

LM-80 Test Report

NF2L757AR

Issue Date: November 25, 2011	Revision Date: April 20, 2012
Test Initiation Date: July 26, 2011	Test Completion Date: -
Test Duration: 6,000 hours	Report Number: SQETMLG14004

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: Nichia Warm White LED
 Model Number: NF2L757AR (Nominal CCT: 2700K)

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	100 mA	97.8%	0.0022	> 36200 hours
2	55°C	> 50°C	200 mA	97.2%	0.0026	> 36200 hours
3	85°C	> 80°C	100 mA	97.2%	0.0022	> 36200 hours
4	85°C	> 80°C	200 mA	95.6%	0.0021	> 36200 hours
5	105°C	> 100°C	100 mA	94.6%	0.0024	> 36200 hours
6	105°C	> 100°C	200 mA	92.0%	0.0028	> 36200 hours

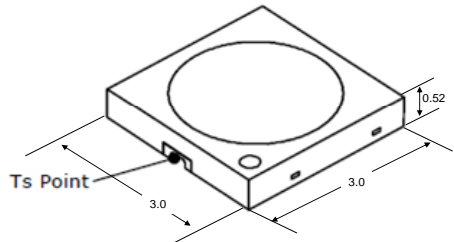
Approved Signatory:



Masanobu TANAKA, Lab Manager

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

IES LM-80-08 Test Report Requirement :

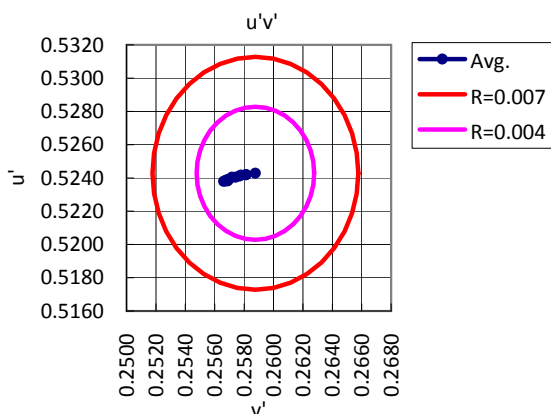
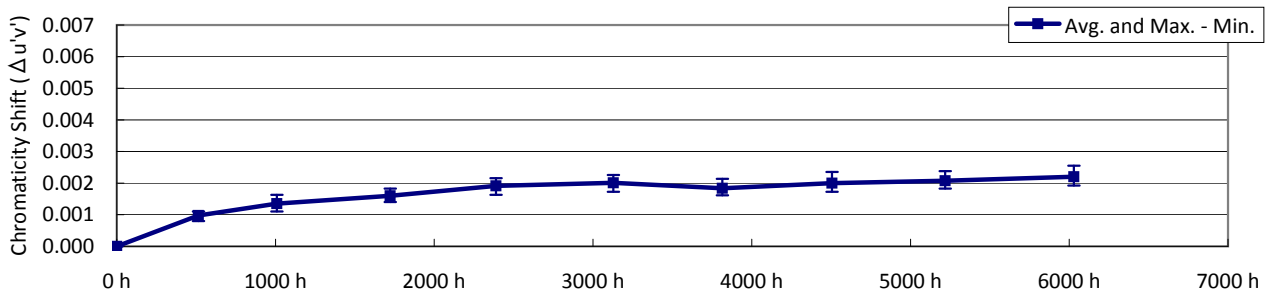
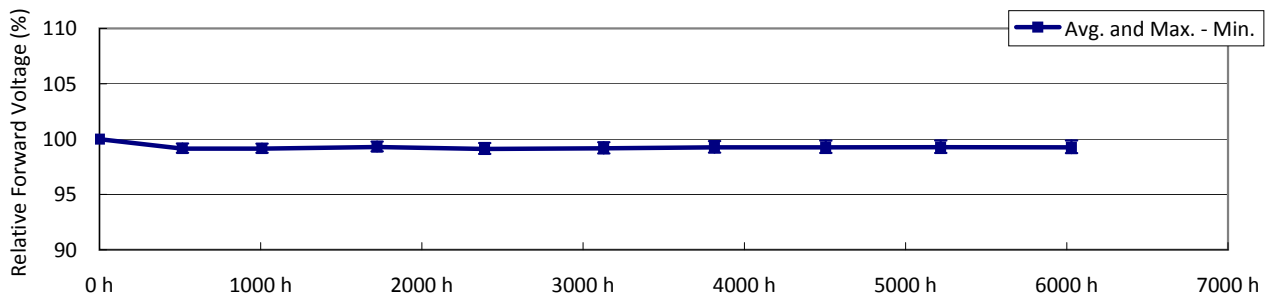
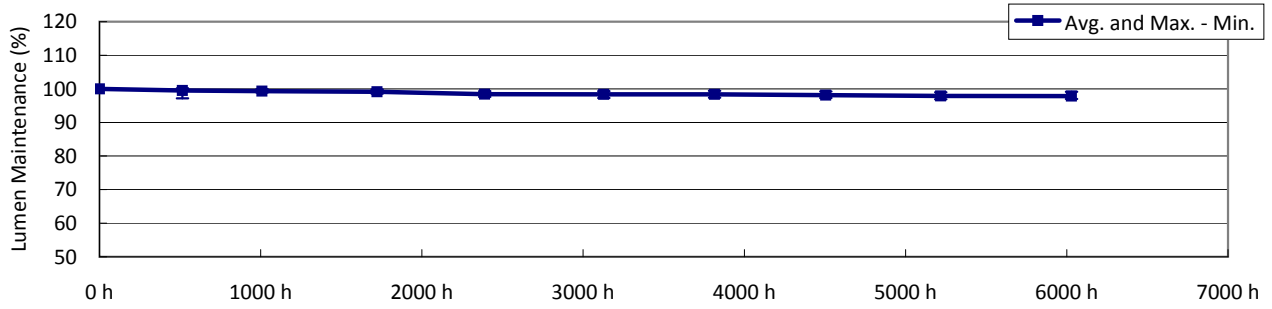
1. **Number of LED light sources tested**
See tables.
 2. **Description of LED light sources**
See Description of Test Samples
 3. **Description of auxiliary equipment**
Active cooling life test system
Consisting of small boxes, in which each box contains a reliability test board, and a water-cooled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

Data Set 1 : 55°C, 100 mA

Actual Case Temperature [T _S]	56.9 °C
Actual Ambient Temperature [T _A]	55.5 °C
Drive Current [I _F]	100 mA
Measurement Current	100 mA

NOTES:

T_S and T_A were measured during initial setup.



Data Set 1 : 55°C, 100 mA

Actual Case Temperature [T _s]	56.9 °C
Actual Ambient Temperature [T _A]	55.5 °C
Drive Current [I _F]	100 mA
Measurement Current	100 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	61.8	6.08	2783	0.452	0.406	0.259	0.524					
2	60.5	6.01	2758	0.456	0.411	0.260	0.527					
3	61.8	6.11	2793	0.450	0.404	0.259	0.524					
4	61.1	6.04	2842	0.446	0.404	0.257	0.523					
5	62.4	6.08	2776	0.454	0.409	0.259	0.526					
6	60.7	6.06	2831	0.447	0.403	0.257	0.523					
7	61.0	5.99	2755	0.455	0.409	0.260	0.526					
8	60.5	6.00	2792	0.452	0.407	0.259	0.525					
9	61.0	5.99	2716	0.459	0.410	0.262	0.527					
10	61.8	6.00	2858	0.441	0.394	0.257	0.518					
11	62.1	5.99	2761	0.454	0.408	0.260	0.526					
12	61.2	6.05	2839	0.447	0.405	0.257	0.523					
13	61.6	6.00	2755	0.454	0.407	0.260	0.525					
14	61.0	6.05	2806	0.449	0.403	0.259	0.523					
15	62.2	6.10	2821	0.447	0.402	0.258	0.522					
16	61.5	5.99	2767	0.454	0.408	0.260	0.525					
17	61.9	5.98	2751	0.456	0.410	0.260	0.526					
18	62.4	6.07	2816	0.448	0.403	0.258	0.523					
19	60.6	6.06	2777	0.453	0.409	0.259	0.526					
20	60.3	6.03	2737	0.457	0.410	0.261	0.527					
21	61.4	6.02	2802	0.450	0.406	0.258	0.524					
22	62.6	6.09	2791	0.452	0.407	0.259	0.525					
23	61.5	6.00	2807	0.451	0.407	0.258	0.525					
24	62.4	6.09	2848	0.445	0.402	0.257	0.522					
25	61.0	6.00	2812	0.450	0.406	0.258	0.524					
n	25	25	25	25	25	25	25					
Avg.	61.5	6.03	2792	0.451	0.406	0.259	0.524					
Med.	61.5	6.03	2792	0.452	0.407	0.259	0.525					
σ	0.67	0.041	36.9	0.0042	0.0036	0.0013	0.0020					
Min.	60.3	5.98	2716	0.441	0.394	0.257	0.518					
Max.	62.6	6.11	2858	0.459	0.411	0.262	0.527					

Data Set 1 : 55°C, 100 mA

Actual Case Temperature [T _s]	56.9 °C
Actual Ambient Temperature [T _A]	55.5 °C
Drive Current [I _F]	100 mA
Measurement Current	100 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	514 h	1008 h	1722 h	2389 h	3128 h	3815 h	4505 h	5218 h	6029 h				
1	100.0	100.0	99.9	99.9	99.3	99.2	99.4	99.2	99.0	99.1				
2	100.0	99.5	99.7	99.7	99.0	99.1	99.3	98.9	98.7	98.7				
3	100.0	100.1	99.8	99.7	99.1	99.3	99.4	99.0	98.8	98.6				
4	100.0	99.4	99.0	98.8	98.2	98.3	98.2	97.8	97.7	97.4				
5	100.0	100.2	99.9	99.7	99.1	99.1	99.0	98.6	98.5	98.3				
6	100.0	99.3	99.0	98.7	98.0	98.0	97.8	97.6	97.3	97.2				
7	100.0	99.3	99.2	99.0	98.2	98.0	97.8	97.6	97.3	97.2				
8	100.0	99.0	98.9	98.8	97.9	97.7	97.6	97.6	97.2	97.3				
9	100.0	97.2	98.9	98.6	97.6	97.3	97.4	97.3	96.9	97.0				
10	100.0	99.1	99.2	99.2	98.5	98.4	98.6	98.5	98.1	98.3				
11	100.0	99.6	99.3	99.2	98.5	98.4	98.7	98.4	98.1	98.1				
12	100.0	99.5	99.1	99.0	98.3	98.3	98.5	98.2	98.0	97.9				
13	100.0	99.9	99.4	99.2	98.5	98.6	98.4	98.1	97.9	97.7				
14	100.0	99.7	99.3	99.0	98.2	98.3	98.0	97.7	97.6	97.4				
15	100.0	99.8	99.2	98.9	98.3	98.4	98.2	98.0	97.8	97.7				
16	100.0	99.8	99.4	99.3	98.7	98.7	98.6	98.5	98.4	98.4				
17	100.0	99.4	99.1	98.9	98.2	98.0	97.8	97.7	97.5	97.4				
18	100.0	99.6	99.2	99.0	98.2	97.9	98.1	98.0	97.7	97.7				
19	100.0	99.6	99.1	99.0	98.2	98.0	98.4	98.3	98.0	98.0				
20	100.0	99.5	99.2	99.1	98.4	98.2	98.5	98.3	98.0	98.1				
21	100.0	98.9	99.1	98.9	98.3	98.3	98.4	98.2	97.9	97.8				
22	100.0	100.0	99.5	99.3	98.6	98.7	98.8	98.5	98.2	98.0				
23	100.0	99.8	99.4	99.1	98.3	98.4	98.3	98.0	97.7	97.6				
24	100.0	100.1	99.5	99.2	98.4	98.6	98.3	98.0	97.8	97.3				
25	100.0	99.6	99.2	98.9	98.2	98.1	97.9	97.7	97.4	97.3				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	100.0	99.5	99.3	99.1	98.4	98.4	98.4	98.1	97.9	97.8				
Med.	100.0	99.6	99.2	99.0	98.3	98.3	98.4	98.1	97.9	97.7				
σ	0.00	0.59	0.29	0.32	0.40	0.48	0.53	0.48	0.52	0.54				
Min.	100.0	97.2	98.9	98.6	97.6	97.3	97.4	97.3	96.9	97.0				
Max.	100.0	100.2	99.9	99.9	99.3	99.3	99.4	99.2	99.0	99.1				

TM-21 Projection

Time	0 h	514 h	1008 h	1722 h	2389 h	3128 h	3815 h	4505 h	5218 h	6029 h				
ln(Avg.)	0.0000	-0.0048	-0.0070	-0.0088	-0.0161	-0.0165	-0.0164	-0.0188	-0.0211	-0.0221				

Test duration used	1008 h	to	6029 h
B	0.9943		
α	2.9215E-06		
R ²	0.8889		
Calculated L ₇₀ (6K)	120000	hours	
Reported L ₇₀ (6K)	> 36200	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, 100 mA

Actual Case Temperature [T _s]	56.9 °C
Actual Ambient Temperature [T _A]	55.5 °C
Drive Current [I _F]	100 mA
Measurement Current	100 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	514 h	1008 h	1722 h	2389 h	3128 h	3815 h	4505 h	5218 h	6029 h				
1	100.0	99.3	99.4	99.6	99.4	99.5	99.6	99.6	99.7	99.7				
2	100.0	98.8	98.8	99.0	98.8	98.8	98.9	98.9	98.9	98.8				
3	100.0	99.5	99.6	99.8	99.6	99.7	99.8	99.8	99.9	99.9				
4	100.0	98.9	99.0	99.1	98.9	99.0	99.1	99.0	99.0	99.0				
5	100.0	99.5	99.6	99.7	99.6	99.7	99.8	99.8	99.9	99.9				
6	100.0	98.8	98.8	98.9	98.7	98.7	98.8	98.7	98.8	98.7				
7	100.0	98.9	98.9	99.1	98.9	98.9	99.0	99.0	99.0	98.9				
8	100.0	99.1	99.1	99.2	99.1	99.1	99.2	99.2	99.2	99.1				
9	100.0	98.9	98.9	99.1	98.9	98.9	99.0	99.0	99.0	99.0				
10	100.0	98.8	98.9	99.0	98.8	98.9	98.9	98.9	98.9	98.9				
11	100.0	99.1	99.0	99.2	99.0	99.0	99.1	99.1	99.1	99.1				
12	100.0	99.1	99.0	99.2	98.9	99.0	99.1	99.0	99.1	99.0				
13	100.0	99.1	99.0	99.2	99.0	99.0	99.1	99.1	99.1	99.1				
14	100.0	99.0	98.9	99.1	98.9	98.9	99.0	99.0	99.0	99.0				
15	100.0	99.5	99.5	99.7	99.6	99.7	99.8	99.8	99.8	99.8				
16	100.0	99.0	99.0	99.1	98.9	99.0	99.1	99.1	99.1	99.1				
17	100.0	99.0	98.9	99.1	98.8	98.9	99.0	99.0	99.0	99.0				
18	100.0	99.4	99.4	99.6	99.5	99.6	99.7	99.7	99.7	99.7				
19	100.0	99.6	99.6	99.8	99.6	99.7	99.8	99.8	99.8	99.8				
20	100.0	99.2	99.2	99.3	99.1	99.2	99.3	99.3	99.2	99.3				
21	100.0	98.9	98.9	99.0	98.8	98.8	98.9	98.9	98.9	98.9				
22	100.0	99.5	99.5	99.7	99.6	99.6	99.8	99.8	99.8	99.9				
23	100.0	99.0	99.0	99.1	98.9	99.0	99.0	99.1	99.1	99.1				
24	100.0	99.6	99.6	99.8	99.6	99.7	99.8	99.9	99.9	99.9				
25	100.0	98.9	98.9	99.0	98.8	98.9	98.9	98.9	98.9	98.9				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	100.0	99.1	99.1	99.3	99.1	99.2	99.3	99.3	99.3	99.3				
Med.	100.0	99.1	99.0	99.2	98.9	99.0	99.1	99.1	99.1	99.1				
σ	0.00	0.26	0.28	0.31	0.34	0.36	0.37	0.38	0.40	0.41				
Min.	100.0	98.8	98.8	98.9	98.7	98.7	98.8	98.7	98.8	98.7				
Max.	100.0	99.6	99.6	99.8	99.6	99.7	99.8	99.9	99.9	99.9				

Data Set 1 : 55°C, 100 mA

Actual Case Temperature [T _s]	56.9 °C
Actual Ambient Temperature [T _A]	55.5 °C
Drive Current [I _F]	100 mA
Measurement Current	100 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 1-4
Chromaticity Shift

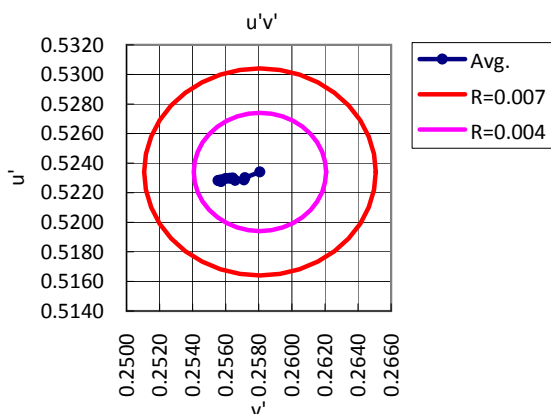
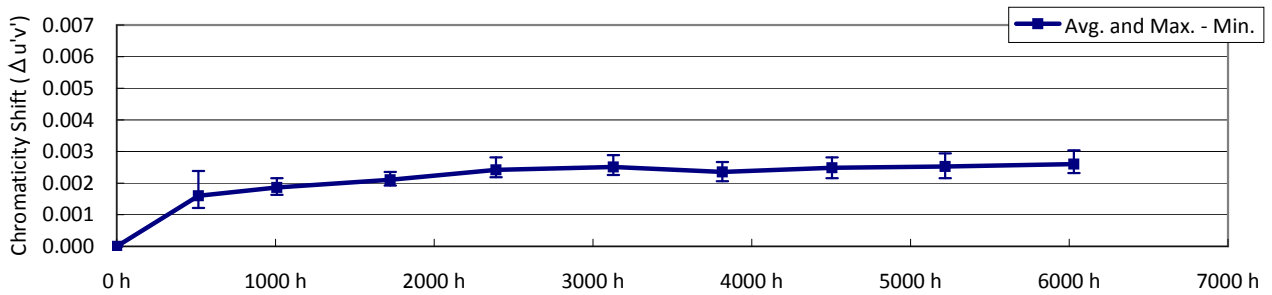
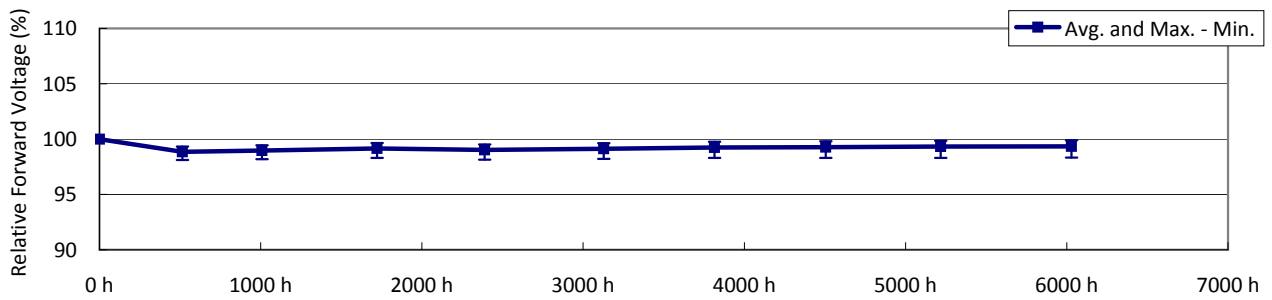
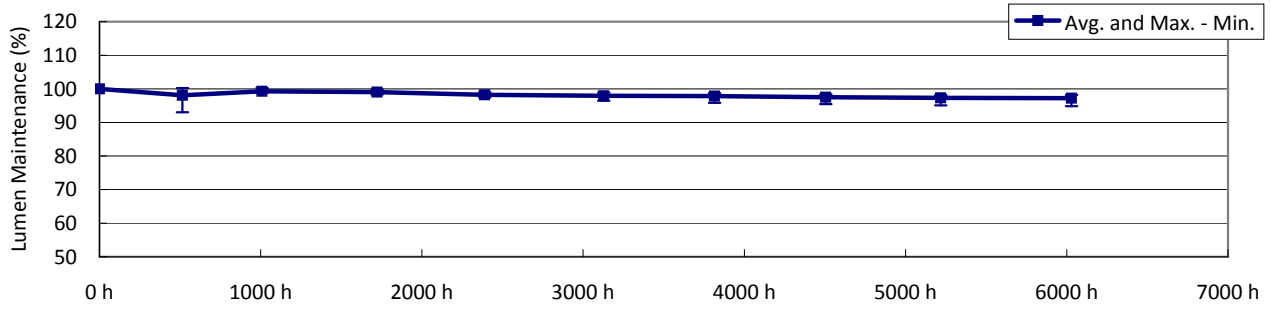
LED No.	Chromaticity Shift Δu'v'														
	0 h	514 h	1008 h	1722 h	2389 h	3128 h	3815 h	4505 h	5218 h	6029 h					
1	0.0000	0.0010	0.0013	0.0016	0.0019	0.0020	0.0018	0.0020	0.0020	0.0022					
2	0.0000	0.0008	0.0011	0.0014	0.0016	0.0017	0.0016	0.0018	0.0018	0.0019					
3	0.0000	0.0010	0.0013	0.0015	0.0019	0.0020	0.0018	0.0019	0.0021	0.0022					
4	0.0000	0.0009	0.0013	0.0016	0.0019	0.0019	0.0017	0.0019	0.0019	0.0021					
5	0.0000	0.0010	0.0013	0.0015	0.0017	0.0018	0.0016	0.0018	0.0019	0.0020					
6	0.0000	0.0008	0.0011	0.0014	0.0017	0.0020	0.0017	0.0019	0.0021	0.0023					
7	0.0000	0.0009	0.0012	0.0015	0.0018	0.0018	0.0017	0.0019	0.0020	0.0022					
8	0.0000	0.0009	0.0012	0.0014	0.0017	0.0018	0.0016	0.0017	0.0018	0.0020					
9	0.0000	0.0010	0.0014	0.0017	0.0021	0.0023	0.0021	0.0024	0.0024	0.0025					
10	0.0000	0.0009	0.0012	0.0014	0.0018	0.0019	0.0018	0.0019	0.0020	0.0021					
11	0.0000	0.0010	0.0014	0.0016	0.0019	0.0020	0.0018	0.0020	0.0021	0.0022					
12	0.0000	0.0011	0.0016	0.0018	0.0022	0.0023	0.0021	0.0023	0.0024	0.0025					
13	0.0000	0.0010	0.0014	0.0017	0.0021	0.0021	0.0020	0.0022	0.0023	0.0025					
14	0.0000	0.0010	0.0013	0.0015	0.0019	0.0020	0.0018	0.0019	0.0020	0.0021					
15	0.0000	0.0010	0.0015	0.0017	0.0021	0.0021	0.0019	0.0022	0.0022	0.0023					
16	0.0000	0.0010	0.0013	0.0016	0.0019	0.0020	0.0018	0.0019	0.0021	0.0021					
17	0.0000	0.0011	0.0014	0.0017	0.0020	0.0021	0.0019	0.0021	0.0022	0.0023					
18	0.0000	0.0009	0.0014	0.0016	0.0020	0.0022	0.0020	0.0022	0.0022	0.0023					
19	0.0000	0.0010	0.0014	0.0018	0.0022	0.0022	0.0020	0.0022	0.0023	0.0024					
20	0.0000	0.0010	0.0013	0.0016	0.0019	0.0020	0.0018	0.0020	0.0020	0.0022					
21	0.0000	0.0009	0.0013	0.0015	0.0017	0.0018	0.0016	0.0017	0.0018	0.0020					
22	0.0000	0.0010	0.0014	0.0016	0.0019	0.0020	0.0017	0.0018	0.0020	0.0021					
23	0.0000	0.0009	0.0013	0.0015	0.0018	0.0019	0.0017	0.0019	0.0019	0.0020					
24	0.0000	0.0011	0.0014	0.0017	0.0020	0.0022	0.0020	0.0021	0.0022	0.0022					
25	0.0000	0.0010	0.0014	0.0016	0.0020	0.0021	0.0018	0.0020	0.0022	0.0023					
n	25	25	25	25	25	25	25	25	25	25					
Avg.	0.0000	0.0010	0.0013	0.0016	0.0019	0.0020	0.0018	0.0020	0.0021	0.0022					
Med.	0.0000	0.0010	0.0013	0.0016	0.0019	0.0020	0.0018	0.0019	0.0021	0.0022					
σ	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0002	0.0002					
Min.	0.0000	0.0008	0.0011	0.0014	0.0016	0.0017	0.0016	0.0017	0.0018	0.0019					
Max.	0.0000	0.0011	0.0016	0.0018	0.0022	0.0023	0.0021	0.0024	0.0024	0.0025					

Data Set 2 : 55°C, 200 mA

Actual Case Temperature [T_S]	60.1 °C
Actual Ambient Temperature [T_A]	57.5 °C
Drive Current [I_F]	200 mA
Measurement Current	200 mA

NOTES:

T_S and T_A were measured during initial setup.



Data Set 2 : 55°C, 200 mA

Actual Case Temperature [T _S]	60.1 °C
Actual Ambient Temperature [T _A]	57.5 °C
Drive Current [I _F]	200 mA
Measurement Current	200 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	116	6.75	2880	0.441	0.397	0.256	0.519					
2	114	6.74	2821	0.447	0.402	0.258	0.522					
3	116	6.76	2869	0.443	0.401	0.256	0.521					
4	115	6.75	2829	0.448	0.404	0.257	0.523					
5	114	6.74	2851	0.445	0.402	0.257	0.522					
6	115	6.74	2830	0.448	0.405	0.257	0.523					
7	116	6.76	2837	0.447	0.404	0.257	0.523					
8	113	6.73	2798	0.450	0.406	0.259	0.524					
9	112	6.55	2795	0.449	0.403	0.259	0.523					
10	115	6.73	2833	0.448	0.406	0.257	0.524					
11	116	6.75	2792	0.451	0.406	0.259	0.524					
12	113	6.73	2822	0.447	0.402	0.258	0.522					
13	112	6.53	2800	0.450	0.406	0.258	0.524					
14	115	6.73	2850	0.446	0.403	0.257	0.522					
15	113	6.50	2798	0.450	0.405	0.259	0.524					
16	115	6.76	2786	0.454	0.410	0.259	0.526					
17	113	6.59	2876	0.443	0.402	0.256	0.521					
18	113	6.50	2874	0.442	0.398	0.256	0.520					
19	113	6.58	2782	0.452	0.407	0.259	0.525					
20	115	6.74	2869	0.444	0.402	0.256	0.522					
21	113	6.64	2819	0.449	0.405	0.258	0.524					
22	112	6.59	2745	0.456	0.410	0.261	0.527					
23	113	6.76	2730	0.458	0.411	0.261	0.527					
24	115	6.74	2791	0.451	0.406	0.259	0.524					
25	111	6.61	2758	0.455	0.409	0.260	0.526					
n	25	25	25	25	25	25	25					
Avg.	114	6.68	2817	0.449	0.404	0.258	0.523					
Med.	114	6.73	2821	0.448	0.405	0.258	0.523					
σ	1.5	0.093	41.1	0.0044	0.0035	0.0014	0.0020					
Min.	111	6.50	2730	0.441	0.397	0.256	0.519					
Max.	116	6.76	2880	0.458	0.411	0.261	0.527					

Data Set 2 : 55°C, 200 mA

Actual Case Temperature [T _s]	60.1 °C
Actual Ambient Temperature [T _A]	57.5 °C
Drive Current [I _F]	200 mA
Measurement Current	200 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	514 h	1008 h	1722 h	2389 h	3128 h	3815 h	4505 h	5218 h	6029 h				
1	100.0	99.5	99.3	99.2	98.5	98.2	98.1	97.8	97.5	97.3				
2	100.0	98.7	99.2	98.9	98.1	98.0	98.0	97.6	97.5	97.5				
3	100.0	99.3	99.0	98.8	98.1	98.0	97.8	97.2	96.9	96.8				
4	100.0	98.2	99.2	99.0	98.4	98.4	98.3	97.8	97.6	97.7				
5	100.0	98.1	99.1	98.9	98.2	98.2	98.0	97.7	97.5	97.4				
6	100.0	96.6	99.1	98.8	97.9	97.5	97.2	96.9	96.5	96.5				
7	100.0	96.1	98.9	98.8	98.1	97.9	97.7	97.6	97.5	97.5				
8	100.0	97.4	99.2	99.0	97.5	96.5	95.8	95.5	95.1	94.8				
9	100.0	99.5	99.2	99.0	98.1	97.7	97.5	97.4	97.2	97.0				
10	100.0	99.4	99.1	98.9	98.1	97.6	97.6	97.3	97.0	96.9				
11	100.0	99.7	99.3	99.0	98.1	98.2	98.2	98.0	97.7	97.6				
12	100.0	98.8	99.5	99.1	98.4	98.3	98.4	98.1	97.9	97.9				
13	100.0	97.6	100.2	99.8	99.0	98.9	98.7	98.4	98.1	98.0				
14	100.0	96.1	99.3	98.8	98.0	97.8	97.3	96.9	96.8	96.7				
15	100.0	96.2	100.2	99.7	99.1	98.8	98.4	98.1	97.9	97.9				
16	100.0	99.9	99.4	99.1	98.3	98.0	97.8	97.7	97.6	97.5				
17	100.0	99.5	99.1	98.9	98.3	98.0	97.7	97.3	97.0	97.2				
18	100.0	100.2	99.8	99.5	98.4	98.3	98.1	97.8	97.7	97.6				
19	100.0	99.8	99.4	99.2	98.5	98.2	98.4	98.3	98.2	98.2				
20	100.0	97.0	98.9	98.7	98.0	97.5	97.8	97.6	97.4	97.4				
21	100.0	98.6	98.8	98.6	97.7	97.3	97.4	97.1	96.9	96.8				
22	100.0	97.7	99.5	99.3	98.6	98.4	98.5	97.9	97.8	97.7				
23	100.0	93.0	98.8	98.3	97.5	97.3	97.2	96.9	96.7	96.6				
24	100.0	99.0	99.6	99.3	98.7	98.5	98.2	97.9	97.9	97.7				
25	100.0	96.0	98.9	98.5	97.8	97.5	97.4	97.0	96.9	96.8				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	100.0	98.1	99.3	99.0	98.2	98.0	97.8	97.5	97.3	97.2				
Med.	100.0	98.6	99.2	99.0	98.1	98.0	97.8	97.6	97.5	97.4				
σ	0.00	1.71	0.37	0.34	0.39	0.52	0.60	0.61	0.65	0.69				
Min.	100.0	93.0	98.8	98.3	97.5	96.5	95.8	95.5	95.1	94.8				
Max.	100.0	100.2	100.2	99.8	99.1	98.9	98.7	98.4	98.2	98.2				

TM-21 Projection

Time	0 h	514 h	1008 h	1722 h	2389 h	3128 h	3815 h	4505 h	5218 h	6029 h				
ln(Avg.)	0.0000	-0.0194	-0.0072	-0.0099	-0.0180	-0.0206	-0.0220	-0.0252	-0.0273	-0.0280				

Test duration used	1008 h	to	6029 h
B	0.9950		
α	4.2547E-06		
R ²	0.9216		
Calculated L ₇₀ (6K)	82700	hours	
Reported L ₇₀ (6K)	> 36200	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, 200 mA

Actual Case Temperature [T _s]	60.1 °C
Actual Ambient Temperature [T _A]	57.5 °C
Drive Current [I _F]	200 mA
Measurement Current	200 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	514 h	1008 h	1722 h	2389 h	3128 h	3815 h	4505 h	5218 h	6029 h				
1	100.0	99.1	99.3	99.6	99.4	99.6	99.7	99.7	99.8	99.8				
2	100.0	99.1	99.3	99.5	99.4	99.6	99.7	99.8	99.8	99.9				
3	100.0	99.0	99.3	99.5	99.4	99.5	99.6	99.7	99.7	99.7				
4	100.0	99.0	99.2	99.4	99.3	99.5	99.6	99.7	99.7	99.8				
5	100.0	99.1	99.3	99.5	99.4	99.5	99.7	99.7	99.7	99.8				
6	100.0	99.2	99.4	99.6	99.5	99.6	99.8	99.8	99.8	99.8				
7	100.0	99.1	99.4	99.6	99.5	99.6	99.8	99.8	99.8	99.9				
8	100.0	99.2	99.3	99.6	99.5	99.6	99.7	99.7	99.8	99.8				
9	100.0	98.1	98.2	98.3	98.1	98.2	98.3	98.3	98.3	98.3				
10	100.0	99.0	99.3	99.5	99.5	99.5	99.7	99.8	99.8	99.9				
11	100.0	99.3	99.4	99.6	99.5	99.6	99.8	99.8	99.9	99.9				
12	100.0	99.1	99.2	99.5	99.4	99.5	99.6	99.7	99.7	99.8				
13	100.0	98.2	98.2	98.3	98.2	98.2	98.3	98.3	98.3	98.3				
14	100.0	99.2	99.2	99.5	99.4	99.5	99.7	99.7	99.8	99.8				
15	100.0	98.3	98.3	98.4	98.3	98.3	98.4	98.4	98.5	98.5				
16	100.0	99.2	99.3	99.5	99.4	99.5	99.6	99.7	99.8	99.7				
17	100.0	98.4	98.4	98.5	98.3	98.3	98.4	98.4	98.5	98.5				
18	100.0	98.3	98.3	98.4	98.3	98.3	98.4	98.4	98.4	98.4				
19	100.0	98.4	98.4	98.5	98.4	98.4	98.5	98.5	98.6	98.5				
20	100.0	99.1	99.2	99.5	99.3	99.5	99.6	99.7	99.8	99.8				
21	100.0	98.9	98.9	99.0	98.9	98.9	99.0	99.1	99.1	99.1				
22	100.0	98.3	98.3	98.4	98.2	98.3	98.4	98.4	98.4	98.4				
23	100.0	99.3	99.4	99.6	99.5	99.6	99.8	99.8	99.9	99.9				
24	100.0	99.1	99.2	99.4	99.3	99.4	99.6	99.6	99.7	99.7				
25	100.0	98.3	98.3	98.4	98.3	98.3	98.4	98.4	98.5	98.5				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	100.0	98.9	99.0	99.2	99.0	99.1	99.2	99.3	99.3	99.3				
Med.	100.0	99.1	99.2	99.5	99.4	99.5	99.6	99.7	99.7	99.8				
σ	0.00	0.41	0.48	0.53	0.56	0.58	0.61	0.63	0.64	0.65				
Min.	100.0	98.1	98.2	98.3	98.1	98.2	98.3	98.3	98.3	98.3				
Max.	100.0	99.3	99.4	99.6	99.5	99.6	99.8	99.8	99.9	99.9				

Data Set 2 : 55°C, 200 mA

Actual Case Temperature [T _s]	60.1 °C
Actual Ambient Temperature [T _A]	57.5 °C
Drive Current [I _F]	200 mA
Measurement Current	200 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 2-4
Chromaticity Shift

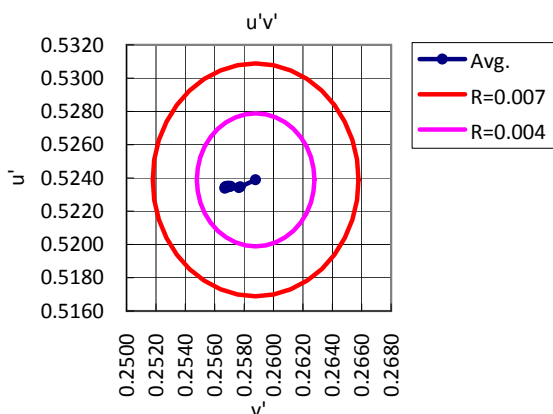
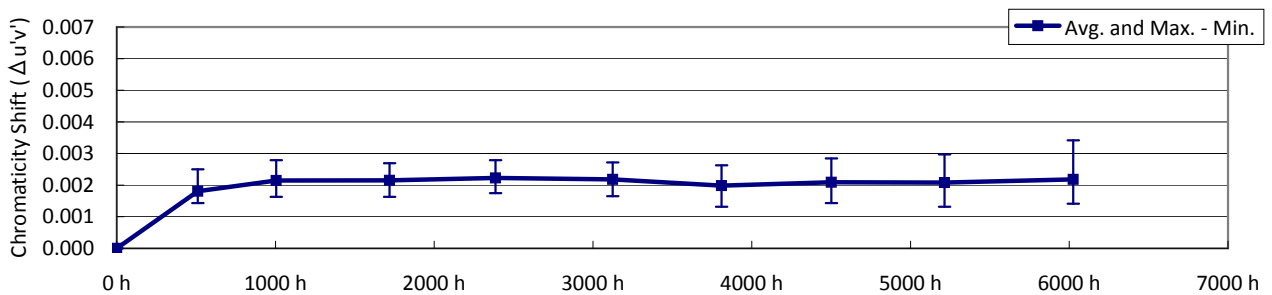
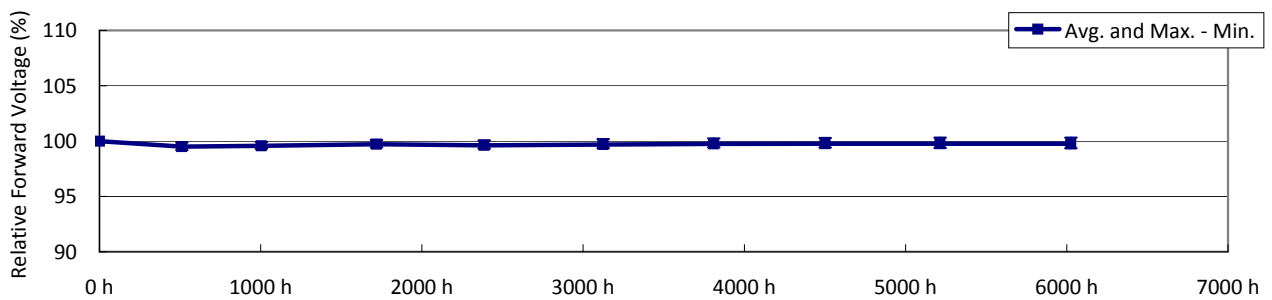
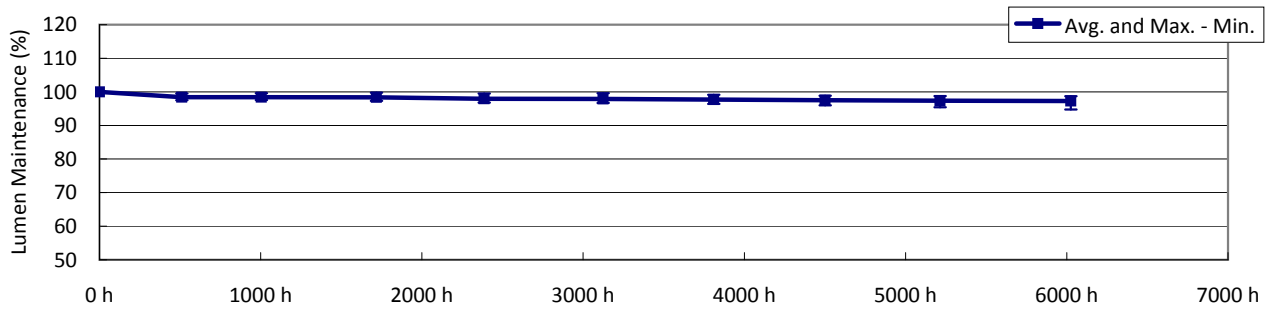
LED No.	Chromaticity Shift Δu'v'														
	0 h	514 h	1008 h	1722 h	2389 h	3128 h	3815 h	4505 h	5218 h	6029 h					
1	0.0000	0.0017	0.0021	0.0023	0.0025	0.0027	0.0026	0.0028	0.0029	0.0030					
2	0.0000	0.0016	0.0020	0.0023	0.0026	0.0027	0.0026	0.0026	0.0027	0.0027					
3	0.0000	0.0017	0.0021	0.0022	0.0025	0.0027	0.0026	0.0027	0.0027	0.0028					
4	0.0000	0.0017	0.0020	0.0023	0.0025	0.0026	0.0024	0.0025	0.0025	0.0025					
5	0.0000	0.0017	0.0021	0.0022	0.0026	0.0026	0.0024	0.0025	0.0025	0.0026					
6	0.0000	0.0016	0.0018	0.0019	0.0023	0.0024	0.0022	0.0024	0.0025	0.0026					
7	0.0000	0.0021	0.0022	0.0024	0.0026	0.0027	0.0025	0.0027	0.0026	0.0027					
8	0.0000	0.0016	0.0019	0.0020	0.0025	0.0027	0.0025	0.0028	0.0029	0.0030					
9	0.0000	0.0015	0.0019	0.0021	0.0025	0.0026	0.0026	0.0027	0.0028	0.0028					
10	0.0000	0.0016	0.0019	0.0022	0.0025	0.0027	0.0025	0.0027	0.0028	0.0029					
11	0.0000	0.0014	0.0018	0.0021	0.0024	0.0025	0.0024	0.0025	0.0025	0.0025					
12	0.0000	0.0014	0.0017	0.0020	0.0023	0.0023	0.0022	0.0023	0.0023	0.0024					
13	0.0000	0.0015	0.0016	0.0019	0.0023	0.0024	0.0022	0.0023	0.0024	0.0024					
14	0.0000	0.0019	0.0019	0.0021	0.0024	0.0025	0.0024	0.0025	0.0026	0.0027					
15	0.0000	0.0018	0.0016	0.0019	0.0022	0.0023	0.0021	0.0023	0.0023	0.0024					
16	0.0000	0.0012	0.0016	0.0020	0.0024	0.0025	0.0022	0.0023	0.0024	0.0024					
17	0.0000	0.0014	0.0018	0.0021	0.0023	0.0023	0.0021	0.0022	0.0022	0.0024					
18	0.0000	0.0014	0.0017	0.0020	0.0022	0.0024	0.0022	0.0024	0.0025	0.0026					
19	0.0000	0.0013	0.0017	0.0020	0.0024	0.0025	0.0023	0.0024	0.0023	0.0025					
20	0.0000	0.0017	0.0019	0.0022	0.0024	0.0025	0.0023	0.0025	0.0025	0.0026					
21	0.0000	0.0012	0.0016	0.0019	0.0023	0.0024	0.0023	0.0024	0.0024	0.0025					
22	0.0000	0.0014	0.0018	0.0021	0.0025	0.0025	0.0023	0.0023	0.0022	0.0023					
23	0.0000	0.0024	0.0021	0.0024	0.0028	0.0029	0.0027	0.0028	0.0028	0.0029					
24	0.0000	0.0015	0.0018	0.0020	0.0023	0.0024	0.0022	0.0022	0.0023	0.0024					
25	0.0000	0.0015	0.0017	0.0019	0.0023	0.0023	0.0023	0.0025	0.0025	0.0026					
n	25	25	25	25	25	25	25	25	25	25					
Avg.	0.0000	0.0016	0.0019	0.0021	0.0024	0.0025	0.0024	0.0025	0.0025	0.0026					
Med.	0.0000	0.0016	0.0018	0.0021	0.0024	0.0025	0.0023	0.0025	0.0025	0.0026					
σ	0.0000	0.0003	0.0002	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002					
Min.	0.0000	0.0012	0.0016	0.0019	0.0022	0.0023	0.0021	0.0022	0.0022	0.0023					
Max.	0.0000	0.0024	0.0022	0.0024	0.0028	0.0029	0.0027	0.0028	0.0029	0.0030					

Data Set 3 : 85°C, 100 mA

Actual Case Temperature [T_S]	86.2 °C
Actual Ambient Temperature [T_A]	82.7 °C
Drive Current [I_F]	100 mA
Measurement Current	100 mA

NOTES:

T_S and T_A were measured during initial setup.



Data Set 3 : 85°C, 100 mA

Actual Case Temperature [T _s]	86.2 °C
Actual Ambient Temperature [T _A]	82.7 °C
Drive Current [I _F]	100 mA
Measurement Current	100 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	62.2	6.08	2838	0.446	0.402	0.257	0.522						
2	61.0	6.05	2813	0.448	0.403	0.258	0.523						
3	60.5	6.06	2782	0.452	0.406	0.259	0.524						
4	61.7	5.92	2782	0.451	0.405	0.259	0.524						
5	61.7	6.01	2839	0.446	0.403	0.257	0.522						
6	60.8	6.05	2787	0.450	0.404	0.259	0.524						
7	62.7	6.10	2769	0.454	0.409	0.260	0.526						
8	61.5	5.97	2802	0.451	0.406	0.258	0.524						
9	62.2	6.10	2848	0.445	0.402	0.257	0.522						
10	61.3	6.08	2724	0.459	0.412	0.261	0.528						
11	61.0	5.93	2749	0.455	0.409	0.260	0.526						
12	60.7	6.02	2801	0.449	0.403	0.259	0.523						
13	62.2	6.09	2792	0.451	0.407	0.259	0.525						
14	61.7	5.99	2762	0.455	0.410	0.260	0.527						
15	60.8	6.02	2824	0.446	0.401	0.258	0.522						
16	61.6	5.99	2746	0.455	0.409	0.261	0.526						
17	61.8	5.99	2779	0.452	0.406	0.259	0.524						
18	61.7	5.99	2750	0.455	0.408	0.260	0.526						
19	62.5	5.98	2868	0.444	0.402	0.256	0.522						
20	60.8	6.08	2789	0.450	0.404	0.259	0.523						
21	60.8	6.02	2757	0.453	0.406	0.260	0.525						
22	61.2	6.01	2773	0.452	0.406	0.260	0.525						
23	60.7	6.05	2805	0.449	0.404	0.259	0.523						
24	61.8	6.08	2837	0.447	0.403	0.257	0.523						
25	61.7	6.08	2849	0.444	0.400	0.257	0.521						
n	25	25	25	25	25	25	25						
Avg.	61.5	6.03	2795	0.450	0.405	0.259	0.524						
Med.	61.6	6.02	2789	0.451	0.405	0.259	0.524						
σ	0.62	0.050	37.5	0.0040	0.0030	0.0014	0.0018						
Min.	60.5	5.92	2724	0.444	0.400	0.256	0.521						
Max.	62.7	6.10	2868	0.459	0.412	0.261	0.528						

Data Set 3 : 85°C, 100 mA

Actual Case Temperature [T _s]	86.2 °C
Actual Ambient Temperature [T _A]	82.7 °C
Drive Current [I _F]	100 mA
Measurement Current	100 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	510 h	1004 h	1718 h	2386 h	3124 h	3810 h	4501 h	5214 h	6025 h				
1	100.0	97.9	98.3	98.3	97.8	97.8	98.0	97.7	97.7	97.6				
2	100.0	98.0	97.8	97.6	97.1	97.0	96.9	96.5	96.2	96.0				
3	100.0	97.5	97.5	97.7	97.4	97.5	97.4	97.1	97.0	97.0				
4	100.0	98.2	98.4	98.5	98.2	98.3	98.0	97.7	97.6	97.5				
5	100.0	98.0	98.1	97.9	97.5	97.6	97.0	96.9	96.8	96.7				
6	100.0	97.9	97.9	97.7	97.3	97.3	97.0	97.0	96.9	96.9				
7	100.0	98.5	98.7	98.7	98.3	98.2	97.9	98.0	97.9	97.8				
8	100.0	97.7	98.0	97.8	97.3	97.1	97.1	97.1	97.1	97.0				
9	100.0	98.4	98.7	98.6	97.9	97.8	97.9	97.7	97.5	97.3				
10	100.0	98.2	98.5	98.5	97.9	97.9	98.0	97.9	97.7	97.6				
11	100.0	99.0	98.9	99.0	98.6	98.5	98.5	98.3	98.1	98.0				
12	100.0	98.2	97.6	97.3	96.8	96.7	96.5	96.0	95.4	94.8				
13	100.0	99.0	98.9	99.0	98.6	98.9	98.6	98.3	98.3	98.2				
14	100.0	98.3	98.1	97.9	97.6	97.6	97.2	96.9	96.8	96.7				
15	100.0	98.2	98.0	98.0	97.6	97.6	97.2	97.0	96.9	96.9				
16	100.0	98.2	97.8	97.6	97.2	97.1	96.7	96.5	96.3	96.1				
17	100.0	98.0	97.7	97.5	97.0	96.7	96.4	96.3	96.1	96.0				
18	100.0	98.5	98.1	97.9	97.5	97.2	97.0	96.9	96.8	96.6				
19	100.0	98.4	98.2	98.1	97.6	97.4	97.6	97.5	97.4	97.2				
20	100.0	99.3	99.1	99.2	98.7	98.6	98.8	98.7	98.5	98.4				
21	100.0	98.2	98.7	98.6	98.2	98.0	98.0	97.7	97.6	97.5				
22	100.0	98.5	98.5	98.5	98.1	98.1	98.0	97.7	97.6	97.6				
23	100.0	99.5	99.6	99.7	99.5	99.6	99.1	98.9	98.8	98.7				
24	100.0	99.5	99.6	99.6	99.4	99.4	99.0	98.8	98.6	98.5				
25	100.0	99.4	99.6	99.6	99.4	99.4	98.9	98.8	98.7	98.6				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	100.0	98.4	98.4	98.4	97.9	97.9	97.7	97.5	97.4	97.2				
Med.	100.0	98.2	98.3	98.3	97.8	97.8	97.9	97.7	97.5	97.3				
σ	0.00	0.56	0.62	0.71	0.76	0.82	0.81	0.82	0.87	0.94				
Min.	100.0	97.5	97.5	97.3	96.8	96.7	96.4	96.0	95.4	94.8				
Max.	100.0	99.5	99.6	99.7	99.5	99.6	99.1	98.9	98.8	98.7				

TM-21 Projection

Time	0 h	510 h	1004 h	1718 h	2386 h	3124 h	3810 h	4501 h	5214 h	6025 h				
ln(Avg.)	0.0000	-0.0159	-0.0161	-0.0166	-0.0209	-0.0214	-0.0232	-0.0251	-0.0267	-0.0279				

Test duration used	1004 h	to	6025 h
B	0.9864		
α	2.4734E-06		
R ²	0.9699		
Calculated L ₇₀ (6K)	139000	hours	
Reported L ₇₀ (6K)	> 36200	hours	

Curve-fit equation:

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

Lumen maintenance life equation:

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

Data Set 3 : 85°C, 100 mA

Actual Case Temperature [T _s]	86.2 °C
Actual Ambient Temperature [T _A]	82.7 °C
Drive Current [I _F]	100 mA
Measurement Current	100 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	510 h	1004 h	1718 h	2386 h	3124 h	3810 h	4501 h	5214 h	6025 h				
1	100.0	99.6	99.7	99.9	99.8	99.9	99.9	99.9	100.0	100.0				
2	100.0	99.4	99.5	99.7	99.5	99.6	99.7	99.7	99.7	99.6				
3	100.0	99.2	99.3	99.5	99.4	99.4	99.4	99.4	99.4	99.4				
4	100.0	99.3	99.4	99.5	99.4	99.5	99.5	99.5	99.5	99.5				
5	100.0	99.2	99.4	99.5	99.4	99.4	99.5	99.5	99.5	99.5				
6	100.0	99.4	99.6	99.7	99.6	99.7	99.8	99.8	99.8	99.8				
7	100.0	99.7	99.9	100.0	100.0	100.0	100.1	100.2	100.2	100.2				
8	100.0	99.3	99.4	99.5	99.4	99.5	99.5	99.5	99.5	99.6				
9	100.0	99.7	99.9	100.1	100.0	100.1	100.2	100.2	100.2	100.2				
10	100.0	99.7	99.9	100.0	99.9	100.0	100.1	100.1	100.1	100.1				
11	100.0	99.3	99.3	99.4	99.3	99.4	99.4	99.4	99.4	99.4				
12	100.0	99.4	99.4	99.6	99.5	99.6	99.6	99.6	99.6	99.6				
13	100.0	99.8	99.8	100.0	99.9	100.0	100.1	100.1	100.1	100.1				
14	100.0	99.4	99.4	99.5	99.4	99.5	99.5	99.5	99.5	99.5				
15	100.0	99.3	99.4	99.5	99.4	99.5	99.5	99.5	99.5	99.5				
16	100.0	99.3	99.3	99.4	99.3	99.4	99.4	99.4	99.4	99.4				
17	100.0	99.4	99.4	99.5	99.4	99.5	99.5	99.6	99.5	99.5				
18	100.0	99.4	99.4	99.5	99.4	99.5	99.5	99.5	99.5	99.5				
19	100.0	99.4	99.4	99.5	99.4	99.5	99.5	99.5	99.5	99.5				
20	100.0	99.9	99.9	100.1	100.0	100.1	100.2	100.2	100.2	100.3				
21	100.0	99.5	99.4	99.6	99.5	99.6	99.6	99.6	99.6	99.6				
22	100.0	99.5	99.5	99.6	99.5	99.6	99.6	99.6	99.6	99.6				
23	100.0	99.8	99.9	100.0	100.0	100.1	100.2	100.2	100.2	100.2				
24	100.0	99.8	99.9	100.0	100.0	100.0	100.1	100.1	100.2	100.2				
25	100.0	99.9	99.9	100.1	100.1	100.2	100.2	100.3	100.3	100.3				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	100.0	99.5	99.6	99.7	99.6	99.7	99.8	99.8	99.8	99.8				
Med.	100.0	99.4	99.4	99.6	99.5	99.6	99.6	99.6	99.6	99.6				
σ	0.00	0.22	0.23	0.25	0.27	0.28	0.30	0.31	0.33	0.34				
Min.	100.0	99.2	99.3	99.4	99.3	99.4	99.4	99.4	99.4	99.4				
Max.	100.0	99.9	99.9	100.1	100.1	100.2	100.2	100.3	100.3	100.3				

Data Set 3 : 85°C, 100 mA

Actual Case Temperature [T _s]	86.2 °C
Actual Ambient Temperature [T _A]	82.7 °C
Drive Current [I _F]	100 mA
Measurement Current	100 mA

NOTES:

T_s and T_A were measured during initial setup.

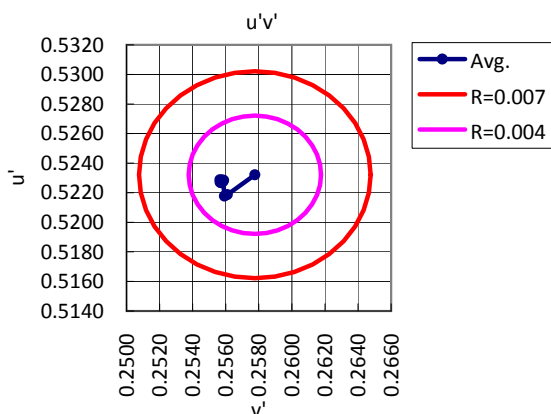
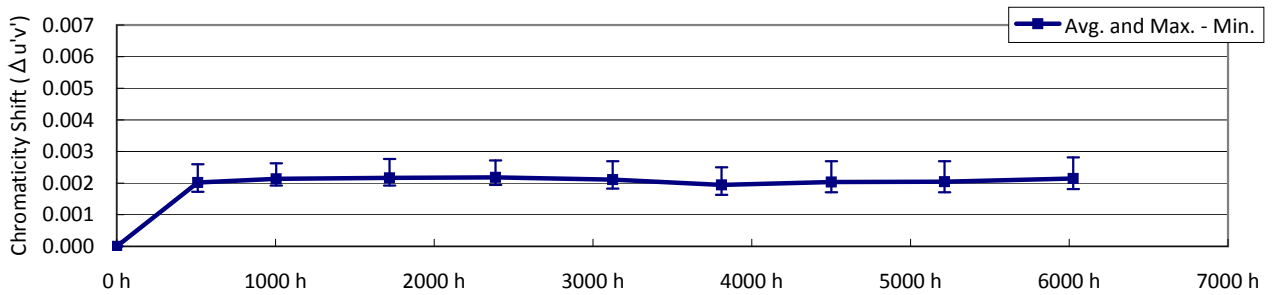
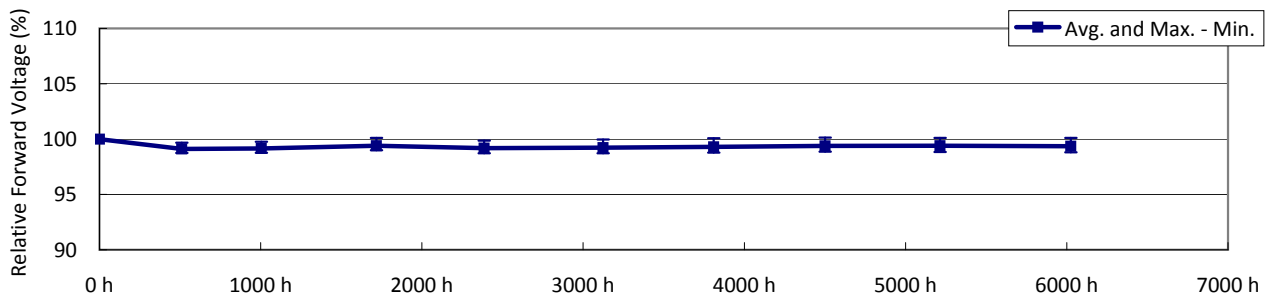
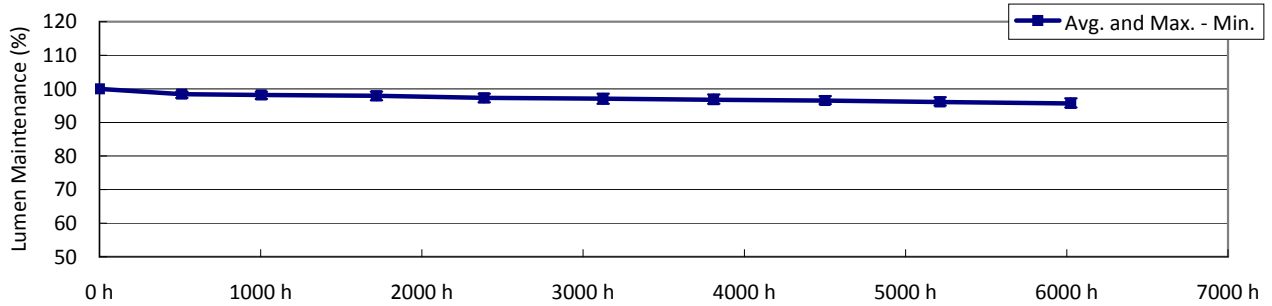
TABLE 3-4
Chromaticity Shift

LED No.	Chromaticity Shift Δu'v'														
	0 h	510 h	1004 h	1718 h	2386 h	3124 h	3810 h	4501 h	5214 h	6025 h					
1	0.0000	0.0025	0.0028	0.0027	0.0028	0.0027	0.0026	0.0026	0.0026	0.0027					
2	0.0000	0.0022	0.0025	0.0025	0.0026	0.0027	0.0025	0.0027	0.0028	0.0028					
3	0.0000	0.0023	0.0024	0.0024	0.0025	0.0025	0.0021	0.0022	0.0022	0.0022					
4	0.0000	0.0024	0.0025	0.0025	0.0025	0.0025	0.0022	0.0023	0.0023	0.0023					
5	0.0000	0.0022	0.0023	0.0022	0.0023	0.0023	0.0020	0.0021	0.0022	0.0023					
6	0.0000	0.0020	0.0024	0.0024	0.0024	0.0022	0.0019	0.0020	0.0020	0.0020					
7	0.0000	0.0017	0.0021	0.0021	0.0023	0.0021	0.0019	0.0020	0.0020	0.0020					
8	0.0000	0.0018	0.0021	0.0021	0.0021	0.0021	0.0019	0.0020	0.0019	0.0020					
9	0.0000	0.0019	0.0023	0.0024	0.0025	0.0025	0.0024	0.0025	0.0026	0.0027					
10	0.0000	0.0021	0.0025	0.0025	0.0026	0.0026	0.0025	0.0025	0.0025	0.0025					
11	0.0000	0.0015	0.0020	0.0020	0.0020	0.0020	0.0019	0.0020	0.0019	0.0020					
12	0.0000	0.0021	0.0027	0.0027	0.0028	0.0027	0.0026	0.0028	0.0030	0.0034					
13	0.0000	0.0018	0.0022	0.0022	0.0022	0.0022	0.0019	0.0020	0.0019	0.0020					
14	0.0000	0.0020	0.0024	0.0022	0.0022	0.0021	0.0019	0.0020	0.0019	0.0020					
15	0.0000	0.0016	0.0019	0.0019	0.0021	0.0019	0.0017	0.0018	0.0018	0.0019					
16	0.0000	0.0017	0.0023	0.0022	0.0024	0.0022	0.0021	0.0022	0.0023	0.0025					
17	0.0000	0.0015	0.0020	0.0020	0.0022	0.0020	0.0018	0.0020	0.0021	0.0022					
18	0.0000	0.0014	0.0019	0.0020	0.0022	0.0021	0.0019	0.0020	0.0021	0.0023					
19	0.0000	0.0015	0.0019	0.0020	0.0022	0.0021	0.0019	0.0020	0.0019	0.0022					
20	0.0000	0.0014	0.0021	0.0021	0.0022	0.0022	0.0019	0.0020	0.0021	0.0022					
21	0.0000	0.0015	0.0016	0.0016	0.0017	0.0017	0.0016	0.0017	0.0016	0.0017					
22	0.0000	0.0015	0.0017	0.0017	0.0017	0.0017	0.0015	0.0016	0.0016	0.0016					
23	0.0000	0.0015	0.0018	0.0017	0.0018	0.0017	0.0013	0.0014	0.0013	0.0014					
24	0.0000	0.0014	0.0016	0.0017	0.0018	0.0017	0.0015	0.0016	0.0016	0.0017					
25	0.0000	0.0015	0.0017	0.0016	0.0018	0.0016	0.0016	0.0016	0.0016	0.0017					
n	25	25	25	25	25	25	25	25	25	25					
Avg.	0.0000	0.0018	0.0021	0.0021	0.0022	0.0022	0.0020	0.0021	0.0021	0.0022					
Med.	0.0000	0.0017	0.0021	0.0021	0.0022	0.0021	0.0019	0.0020	0.0020	0.0022					
σ	0.0000	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0004	0.0004	0.0004					
Min.	0.0000	0.0014	0.0016	0.0016	0.0017	0.0016	0.0013	0.0014	0.0013	0.0014					
Max.	0.0000	0.0025	0.0028	0.0027	0.0028	0.0027	0.0026	0.0028	0.0030	0.0034					

Data Set 4 : 85°C, 200 mA

Actual Case Temperature [T _S]	89.0 °C
Actual Ambient Temperature [T _A]	85.3 °C
Drive Current [I _F]	200 mA
Measurement Current	200 mA

NOTES:
T_S and T_A were measured during initial setup.



Data Set 4 : 85°C, 200 mA

Actual Case Temperature [T _S]	89.0 °C
Actual Ambient Temperature [T _A]	85.3 °C
Drive Current [I _F]	200 mA
Measurement Current	200 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	111	6.64	2790	0.453	0.410	0.259	0.526					
2	112	6.65	2847	0.447	0.405	0.257	0.523					
3	115	6.78	2768	0.453	0.407	0.260	0.525					
4	115	6.76	2814	0.449	0.404	0.258	0.523					
5	112	6.63	2844	0.445	0.402	0.257	0.522					
6	112	6.73	2806	0.450	0.406	0.258	0.524					
7	116	6.79	2875	0.443	0.401	0.256	0.521					
8	113	6.60	2806	0.451	0.408	0.258	0.525					
9	111	6.61	2786	0.451	0.406	0.259	0.524					
10	113	6.48	2884	0.441	0.397	0.256	0.519					
11	111	6.60	2755	0.455	0.409	0.260	0.526					
12	113	6.74	2755	0.456	0.411	0.260	0.527					
13	112	6.51	2819	0.447	0.402	0.258	0.522					
14	112	6.61	2838	0.447	0.404	0.257	0.523					
15	115	6.76	2877	0.441	0.398	0.256	0.520					
16	113	6.60	2847	0.446	0.403	0.257	0.522					
17	114	6.75	2883	0.442	0.400	0.256	0.521					
18	113	6.64	2814	0.450	0.408	0.258	0.525					
19	112	6.59	2845	0.446	0.402	0.257	0.522					
20	113	6.74	2828	0.448	0.404	0.257	0.523					
21	114	6.74	2876	0.443	0.402	0.256	0.521					
22	113	6.61	2784	0.453	0.409	0.259	0.526					
23	113	6.69	2810	0.449	0.405	0.258	0.523					
24	111	6.61	2746	0.454	0.406	0.261	0.525					
25	112	6.62	2802	0.451	0.407	0.258	0.524					
n	25	25	25	25	25	25	25					
Avg.	113	6.66	2820	0.449	0.405	0.258	0.523					
Med.	113	6.64	2814	0.449	0.405	0.258	0.523					
σ	1.4	0.084	41.4	0.0045	0.0036	0.0014	0.0021					
Min.	111	6.48	2746	0.441	0.397	0.256	0.519					
Max.	116	6.79	2884	0.456	0.411	0.261	0.527					

Data Set 4 : 85°C, 200 mA

Actual Case Temperature [T _s]	89.0 °C
Actual Ambient Temperature [T _A]	85.3 °C
Drive Current [I _F]	200 mA
Measurement Current	200 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	510 h	1004 h	1718 h	2386 h	3124 h	3810 h	4501 h	5214 h	6025 h				
1	100.0	98.1	97.8	97.6	96.9	96.7	96.5	96.2	95.6	94.9				
2	100.0	98.0	98.1	98.1	97.5	97.5	97.5	97.0	96.7	96.4				
3	100.0	99.2	99.1	99.2	98.5	98.6	98.3	97.8	97.5	97.2				
4	100.0	98.9	98.7	98.6	97.9	97.7	97.3	96.7	96.4	96.0				
5	100.0	98.7	98.4	98.1	97.5	97.4	97.0	96.7	96.4	96.1				
6	100.0	98.2	98.0	97.8	97.0	96.8	96.3	96.1	95.7	95.3				
7	100.0	98.8	98.6	98.5	97.7	97.4	96.9	96.7	96.2	95.6				
8	100.0	97.4	97.2	97.0	96.3	96.0	95.6	95.7	95.3	94.9				
9	100.0	98.3	98.2	98.1	97.5	97.1	97.0	97.1	96.8	96.5				
10	100.0	98.1	98.6	98.5	98.0	97.7	97.6	97.6	97.2	96.9				
11	100.0	98.8	98.4	98.1	97.5	97.2	97.1	96.8	96.4	95.8				
12	100.0	99.2	98.8	98.6	97.9	97.8	97.5	97.0	96.4	95.7				
13	100.0	99.1	98.9	98.7	98.1	98.2	97.7	97.3	96.8	96.1				
14	100.0	97.5	97.2	97.0	96.5	96.4	95.8	95.5	95.0	94.5				
15	100.0	98.7	98.4	98.1	97.5	97.4	96.7	96.4	95.8	94.9				
16	100.0	97.8	97.5	97.1	96.5	96.3	95.7	95.6	95.2	94.8				
17	100.0	98.5	98.1	97.7	97.0	96.6	96.1	95.8	95.3	94.8				
18	100.0	98.6	98.1	97.9	97.3	96.9	96.6	96.8	96.6	96.3				
19	100.0	97.3	97.0	96.6	96.0	95.6	95.6	95.5	95.0	94.6				
20	100.0	98.8	98.2	97.8	97.1	96.6	96.4	96.1	95.4	95.0				
21	100.0	98.5	98.0	97.7	97.1	96.7	96.5	96.3	95.9	95.3				
22	100.0	98.4	97.9	97.5	97.0	96.9	96.6	96.3	96.0	95.5				
23	100.0	98.4	98.0	97.9	97.2	97.1	96.6	96.4	96.0	95.7				
24	100.0	98.5	98.2	98.0	97.4	97.3	96.6	96.5	96.2	95.8				
25	100.0	99.0	98.6	98.3	97.8	97.7	97.0	96.9	96.6	96.3				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	100.0	98.4	98.2	97.9	97.3	97.1	96.8	96.5	96.1	95.6				
Med.	100.0	98.5	98.2	98.0	97.4	97.1	96.6	96.5	96.2	95.7				
σ	0.00	0.52	0.54	0.60	0.60	0.69	0.69	0.63	0.66	0.73				
Min.	100.0	97.3	97.0	96.6	96.0	95.6	95.6	95.5	95.0	94.5				
Max.	100.0	99.2	99.1	99.2	98.5	98.6	98.3	97.8	97.5	97.2				

TM-21 Projection

Time	0 h	510 h	1004 h	1718 h	2386 h	3124 h	3810 h	4501 h	5214 h	6025 h				
ln(Avg.)	0.0000	-0.0158	-0.0186	-0.0208	-0.0273	-0.0295	-0.0330	-0.0355	-0.0398	-0.0446				

Test duration used	1004 h	to	6025 h
B	0.9867		
α	5.1233E-06		
R ²	0.9895		
Calculated L ₇₀ (6K)	67000	hours	
Reported L ₇₀ (6K)	> 36200	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, 200 mA

Actual Case Temperature [T _s]	89.0 °C
Actual Ambient Temperature [T _A]	85.3 °C
Drive Current [I _F]	200 mA
Measurement Current	200 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	510 h	1004 h	1718 h	2386 h	3124 h	3810 h	4501 h	5214 h	6025 h				
1	100.0	98.8	98.9	99.2	98.9	99.0	99.0	99.1	99.1	99.0				
2	100.0	98.8	98.8	99.1	98.8	98.9	98.9	99.0	99.0	99.0				
3	100.0	99.5	99.7	99.9	99.7	99.8	99.9	100.0	100.0	100.0				
4	100.0	99.7	99.8	100.1	99.9	100.0	100.1	100.1	100.1	100.1				
5	100.0	98.8	98.9	99.1	98.9	98.9	99.0	99.0	99.0	99.0				
6	100.0	99.1	99.2	99.6	99.3	99.4	99.5	99.5	99.6	99.5				
7	100.0	99.5	99.7	100.0	99.8	99.8	99.9	100.0	100.0	100.0				
8	100.0	99.1	99.2	99.5	99.3	99.3	99.4	99.4	99.4	99.2				
9	100.0	98.7	98.8	99.0	98.7	98.8	98.9	98.9	98.9	98.9				
10	100.0	98.8	98.8	99.1	98.9	98.9	99.0	99.0	99.1	99.1				
11	100.0	98.9	98.9	99.0	98.8	98.8	98.9	99.0	99.0	98.9				
12	100.0	99.3	99.4	99.6	99.4	99.5	99.6	99.7	99.7	99.7				
13	100.0	99.0	99.0	99.2	99.0	99.0	99.0	99.2	99.2	99.1				
14	100.0	98.8	98.9	99.1	98.9	98.9	99.0	99.1	99.1	99.0				
15	100.0	99.6	99.7	100.0	99.8	99.8	99.9	100.1	100.1	100.0				
16	100.0	98.8	98.9	99.1	98.9	98.9	99.0	99.1	99.1	99.1				
17	100.0	99.4	99.4	99.7	99.4	99.5	99.6	99.7	99.7	99.8				
18	100.0	98.8	98.8	99.0	98.7	98.7	98.8	98.9	98.8	98.8				
19	100.0	98.9	98.9	99.1	98.8	98.9	99.0	99.1	99.1	99.0				
20	100.0	99.4	99.4	99.6	99.4	99.5	99.6	99.7	99.7	99.7				
21	100.0	99.6	99.6	99.9	99.7	99.8	99.8	100.0	100.0	99.9				
22	100.0	98.9	98.8	99.1	98.9	98.9	99.0	99.1	99.1	99.1				
23	100.0	99.1	99.2	99.5	99.2	99.3	99.3	99.4	99.4	99.3				
24	100.0	98.9	98.9	99.1	98.9	98.9	98.9	99.0	99.1	99.0				
25	100.0	99.5	99.5	99.7	99.5	99.6	99.6	99.7	99.8	99.8				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	100.0	99.1	99.2	99.4	99.2	99.2	99.3	99.4	99.4	99.4				
Med.	100.0	99.0	99.0	99.2	99.0	99.0	99.0	99.2	99.2	99.1				
σ	0.00	0.32	0.34	0.38	0.38	0.40	0.41	0.42	0.42	0.43				
Min.	100.0	98.7	98.8	99.0	98.7	98.7	98.8	98.9	98.8	98.8				
Max.	100.0	99.7	99.8	100.1	99.9	100.0	100.1	100.1	100.1	100.1				

Data Set 4 : 85°C, 200 mA

Actual Case Temperature [T _s]	89.0 °C
Actual Ambient Temperature [T _A]	85.3 °C
Drive Current [I _F]	200 mA
Measurement Current	200 mA

NOTES:

T_s and T_A were measured during initial setup.

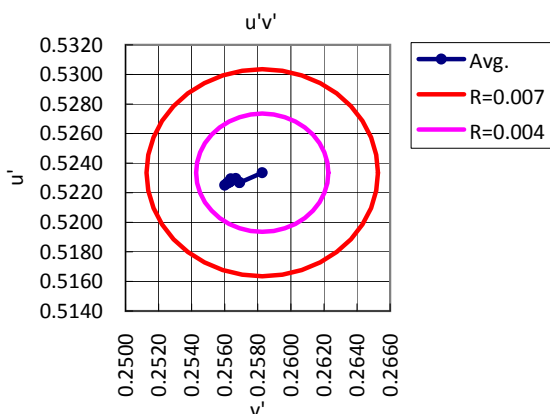
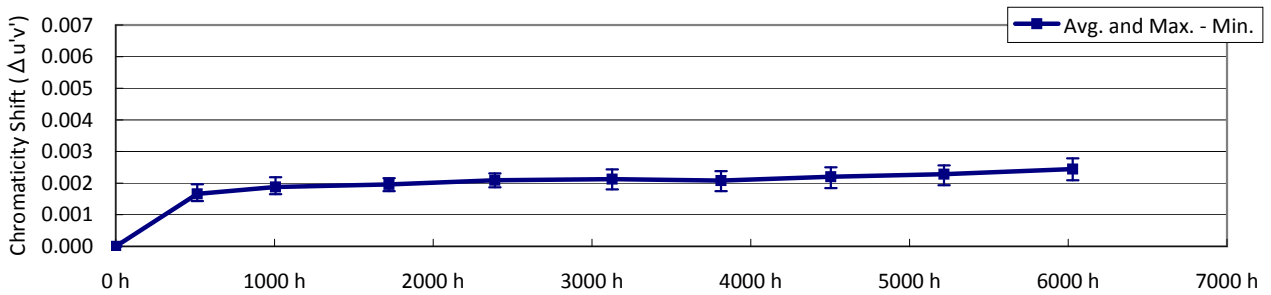
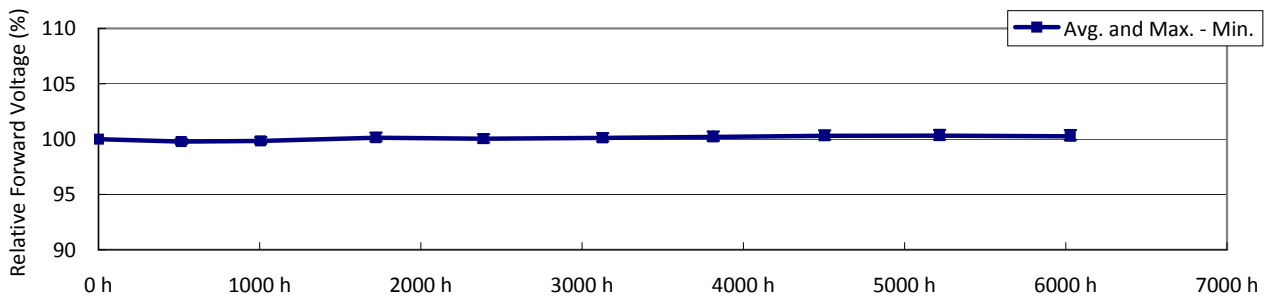
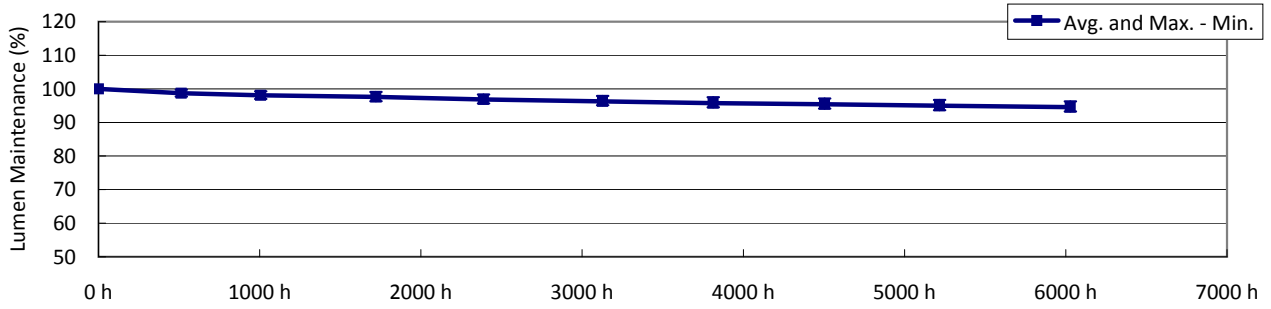
TABLE 4-4
Chromaticity Shift

LED No.	Chromaticity Shift Δu'v'														
	0 h	510 h	1004 h	1718 h	2386 h	3124 h	3810 h	4501 h	5214 h	6025 h					
1	0.0000	0.0020	0.0019	0.0020	0.0020	0.0021	0.0019	0.0020	0.0020	0.0022					
2	0.0000	0.0021	0.0022	0.0020	0.0019	0.0018	0.0017	0.0017	0.0017	0.0018					
3	0.0000	0.0023	0.0021	0.0021	0.0020	0.0019	0.0018	0.0018	0.0018	0.0019					
4	0.0000	0.0022	0.0022	0.0020	0.0022	0.0022	0.0020	0.0021	0.0023	0.0024					
5	0.0000	0.0020	0.0021	0.0019	0.0020	0.0018	0.0017	0.0018	0.0018	0.0019					
6	0.0000	0.0020	0.0021	0.0020	0.0021	0.0019	0.0017	0.0018	0.0018	0.0019					
7	0.0000	0.0020	0.0021	0.0021	0.0022	0.0022	0.0019	0.0022	0.0023	0.0024					
8	0.0000	0.0019	0.0020	0.0019	0.0020	0.0018	0.0016	0.0017	0.0017	0.0018					
9	0.0000	0.0018	0.0019	0.0020	0.0020	0.0019	0.0018	0.0018	0.0018	0.0019					
10	0.0000	0.0020	0.0021	0.0021	0.0022	0.0020	0.0018	0.0019	0.0019	0.0021					
11	0.0000	0.0018	0.0019	0.0020	0.0021	0.0020	0.0019	0.0019	0.0019	0.0019					
12	0.0000	0.0021	0.0021	0.0022	0.0022	0.0021	0.0019	0.0020	0.0020	0.0021					
13	0.0000	0.0021	0.0023	0.0022	0.0023	0.0021	0.0020	0.0020	0.0021	0.0021					
14	0.0000	0.0026	0.0026	0.0028	0.0027	0.0027	0.0025	0.0026	0.0027	0.0028					
15	0.0000	0.0024	0.0026	0.0026	0.0025	0.0024	0.0022	0.0023	0.0023	0.0024					
16	0.0000	0.0023	0.0025	0.0026	0.0027	0.0026	0.0024	0.0025	0.0025	0.0027					
17	0.0000	0.0021	0.0023	0.0023	0.0025	0.0024	0.0023	0.0025	0.0025	0.0026					
18	0.0000	0.0017	0.0020	0.0022	0.0021	0.0020	0.0018	0.0019	0.0019	0.0020					
19	0.0000	0.0019	0.0021	0.0021	0.0022	0.0022	0.0019	0.0020	0.0021	0.0022					
20	0.0000	0.0019	0.0022	0.0024	0.0025	0.0026	0.0025	0.0027	0.0026	0.0028					
21	0.0000	0.0017	0.0019	0.0020	0.0019	0.0019	0.0017	0.0018	0.0018	0.0019					
22	0.0000	0.0018	0.0021	0.0021	0.0022	0.0020	0.0019	0.0020	0.0019	0.0020					
23	0.0000	0.0019	0.0021	0.0020	0.0020	0.0020	0.0017	0.0018	0.0018	0.0018					
24	0.0000	0.0019	0.0020	0.0020	0.0020	0.0019	0.0017	0.0018	0.0018	0.0018					
25	0.0000	0.0020	0.0021	0.0022	0.0021	0.0021	0.0019	0.0020	0.0020	0.0020					
n	25	25	25	25	25	25	25	25	25	25					
Avg.	0.0000	0.0020	0.0021	0.0022	0.0022	0.0021	0.0019	0.0020	0.0020	0.0021					
Med.	0.0000	0.0020	0.0021	0.0021	0.0021	0.0020	0.0019	0.0020	0.0019	0.0020					
σ	0.0000	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	0.0003	0.0003					
Min.	0.0000	0.0017	0.0019	0.0019	0.0019	0.0018	0.0016	0.0017	0.0017	0.0018					
Max.	0.0000	0.0026	0.0026	0.0028	0.0027	0.0027	0.0025	0.0027	0.0027	0.0028					

Data Set 5 : 105°C, 100 mA

Actual Case Temperature [T _S]	105.9 °C
Actual Ambient Temperature [T _A]	102.7 °C
Drive Current [I _F]	100 mA
Measurement Current	100 mA

NOTES:
T_S and T_A were measured during initial setup.



Data Set 5 : 105°C, 100 mA

Actual Case Temperature [T _S]	105.9 °C
Actual Ambient Temperature [T _A]	102.7 °C
Drive Current [I _F]	100 mA
Measurement Current	100 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	62.5	6.10	2843	0.446	0.402	0.257	0.522						
2	62.1	6.07	2785	0.452	0.407	0.259	0.525						
3	61.9	6.10	2828	0.447	0.403	0.258	0.522						
4	62.4	5.99	2846	0.445	0.402	0.257	0.522						
5	60.5	6.02	2826	0.446	0.401	0.258	0.522						
6	61.4	6.07	2800	0.451	0.407	0.258	0.525						
7	60.7	6.02	2807	0.449	0.404	0.258	0.523						
8	60.3	6.05	2775	0.451	0.404	0.260	0.524						
9	62.7	6.07	2817	0.448	0.404	0.258	0.523						
10	61.8	5.97	2808	0.448	0.403	0.258	0.522						
11	61.9	5.98	2823	0.446	0.401	0.258	0.521						
12	62.6	6.10	2752	0.456	0.409	0.260	0.526						
13	61.2	5.99	2744	0.455	0.408	0.261	0.526						
14	61.4	6.05	2829	0.448	0.405	0.257	0.523						
15	62.2	5.93	2851	0.445	0.402	0.257	0.522						
16	61.3	6.01	2806	0.451	0.407	0.258	0.525						
17	61.6	5.94	2763	0.452	0.405	0.260	0.524						
18	61.4	6.09	2807	0.448	0.402	0.259	0.522						
19	61.3	6.09	2765	0.455	0.409	0.260	0.526						
20	62.1	6.07	2782	0.452	0.407	0.259	0.525						
21	61.9	6.06	2750	0.457	0.412	0.260	0.527						
22	61.7	5.94	2771	0.453	0.406	0.260	0.525						
23	62.3	5.99	2830	0.447	0.403	0.258	0.523						
24	62.0	5.94	2844	0.445	0.401	0.257	0.522						
25	62.3	5.99	2872	0.444	0.403	0.256	0.522						
n	25	25	25	25	25	25	25						
Avg.	61.7	6.03	2805	0.449	0.405	0.258	0.524						
Med.	61.9	6.02	2807	0.448	0.404	0.258	0.523						
σ	0.62	0.056	35.2	0.0037	0.0029	0.0013	0.0017						
Min.	60.3	5.93	2744	0.444	0.401	0.256	0.521						
Max.	62.7	6.10	2872	0.457	0.412	0.261	0.527						

Data Set 5 : 105°C, 100 mA

Actual Case Temperature [T _s]	105.9 °C
Actual Ambient Temperature [T _A]	102.7 °C
Drive Current [I _F]	100 mA
Measurement Current	100 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 5-2
Lumen Maintenance

LED No.	Lumen Maintenance % (Normalized to 100% at 0 hours)													
	0 h	513 h	1006 h	1721 h	2388 h	3127 h	3813 h	4504 h	5217 h	6028 h				
1	100.0	99.8	99.3	99.1	98.3	97.8	97.5	97.1	96.7	96.3				
2	100.0	99.3	98.7	98.2	97.5	97.0	96.6	96.2	95.7	95.2				
3	100.0	99.7	99.2	99.0	98.2	97.9	97.3	96.9	96.5	96.1				
4	100.0	98.0	97.4	96.6	95.8	95.4	94.5	94.1	93.7	93.4				
5	100.0	97.8	97.0	96.4	95.7	95.3	94.5	94.3	93.8	93.5				
6	100.0	99.3	98.8	98.5	97.7	97.0	96.3	96.2	95.8	95.4				
7	100.0	98.5	97.8	97.2	96.4	95.5	94.9	94.7	94.3	94.0				
8	100.0	99.0	98.4	98.1	97.2	96.7	96.2	96.1	95.7	95.3				
9	100.0	98.6	97.8	97.2	96.4	95.6	95.3	95.1	94.7	94.3				
10	100.0	99.1	98.5	98.2	97.4	96.8	96.5	96.3	95.8	95.5				
11	100.0	97.9	97.2	96.6	95.8	95.1	94.7	94.3	93.8	93.4				
12	100.0	98.2	97.8	97.6	96.9	96.6	96.1	95.7	95.2	94.8				
13	100.0	97.7	97.0	96.3	95.6	95.3	94.6	94.3	93.9	93.4				
14	100.0	98.5	97.8	97.1	96.4	95.9	95.1	94.8	94.5	94.0				
15	100.0	98.4	97.8	97.3	96.6	96.2	95.4	95.0	94.8	94.2				
16	100.0	98.5	97.9	97.2	96.5	95.9	95.2	95.0	94.7	94.3				
17	100.0	98.3	97.7	97.1	96.3	95.7	95.1	94.8	94.4	94.1				
18	100.0	99.0	98.6	98.3	97.5	97.0	96.6	96.4	95.9	95.0				
19	100.0	98.7	98.2	97.8	97.0	96.4	96.2	96.0	95.4	95.2				
20	100.0	99.7	99.0	98.6	97.7	97.0	96.7	96.4	95.7	95.4				
21	100.0	99.2	98.5	98.0	97.3	96.7	96.3	95.9	95.4	95.0				
22	100.0	98.9	98.3	97.7	96.9	96.4	96.0	95.5	95.0	94.7				
23	100.0	98.3	97.5	96.7	95.8	95.4	94.7	94.1	93.7	93.3				
24	100.0	99.0	98.5	97.9	97.1	96.7	95.9	95.5	95.0	94.7				
25	100.0	98.5	97.8	97.1	96.3	95.8	95.0	94.6	94.2	93.8				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	100.0	98.7	98.1	97.6	96.8	96.3	95.7	95.4	95.0	94.6				
Med.	100.0	98.6	97.9	97.6	96.9	96.4	95.9	95.5	95.0	94.7				
σ	0.00	0.58	0.64	0.78	0.78	0.79	0.90	0.90	0.88	0.86				
Min.	100.0	97.7	97.0	96.3	95.6	95.1	94.5	94.1	93.7	93.3				
Max.	100.0	99.8	99.3	99.1	98.3	97.9	97.5	97.1	96.7	96.3				

TM-21 Projection

Time	0 h	513 h	1006 h	1721 h	2388 h	3127 h	3813 h	4504 h	5217 h	6028 h				
ln(Avg.)	0.0000	-0.0129	-0.0192	-0.0244	-0.0323	-0.0378	-0.0436	-0.0470	-0.0516	-0.0559				

Test duration used	1006 h	to	6028 h
B	0.9869		
α	7.4060E-06		
R ²	0.9850		
Calculated L ₇₀ (6K)	46400	hours	
Reported L ₇₀ (6K)	> 36200	hours	

Curve-fit equation:

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

Lumen maintenance life equation:

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

Data Set 5 : 105°C, 100 mA

Actual Case Temperature [T _s]	105.9 °C
Actual Ambient Temperature [T _A]	102.7 °C
Drive Current [I _F]	100 mA
Measurement Current	100 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 5-3
Forward Voltage

LED No.	Relative Forward Voltage % (Normalized to 100% at 0 hours)													
	0 h	513 h	1006 h	1721 h	2388 h	3127 h	3813 h	4504 h	5217 h	6028 h				
1	100.0	99.9	100.0	100.3	100.2	100.3	100.5	100.6	100.7	100.7				
2	100.0	99.7	99.7	99.9	99.8	99.9	99.9	100.0	100.1	100.0				
3	100.0	99.9	100.0	100.4	100.3	100.4	100.5	100.7	100.7	100.7				
4	100.0	99.6	99.6	99.9	99.8	99.9	100.0	100.1	100.1	100.0				
5	100.0	99.8	99.9	100.2	100.1	100.2	100.2	100.3	100.2	100.2				
6	100.0	99.9	100.0	100.3	100.3	100.4	100.5	100.7	100.7	100.7				
7	100.0	99.8	99.9	100.2	100.2	100.2	100.4	100.5	100.5	100.3				
8	100.0	99.9	100.0	100.3	100.3	100.4	100.5	100.6	100.6	100.6				
9	100.0	99.6	99.6	99.8	99.7	99.8	99.8	100.0	100.0	99.9				
10	100.0	99.9	99.9	100.2	100.1	100.2	100.2	100.3	100.3	100.2				
11	100.0	99.7	99.7	100.0	99.9	100.0	100.0	100.1	100.1	100.1				
12	100.0	99.8	99.9	100.2	100.1	100.3	100.4	100.5	100.5	100.6				
13	100.0	99.6	99.7	100.0	99.9	99.9	100.0	100.0	100.1	100.0				
14	100.0	100.0	100.2	100.6	100.4	100.5	100.6	100.7	100.7	100.6				
15	100.0	99.7	99.7	100.0	99.9	99.9	100.0	100.1	100.1	100.0				
16	100.0	99.7	99.8	100.1	100.0	100.1	100.1	100.2	100.2	100.1				
17	100.0	99.7	99.8	100.0	99.8	99.9	100.0	100.0	100.0	100.0				
18	100.0	100.0	100.1	100.4	100.4	100.5	100.7	100.8	100.8	100.8				
19	100.0	100.0	100.0	100.3	100.3	100.4	100.5	100.6	100.7	100.7				
20	100.0	99.8	99.8	100.0	99.9	100.0	100.1	100.1	100.2	100.2				
21	100.0	99.6	99.6	99.8	99.7	99.8	99.9	100.0	99.9	99.9				
22	100.0	99.8	99.8	100.1	100.0	100.0	100.1	100.2	100.2	100.1				
23	100.0	99.7	99.7	100.0	99.9	99.9	100.1	100.1	100.1	100.1				
24	100.0	99.6	99.7	99.9	99.9	99.9	100.0	100.0	100.0	99.9				
25	100.0	99.7	99.7	100.0	99.9	99.9	100.0	100.1	100.1	100.1				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	100.0	99.8	99.8	100.1	100.0	100.1	100.2	100.3	100.3	100.3				
Med.	100.0	99.8	99.8	100.1	100.0	100.0	100.1	100.2	100.2	100.1				
σ	0.00	0.13	0.16	0.21	0.21	0.24	0.26	0.28	0.29	0.30				
Min.	100.0	99.6	99.6	99.8	99.7	99.8	99.8	100.0	99.9	99.9				
Max.	100.0	100.0	100.2	100.6	100.4	100.5	100.7	100.8	100.8	100.8				

Data Set 5 : 105°C, 100 mA

Actual Case Temperature [T _s]	105.9 °C
Actual Ambient Temperature [T _A]	102.7 °C
Drive Current [I _F]	100 mA
Measurement Current	100 mA

NOTES:

T_s and T_A were measured during initial setup.

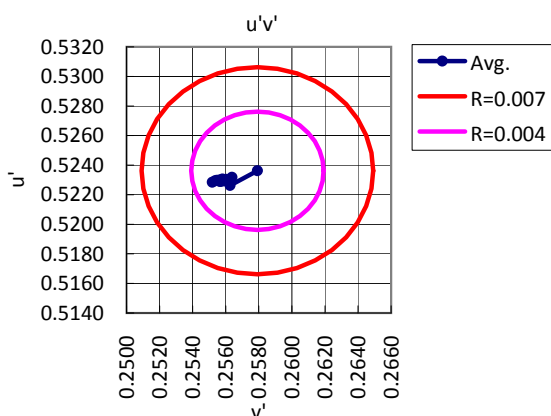
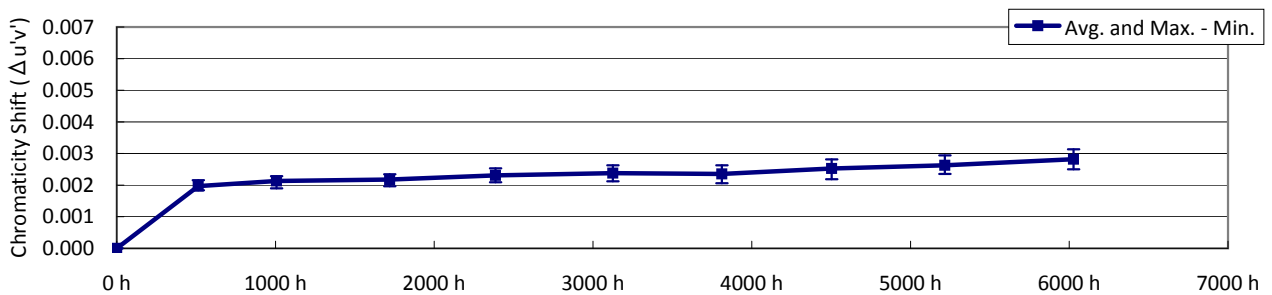
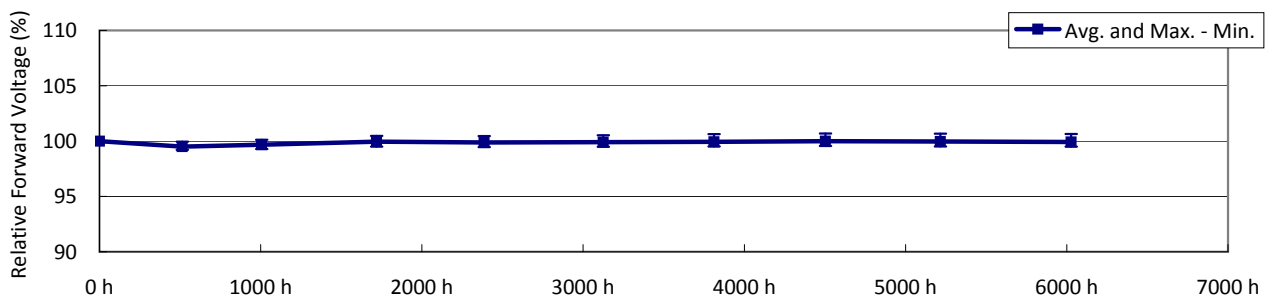
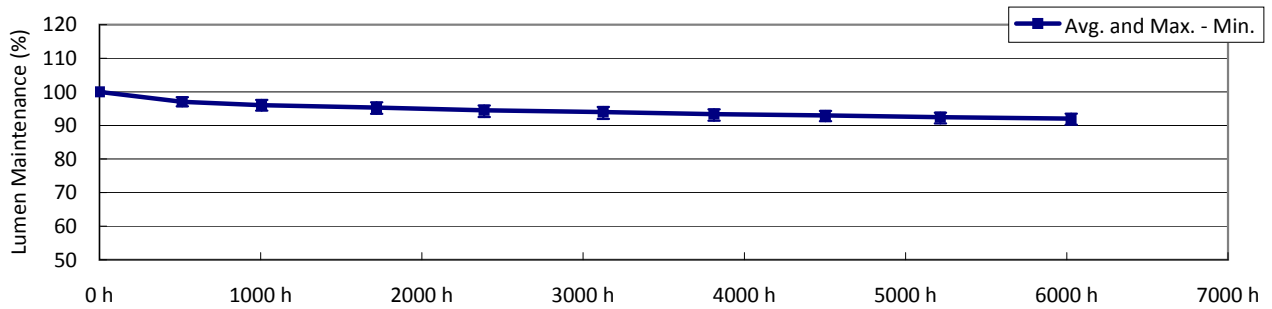
TABLE 5-4
Chromaticity Shift

LED No.	Chromaticity Shift Δu'v'														
	0 h	513 h	1006 h	1721 h	2388 h	3127 h	3813 h	4504 h	5217 h	6028 h					
1	0.0000	0.0015	0.0017	0.0017	0.0019	0.0020	0.0019	0.0021	0.0021	0.0023					
2	0.0000	0.0016	0.0019	0.0019	0.0021	0.0021	0.0021	0.0022	0.0022	0.0024					
3	0.0000	0.0016	0.0019	0.0019	0.0021	0.0022	0.0023	0.0024	0.0025	0.0027					
4	0.0000	0.0016	0.0019	0.0018	0.0020	0.0020	0.0020	0.0020	0.0021	0.0024					
5	0.0000	0.0016	0.0018	0.0018	0.0019	0.0019	0.0018	0.0019	0.0020	0.0022					
6	0.0000	0.0015	0.0017	0.0018	0.0019	0.0019	0.0017	0.0018	0.0020	0.0021					
7	0.0000	0.0016	0.0018	0.0019	0.0021	0.0020	0.0019	0.0021	0.0021	0.0022					
8	0.0000	0.0014	0.0017	0.0019	0.0021	0.0022	0.0022	0.0024	0.0025	0.0027					
9	0.0000	0.0017	0.0020	0.0022	0.0023	0.0023	0.0023	0.0025	0.0026	0.0028					
10	0.0000	0.0017	0.0018	0.0018	0.0019	0.0019	0.0019	0.0020	0.0020	0.0022					
11	0.0000	0.0018	0.0020	0.0021	0.0022	0.0022	0.0022	0.0024	0.0025	0.0027					
12	0.0000	0.0019	0.0021	0.0022	0.0022	0.0023	0.0023	0.0023	0.0024	0.0025					
13	0.0000	0.0020	0.0022	0.0022	0.0023	0.0023	0.0023	0.0024	0.0024	0.0026					
14	0.0000	0.0018	0.0020	0.0022	0.0023	0.0024	0.0023	0.0024	0.0025	0.0028					
15	0.0000	0.0018	0.0020	0.0020	0.0021	0.0022	0.0021	0.0022	0.0023	0.0024					
16	0.0000	0.0016	0.0018	0.0018	0.0020	0.0019	0.0018	0.0020	0.0020	0.0021					
17	0.0000	0.0017	0.0021	0.0021	0.0023	0.0023	0.0021	0.0023	0.0024	0.0025					
18	0.0000	0.0016	0.0019	0.0020	0.0021	0.0021	0.0021	0.0022	0.0023	0.0023					
19	0.0000	0.0018	0.0021	0.0021	0.0023	0.0024	0.0024	0.0024	0.0025	0.0026					
20	0.0000	0.0015	0.0017	0.0019	0.0021	0.0022	0.0021	0.0023	0.0024	0.0025					
21	0.0000	0.0016	0.0018	0.0019	0.0022	0.0022	0.0022	0.0023	0.0024	0.0025					
22	0.0000	0.0016	0.0019	0.0020	0.0022	0.0022	0.0022	0.0023	0.0024	0.0026					
23	0.0000	0.0016	0.0018	0.0018	0.0020	0.0021	0.0020	0.0021	0.0022	0.0024					
24	0.0000	0.0016	0.0019	0.0018	0.0021	0.0021	0.0020	0.0021	0.0021	0.0023					
25	0.0000	0.0014	0.0016	0.0017	0.0019	0.0018	0.0018	0.0019	0.0019	0.0022					
n	25	25	25	25	25	25	25	25	25	25					
Avg.	0.0000	0.0017	0.0019	0.0020	0.0021	0.0021	0.0021	0.0022	0.0023	0.0024					
Med.	0.0000	0.0016	0.0019	0.0019	0.0021	0.0022	0.0021	0.0022	0.0023	0.0024					
σ	0.0000	0.0001	0.0001	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002					
Min.	0.0000	0.0014	0.0016	0.0017	0.0019	0.0018	0.0017	0.0018	0.0019	0.0021					
Max.	0.0000	0.0020	0.0022	0.0022	0.0023	0.0024	0.0024	0.0025	0.0026	0.0028					

Data Set 6 : 105°C, 200 mA

Actual Case Temperature [T _S]	108.8 °C
Actual Ambient Temperature [T _A]	104.7 °C
Drive Current [I _F]	200 mA
Measurement Current	200 mA

NOTES:
T_S and T_A were measured during initial setup.



Data Set 6 : 105°C, 200 mA

Actual Case Temperature [T _S]	108.8 °C
Actual Ambient Temperature [T _A]	104.7 °C
Drive Current [I _F]	200 mA
Measurement Current	200 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	115	6.74	2770	0.455	0.410	0.259	0.526						
2	115	6.74	2844	0.446	0.404	0.257	0.523						
3	115	6.79	2744	0.457	0.411	0.260	0.527						
4	114	6.64	2796	0.452	0.409	0.258	0.526						
5	112	6.64	2839	0.446	0.402	0.257	0.522						
6	113	6.52	2887	0.440	0.396	0.256	0.518						
7	112	6.68	2856	0.445	0.403	0.256	0.522						
8	112	6.70	2797	0.450	0.405	0.259	0.523						
9	112	6.57	2853	0.443	0.399	0.257	0.520						
10	116	6.78	2830	0.448	0.405	0.257	0.523						
11	115	6.77	2770	0.455	0.410	0.259	0.526						
12	114	6.70	2836	0.448	0.406	0.257	0.524						
13	113	6.53	2783	0.452	0.407	0.259	0.525						
14	112	6.62	2738	0.457	0.410	0.261	0.527						
15	117	6.77	2831	0.447	0.404	0.257	0.523						
16	112	6.68	2859	0.443	0.399	0.257	0.520						
17	112	6.63	2837	0.447	0.404	0.257	0.523						
18	112	6.69	2834	0.448	0.406	0.257	0.524						
19	113	6.50	2801	0.450	0.406	0.258	0.524						
20	116	6.73	2887	0.442	0.401	0.255	0.521						
21	113	6.53	2793	0.451	0.406	0.259	0.524						
22	112	6.50	2805	0.449	0.404	0.258	0.523						
23	113	6.51	2771	0.454	0.408	0.259	0.526						
24	112	6.67	2857	0.444	0.402	0.257	0.522						
25	113	6.68	2789	0.452	0.408	0.259	0.525						
n	25	25	25	25	25	25	25						
Avg.	113	6.65	2816	0.449	0.405	0.258	0.524						
Med.	113	6.68	2830	0.448	0.405	0.257	0.523						
σ	1.5	0.096	41.0	0.0047	0.0039	0.0014	0.0022						
Min.	112	6.50	2738	0.440	0.396	0.255	0.518						
Max.	117	6.79	2887	0.457	0.411	0.261	0.527						

Data Set 6 : 105°C, 200 mA

Actual Case Temperature [T _s]	108.8 °C
Actual Ambient Temperature [T _A]	104.7 °C
Drive Current [I _F]	200 mA
Measurement Current	200 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 6-2
Lumen Maintenance

LED No.	Lumen Maintenance % (Normalized to 100% at 0 hours)									
	0 h	513 h	1006 h	1719 h	2386 h	3125 h	3812 h	4503 h	5216 h	6027 h
1	100.0	97.7	96.5	96.0	95.1	94.7	94.3	94.0	93.4	93.0
2	100.0	97.9	96.8	96.3	95.6	95.1	94.6	94.1	93.6	93.1
3	100.0	97.2	95.9	95.3	94.7	94.2	93.6	93.1	92.5	92.1
4	100.0	97.0	95.9	95.3	94.8	94.2	93.6	93.0	92.6	92.2
5	100.0	96.0	94.8	94.1	93.6	93.1	92.4	91.8	91.3	90.9
6	100.0	97.6	96.6	95.9	95.1	94.4	93.6	93.2	92.7	92.3
7	100.0	96.5	95.3	94.6	93.8	93.2	92.5	92.3	91.7	91.4
8	100.0	95.8	94.9	94.2	93.4	93.0	92.5	92.4	91.9	91.5
9	100.0	96.7	96.0	95.4	94.4	94.0	93.6	93.7	93.2	92.9
10	100.0	95.7	94.4	93.4	92.5	91.9	91.4	91.2	90.6	90.2
11	100.0	97.6	96.8	96.1	95.0	94.3	93.8	93.2	92.6	92.1
12	100.0	98.1	97.3	96.6	95.5	95.0	94.5	93.9	93.3	92.8
13	100.0	98.4	97.6	96.9	95.9	95.5	94.8	94.3	93.8	93.5
14	100.0	96.2	95.2	94.5	93.7	93.5	92.6	92.2	91.7	91.4
15	100.0	97.3	96.7	95.9	94.9	94.4	93.5	93.1	92.6	92.1
16	100.0	96.2	95.4	94.7	93.8	93.3	92.6	92.4	91.9	91.5
17	100.0	96.4	95.4	94.4	93.7	93.2	92.5	92.2	91.7	91.3
18	100.0	96.6	95.5	94.9	94.0	93.3	92.9	92.6	92.1	91.7
19	100.0	97.7	96.7	96.1	95.3	94.6	94.3	94.0	93.6	93.3
20	100.0	98.3	97.5	96.6	95.8	94.9	94.6	94.1	93.6	93.2
21	100.0	97.4	96.6	95.8	94.8	94.1	93.5	93.0	92.5	92.1
22	100.0	96.4	95.3	94.5	93.5	93.0	92.3	91.8	91.2	90.7
23	100.0	97.7	96.9	96.2	95.2	94.7	93.9	93.4	92.8	92.3
24	100.0	96.4	95.1	94.6	93.8	93.4	92.5	92.0	91.5	91.0
25	100.0	96.7	95.8	95.1	94.4	94.1	93.3	93.0	92.6	92.2
n	25	25	25	25	25	25	25	25	25	25
Avg.	100.0	97.0	96.0	95.3	94.5	94.0	93.4	93.0	92.4	92.0
Med.	100.0	97.0	95.9	95.3	94.7	94.1	93.5	93.0	92.6	92.1
σ	0.00	0.80	0.90	0.92	0.87	0.84	0.89	0.85	0.86	0.86
Min.	100.0	95.7	94.4	93.4	92.5	91.9	91.4	91.2	90.6	90.2
Max.	100.0	98.4	97.6	96.9	95.9	95.5	94.8	94.3	93.8	93.5

TM-21 Projection

Time	0 h	513 h	1006 h	1719 h	2386 h	3125 h	3812 h	4503 h	5216 h	6027 h
ln(Avg.)	0.0000	-0.0302	-0.0403	-0.0478	-0.0567	-0.0623	-0.0687	-0.0730	-0.0787	-0.0831

Test duration used	1006 h	to	6027 h
B	0.9663		
α	8.5075E-06		
R ²	0.9843		
Calculated L ₇₀ (6K)	37900	hours	
Reported L ₇₀ (6K)	> 36200	hours	

Curve-fit equation:

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

Lumen maintenance life equation:

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

Data Set 6 : 105°C, 200 mA

Actual Case Temperature [T _s]	108.8 °C
Actual Ambient Temperature [T _A]	104.7 °C
Drive Current [I _F]	200 mA
Measurement Current	200 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 6-3
Forward Voltage

LED No.	Relative Forward Voltage % (Normalized to 100% at 0 hours)													
	0 h	513 h	1006 h	1719 h	2386 h	3125 h	3812 h	4503 h	5216 h	6027 h				
1	100.0	99.4	99.6	99.8	99.8	99.8	99.8	99.8	99.8	99.8				
2	100.0	99.2	99.3	99.5	99.5	99.5	99.5	99.6	99.5	99.5				
3	100.0	99.4	99.5	99.7	99.7	99.7	99.7	99.8	99.7	99.7				
4	100.0	99.3	99.5	99.6	99.6	99.6	99.5	99.6	99.6	99.5				
5	100.0	99.5	99.8	100.0	99.9	99.9	99.9	99.9	99.9	99.8				
6	100.0	99.5	99.6	99.8	99.8	99.9	99.9	99.9	99.9	99.9				
7	100.0	99.7	100.1	100.5	100.5	100.5	100.4	100.5	100.5	100.4				
8	100.0	99.3	99.5	99.7	99.6	99.6	99.6	99.7	99.7	99.6				
9	100.0	99.3	99.5	99.6	99.6	99.6	99.6	99.7	99.7	99.6				
10	100.0	99.2	99.5	99.7	99.7	99.7	99.7	99.8	99.8	99.7				
11	100.0	99.7	99.9	100.2	100.2	100.2	100.3	100.4	100.3	100.3				
12	100.0	99.9	100.1	100.5	100.5	100.5	100.6	100.7	100.7	100.6				
13	100.0	99.5	99.6	99.8	99.7	99.8	99.9	99.9	99.9	99.8				
14	100.0	99.2	99.3	99.6	99.5	99.5	99.5	99.6	99.6	99.5				
15	100.0	99.8	100.0	100.4	100.3	100.4	100.5	100.6	100.5	100.5				
16	100.0	99.8	100.0	100.3	100.1	100.1	100.1	100.2	100.1	100.0				
17	100.0	99.3	99.4	99.6	99.6	99.5	99.6	99.6	99.6	99.5				
18	100.0	99.7	99.9	100.1	100.0	100.0	100.1	100.1	100.0	100.0				
19	100.0	99.3	99.4	99.6	99.5	99.6	99.7	99.7	99.6	99.6				
20	100.0	99.4	99.5	99.7	99.7	99.7	99.8	99.9	99.8	99.8				
21	100.0	99.4	99.6	99.9	99.8	99.9	100.0	100.1	100.1	100.0				
22	100.0	99.3	99.5	99.9	99.8	99.8	99.9	100.0	100.0	99.9				
23	100.0	99.8	99.9	100.4	100.3	100.4	100.5	100.5	100.4	100.4				
24	100.0	100.0	100.1	100.4	100.3	100.3	100.4	100.4	100.3	100.2				
25	100.0	99.6	99.7	100.0	99.9	99.9	100.0	100.0	100.0	99.9				
n	25	25	25	25	25	25	25	25	25	25				
Avg.	100.0	99.5	99.7	99.9	99.9	99.9	99.9	100.0	100.0	99.9				
Med.	100.0	99.4	99.6	99.8	99.8	99.8	99.9	99.9	99.9	99.8				
σ	0.00	0.24	0.27	0.32	0.31	0.32	0.34	0.34	0.33	0.33				
Min.	100.0	99.2	99.3	99.5	99.5	99.5	99.5	99.6	99.5	99.5				
Max.	100.0	100.0	100.1	100.5	100.5	100.5	100.6	100.7	100.7	100.6				

Data Set 6 : 105°C, 200 mA

Actual Case Temperature [T _s]	108.8 °C
Actual Ambient Temperature [T _A]	104.7 °C
Drive Current [I _F]	200 mA
Measurement Current	200 mA

NOTES:

T_s and T_A were measured during initial setup.

TABLE 6-4
Chromaticity Shift

LED No.	Chromaticity Shift Δu'v'														
	0 h	513 h	1006 h	1719 h	2386 h	3125 h	3812 h	4503 h	5216 h	6027 h					
1	0.0000	0.0018	0.0022	0.0022	0.0023	0.0024	0.0024	0.0025	0.0026	0.0029					
2	0.0000	0.0020	0.0023	0.0023	0.0024	0.0025	0.0025	0.0027	0.0028	0.0030					
3	0.0000	0.0020	0.0022	0.0023	0.0024	0.0025	0.0024	0.0025	0.0026	0.0029					
4	0.0000	0.0019	0.0020	0.0021	0.0022	0.0023	0.0023	0.0024	0.0025	0.0028					
5	0.0000	0.0018	0.0021	0.0021	0.0021	0.0022	0.0021	0.0023	0.0024	0.0026					
6	0.0000	0.0020	0.0022	0.0021	0.0023	0.0024	0.0023	0.0025	0.0027	0.0028					
7	0.0000	0.0019	0.0022	0.0022	0.0022	0.0022	0.0021	0.0024	0.0024	0.0026					
8	0.0000	0.0020	0.0022	0.0023	0.0025	0.0024	0.0024	0.0027	0.0027	0.0029					
9	0.0000	0.0020	0.0021	0.0021	0.0021	0.0022	0.0022	0.0024	0.0024	0.0027					
10	0.0000	0.0019	0.0021	0.0023	0.0025	0.0026	0.0026	0.0028	0.0029	0.0031					
11	0.0000	0.0021	0.0022	0.0023	0.0024	0.0025	0.0025	0.0027	0.0028	0.0030					
12	0.0000	0.0020	0.0022	0.0023	0.0025	0.0025	0.0026	0.0027	0.0028	0.0030					
13	0.0000	0.0019	0.0021	0.0021	0.0023	0.0024	0.0024	0.0026	0.0027	0.0028					
14	0.0000	0.0019	0.0019	0.0020	0.0021	0.0022	0.0022	0.0023	0.0024	0.0025					
15	0.0000	0.0021	0.0022	0.0022	0.0023	0.0023	0.0023	0.0024	0.0025	0.0027					
16	0.0000	0.0021	0.0021	0.0022	0.0022	0.0023	0.0022	0.0025	0.0026	0.0027					
17	0.0000	0.0020	0.0021	0.0023	0.0025	0.0025	0.0026	0.0028	0.0029	0.0031					
18	0.0000	0.0019	0.0020	0.0021	0.0022	0.0022	0.0023	0.0025	0.0026	0.0027					
19	0.0000	0.0018	0.0021	0.0021	0.0023	0.0024	0.0024	0.0026	0.0027	0.0028					
20	0.0000	0.0020	0.0021	0.0023	0.0025	0.0026	0.0026	0.0028	0.0029	0.0031					
21	0.0000	0.0020	0.0021	0.0021	0.0022	0.0023	0.0023	0.0025	0.0026	0.0028					
22	0.0000	0.0022	0.0023	0.0023	0.0025	0.0026	0.0026	0.0028	0.0029	0.0031					
23	0.0000	0.0022	0.0023	0.0023	0.0024	0.0025	0.0025	0.0025	0.0026	0.0029					
24	0.0000	0.0019	0.0021	0.0021	0.0022	0.0023	0.0022	0.0024	0.0025	0.0026					
25	0.0000	0.0020	0.0020	0.0021	0.0021	0.0021	0.0021	0.0022	0.0024	0.0025					
n	25	25	25	25	25	25	25	25	25	25					
Avg.	0.0000	0.0020	0.0021	0.0022	0.0023	0.0024	0.0024	0.0025	0.0026	0.0028					
Med.	0.0000	0.0020	0.0021	0.0022	0.0023	0.0024	0.0024	0.0025	0.0026	0.0028					
σ	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002					
Min.	0.0000	0.0018	0.0019	0.0020	0.0021	0.0021	0.0021	0.0022	0.0024	0.0025					
Max.	0.0000	0.0022	0.0023	0.0023	0.0025	0.0026	0.0026	0.0028	0.0029	0.0031					