	0.521					
19	50.8	3.16	2631	0.466	0.412	0.266	0.529					
20	51.9	3.15	2640	0.469	0.420	0.265	0.532					
21	51.1	3.17	2823	0.444	0.397	0.258	0.520					
22	50.3	3.16	2746	0.449	0.397	0.262	0.520					
23	50.6	3.16	2673	0.465	0.417	0.263	0.530					
24	50.7	3.16	2806	0.443	0.393	0.260	0.518					
25	50.9	3.16	2747	0.453	0.405	0.261	0.524					
n	25	25	25	25	25	25	25					
Avg.	50.6	3.16	2715	0.455	0.404	0.262	0.524					
Med.	50.5	3.16	2717	0.457	0.405	0.262	0.524					
σ	0.46	0.006	66.8	0.0089	0.0084	0.0024	0.0046					
Min.	49.9	3.15	2601	0.443	0.393	0.258	0.518					
Max.	51.9	3.18	2823	0.469	0.420	0.267	0.532					

Data Set 5 : 85 °C, 150 mA

Actual Case Temperature [T _s]	86.2 °C
Actual Ambient Temperature [T _A]	84.3 °C
Drive Current [I _F]	150 mA
Measurement Current	150 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	490 h	1052 h	1744 h	2354 h	3116 h	3802 h	4494 h	5185 h	6115 h					
1	100.0	98.8	98.6	98.5	98.3	98.0	97.9	97.9	97.9	97.7					
2	100.0	98.7	98.4	98.3	98.0	97.8	97.9	98.0	98.1	98.1					
3	100.0	98.4	98.1	98.1	97.8	97.6	97.6	97.6	97.5	97.6					
4	100.0	98.6	98.4	98.5	98.0	97.9	97.9	98.0	97.9	97.9					
5	100.0	98.7	98.6	98.6	98.2	98.0	98.1	98.1	97.9	97.9					
6	100.0	98.5	98.2	98.1	97.8	97.6	97.6	97.5	97.3	97.1					
7	100.0	98.6	98.4	98.3	98.0	97.7	97.6	97.5	97.2	96.9					
8	100.0	99.1	98.9	98.8	98.7	98.4	98.3	98.2	98.1	97.9					
9	100.0	99.0	98.8	98.6	98.5	98.2	97.9	97.8	97.6	97.3					
10	100.0	99.1	98.9	98.8	98.7	98.4	98.2	98.0	98.0	97.7					
11	100.0	98.8	98.1	97.9	97.6	97.3	97.2	97.2	97.1	97.0					
12	100.0	98.7	98.6	98.6	98.2	98.1	98.0	98.0	98.1	97.9					
13	100.0	98.6	98.4	98.3	98.0	97.8	97.7	97.6	97.8	97.7					
14	100.0	98.5	98.4	98.2	97.9	97.6	97.4	97.3	97.5	97.3					
15	100.0	98.6	98.4	98.3	98.0	97.8	97.7	97.7	97.7	97.5					
16	100.0	98.6	98.3	98.1	97.9	97.6	97.4	97.3	97.1	96.8					
17	100.0	98.6	98.4	98.3	98.0	97.8	97.7	97.7	97.4	97.2					
18	100.0	99.2	99.0	99.0	98.7	98.6	98.5	98.4	98.0	97.8					
19	100.0	99.2	99.0	98.9	98.6	98.3	98.3	98.2	97.8	97.7					
20	100.0	98.9	98.9	98.9	98.6	98.3	98.2	98.1	97.8	97.7					
21	100.0	99.0	98.9	98.6	98.6	98.4	98.4	98.3	98.3	98.2					
22	100.0	98.8	98.7	98.6	98.3	98.2	98.0	97.9	97.6	97.7					
23	100.0	98.5	98.4	98.3	98.0	97.9	97.8	97.8	97.7	97.8					
24	100.0	98.8	98.6	98.5	98.2	98.0	98.0	98.0	97.8	97.9					
25	100.0	98.9	98.6	98.5	98.2	97.9	97.8	97.7	97.5	97.5					
n	25	25	25	25	25	25	25	25	25	25					
Avg.	100.0	98.8	98.6	98.5	98.2	98.0	97.9	97.8	97.7	97.6					
Med.	100.0	98.7	98.6	98.5	98.2	97.9	97.9	97.9	97.8	97.7					
σ	0.00	0.23	0.27	0.29	0.32	0.31	0.32	0.31	0.33	0.38					
Min.	100.0	98.4	98.1	97.9	97.6	97.3	97.2	97.2	97.1	96.8					
Max.	100.0	99.2	99.0	99.0	98.7	98.6	98.5	98.4	98.3	98.2					

TM-21 Projection

Time	1744 h	2354 h	3116 h	3802 h	4494 h	5185 h	6115 h								
ln(Avg.)	-0.0155	-0.0182	-0.0203	-0.0213	-0.0219	-0.0232	-0.0243								

Test duration used	1744 h	to	6115 h
B	0.9865		
α	1.8622E-06		
R ²	0.9320		
Calculated L ₇₀ (6K)	184000	hours	
Reported L ₇₀ (6K)	> 36700	hours	

Curve-fit equation:

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

Lumen maintenance life equation:

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

Data Set 5 : 85 °C, 150 mA

Actual Case Temperature [T _s]	86.2 °C
Actual Ambient Temperature [T _A]	84.3 °C
Drive Current [I _F]	150 mA
Measurement Current	150 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	490 h	1052 h	1744 h	2354 h	3116 h	3802 h	4494 h	5185 h	6115 h					
1	100.0	101.1	101.6	102.0	102.3	102.4	102.6	102.7	102.9	103.0					
2	100.0	101.0	101.5	101.8	102.1	102.1	102.3	102.4	102.6	102.7					
3	100.0	101.2	101.6	102.0	102.4	102.5	102.6	102.8	102.9	103.1					
4	100.0	101.0	101.5	101.8	102.1	102.1	102.3	102.4	102.5	102.7					
5	100.0	100.8	101.3	101.5	101.8	101.8	102.0	102.1	102.2	102.4					
6	100.0	101.1	101.6	102.0	102.3	102.3	102.6	102.7	102.9	103.0					
7	100.0	101.0	101.4	101.7	102.0	102.0	102.2	102.3	102.4	102.6					
8	100.0	101.2	101.6	102.0	102.4	102.3	102.6	102.7	102.8	103.0					
9	100.0	101.2	101.7	102.1	102.5	102.5	102.7	102.9	103.0	103.1					
10	100.0	101.1	101.6	102.0	102.3	102.3	102.5	102.7	102.8	103.0					
11	100.0	100.2	100.7	101.1	101.4	101.5	101.7	101.7	101.8	102.1					
12	100.0	100.2	100.6	100.9	101.2	101.2	101.5	101.5	101.6	101.8					
13	100.0	100.2	100.7	101.1	101.4	101.4	101.6	101.7	101.8	102.1					
14	100.0	100.2	100.7	101.0	101.4	101.5	101.7	101.8	101.9	102.1					
15	100.0	100.2	100.7	101.1	101.4	101.5	101.6	101.8	101.9	102.1					
16	100.0	100.2	100.6	101.0	101.3	101.4	101.5	101.7	101.8	102.0					
17	100.0	100.2	100.6	100.9	101.2	101.3	101.4	101.4	101.6	101.9					
18	100.0	100.2	100.7	101.0	101.3	101.4	101.6	101.8	101.9	102.1					
19	100.0	100.1	100.5	100.9	101.1	101.2	101.3	101.5	101.5	101.7					
20	100.0	100.1	100.4	100.7	101.0	101.1	101.2	101.3	101.4	101.5					
21	100.0	100.2	100.6	101.0	101.3	101.4	101.6	101.7	101.8	102.0					
22	100.0	100.3	100.7	101.0	101.3	101.4	101.6	101.7	101.8	101.9					
23	100.0	100.2	100.6	100.9	101.2	101.3	101.5	101.6	101.7	101.9					
24	100.0	100.3	100.8	101.1	101.4	101.5	101.7	101.8	101.9	102.1					
25	100.0	100.8	100.8	101.2	101.4	101.5	101.8	101.8	101.9	102.1					
n	25	25	25	25	25	25	25	25	25	25					
Avg.	100.0	100.6	101.0	101.4	101.7	101.7	101.9	102.0	102.1	102.3					
Med.	100.0	100.3	100.7	101.1	101.4	101.5	101.7	101.8	101.9	102.1					
σ	0.00	0.45	0.46	0.47	0.50	0.46	0.47	0.50	0.51	0.51					
Min.	100.0	100.1	100.4	100.7	101.0	101.1	101.2	101.3	101.4	101.5					
Max.	100.0	101.2	101.7	102.1	102.5	102.5	102.7	102.9	103.0	103.1					

Data Set 5 : 85 °C, 150 mA

Actual Case Temperature [T _s]	86.2 °C
Actual Ambient Temperature [T _A]	84.3 °C
Drive Current [I _F]	150 mA
Measurement Current	150 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 5-4
Chromaticity Shift

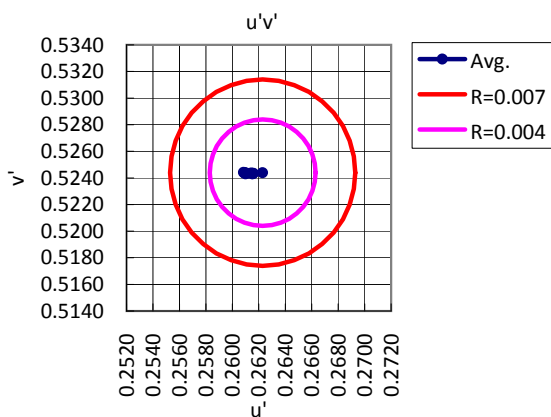
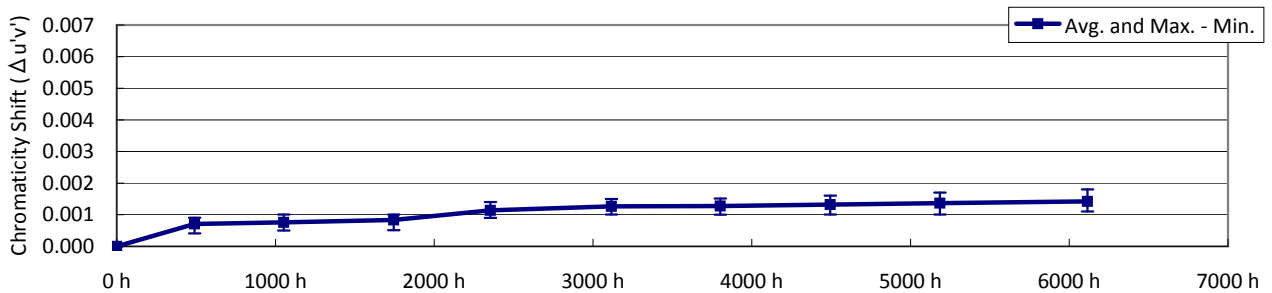
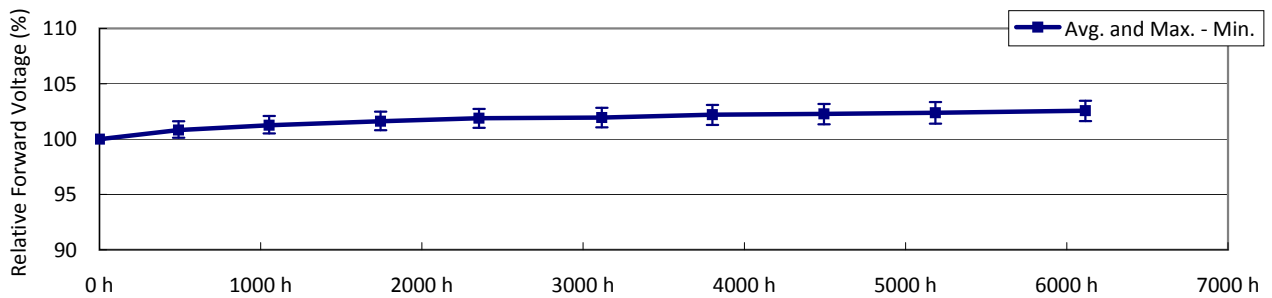
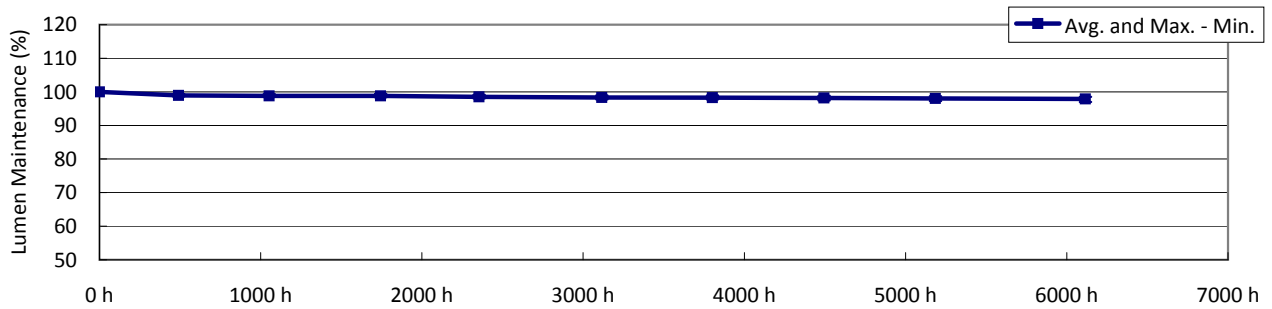
LED No.	Chromaticity Shift Δu'v'													
	0 h	490 h	1052 h	1744 h	2354 h	3116 h	3802 h	4494 h	5185 h	6115 h				
1	0.0000	0.0004	0.0005	0.0006	0.0008	0.0009	0.0010	0.0009	0.0010	0.0011				
2	0.0000	0.0005	0.0004	0.0005	0.0005	0.0006	0.0007	0.0008	0.0009	0.0010				
3	0.0000	0.0005	0.0005	0.0006	0.0008	0.0009	0.0009	0.0009	0.0010	0.0010				
4	0.0000	0.0005	0.0005	0.0006	0.0007	0.0008	0.0009	0.0009	0.0009	0.0011				
5	0.0000	0.0005	0.0006	0.0006	0.0008	0.0009	0.0009	0.0009	0.0010	0.0011				
6	0.0000	0.0007	0.0007	0.0008	0.0010	0.0011	0.0012	0.0012	0.0013	0.0013				
7	0.0000	0.0006	0.0007	0.0008	0.0010	0.0010	0.0011	0.0011	0.0011	0.0012				
8	0.0000	0.0005	0.0006	0.0007	0.0009	0.0010	0.0010	0.0010	0.0010	0.0011				
9	0.0000	0.0006	0.0006	0.0007	0.0009	0.0010	0.0010	0.0010	0.0010	0.0011				
10	0.0000	0.0005	0.0006	0.0007	0.0009	0.0009	0.0010	0.0010	0.0011	0.0011				
11	0.0000	0.0007	0.0005	0.0006	0.0009	0.0009	0.0010	0.0010	0.0011	0.0011				
12	0.0000	0.0008	0.0008	0.0009	0.0011	0.0013	0.0013	0.0013	0.0013	0.0014				
13	0.0000	0.0008	0.0008	0.0010	0.0011	0.0012	0.0012	0.0012	0.0013	0.0014				
14	0.0000	0.0008	0.0008	0.0009	0.0011	0.0013	0.0013	0.0014	0.0014	0.0014				
15	0.0000	0.0008	0.0008	0.0009	0.0011	0.0012	0.0013	0.0013	0.0013	0.0014				
16	0.0000	0.0009	0.0009	0.0010	0.0012	0.0013	0.0014	0.0014	0.0014	0.0015				
17	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0014	0.0014	0.0015	0.0015				
18	0.0000	0.0008	0.0008	0.0009	0.0011	0.0012	0.0012	0.0013	0.0012	0.0013				
19	0.0000	0.0007	0.0008	0.0009	0.0011	0.0012	0.0012	0.0013	0.0013	0.0014				
20	0.0000	0.0008	0.0008	0.0009	0.0012	0.0011	0.0012	0.0013	0.0013	0.0014				
21	0.0000	0.0007	0.0008	0.0010	0.0012	0.0013	0.0013	0.0013	0.0013	0.0014				
22	0.0000	0.0008	0.0008	0.0009	0.0011	0.0013	0.0013	0.0013	0.0013	0.0015				
23	0.0000	0.0008	0.0008	0.0009	0.0011	0.0012	0.0012	0.0013	0.0013	0.0013				
24	0.0000	0.0007	0.0008	0.0009	0.0011	0.0012	0.0012	0.0013	0.0013	0.0014				
25	0.0000	0.0009	0.0009	0.0009	0.0012	0.0013	0.0013	0.0014	0.0014	0.0015				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	0.0000	0.0007	0.0007	0.0008	0.0010	0.0011	0.0011	0.0012	0.0012	0.0013				
Med.	0.0000	0.0007	0.0008	0.0009	0.0011	0.0012	0.0012	0.0013	0.0013	0.0013				
σ	0.0000	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002				
Min.	0.0000	0.0004	0.0004	0.0005	0.0005	0.0006	0.0007	0.0008	0.0009	0.0010				
Max.	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0014	0.0014	0.0015	0.0015				

Data Set 6 : 85 °C, 180 mA

Actual Case Temperature [T _S]	88.1 °C
Actual Ambient Temperature [T _A]	86.3 °C
Drive Current [I _F]	180 mA
Measurement Current	180 mA

NOTES:

T_S and T_A were measured during initial setup.



Data Set 6 : 85 °C, 180 mA

Actual Case Temperature [T _s]	88.1 °C
Actual Ambient Temperature [T _A]	86.3 °C
Drive Current [I _F]	180 mA
Measurement Current	180 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	58.9	3.25	2812	0.442	0.392	0.259	0.517						
2	59.3	3.24	2841	0.441	0.394	0.258	0.518						
3	59.4	3.24	2741	0.452	0.401	0.262	0.522						
4	58.9	3.24	2669	0.460	0.407	0.264	0.526						
5	59.1	3.24	2687	0.459	0.407	0.263	0.526						
6	59.4	3.23	2680	0.457	0.404	0.264	0.524						
7	58.8	3.25	2823	0.442	0.393	0.259	0.518						
8	58.5	3.24	2625	0.466	0.412	0.266	0.529						
9	59.9	3.25	2785	0.450	0.403	0.260	0.523						
10	58.2	3.24	2670	0.458	0.403	0.265	0.524						
11	59.3	3.24	2718	0.454	0.402	0.263	0.523						
12	59.3	3.24	2624	0.470	0.419	0.265	0.532						
13	58.5	3.24	2649	0.466	0.414	0.265	0.530						
14	58.7	3.24	2618	0.469	0.415	0.266	0.530						
15	58.9	3.25	2771	0.447	0.395	0.261	0.519						
16	60.0	3.23	2726	0.456	0.408	0.262	0.526						
17	58.0	3.25	2614	0.469	0.415	0.266	0.530						
18	59.0	3.25	2756	0.451	0.402	0.261	0.523						
19	60.3	3.24	2746	0.454	0.406	0.261	0.525						
20	59.8	3.24	2740	0.456	0.409	0.261	0.526						
21	59.4	3.25	2696	0.460	0.410	0.263	0.527						
22	59.4	3.24	2760	0.450	0.401	0.261	0.522						
23	58.3	3.24	2614	0.469	0.415	0.266	0.530						
24	58.8	3.24	2779	0.448	0.399	0.260	0.521						
25	58.8	3.25	2786	0.446	0.396	0.260	0.519						
n	25	25	25	25	25	25	25						
Avg.	59.1	3.24	2717	0.456	0.405	0.262	0.524						
Med.	59.0	3.24	2726	0.456	0.404	0.262	0.524						
σ	0.58	0.004	69.9	0.0089	0.0077	0.0025	0.0043						
Min.	58.0	3.23	2614	0.441	0.392	0.258	0.517						
Max.	60.3	3.25	2841	0.470	0.419	0.266	0.532						

Data Set 6 : 85 °C, 180 mA

Actual Case Temperature [T _s]	88.1 °C
Actual Ambient Temperature [T _A]	86.3 °C
Drive Current [I _F]	180 mA
Measurement Current	180 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	490 h	1052 h	1744 h	2354 h	3116 h	3802 h	4494 h	5185 h	6115 h				
1	100.0	98.9	98.9	99.0	98.6	98.5	98.5	98.4	98.3	98.2				
2	100.0	98.8	98.7	98.7	98.5	98.4	98.3	98.3	98.4	98.4				
3	100.0	98.8	98.5	98.6	98.4	98.4	98.2	98.1	98.2	98.2				
4	100.0	98.9	98.5	98.5	98.3	98.2	98.0	98.0	98.0	98.0				
5	100.0	99.1	98.9	99.0	98.9	98.7	98.6	98.5	98.5	98.4				
6	100.0	98.8	98.6	98.6	98.4	98.3	98.2	98.2	98.0	97.8				
7	100.0	98.8	98.7	98.6	98.4	98.1	98.2	98.1	97.7	97.5				
8	100.0	99.0	98.9	98.9	98.6	98.3	98.4	98.2	97.8	97.4				
9	100.0	99.1	99.1	99.1	98.8	98.4	98.6	98.4	98.1	97.7				
10	100.0	99.2	99.2	99.2	98.9	98.6	98.7	98.5	98.3	98.1				
11	100.0	99.0	99.0	99.0	98.8	98.5	98.6	98.5	98.4	98.3				
12	100.0	99.0	98.9	99.0	98.6	98.4	98.4	98.3	98.3	98.2				
13	100.0	98.9	98.7	98.7	98.4	98.1	98.2	98.0	98.0	97.9				
14	100.0	98.8	98.4	98.4	98.0	97.7	97.7	97.4	97.3	97.2				
15	100.0	98.7	98.5	98.4	98.1	97.9	97.9	97.8	97.7	97.5				
16	100.0	98.7	98.5	98.4	98.1	97.8	97.8	97.7	97.3	97.0				
17	100.0	98.8	98.6	98.6	98.4	98.1	98.1	98.1	97.8	97.4				
18	100.0	99.1	99.0	98.9	98.5	98.3	98.3	98.2	97.9	97.7				
19	100.0	99.3	99.2	99.2	98.9	98.6	98.6	98.5	98.2	97.9				
20	100.0	99.3	99.3	99.4	99.1	98.9	98.9	98.9	98.7	98.5				
21	100.0	99.2	99.2	99.1	98.8	98.7	98.7	98.6	98.5	98.4				
22	100.0	98.8	98.8	98.9	98.5	98.2	98.2	98.0	98.1	97.9				
23	100.0	98.6	98.5	98.7	98.2	98.0	98.0	97.8	97.9	97.9				
24	100.0	98.8	98.6	98.7	98.2	98.0	98.0	97.8	97.7	97.6				
25	100.0	98.9	98.8	98.9	98.5	98.4	98.3	98.2	98.2	98.0				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	100.0	98.9	98.8	98.8	98.5	98.3	98.3	98.2	98.1	97.9				
Med.	100.0	98.9	98.8	98.9	98.5	98.3	98.3	98.2	98.1	97.9				
σ	0.00	0.19	0.26	0.27	0.28	0.29	0.30	0.33	0.37	0.41				
Min.	100.0	98.6	98.4	98.4	98.0	97.7	97.7	97.4	97.3	97.0				
Max.	100.0	99.3	99.3	99.4	99.1	98.9	98.9	98.9	98.7	98.5				

TM-21 Projection

Time	1744 h	2354 h	3116 h	3802 h	4494 h	5185 h	6115 h							
ln(Avg.)	-0.0119	-0.0149	-0.0171	-0.0172	-0.0183	-0.0197	-0.0213							

Test duration used	1744 h	to	6115 h
B	0.9902		
α	1.9216E-06		
R ²	0.9340		
Calculated L ₇₀ (6K)	180000	hours	
Reported L ₇₀ (6K)	> 36700	hours	

Curve-fit equation:

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

Lumen maintenance life equation:

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

Data Set 6 : 85 °C, 180 mA

Actual Case Temperature [T _s]	88.1 °C
Actual Ambient Temperature [T _A]	86.3 °C
Drive Current [I _F]	180 mA
Measurement Current	180 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	490 h	1052 h	1744 h	2354 h	3116 h	3802 h	4494 h	5185 h	6115 h
1	100.0	101.6	102.1	102.4	102.7	102.8	103.0	103.2	103.3	103.4
2	100.0	101.6	102.1	102.5	102.7	102.8	103.1	103.1	103.2	103.5
3	100.0	101.4	101.9	102.2	102.4	102.6	102.8	102.8	103.0	103.1
4	100.0	101.6	102.1	102.5	102.7	102.8	103.0	103.1	103.3	103.4
5	100.0	101.2	101.6	101.9	102.2	102.2	102.4	102.5	102.6	102.8
6	100.0	101.2	101.6	101.9	102.1	102.3	102.4	102.4	102.5	102.7
7	100.0	101.5	101.9	102.4	102.6	102.7	103.0	103.1	103.3	103.4
8	100.0	101.4	101.8	102.1	102.3	102.4	102.7	102.7	102.8	103.0
9	100.0	101.5	102.0	102.4	102.7	102.8	103.0	103.1	103.2	103.5
10	100.0	101.5	102.1	102.4	102.7	102.8	103.0	103.1	103.2	103.4
11	100.0	100.3	100.7	101.0	101.3	101.4	101.6	101.7	101.7	102.0
12	100.0	100.4	100.8	101.2	101.5	101.5	101.8	102.0	102.0	102.2
13	100.0	100.3	100.7	101.1	101.3	101.4	101.7	101.7	101.8	102.0
14	100.0	100.5	101.0	101.3	101.7	101.7	102.0	102.1	102.2	102.4
15	100.0	100.5	101.0	101.3	101.6	101.6	101.9	102.0	102.1	102.3
16	100.0	100.1	100.5	100.8	101.0	101.1	101.3	101.3	101.4	101.6
17	100.0	100.4	100.9	101.3	101.6	101.7	102.0	102.0	102.2	102.2
18	100.0	100.4	100.9	101.2	101.5	101.5	101.8	101.8	101.9	102.1
19	100.0	100.3	100.6	100.9	101.1	101.2	101.4	101.4	101.6	101.7
20	100.0	100.3	100.8	101.2	101.5	101.6	101.8	101.9	102.0	102.2
21	100.0	100.4	100.9	101.2	101.5	101.6	101.8	101.9	102.0	102.2
22	100.0	100.3	100.8	101.2	101.4	101.5	101.7	101.8	101.8	102.1
23	100.0	100.4	100.9	101.3	101.5	101.6	101.9	102.0	102.1	102.3
24	100.0	100.4	101.0	101.4	101.6	101.7	102.0	102.0	102.1	102.3
25	100.0	101.0	101.0	101.4	101.6	101.7	102.0	102.1	102.2	102.3
n	25	25	25	25	25	25	25	25	25	25
Avg.	100.0	100.8	101.3	101.6	101.9	102.0	102.2	102.3	102.4	102.6
Med.	100.0	100.5	101.0	101.3	101.6	101.7	102.0	102.0	102.2	102.3
σ	0.00	0.55	0.56	0.57	0.58	0.59	0.59	0.59	0.61	0.60
Min.	100.0	100.1	100.5	100.8	101.0	101.1	101.3	101.3	101.4	101.6
Max.	100.0	101.6	102.1	102.5	102.7	102.8	103.1	103.2	103.3	103.5

Data Set 6 : 85 °C, 180 mA

Actual Case Temperature [T _s]	88.1 °C
Actual Ambient Temperature [T _A]	86.3 °C
Drive Current [I _F]	180 mA
Measurement Current	180 mA

NOTES:

T_s and T_A were measured during initial setup.

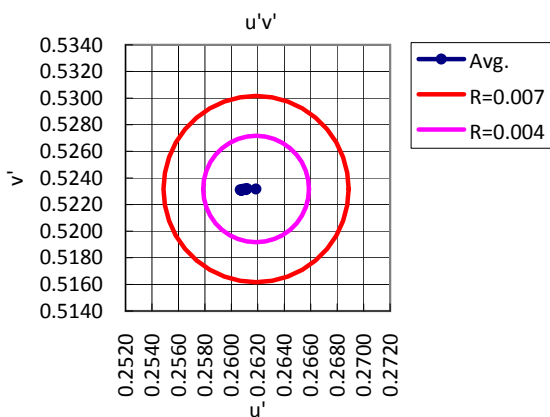
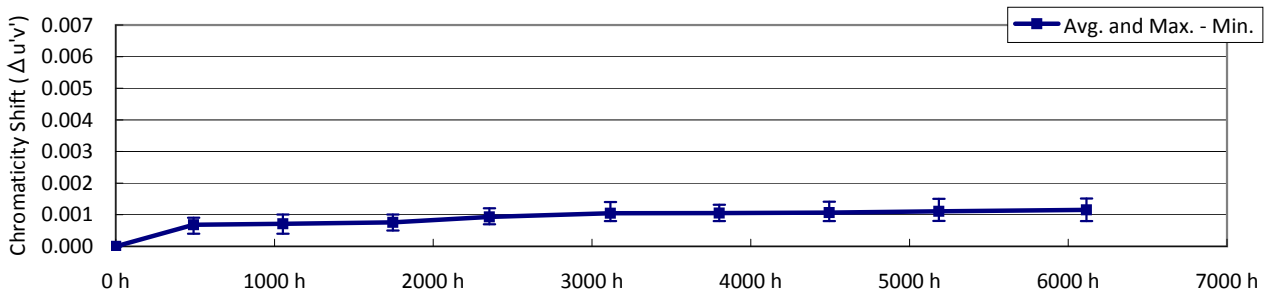
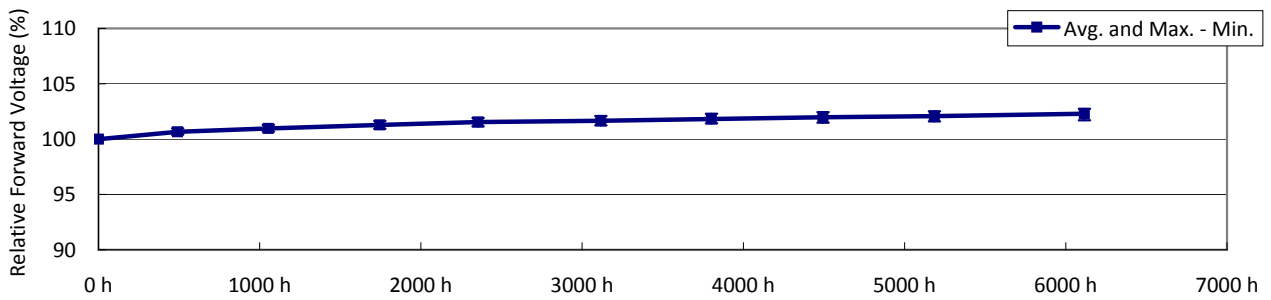
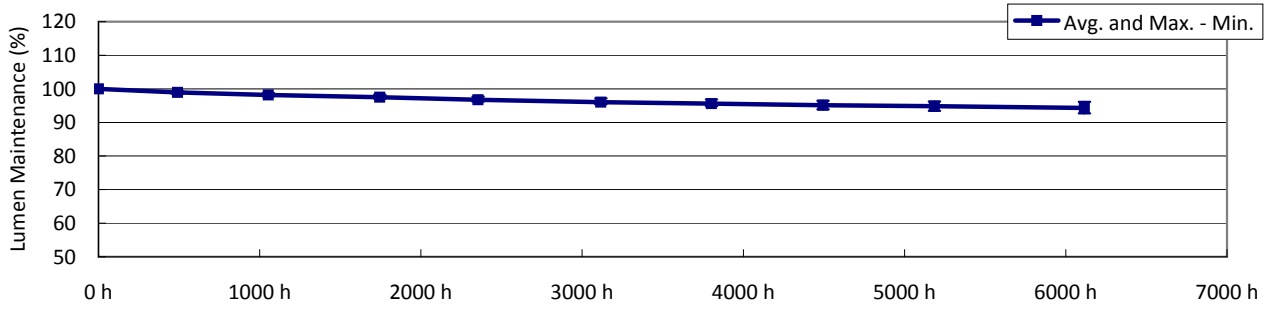
TABLE 6-4
Chromaticity Shift

LED No.	Chromaticity Shift Δu'v'														
	0 h	490 h	1052 h	1744 h	2354 h	3116 h	3802 h	4494 h	5185 h	6115 h					
1	0.0000	0.0005	0.0005	0.0007	0.0010	0.0011	0.0011	0.0012	0.0012	0.0012					
2	0.0000	0.0005	0.0005	0.0006	0.0009	0.0010	0.0010	0.0011	0.0012	0.0012					
3	0.0000	0.0005	0.0006	0.0006	0.0009	0.0011	0.0011	0.0010	0.0010	0.0011					
4	0.0000	0.0005	0.0006	0.0006	0.0010	0.0011	0.0010	0.0011	0.0011	0.0012					
5	0.0000	0.0005	0.0006	0.0007	0.0010	0.0011	0.0011	0.0012	0.0013	0.0013					
6	0.0000	0.0006	0.0006	0.0007	0.0009	0.0011	0.0011	0.0012	0.0012	0.0012					
7	0.0000	0.0006	0.0007	0.0008	0.0011	0.0012	0.0012	0.0013	0.0013	0.0013					
8	0.0000	0.0005	0.0005	0.0006	0.0009	0.0011	0.0011	0.0011	0.0011	0.0012					
9	0.0000	0.0004	0.0005	0.0005	0.0009	0.0010	0.0010	0.0011	0.0011	0.0013					
10	0.0000	0.0005	0.0006	0.0006	0.0009	0.0010	0.0011	0.0011	0.0012	0.0012					
11	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0015	0.0015	0.0016	0.0016					
12	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0015	0.0016	0.0016	0.0017					
13	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0014	0.0014	0.0014	0.0015					
14	0.0000	0.0008	0.0009	0.0010	0.0012	0.0014	0.0013	0.0015	0.0015	0.0015					
15	0.0000	0.0008	0.0009	0.0010	0.0013	0.0014	0.0015	0.0015	0.0016	0.0017					
16	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0015	0.0016	0.0017	0.0018					
17	0.0000	0.0009	0.0010	0.0010	0.0014	0.0015	0.0015	0.0016	0.0016	0.0017					
18	0.0000	0.0008	0.0008	0.0009	0.0012	0.0013	0.0013	0.0013	0.0013	0.0014					
19	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0014	0.0014	0.0015	0.0015					
20	0.0000	0.0008	0.0009	0.0010	0.0013	0.0014	0.0014	0.0014	0.0015	0.0015					
21	0.0000	0.0008	0.0008	0.0009	0.0012	0.0013	0.0013	0.0013	0.0014	0.0014					
22	0.0000	0.0008	0.0008	0.0009	0.0013	0.0014	0.0015	0.0016	0.0016	0.0017					
23	0.0000	0.0007	0.0008	0.0009	0.0011	0.0012	0.0013	0.0013	0.0013	0.0014					
24	0.0000	0.0008	0.0008	0.0009	0.0012	0.0014	0.0013	0.0013	0.0014	0.0014					
25	0.0000	0.0008	0.0009	0.0009	0.0012	0.0014	0.0013	0.0013	0.0014	0.0014					
n	25	25	25	25	25	25	25	25	25	25					
Avg.	0.0000	0.0007	0.0008	0.0008	0.0011	0.0013	0.0013	0.0013	0.0014	0.0014					
Med.	0.0000	0.0008	0.0008	0.0009	0.0012	0.0013	0.0013	0.0013	0.0014	0.0014					
σ	0.0000	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002					
Min.	0.0000	0.0004	0.0005	0.0005	0.0009	0.0010	0.0010	0.0010	0.0010	0.0011					
Max.	0.0000	0.0009	0.0010	0.0010	0.0014	0.0015	0.0015	0.0016	0.0017	0.0018					

Data Set 7 : 105 °C, 65 mA

Actual Case Temperature [T _S]	105.2 °C
Actual Ambient Temperature [T _A]	103.2 °C
Drive Current [I _F]	65 mA
Measurement Current	65 mA

NOTES:
T_S and T_A were measured during initial setup.



Data Set 7 : 105 °C, 65 mA

Actual Case Temperature [T _s]	105.2 °C
Actual Ambient Temperature [T _A]	103.2 °C
Drive Current [I _F]	65 mA
Measurement Current	65 mA

NOTES:

 T_s and T_A were measured during initial setup.

TABLE 7-1
 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	24.2	2.90	2714	0.454	0.402	0.263	0.523						
2	23.9	2.90	2810	0.442	0.391	0.260	0.517						
3	24.2	2.90	2678	0.460	0.408	0.264	0.527						
4	23.8	2.90	2750	0.450	0.398	0.261	0.521						
5	24.3	2.90	2762	0.452	0.405	0.260	0.524						
6	24.5	2.90	2854	0.443	0.399	0.257	0.520						
7	24.0	2.90	2764	0.447	0.395	0.261	0.519						
8	24.2	2.89	2644	0.465	0.412	0.265	0.529						
9	24.2	2.90	2755	0.449	0.397	0.261	0.521						
10	24.1	2.90	2811	0.444	0.395	0.259	0.519						
11	23.9	2.90	2699	0.456	0.403	0.263	0.524						
12	24.2	2.90	2748	0.454	0.406	0.261	0.525						
13	24.6	2.91	2778	0.452	0.406	0.259	0.525						
14	23.9	2.90	2664	0.461	0.407	0.265	0.526						
15	23.9	2.90	2694	0.457	0.404	0.263	0.524						
16	24.1	2.90	2732	0.451	0.399	0.262	0.521						
17	23.8	2.90	2610	0.467	0.412	0.267	0.529						
18	24.4	2.89	2671	0.463	0.412	0.264	0.528						
19	23.8	2.90	2731	0.451	0.399	0.262	0.522						
20	24.2	2.90	2743	0.455	0.407	0.261	0.525						
21	24.0	2.91	2767	0.449	0.399	0.261	0.521						
22	24.1	2.90	2762	0.448	0.397	0.261	0.520						
23	24.2	2.90	2702	0.455	0.403	0.263	0.524						
24	24.0	2.90	2637	0.464	0.410	0.266	0.528						
25	24.5	2.89	2823	0.446	0.401	0.258	0.522						
n	25	25	25	25	25	25	25						
Avg.	24.1	2.90	2732	0.453	0.403	0.262	0.523						
Med.	24.1	2.90	2743	0.452	0.403	0.261	0.524						
σ	0.22	0.004	61.1	0.0069	0.0058	0.0024	0.0033						
Min.	23.8	2.89	2610	0.442	0.391	0.257	0.517						
Max.	24.6	2.91	2854	0.467	0.412	0.267	0.529						

Data Set 7 : 105 °C, 65 mA

Actual Case Temperature [T _s]	105.2 °C
Actual Ambient Temperature [T _A]	103.2 °C
Drive Current [I _F]	65 mA
Measurement Current	65 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 7-2
Lumen Maintenance

LED No.	Lumen Maintenance % (Normalized to 100 % at 0 hours)													
	0 h	490 h	1053 h	1745 h	2354 h	3116 h	3802 h	4494 h	5185 h	6115 h				
1	100.0	99.0	98.1	97.4	96.5	95.9	95.5	95.1	94.6	94.1				
2	100.0	98.7	98.2	97.6	96.8	96.2	95.8	95.6	95.4	95.0				
3	100.0	98.6	97.9	97.2	96.3	95.6	95.3	95.0	94.8	94.3				
4	100.0	98.5	97.8	97.0	96.2	95.4	95.1	94.7	94.4	93.9				
5	100.0	98.6	98.0	97.2	96.4	95.7	95.4	95.0	94.7	94.1				
6	100.0	99.0	98.3	97.7	97.1	96.5	96.1	95.9	95.5	95.0				
7	100.0	98.8	97.9	97.1	96.4	95.6	95.1	94.7	94.1	93.5				
8	100.0	99.4	98.7	98.2	97.6	96.8	96.4	95.9	95.2	94.5				
9	100.0	99.2	98.2	97.5	96.7	95.9	95.3	95.0	94.3	93.7				
10	100.0	98.9	98.0	97.4	96.6	95.9	95.4	95.0	94.4	93.9				
11	100.0	99.1	98.3	97.7	96.8	96.1	95.6	95.0	94.9	94.3				
12	100.0	98.8	98.0	97.4	96.4	95.5	94.8	93.9	93.5	92.7				
13	100.0	98.9	98.0	97.3	96.5	95.7	95.2	94.6	94.5	94.0				
14	100.0	99.0	98.2	97.6	96.8	96.0	95.5	95.0	94.8	94.3				
15	100.0	99.0	98.2	97.5	96.7	95.9	95.3	94.7	94.3	93.7				
16	100.0	98.8	97.9	97.1	96.4	95.6	95.2	94.7	94.2	93.5				
17	100.0	98.9	98.2	97.5	96.8	96.1	95.7	95.2	94.7	94.1				
18	100.0	99.3	98.8	98.3	97.7	97.2	96.9	96.4	96.1	95.7				
19	100.0	99.2	98.4	97.7	97.0	96.2	95.8	95.2	94.9	94.2				
20	100.0	99.2	98.4	97.8	97.0	96.3	95.8	95.2	95.0	94.4				
21	100.0	99.1	98.3	97.8	97.0	96.3	95.9	95.4	95.3	94.8				
22	100.0	98.9	98.1	97.5	96.8	96.1	95.7	95.2	95.0	94.6				
23	100.0	98.6	97.9	97.2	96.4	95.7	95.3	94.9	94.7	94.3				
24	100.0	98.8	98.0	97.4	96.5	96.0	95.7	95.2	95.1	94.8				
25	100.0	99.2	98.6	98.2	97.7	97.1	96.8	96.5	96.2	96.1				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	100.0	98.9	98.2	97.5	96.8	96.0	95.6	95.1	94.8	94.3				
Med.	100.0	98.9	98.2	97.5	96.7	96.0	95.5	95.0	94.8	94.3				
σ	0.00	0.23	0.26	0.33	0.41	0.46	0.50	0.56	0.61	0.71				
Min.	100.0	98.5	97.8	97.0	96.2	95.4	94.8	93.9	93.5	92.7				
Max.	100.0	99.4	98.8	98.3	97.7	97.2	96.9	96.5	96.2	96.1				

TM-21 Projection

Time	1745 h	2354 h	3116 h	3802 h	4494 h	5185 h	6115 h							
ln(Avg.)	-0.0250	-0.0330	-0.0403	-0.0448	-0.0498	-0.0532	-0.0585							

Test duration used	1745 h	to	6115 h
B	0.9851		
α	7.4336E-06		
R ²	0.9738		
Calculated L ₇₀ (6K)	46000	hours	
Reported L ₇₀ (6K)	> 36700	hours	

Curve-fit equation:

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

Lumen maintenance life equation:

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

Data Set 7 : 105 °C, 65 mA

Actual Case Temperature [T _s]	105.2 °C
Actual Ambient Temperature [T _A]	103.2 °C
Drive Current [I _F]	65 mA
Measurement Current	65 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 7-3
Forward Voltage

LED No.	Relative Forward Voltage % (Normalized to 100 % at 0 hours)													
	0 h	490 h	1053 h	1745 h	2354 h	3116 h	3802 h	4494 h	5185 h	6115 h				
1	100.0	100.9	101.2	101.6	101.8	102.0	102.1	102.3	102.4	102.6				
2	100.0	100.8	101.1	101.5	101.7	101.7	101.9	102.1	102.2	102.4				
3	100.0	100.8	101.2	101.5	101.8	101.9	102.1	102.2	102.4	102.6				
4	100.0	101.0	101.3	101.6	101.9	102.1	102.3	102.4	102.5	102.7				
5	100.0	100.9	101.2	101.5	101.9	102.0	102.1	102.3	102.4	102.6				
6	100.0	100.8	101.0	101.3	101.5	101.7	101.8	101.9	102.0	102.2				
7	100.0	100.9	101.2	101.5	101.9	102.0	102.2	102.3	102.4	102.6				
8	100.0	100.8	101.1	101.3	101.5	101.6	101.8	101.9	102.0	102.2				
9	100.0	100.9	101.2	101.6	101.9	102.0	102.2	102.3	102.5	102.7				
10	100.0	100.9	101.3	101.6	101.9	102.0	102.2	102.4	102.5	102.7				
11	100.0	100.5	100.9	101.2	101.5	101.6	101.7	101.9	102.0	102.3				
12	100.0	100.5	100.9	101.1	101.4	101.5	101.7	101.9	102.0	102.2				
13	100.0	100.6	100.8	101.2	101.4	101.6	101.7	101.9	102.0	102.3				
14	100.0	100.5	100.8	101.2	101.4	101.5	101.6	101.8	102.0	102.2				
15	100.0	100.6	100.8	101.1	101.4	101.5	101.7	101.8	101.9	102.2				
16	100.0	100.6	100.8	101.1	101.4	101.5	101.7	101.9	101.9	102.2				
17	100.0	100.5	100.9	101.1	101.4	101.5	101.7	101.8	102.0	102.1				
18	100.0	100.4	100.7	101.0	101.2	101.2	101.4	101.5	101.6	101.8				
19	100.0	100.6	100.8	101.2	101.4	101.6	101.7	101.9	102.0	102.2				
20	100.0	100.5	100.8	101.1	101.4	101.5	101.7	101.8	102.0	102.2				
21	100.0	100.6	100.8	101.2	101.4	101.5	101.7	101.9	102.0	102.1				
22	100.0	100.5	100.8	101.1	101.4	101.5	101.6	101.8	101.9	102.1				
23	100.0	100.4	100.7	101.1	101.3	101.4	101.7	101.7	101.9	102.1				
24	100.0	100.5	100.8	101.1	101.4	101.5	101.7	101.8	102.0	102.1				
25	100.0	100.7	100.7	100.9	101.1	101.3	101.4	101.5	101.6	101.7				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	100.0	100.7	101.0	101.3	101.5	101.6	101.8	102.0	102.1	102.3				
Med.	100.0	100.6	100.9	101.2	101.4	101.6	101.7	101.9	102.0	102.2				
σ	0.00	0.18	0.20	0.22	0.23	0.24	0.24	0.25	0.25	0.27				
Min.	100.0	100.4	100.7	100.9	101.1	101.2	101.4	101.5	101.6	101.7				
Max.	100.0	101.0	101.3	101.6	101.9	102.1	102.3	102.4	102.5	102.7				

Data Set 7 : 105 °C, 65 mA

Actual Case Temperature [T _s]	105.2 °C
Actual Ambient Temperature [T _A]	103.2 °C
Drive Current [I _F]	65 mA
Measurement Current	65 mA

NOTES:

T_s and T_A were measured during initial setup.

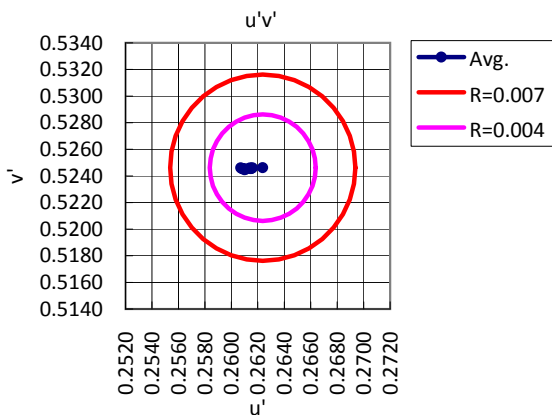
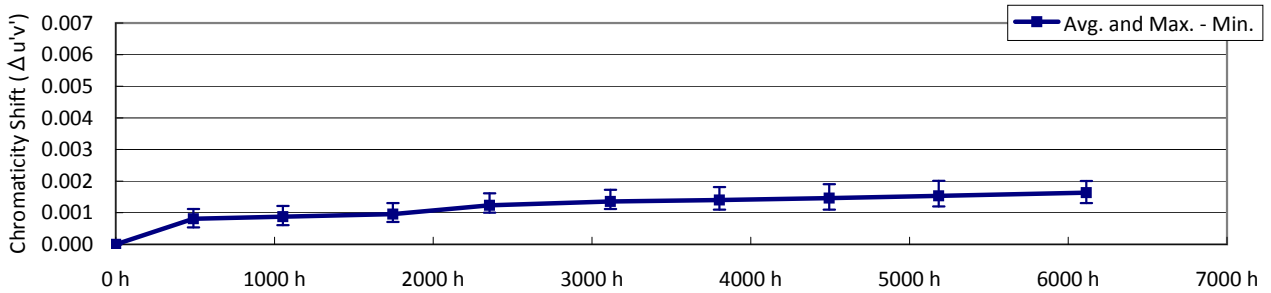
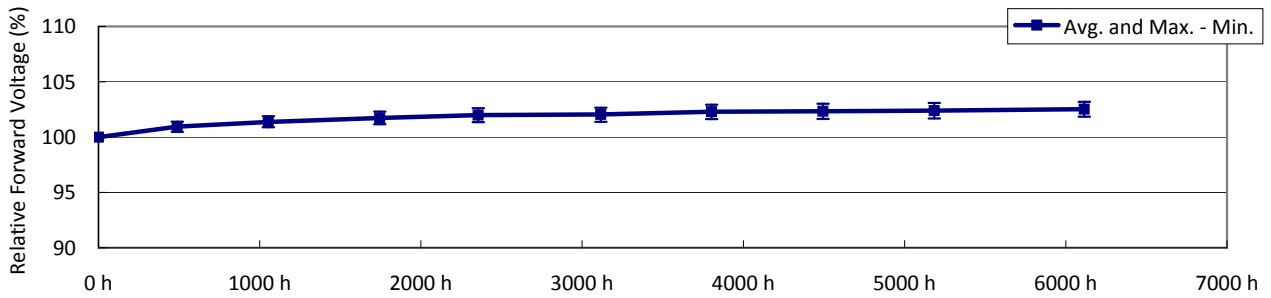
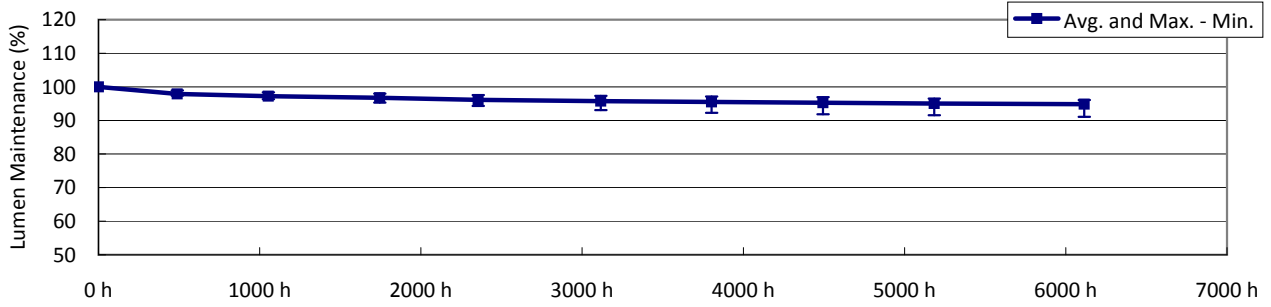
TABLE 7-4
Chromaticity Shift

LED No.	Chromaticity Shift Δu'v'														
	0 h	490 h	1053 h	1745 h	2354 h	3116 h	3802 h	4494 h	5185 h	6115 h					
1	0.0000	0.0004	0.0005	0.0005	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008					
2	0.0000	0.0004	0.0004	0.0006	0.0007	0.0008	0.0008	0.0009	0.0009	0.0010					
3	0.0000	0.0004	0.0005	0.0005	0.0007	0.0009	0.0009	0.0008	0.0009	0.0009					
4	0.0000	0.0005	0.0005	0.0005	0.0007	0.0008	0.0008	0.0008	0.0009	0.0009					
5	0.0000	0.0005	0.0005	0.0006	0.0007	0.0008	0.0009	0.0009	0.0009	0.0010					
6	0.0000	0.0006	0.0006	0.0006	0.0008	0.0009	0.0010	0.0009	0.0010	0.0011					
7	0.0000	0.0006	0.0007	0.0007	0.0009	0.0010	0.0011	0.0011	0.0011	0.0012					
8	0.0000	0.0005	0.0005	0.0006	0.0007	0.0008	0.0008	0.0008	0.0009	0.0009					
9	0.0000	0.0005	0.0005	0.0006	0.0008	0.0009	0.0009	0.0010	0.0010	0.0011					
10	0.0000	0.0005	0.0005	0.0005	0.0007	0.0008	0.0009	0.0009	0.0009	0.0010					
11	0.0000	0.0007	0.0008	0.0008	0.0010	0.0011	0.0011	0.0011	0.0011	0.0012					
12	0.0000	0.0008	0.0008	0.0008	0.0010	0.0010	0.0010	0.0011	0.0011	0.0011					
13	0.0000	0.0007	0.0006	0.0008	0.0009	0.0010	0.0010	0.0010	0.0010	0.0010					
14	0.0000	0.0008	0.0008	0.0009	0.0010	0.0011	0.0011	0.0011	0.0012	0.0012					
15	0.0000	0.0008	0.0009	0.0009	0.0011	0.0011	0.0011	0.0012	0.0012	0.0012					
16	0.0000	0.0009	0.0010	0.0010	0.0012	0.0013	0.0013	0.0014	0.0014	0.0015					
17	0.0000	0.0009	0.0010	0.0010	0.0012	0.0014	0.0013	0.0014	0.0015	0.0015					
18	0.0000	0.0008	0.0008	0.0008	0.0010	0.0011	0.0011	0.0011	0.0012	0.0012					
19	0.0000	0.0008	0.0008	0.0009	0.0010	0.0012	0.0012	0.0012	0.0012	0.0013					
20	0.0000	0.0009	0.0009	0.0009	0.0011	0.0012	0.0012	0.0013	0.0012	0.0012					
21	0.0000	0.0009	0.0009	0.0010	0.0012	0.0013	0.0013	0.0013	0.0014	0.0014					
22	0.0000	0.0007	0.0007	0.0008	0.0010	0.0011	0.0011	0.0011	0.0012	0.0012					
23	0.0000	0.0007	0.0008	0.0008	0.0010	0.0012	0.0011	0.0011	0.0011	0.0012					
24	0.0000	0.0008	0.0009	0.0009	0.0010	0.0012	0.0012	0.0012	0.0012	0.0013					
25	0.0000	0.0008	0.0008	0.0009	0.0011	0.0012	0.0012	0.0011	0.0013	0.0013					
n	25	25	25	25	25	25	25	25	25	25					
Avg.	0.0000	0.0007	0.0007	0.0008	0.0009	0.0010	0.0011	0.0011	0.0011	0.0012					
Med.	0.0000	0.0007	0.0008	0.0008	0.0010	0.0011	0.0011	0.0011	0.0011	0.0012					
σ	0.0000	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002					
Min.	0.0000	0.0004	0.0004	0.0005	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008					
Max.	0.0000	0.0009	0.0010	0.0010	0.0012	0.0014	0.0013	0.0014	0.0015	0.0015					

Data Set 8 : 105 °C, 150 mA

Actual Case Temperature [T_S]	106.6 °C
Actual Ambient Temperature [T_A]	102.9 °C
Drive Current [I_F]	150 mA
Measurement Current	150 mA

NOTES:
 T_S and T_A were measured during initial setup.



Data Set 8 : 105 °C, 150 mA

Actual Case Temperature [T _S]	106.6 °C
Actual Ambient Temperature [T _A]	102.9 °C
Drive Current [I _F]	150 mA
Measurement Current	150 mA

NOTES:

 T_S and T_A were measured during initial setup.

TABLE 8-1
 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	50.3	3.17	2697	0.454	0.400	0.264	0.522						
2	51.5	3.15	2742	0.452	0.402	0.261	0.523						
3	50.5	3.16	2753	0.448	0.396	0.262	0.520						
4	51.1	3.16	2800	0.447	0.400	0.259	0.522						
5	51.3	3.16	2772	0.450	0.402	0.260	0.523						
6	50.6	3.16	2741	0.452	0.402	0.261	0.523						
7	50.0	3.17	2716	0.452	0.398	0.263	0.521						
8	50.4	3.16	2619	0.470	0.418	0.266	0.532						
9	50.6	3.16	2641	0.463	0.408	0.266	0.527						
10	51.2	3.16	2778	0.451	0.405	0.260	0.524						
11	51.6	3.16	2635	0.467	0.415	0.265	0.530						
12	50.1	3.16	2742	0.449	0.397	0.262	0.521						
13	51.2	3.17	2782	0.447	0.398	0.260	0.521						
14	50.5	3.16	2633	0.466	0.413	0.266	0.529						
15	50.2	3.16	2606	0.471	0.419	0.266	0.532						
16	51.2	3.16	2767	0.447	0.396	0.261	0.520						
17	50.7	3.16	2692	0.458	0.405	0.263	0.525						
18	51.5	3.15	2777	0.450	0.403	0.260	0.523						
19	50.8	3.16	2597	0.468	0.412	0.267	0.529						
20	50.5	3.17	2598	0.472	0.418	0.267	0.532						
21	50.8	3.16	2771	0.450	0.402	0.260	0.522						
22	51.3	3.16	2782	0.448	0.400	0.260	0.522						
23	51.2	3.15	2647	0.466	0.414	0.265	0.530						
24	50.3	3.16	2694	0.459	0.408	0.263	0.526						
25	51.7	3.17	2788	0.452	0.407	0.259	0.525						
n	25	25	25	25	25	25	25						
Avg.	50.8	3.16	2711	0.456	0.406	0.263	0.525						
Med.	50.8	3.16	2741	0.452	0.403	0.262	0.523						
σ	0.50	0.006	69.2	0.0086	0.0073	0.0027	0.0041						
Min.	50.0	3.15	2597	0.447	0.396	0.259	0.520						
Max.	51.7	3.17	2800	0.472	0.419	0.267	0.532						

Data Set 8 : 105 °C, 150 mA

Actual Case Temperature [T _s]	106.6 °C
Actual Ambient Temperature [T _A]	102.9 °C
Drive Current [I _F]	150 mA
Measurement Current	150 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 8-2
Lumen Maintenance

LED No.	Lumen Maintenance % (Normalized to 100 % at 0 hours)													
	0 h	489 h	1053 h	1745 h	2355 h	3116 h	3803 h	4494 h	5184 h	6114 h				
1	100.0	97.8	97.0	96.8	96.1	95.7	95.6	95.3	95.2	95.0				
2	100.0	98.0	97.5	97.2	96.8	96.4	96.3	96.2	96.1	95.9				
3	100.0	97.6	97.1	96.5	96.1	95.6	95.5	95.4	95.4	95.2				
4	100.0	97.5	97.1	96.4	96.0	95.5	95.4	95.4	95.3	95.1				
5	100.0	97.7	97.1	96.2	95.5	94.7	94.4	94.3	94.0	93.8				
6	100.0	97.8	97.2	96.7	96.3	95.9	95.8	95.7	95.4	95.2				
7	100.0	97.5	96.5	95.9	95.2	94.6	94.5	94.2	93.8	93.4				
8	100.0	98.0	97.2	96.9	96.2	95.9	95.8	95.5	95.2	94.9				
9	100.0	98.0	97.3	97.1	96.4	96.2	96.2	95.8	95.6	95.3				
10	100.0	98.0	97.1	96.8	95.9	95.6	95.4	94.9	94.7	94.4				
11	100.0	98.1	97.7	97.5	97.0	96.9	96.7	96.4	96.3	96.1				
12	100.0	97.8	97.1	96.4	95.5	95.0	94.6	94.3	94.3	94.4				
13	100.0	98.0	97.4	97.0	96.4	96.2	96.0	95.9	95.7	95.7				
14	100.0	97.4	96.8	96.5	96.0	95.7	95.6	95.4	95.3	95.2				
15	100.0	98.0	97.3	97.0	96.3	96.0	95.9	95.8	95.7	95.5				
16	100.0	97.9	97.4	97.1	96.6	96.3	96.2	96.0	95.7	95.4				
17	100.0	97.9	97.3	96.9	96.4	96.1	96.0	95.8	95.4	95.1				
18	100.0	98.9	98.4	98.0	97.5	97.3	97.1	96.9	96.5	96.1				
19	100.0	98.5	98.0	97.7	97.2	97.0	96.9	96.7	96.4	96.0				
20	100.0	98.0	97.4	97.0	96.4	96.2	95.9	95.6	95.3	95.0				
21	100.0	98.0	97.4	97.1	96.5	96.3	96.1	95.9	95.6	95.5				
22	100.0	97.4	96.3	95.3	94.3	93.4	92.6	91.8	91.6	91.1				
23	100.0	98.0	97.4	97.0	96.1	95.4	95.0	94.6	94.6	94.5				
24	100.0	97.6	96.4	95.5	94.3	93.1	92.3	92.0	91.6	91.1				
25	100.0	98.0	97.4	96.9	96.4	96.1	96.0	95.7	95.6	95.5				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	100.0	97.9	97.2	96.8	96.1	95.7	95.5	95.3	95.0	94.8				
Med.	100.0	98.0	97.3	96.9	96.3	95.9	95.8	95.6	95.4	95.2				
σ	0.00	0.34	0.45	0.61	0.75	0.99	1.14	1.22	1.24	1.30				
Min.	100.0	97.4	96.3	95.3	94.3	93.1	92.3	91.8	91.6	91.1				
Max.	100.0	98.9	98.4	98.0	97.5	97.3	97.1	96.9	96.5	96.1				

TM-21 Projection

Time	1745 h	2355 h	3116 h	3803 h	4494 h	5184 h	6114 h							
ln(Avg.)	-0.0329	-0.0393	-0.0436	-0.0460	-0.0485	-0.0508	-0.0532							

Test duration used	1745 h	to	6114 h
B	0.9722		
α	4.3708E-06		
R ²	0.9412		
Calculated L ₇₀ (6K)	75200	hours	
Reported L ₇₀ (6K)	> 36700	hours	

Curve-fit equation:

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

Lumen maintenance life equation:

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

Data Set 8 : 105 °C, 150 mA

Actual Case Temperature [T _s]	106.6 °C
Actual Ambient Temperature [T _A]	102.9 °C
Drive Current [I _F]	150 mA
Measurement Current	150 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 8-3
Forward Voltage

LED No.	Relative Forward Voltage % (Normalized to 100 % at 0 hours)														
	0 h	489 h	1053 h	1745 h	2355 h	3116 h	3803 h	4494 h	5184 h	6114 h					
1	100.0	101.3	101.8	102.3	102.5	102.6	102.9	102.9	102.9	103.1					
2	100.0	101.0	101.4	101.7	101.9	102.0	102.2	102.2	102.3	102.4					
3	100.0	101.3	101.8	102.2	102.5	102.5	102.7	102.9	102.9	103.1					
4	100.0	101.4	101.9	102.3	102.6	102.7	102.9	103.0	103.1	103.2					
5	100.0	101.1	101.5	101.9	102.1	102.1	102.3	102.3	102.4	102.5					
6	100.0	101.4	101.9	102.2	102.5	102.6	102.8	102.8	103.0	103.1					
7	100.0	101.4	101.8	102.3	102.6	102.6	102.9	102.9	103.0	103.1					
8	100.0	101.3	101.8	102.3	102.6	102.6	102.9	102.9	103.1	103.2					
9	100.0	101.2	101.6	102.0	102.2	102.3	102.5	102.5	102.7	102.6					
10	100.0	101.4	101.8	102.3	102.6	102.6	102.9	103.0	103.1	103.2					
11	100.0	100.5	100.9	101.2	101.4	101.4	101.6	101.6	101.7	101.8					
12	100.0	100.8	101.2	101.4	101.7	101.7	102.0	102.0	102.0	102.1					
13	100.0	100.7	101.1	101.5	101.9	101.9	102.2	102.2	102.3	102.5					
14	100.0	100.6	101.0	101.3	101.5	101.6	101.8	101.9	101.9	102.0					
15	100.0	100.7	101.2	101.6	101.9	102.0	102.3	102.3	102.4	102.5					
16	100.0	100.6	101.0	101.3	101.5	101.6	101.8	101.8	101.8	102.0					
17	100.0	100.6	101.1	101.4	101.6	101.7	101.9	101.9	102.0	102.1					
18	100.0	100.5	101.0	101.2	101.5	101.5	101.7	101.8	101.8	101.9					
19	100.0	100.6	100.9	101.3	101.5	101.5	101.8	101.8	101.9	102.0					
20	100.0	100.8	101.2	101.6	101.9	102.0	102.3	102.3	102.4	102.5					
21	100.0	100.8	101.3	101.7	102.0	102.1	102.3	102.3	102.4	102.6					
22	100.0	100.8	101.1	101.5	101.7	101.8	102.0	102.1	102.1	102.3					
23	100.0	100.8	101.1	101.5	101.7	101.7	101.9	101.9	102.0	102.2					
24	100.0	100.8	101.3	101.8	102.0	102.1	102.4	102.4	102.4	102.6					
25	100.0	101.2	101.2	101.6	101.9	102.0	102.2	102.3	102.4	102.5					
n	25	25	25	25	25	25	25	25	25	25					
Avg.	100.0	100.9	101.4	101.7	102.0	102.0	102.3	102.3	102.4	102.5					
Med.	100.0	100.8	101.2	101.6	101.9	102.0	102.3	102.3	102.4	102.5					
σ	0.00	0.33	0.35	0.39	0.41	0.42	0.43	0.43	0.46	0.45					
Min.	100.0	100.5	100.9	101.2	101.4	101.4	101.6	101.6	101.7	101.8					
Max.	100.0	101.4	101.9	102.3	102.6	102.7	102.9	103.0	103.1	103.2					

Data Set 8 : 105 °C, 150 mA

Actual Case Temperature [T _s]	106.6 °C
Actual Ambient Temperature [T _A]	102.9 °C
Drive Current [I _F]	150 mA
Measurement Current	150 mA

NOTES:

T_s and T_A were measured during initial setup.

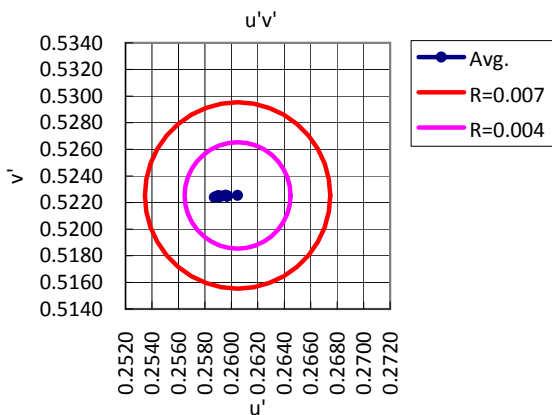
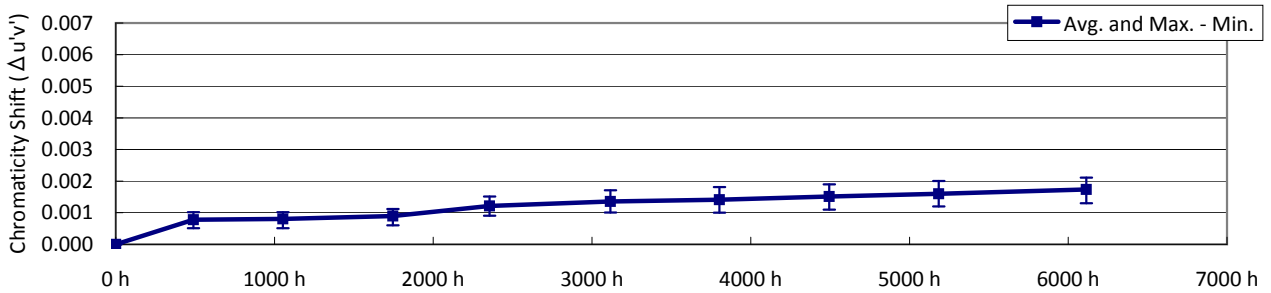
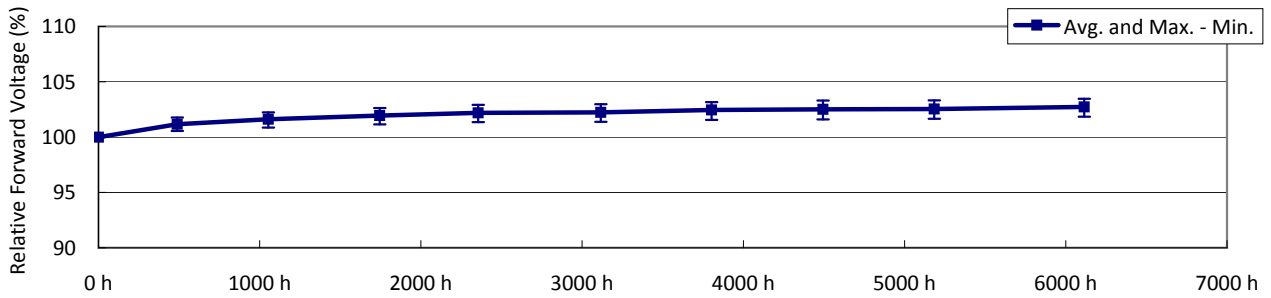
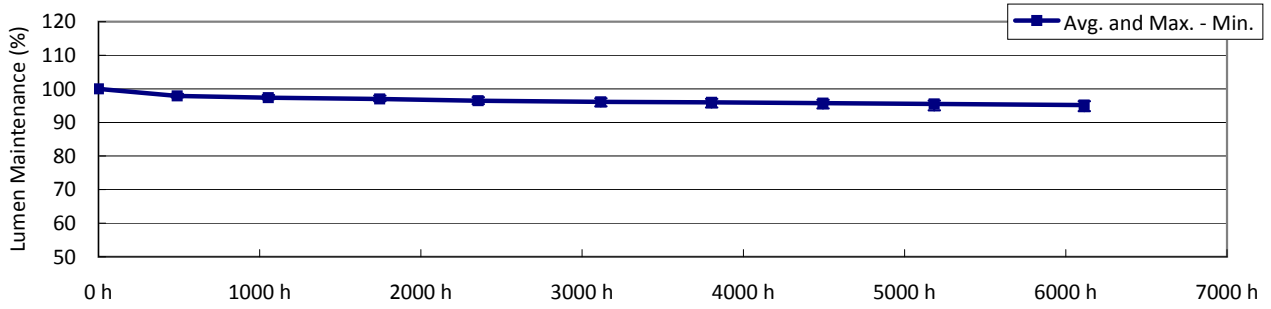
TABLE 8-4
Chromaticity Shift

LED No.	Chromaticity Shift Δu'v'														
	0 h	489 h	1053 h	1745 h	2355 h	3116 h	3803 h	4494 h	5184 h	6114 h					
1	0.0000	0.0005	0.0006	0.0007	0.0010	0.0011	0.0011	0.0012	0.0013	0.0014					
2	0.0000	0.0006	0.0006	0.0007	0.0010	0.0011	0.0011	0.0013	0.0013	0.0014					
3	0.0000	0.0006	0.0007	0.0007	0.0011	0.0012	0.0013	0.0013	0.0014	0.0015					
4	0.0000	0.0006	0.0007	0.0008	0.0010	0.0011	0.0011	0.0011	0.0013	0.0013					
5	0.0000	0.0006	0.0007	0.0007	0.0010	0.0011	0.0011	0.0012	0.0012	0.0013					
6	0.0000	0.0007	0.0008	0.0009	0.0011	0.0013	0.0013	0.0013	0.0014	0.0015					
7	0.0000	0.0007	0.0009	0.0009	0.0013	0.0013	0.0015	0.0014	0.0016	0.0016					
8	0.0000	0.0007	0.0007	0.0008	0.0010	0.0012	0.0013	0.0013	0.0014	0.0016					
9	0.0000	0.0006	0.0007	0.0008	0.0011	0.0012	0.0013	0.0014	0.0014	0.0016					
10	0.0000	0.0007	0.0007	0.0008	0.0011	0.0012	0.0012	0.0013	0.0014	0.0015					
11	0.0000	0.0009	0.0009	0.0011	0.0013	0.0015	0.0016	0.0017	0.0017	0.0018					
12	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0014	0.0015	0.0016	0.0017					
13	0.0000	0.0008	0.0010	0.0010	0.0012	0.0013	0.0014	0.0015	0.0015	0.0016					
14	0.0000	0.0011	0.0012	0.0013	0.0016	0.0017	0.0018	0.0019	0.0020	0.0020					
15	0.0000	0.0009	0.0010	0.0010	0.0013	0.0014	0.0014	0.0015	0.0016	0.0017					
16	0.0000	0.0011	0.0011	0.0012	0.0015	0.0016	0.0017	0.0017	0.0018	0.0019					
17	0.0000	0.0011	0.0011	0.0011	0.0015	0.0016	0.0016	0.0017	0.0017	0.0019					
18	0.0000	0.0007	0.0007	0.0008	0.0011	0.0012	0.0012	0.0013	0.0013	0.0015					
19	0.0000	0.0009	0.0009	0.0011	0.0013	0.0015	0.0015	0.0015	0.0016	0.0017					
20	0.0000	0.0009	0.0010	0.0011	0.0014	0.0015	0.0016	0.0017	0.0018	0.0019					
21	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0015	0.0015	0.0016	0.0017					
22	0.0000	0.0009	0.0009	0.0010	0.0013	0.0015	0.0016	0.0016	0.0017	0.0018					
23	0.0000	0.0009	0.0010	0.0011	0.0013	0.0014	0.0015	0.0015	0.0015	0.0016					
24	0.0000	0.0010	0.0011	0.0011	0.0013	0.0014	0.0014	0.0015	0.0016	0.0016					
25	0.0000	0.0008	0.0010	0.0010	0.0013	0.0014	0.0015	0.0015	0.0015	0.0016					
n	25	25	25	25	25	25	25	25	25	25					
Avg.	0.0000	0.0008	0.0009	0.0010	0.0012	0.0014	0.0014	0.0015	0.0015	0.0016					
Med.	0.0000	0.0008	0.0009	0.0010	0.0013	0.0014	0.0014	0.0015	0.0015	0.0016					
σ	0.0000	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002					
Min.	0.0000	0.0005	0.0006	0.0007	0.0010	0.0011	0.0011	0.0011	0.0012	0.0013					
Max.	0.0000	0.0011	0.0012	0.0013	0.0016	0.0017	0.0018	0.0019	0.0020	0.0020					

Data Set 9 : 105 °C, 180 mA

Actual Case Temperature [T _S]	107.3 °C
Actual Ambient Temperature [T _A]	105.1 °C
Drive Current [I _F]	180 mA
Measurement Current	180 mA

NOTES:
T_S and T_A were measured during initial setup.



Data Set 9 : 105 °C, 180 mA

Actual Case Temperature [T _s]	107.3 °C
Actual Ambient Temperature [T _A]	105.1 °C
Drive Current [I _F]	180 mA
Measurement Current	180 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 9-1
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	59.8	3.24	2807	0.447	0.401	0.259	0.522					
2	60.0	3.24	2708	0.459	0.411	0.262	0.527					
3	58.6	3.25	2820	0.442	0.392	0.259	0.517					
4	59.4	3.24	2851	0.442	0.396	0.257	0.519					
5	60.2	3.24	2793	0.447	0.398	0.260	0.521					
6	58.7	3.26	2774	0.446	0.395	0.261	0.519					
7	59.4	3.25	2674	0.465	0.416	0.263	0.530					
8	59.3	3.24	2844	0.442	0.394	0.258	0.518					
9	58.1	3.24	2765	0.446	0.394	0.261	0.519					
10	59.1	3.25	2767	0.447	0.395	0.261	0.519					
11	60.1	3.24	2794	0.449	0.402	0.259	0.522					
12	59.9	3.24	2753	0.456	0.411	0.260	0.527					
13	58.4	3.24	2750	0.448	0.396	0.262	0.520					
14	59.8	3.23	2794	0.445	0.394	0.260	0.519					
15	59.2	3.24	2681	0.463	0.414	0.263	0.529					
16	59.2	3.24	2804	0.445	0.397	0.259	0.520					
17	60.0	3.24	2782	0.451	0.405	0.259	0.524					
18	58.5	3.25	2777	0.446	0.395	0.261	0.519					
19	59.4	3.25	2707	0.461	0.414	0.262	0.529					
20	60.0	3.23	2795	0.446	0.396	0.260	0.520					
21	59.6	3.24	2797	0.449	0.404	0.259	0.523					
22	59.0	3.26	2819	0.444	0.396	0.259	0.519					
23	59.0	3.24	2790	0.446	0.397	0.260	0.520					
24	58.9	3.24	2770	0.449	0.400	0.260	0.522					
25	59.8	3.24	2744	0.457	0.411	0.260	0.527					
n	25	25	25	25	25	25	25					
Avg.	59.3	3.24	2774	0.450	0.401	0.260	0.522					
Med.	59.4	3.24	2782	0.447	0.397	0.260	0.520					
σ	0.59	0.006	45.2	0.0067	0.0075	0.0015	0.0039					
Min.	58.1	3.23	2674	0.442	0.392	0.257	0.517					
Max.	60.2	3.26	2851	0.465	0.416	0.263	0.530					

Data Set 9 : 105 °C, 180 mA

Actual Case Temperature [T _s]	107.3 °C
Actual Ambient Temperature [T _A]	105.1 °C
Drive Current [I _F]	180 mA
Measurement Current	180 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 9-2
Lumen Maintenance

LED No.	Lumen Maintenance % (Normalized to 100 % at 0 hours)													
	0 h	489 h	1053 h	1745 h	2355 h	3116 h	3803 h	4494 h	5184 h	6114 h				
1	100.0	97.9	97.3	97.1	96.5	96.1	96.0	95.8	95.7	95.3				
2	100.0	97.9	97.4	97.2	96.8	96.5	96.5	96.2	96.2	95.9				
3	100.0	97.9	97.5	97.3	96.9	96.5	96.6	96.3	96.4	96.3				
4	100.0	97.8	97.2	96.8	96.5	96.2	96.1	95.8	96.0	95.9				
5	100.0	97.9	97.2	96.7	96.2	95.7	95.5	95.0	94.8	94.3				
6	100.0	97.5	96.9	96.6	96.1	95.7	95.6	95.3	95.0	94.7				
7	100.0	97.5	96.9	96.6	96.1	95.7	95.6	95.4	94.9	94.5				
8	100.0	97.9	97.1	96.3	95.5	94.8	94.5	94.2	93.6	93.6				
9	100.0	98.0	97.3	96.5	95.8	95.1	94.7	94.5	93.9	93.4				
10	100.0	97.9	97.5	97.1	96.6	96.2	96.1	95.9	95.5	95.0				
11	100.0	98.3	98.0	97.8	97.2	97.0	96.8	96.6	96.5	96.2				
12	100.0	97.9	97.4	97.2	96.6	96.4	96.0	95.9	95.8	95.4				
13	100.0	97.6	97.1	96.8	96.2	96.1	95.8	95.6	95.5	95.3				
14	100.0	98.1	97.7	97.4	97.0	96.8	96.5	96.4	96.3	96.0				
15	100.0	97.8	97.3	97.0	96.4	96.2	96.0	95.8	95.6	95.3				
16	100.0	97.4	96.9	96.5	96.1	95.8	95.6	95.5	95.1	94.6				
17	100.0	97.9	97.5	97.1	96.7	96.2	96.1	95.9	95.6	95.1				
18	100.0	98.0	97.2	96.7	96.2	95.8	95.7	95.4	94.9	94.5				
19	100.0	98.4	97.8	97.5	97.1	96.8	96.7	96.5	96.1	95.8				
20	100.0	98.5	98.2	98.0	97.5	97.2	97.0	96.7	96.5	96.1				
21	100.0	98.2	97.7	97.4	96.9	96.8	96.5	96.4	96.1	95.9				
22	100.0	98.0	97.5	97.2	96.7	96.5	96.3	96.1	95.9	95.7				
23	100.0	97.6	97.0	96.6	96.0	95.8	95.6	95.5	95.2	95.0				
24	100.0	97.8	97.3	96.9	96.4	96.1	95.9	95.9	95.5	95.4				
25	100.0	97.5	97.0	96.6	96.1	95.8	95.6	95.4	95.0	94.6				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	100.0	97.9	97.4	97.0	96.5	96.1	96.0	95.8	95.5	95.2				
Med.	100.0	97.9	97.3	97.0	96.5	96.2	96.0	95.8	95.6	95.3				
σ	0.00	0.27	0.34	0.42	0.47	0.57	0.60	0.62	0.74	0.78				
Min.	100.0	97.4	96.9	96.3	95.5	94.8	94.5	94.2	93.6	93.4				
Max.	100.0	98.5	98.2	98.0	97.5	97.2	97.0	96.7	96.5	96.3				

TM-21 Projection

Time	1745 h	2355 h	3116 h	3803 h	4494 h	5184 h	6114 h							
ln(Avg.)	-0.0304	-0.0359	-0.0393	-0.0412	-0.0434	-0.0460	-0.0493							

Test duration used	1745 h	to	6114 h
B	0.9749		
α	4.0017E-06		
R ²	0.9689		
Calculated L ₇₀ (6K)	82800	hours	
Reported L ₇₀ (6K)	> 36700	hours	

Curve-fit equation:

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

Lumen maintenance life equation:

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

Data Set 9 : 105 °C, 180 mA

Actual Case Temperature [T _s]	107.3 °C
Actual Ambient Temperature [T _A]	105.1 °C
Drive Current [I _F]	180 mA
Measurement Current	180 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 9-3
Forward Voltage

LED No.	Relative Forward Voltage % (Normalized to 100 % at 0 hours)													
	0 h	489 h	1053 h	1745 h	2355 h	3116 h	3803 h	4494 h	5184 h	6114 h				
1	100.0	101.7	102.1	102.5	102.8	102.8	103.1	103.2	103.2	103.4				
2	100.0	101.4	101.9	102.2	102.5	102.4	102.6	102.7	102.7	102.9				
3	100.0	101.7	102.2	102.6	102.9	103.0	103.1	103.3	103.3	103.5				
4	100.0	101.7	102.2	102.6	102.9	102.9	103.2	103.2	103.3	103.5				
5	100.0	101.5	101.9	102.2	102.5	102.4	102.7	102.7	102.7	102.9				
6	100.0	101.6	102.1	102.5	102.8	102.8	103.1	103.1	103.1	103.4				
7	100.0	101.6	102.1	102.5	102.8	102.8	103.0	103.1	103.1	103.3				
8	100.0	101.8	102.2	102.6	102.8	102.8	103.0	103.1	103.2	103.3				
9	100.0	101.7	102.2	102.6	102.9	102.9	103.1	103.2	103.3	103.4				
10	100.0	101.4	101.8	102.2	102.4	102.4	102.6	102.7	102.7	102.9				
11	100.0	100.6	101.0	101.3	101.6	101.6	101.8	101.9	101.9	102.1				
12	100.0	100.8	101.2	101.6	101.7	101.8	101.9	102.0	102.0	102.1				
13	100.0	101.0	101.5	101.8	102.1	102.2	102.4	102.4	102.5	102.7				
14	100.0	100.6	100.9	101.2	101.4	101.4	101.6	101.6	101.7	101.8				
15	100.0	100.9	101.5	101.8	102.0	102.1	102.3	102.4	102.5	102.6				
16	100.0	100.9	101.4	101.8	102.0	102.1	102.3	102.3	102.4	102.6				
17	100.0	100.9	101.4	101.7	101.9	102.0	102.2	102.4	102.3	102.6				
18	100.0	100.9	101.4	101.8	102.0	102.1	102.3	102.4	102.4	102.6				
19	100.0	100.9	101.4	101.7	102.0	102.0	102.2	102.2	102.3	102.4				
20	100.0	100.6	101.0	101.1	101.4	101.4	101.5	101.6	101.7	101.9				
21	100.0	100.9	101.4	101.7	101.9	102.0	102.2	102.3	102.2	102.5				
22	100.0	100.9	101.4	101.8	102.0	102.1	102.3	102.4	102.3	102.6				
23	100.0	100.9	101.4	101.7	101.9	102.1	102.3	102.3	102.3	102.5				
24	100.0	100.8	101.3	101.6	101.7	101.9	102.0	102.0	102.0	102.2				
25	100.0	101.4	101.4	101.7	101.9	102.0	102.2	102.3	102.2	102.5				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	100.0	101.2	101.6	102.0	102.2	102.2	102.4	102.5	102.5	102.7				
Med.	100.0	100.9	101.4	101.8	102.0	102.1	102.3	102.4	102.4	102.6				
σ	0.00	0.41	0.43	0.45	0.49	0.47	0.49	0.50	0.51	0.50				
Min.	100.0	100.6	100.9	101.1	101.4	101.4	101.5	101.6	101.7	101.8				
Max.	100.0	101.8	102.2	102.6	102.9	103.0	103.2	103.3	103.3	103.5				

Data Set 9 : 105 °C, 180 mA

Actual Case Temperature [T _s]	107.3 °C
Actual Ambient Temperature [T _A]	105.1 °C
Drive Current [I _F]	180 mA
Measurement Current	180 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 9-4
Chromaticity Shift

LED No.	Chromaticity Shift Δu'v'														
	0 h	489 h	1053 h	1745 h	2355 h	3116 h	3803 h	4494 h	5184 h	6114 h					
1	0.0000	0.0005	0.0005	0.0006	0.0009	0.0010	0.0010	0.0012	0.0013	0.0014					
2	0.0000	0.0005	0.0005	0.0006	0.0009	0.0010	0.0010	0.0011	0.0012	0.0013					
3	0.0000	0.0007	0.0007	0.0008	0.0010	0.0012	0.0012	0.0013	0.0014	0.0015					
4	0.0000	0.0006	0.0006	0.0007	0.0010	0.0011	0.0012	0.0013	0.0013	0.0015					
5	0.0000	0.0006	0.0007	0.0008	0.0012	0.0014	0.0015	0.0016	0.0017	0.0018					
6	0.0000	0.0007	0.0008	0.0008	0.0011	0.0013	0.0013	0.0014	0.0016	0.0016					
7	0.0000	0.0006	0.0007	0.0007	0.0011	0.0012	0.0013	0.0014	0.0014	0.0015					
8	0.0000	0.0005	0.0006	0.0007	0.0011	0.0013	0.0014	0.0015	0.0016	0.0017					
9	0.0000	0.0005	0.0005	0.0006	0.0010	0.0012	0.0012	0.0013	0.0013	0.0015					
10	0.0000	0.0006	0.0006	0.0007	0.0010	0.0011	0.0013	0.0014	0.0015	0.0017					
11	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0015	0.0016	0.0017	0.0018					
12	0.0000	0.0008	0.0008	0.0009	0.0011	0.0014	0.0014	0.0015	0.0016	0.0017					
13	0.0000	0.0009	0.0010	0.0011	0.0014	0.0015	0.0016	0.0017	0.0018	0.0019					
14	0.0000	0.0009	0.0010	0.0011	0.0014	0.0015	0.0016	0.0017	0.0018	0.0019					
15	0.0000	0.0009	0.0010	0.0011	0.0014	0.0015	0.0015	0.0016	0.0017	0.0017					
16	0.0000	0.0010	0.0010	0.0011	0.0014	0.0015	0.0016	0.0017	0.0018	0.0019					
17	0.0000	0.0010	0.0010	0.0011	0.0015	0.0017	0.0018	0.0018	0.0019	0.0021					
18	0.0000	0.0010	0.0010	0.0011	0.0015	0.0017	0.0018	0.0019	0.0020	0.0021					
19	0.0000	0.0010	0.0010	0.0011	0.0014	0.0015	0.0015	0.0016	0.0016	0.0017					
20	0.0000	0.0009	0.0009	0.0011	0.0014	0.0015	0.0016	0.0017	0.0018	0.0020					
21	0.0000	0.0008	0.0008	0.0009	0.0012	0.0013	0.0012	0.0014	0.0015	0.0017					
22	0.0000	0.0008	0.0009	0.0009	0.0011	0.0013	0.0014	0.0015	0.0015	0.0017					
23	0.0000	0.0008	0.0008	0.0009	0.0013	0.0014	0.0015	0.0016	0.0017	0.0019					
24	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0014	0.0015	0.0016	0.0017					
25	0.0000	0.0009	0.0008	0.0009	0.0012	0.0013	0.0013	0.0014	0.0015	0.0017					
n	25	25	25	25	25	25	25	25	25	25					
Avg.	0.0000	0.0008	0.0008	0.0009	0.0012	0.0014	0.0014	0.0015	0.0016	0.0017					
Med.	0.0000	0.0008	0.0008	0.0009	0.0012	0.0014	0.0014	0.0015	0.0016	0.0017					
σ	0.0000	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002					
Min.	0.0000	0.0005	0.0005	0.0006	0.0009	0.0010	0.0010	0.0011	0.0012	0.0013					
Max.	0.0000	0.0010	0.0010	0.0011	0.0015	0.0017	0.0018	0.0019	0.0020	0.0021					