

# LM-80 Test Report

## NFSL757D

<b>Issue Date:</b> July 1, 2013	<b>Revision Date:</b> August 8, 2014
<b>Test Initiation Date:</b> April 26, 2013	<b>Test Completion Date:</b> -
<b>Test Duration:</b> 10,000 hours	<b>Report Number:</b> SQETMN547101

**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 <sub>s</sub> ]	Ambient Temperature [T <sub>A</sub> ]	Drive Current [I <sub>F</sub> ]	Lumen Maintenance at 10,000 hours	Chromaticity Shift (Δu'v') at 10,000 hours	TM-21 Projection L <sub>70</sub> (10K)
1	55 °C	> 50 °C	65 mA	97.9 %	0.0011	> 60300 hours
2	55 °C	> 50 °C	150 mA	99.0 %	0.0014	> 60300 hours
3	55 °C	> 50 °C	180 mA	99.3 %	0.0013	> 60300 hours
4	85 °C	> 80 °C	65 mA	96.5 %	0.0010	> 60300 hours
5	85 °C	> 80 °C	150 mA	97.0 %	0.0014	> 60300 hours
6	85 °C	> 80 °C	180 mA	97.0 %	0.0017	> 60300 hours
7	105 °C	> 100 °C	65 mA	92.5 %	0.0012	> 60300 hours
8	105 °C	> 100 °C	150 mA	93.8 %	0.0020	> 60300 hours
9	105 °C	> 100 °C	180 mA	93.6 %	0.0024	> 60300 hours

Approved Signatory:



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 Hitoshi TOHYAMA, Lab Manager

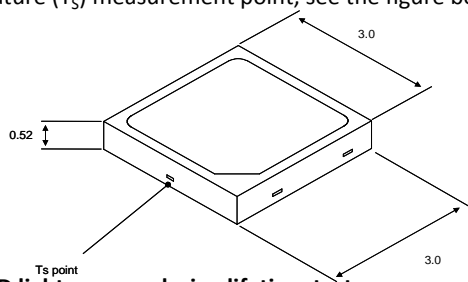
**Nichia Corporation LED Testing Laboratory**  
 1-1, Tatsumi-Cho, Anan-Shi, TOKUSHIMA 774-0001, JAPAN

**Applicable Model Numbers:**

This LM-80 test report applies to the following models:

Series	Model Number	Case Temperature [°C]	Forward Current [mA]	Nominal CCT [K]
757	NFSW757D	55	65	≥ 2700
		55	150	≥ 2700
		55	180	≥ 2700
		85	65	≥ 2700
		85	150	≥ 2700
		85	180	≥ 2700
		105	65	≥ 2700
		105	150	≥ 2700
757	NFSL757D-V1	55	65	≥ 2700
		55	150	≥ 2700
		55	180	≥ 2700
		85	65	≥ 2700
		85	150	≥ 2700
		85	180	≥ 2700
		105	65	≥ 2700
		105	150	≥ 2700
757	NFSW757D-V1	55	65	≥ 2700
		55	150	≥ 2700
		55	180	≥ 2700
		85	65	≥ 2700
		85	150	≥ 2700
		85	180	≥ 2700
		105	65	≥ 2700
		105	150	≥ 2700
		105	180	≥ 2700

**IES LM-80-08 Test Report Requirement :**

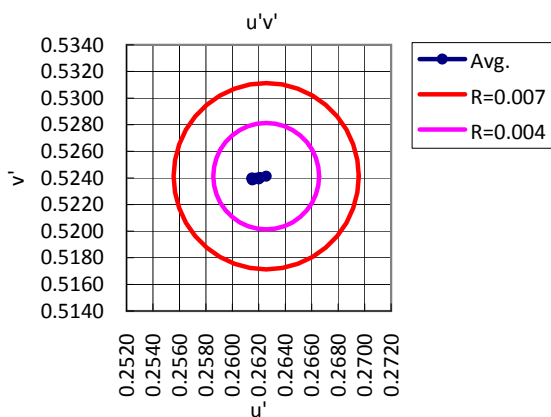
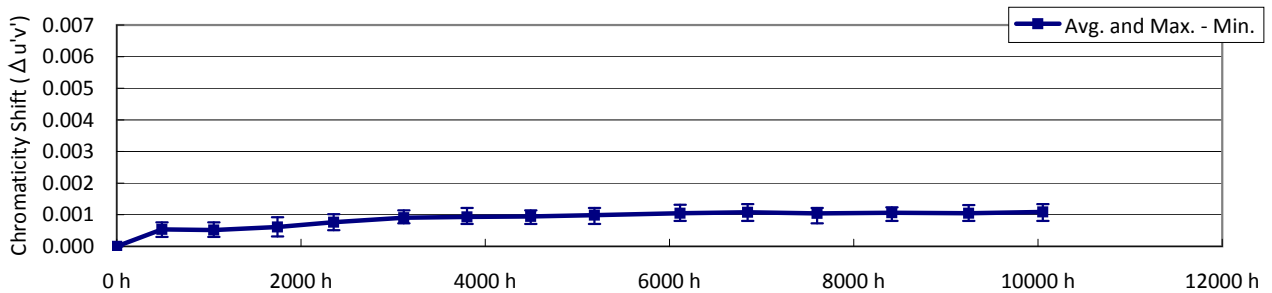
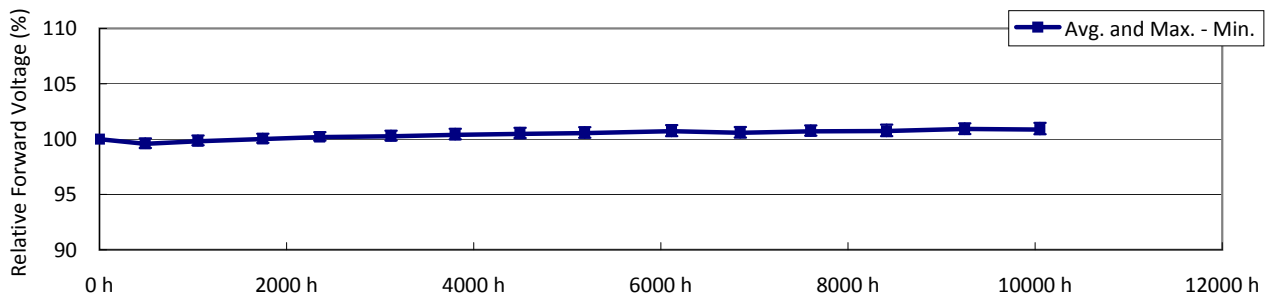
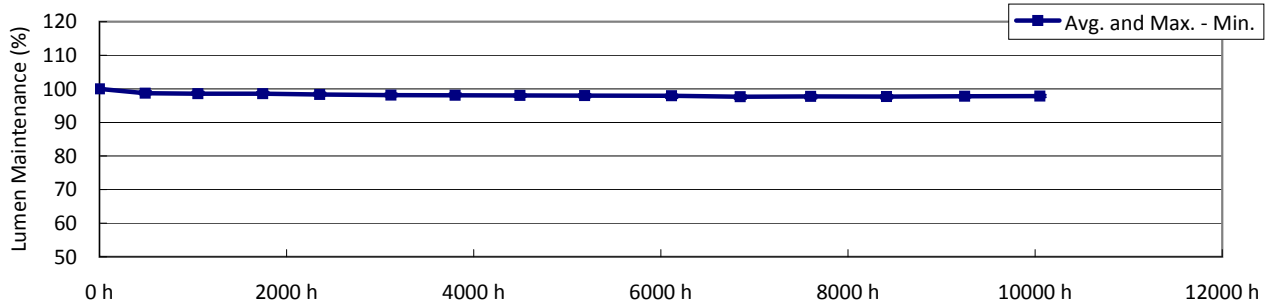
1. **Number of LED light sources tested**  
See tables.
  2. **Description of LED light sources**  
See Description of Test Samples
  3. **Description of auxiliary equipment**  
Active cooling life test system  
Consisting of small boxes, in which each box contains a reliability test board, and a water-cooled 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 <sub>s</sub> ]	55.2 °C
Actual Ambient Temperature [T <sub>A</sub> ]	54.2 °C
Drive Current [I <sub>F</sub> ]	65 mA
Measurement Current	65 mA

## NOTES:

 T<sub>s</sub> and T<sub>A</sub> were measured during initial setup.

**TABLE 1-1**  
Initial Characteristics

LED No.	Luminous flux	Forward voltage	CCT	CIE1931		CIE1976							
	Φ <sub>v</sub> [lm]	V <sub>F</sub> [V]	T <sub>CP</sub> [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 <sub>s</sub> ]	55.2 °C
Actual Ambient Temperature [T <sub>A</sub> ]	54.2 °C
Drive Current [I <sub>F</sub> ]	65 mA
Measurement Current	65 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> 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	6848 h	7602 h	8413 h	9248 h	10052 h
1	100.0	98.8	98.6	98.6	98.2	98.3	98.1	98.2	98.0	98.1	97.7	97.9	97.8	97.9	97.6
2	100.0	98.5	98.3	98.4	98.2	98.1	97.9	98.1	98.0	98.1	97.8	97.8	97.8	97.9	97.8
3	100.0	98.6	98.4	98.4	98.3	98.1	97.9	98.1	98.0	98.2	97.9	97.8	97.9	97.9	98.0
4	100.0	98.6	98.3	98.4	98.3	98.0	97.9	98.1	97.8	98.2	97.8	97.6	97.8	97.8	98.0
5	100.0	98.9	98.7	98.6	98.5	98.4	98.2	98.3	98.0	98.1	97.8	97.7	97.8	97.9	98.1
6	100.0	98.5	98.3	98.3	98.2	98.0	98.0	98.0	97.7	97.8	97.4	97.4	97.5	97.7	98.2
7	100.0	98.4	98.2	98.2	98.0	97.9	97.9	97.9	97.6	97.5	97.2	97.2	97.2	97.5	98.0
8	100.0	99.0	99.0	98.9	98.5	98.5	98.5	98.4	98.1	97.9	97.7	97.8	97.6	97.8	97.8
9	100.0	99.0	98.9	98.8	98.3	98.4	98.3	98.2	98.1	97.8	97.6	97.8	97.5	97.8	97.7
10	100.0	98.7	98.7	98.6	98.2	98.2	98.2	98.1	98.0	97.8	97.6	97.8	97.6	97.7	97.5
11	100.0	99.0	98.8	98.8	98.5	98.4	98.3	98.3	98.3	98.3	97.9	98.1	98.0	98.0	97.9
12	100.0	98.7	98.6	98.5	98.3	98.1	98.1	98.1	98.1	98.2	97.8	98.1	97.9	98.0	97.8
13	100.0	98.6	98.5	98.5	98.3	98.0	98.0	98.1	98.1	98.1	97.8	98.0	97.8	97.9	97.9
14	100.0	98.6	98.5	98.4	98.2	98.0	97.9	97.9	97.9	97.9	97.5	97.6	97.4	97.5	97.5
15	100.0	98.4	98.3	98.3	98.2	98.0	97.9	98.0	97.9	97.9	97.5	97.6	97.6	97.8	98.0
16	100.0	98.5	98.3	98.2	98.1	97.8	97.8	97.8	97.7	97.6	97.3	97.4	97.4	97.5	98.1
17	100.0	98.6	98.4	98.4	98.2	97.7	97.8	97.6	97.4	97.3	97.0	97.1	97.1	97.4	98.0
18	100.0	99.3	99.2	99.1	98.9	98.6	98.6	98.4	98.2	98.0	97.7	97.7	97.6	97.7	97.8
19	100.0	99.2	99.1	99.1	98.9	98.6	98.7	98.5	98.4	98.3	98.1	98.2	98.1	98.2	98.2
20	100.0	99.0	98.9	98.9	98.6	98.3	98.3	98.2	98.1	98.0	97.7	97.8	97.6	97.7	97.5
21	100.0	98.8	98.7	98.7	98.3	98.2	98.2	97.9	98.1	98.1	97.9	98.2	97.8	98.0	97.8
22	100.0	98.7	98.6	98.6	98.2	98.0	98.0	97.7	98.0	98.0	97.7	98.0	97.7	97.8	97.6
23	100.0	98.5	98.5	98.5	98.2	98.0	98.0	97.7	98.1	98.1	97.8	98.1	97.9	98.1	97.9
24	100.0	98.5	98.3	98.4	98.1	97.9	97.9	97.6	97.9	97.9	97.5	97.8	97.7	97.9	97.8
25	100.0	98.5	98.4	98.4	98.3	98.0	98.0	97.8	97.9	97.8	97.5	97.6	97.5	97.7	97.7
n	25	25	25	25	25	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	97.7	97.8	97.7	97.8	97.9
Med.	100.0	98.6	98.5	98.5	98.3	98.1	98.0	98.1	98.0	98.0	97.7	97.8	97.7	97.8	97.8
σ	0.00	0.25	0.27	0.25	0.23	0.24	0.24	0.24	0.21	0.25	0.25	0.28	0.23	0.19	0.21
Min.	100.0	98.4	98.2	98.2	98.0	97.7	97.8	97.6	97.4	97.3	97.0	97.1	97.1	97.4	97.5
Max.	100.0	99.3	99.2	99.1	98.9	98.6	98.7	98.5	98.4	98.3	98.1	98.2	98.1	98.2	98.2

**TM-21 Projection**

Time	4494 h	5185 h	6115 h	6848 h	7602 h	8413 h	9248 h	10052 h							
ln(Avg.)	-0.0198	-0.0204	-0.0207	-0.0237	-0.0226	-0.0235	-0.0222	-0.0216							

Test duration used	4494 h	to	10052 h
B	0.9816		
α	4.4273E-07		
R <sup>2</sup>	0.3532		
Calculated L <sub>70</sub> (10K)	764000	hours	
Reported L <sub>70</sub> (10K)	> 60300	hours	

Curve-fit equation:

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

Lumen maintenance life equation:

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

**Data Set 1 : 55 °C, 65 mA**

Actual Case Temperature [T <sub>s</sub> ]	55.2 °C
Actual Ambient Temperature [T <sub>A</sub> ]	54.2 °C
Drive Current [I <sub>F</sub> ]	65 mA
Measurement Current	65 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> 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	6848 h	7602 h	8413 h	9248 h	10052 h
1	100.0	100.0	100.2	100.5	100.6	100.7	100.9	100.9	101.0	101.2	101.1	101.1	101.2	101.4	101.4
2	100.0	99.9	100.2	100.3	100.4	100.5	100.7	100.7	100.7	100.9	100.8	100.9	100.9	101.1	101.0
3	100.0	99.9	100.1	100.4	100.5	100.6	100.7	100.9	100.9	101.1	101.0	101.0	101.1	101.3	101.2
4	100.0	100.1	100.3	100.5	100.6	100.8	100.9	101.0	101.1	101.3	101.1	101.2	101.3	101.4	101.5
5	100.0	100.0	100.2	100.5	100.6	100.7	100.8	100.9	101.0	101.2	101.1	101.1	101.3	101.3	101.4
6	100.0	100.0	100.2	100.4	100.5	100.7	100.8	100.8	101.0	101.1	101.0	101.1	101.1	101.3	101.2
7	100.0	99.9	100.1	100.2	100.3	100.4	100.5	100.6	100.7	100.9	100.7	100.7	100.8	100.9	100.9
8	100.0	100.0	100.2	100.4	100.6	100.7	100.9	100.9	100.9	101.2	101.0	101.2	101.2	101.3	101.3
9	100.0	99.9	100.2	100.4	100.5	100.6	100.8	100.8	101.0	101.2	101.1	101.2	101.2	101.3	101.3
10	100.0	100.0	100.2	100.4	100.6	100.7	100.8	101.0	101.0	101.2	101.1	101.2	101.2	101.4	101.3
11	100.0	99.3	99.5	99.7	100.0	100.0	100.1	100.2	100.3	100.5	100.3	100.4	100.5	100.7	100.6
12	100.0	99.3	99.5	99.8	100.0	100.0	100.1	100.3	100.3	100.5	100.3	100.6	100.6	100.8	100.7
13	100.0	99.4	99.6	99.8	99.9	100.0	100.2	100.2	100.3	100.5	100.3	100.5	100.5	100.7	100.6
14	100.0	99.3	99.5	99.8	100.0	100.0	100.1	100.3	100.3	100.5	100.3	100.6	100.5	100.8	100.6
15	100.0	99.4	99.6	99.7	99.9	99.9	100.0	100.2	100.1	100.3	100.1	100.3	100.3	100.6	100.4
16	100.0	99.2	99.4	99.7	99.9	99.9	100.0	100.1	100.2	100.3	100.1	100.3	100.3	100.6	100.5
17	100.0	99.3	99.5	99.7	100.0	100.0	100.1	100.3	100.3	100.5	100.3	100.5	100.5	100.7	100.6
18	100.0	99.3	99.5	99.7	99.9	100.0	100.1	100.2	100.3	100.5	100.3	100.5	100.5	100.7	100.6
19	100.0	99.3	99.4	99.7	99.9	99.9	100.1	100.2	100.3	100.4	100.2	100.4	100.4	100.7	100.6
20	100.0	99.2	99.5	99.7	99.9	100.0	100.1	100.1	100.3	100.4	100.3	100.4	100.4	100.7	100.6
21	100.0	99.3	99.5	99.8	100.0	100.1	100.2	100.3	100.3	100.5	100.4	100.5	100.5	100.8	100.6
22	100.0	99.3	99.6	99.8	100.0	100.1	100.2	100.3	100.4	100.5	100.4	100.6	100.6	100.8	100.8
23	100.0	99.4	99.6	99.8	99.9	100.0	100.1	100.2	100.2	100.3	100.3	100.4	100.4	100.6	100.5
24	100.0	99.3	99.6	99.8	100.0	100.0	100.2	100.3	100.3	100.5	100.4	100.6	100.5	100.8	100.7
25	100.0	99.4	99.5	99.7	99.9	99.9	100.0	100.1	100.1	100.3	100.2	100.3	100.3	100.5	100.5
n	25	25	25	25	25	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	100.6	100.7	100.7	100.9	100.9
Med.	100.0	99.4	99.6	99.8	100.0	100.0	100.2	100.3	100.3	100.5	100.4	100.6	100.5	100.8	100.7
σ	0.00	0.33	0.34	0.34	0.29	0.34	0.35	0.32	0.35	0.36	0.37	0.32	0.36	0.32	0.35
Min.	100.0	99.2	99.4	99.7	99.9	99.9	100.0	100.1	100.1	100.3	100.1	100.3	100.3	100.5	100.4
Max.	100.0	100.1	100.3	100.5	100.6	100.8	100.9	101.0	101.1	101.3	101.1	101.2	101.3	101.4	101.5

**Data Set 1 : 55 °C, 65 mA**

Actual Case Temperature [T <sub>s</sub> ]	55.2 °C
Actual Ambient Temperature [T <sub>A</sub> ]	54.2 °C
Drive Current [I <sub>F</sub> ]	65 mA
Measurement Current	65 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> 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	6848 h	7602 h	8413 h	9248 h	10052 h
1	0.0000	0.0003	0.0003	0.0005	0.0005	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0009	0.0009	0.0010	0.0009
2	0.0000	0.0004	0.0003	0.0004	0.0005	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0009
3	0.0000	0.0003	0.0003	0.0003	0.0005	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0007	0.0008	0.0008	0.0009
4	0.0000	0.0004	0.0003	0.0005	0.0006	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0009	0.0008	0.0008	0.0009
5	0.0000	0.0004	0.0004	0.0004	0.0007	0.0009	0.0008	0.0009	0.0008	0.0009	0.0010	0.0009	0.0009	0.0010	0.0010
6	0.0000	0.0004	0.0004	0.0005	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0011	0.0009	0.0010	0.0011	0.0009
7	0.0000	0.0005	0.0004	0.0005	0.0007	0.0009	0.0009	0.0009	0.0010	0.0010	0.0010	0.0010	0.0010	0.0011	0.0009
8	0.0000	0.0004	0.0004	0.0005	0.0006	0.0008	0.0007	0.0008	0.0008	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009
9	0.0000	0.0003	0.0003	0.0004	0.0005	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0009	0.0008	0.0008
10	0.0000	0.0003	0.0003	0.0004	0.0006	0.0007	0.0007	0.0007	0.0008	0.0008	0.0009	0.0008	0.0008	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	0.0011	0.0011	0.0012	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	0.0010	0.0010	0.0010	0.0010	0.0011
13	0.0000	0.0005	0.0005	0.0006	0.0008	0.0009	0.0009	0.0010	0.0010	0.0011	0.0012	0.0011	0.0011	0.0011	0.0012
14	0.0000	0.0007	0.0006	0.0007	0.0009	0.0010	0.0011	0.0011	0.0011	0.0012	0.0012	0.0011	0.0012	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	0.0012	0.0012	0.0012	0.0011	0.0012
16	0.0000	0.0007	0.0007	0.0009	0.0009	0.0011	0.0012	0.0011	0.0012	0.0013	0.0013	0.0012	0.0012	0.0013	0.0012
17	0.0000	0.0008	0.0008	0.0009	0.0010	0.0009	0.0010	0.0009	0.0009	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
18	0.0000	0.0006	0.0006	0.0008	0.0009	0.0010	0.0011	0.0011	0.0011	0.0011	0.0012	0.0012	0.0012	0.0012	0.0012
19	0.0000	0.0006	0.0005	0.0006	0.0008	0.0009	0.0009	0.0010	0.0010	0.0011	0.0010	0.0011	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	0.0013	0.0011	0.0012	0.0011	0.0012
21	0.0000	0.0005	0.0007	0.0006	0.0008	0.0009	0.0010	0.0010	0.0010	0.0011	0.0012	0.0011	0.0011	0.0012	0.0013
22	0.0000	0.0007	0.0006	0.0007	0.0009	0.0011	0.0010	0.0011	0.0011	0.0011	0.0013	0.0012	0.0012	0.0011	0.0012
23	0.0000	0.0006	0.0006	0.0007	0.0008	0.0010	0.0010	0.0010	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0012
24	0.0000	0.0006	0.0006	0.0007	0.0009	0.0010	0.0011	0.0011	0.0011	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012
25	0.0000	0.0007	0.0007	0.0007	0.0009	0.0010	0.0010	0.0011	0.0011	0.0012	0.0012	0.0012	0.0012	0.0012	0.0013
n	25	25	25	25	25	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	0.0011	0.0010	0.0011	0.0010	0.0011
Med.	0.0000	0.0005	0.0005	0.0006	0.0008	0.0009	0.0009	0.0010	0.0010	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
σ	0.0000	0.0001	0.0002	0.0002	0.0002	0.0001	0.0002	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	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	0.0008	0.0007	0.0008	0.0008	0.0008
Max.	0.0000	0.0008	0.0008	0.0009	0.0010	0.0011	0.0012	0.0011	0.0012	0.0013	0.0013	0.0012	0.0012	0.0013	0.0013

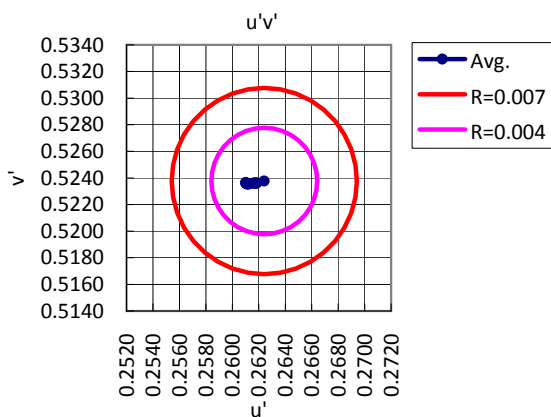
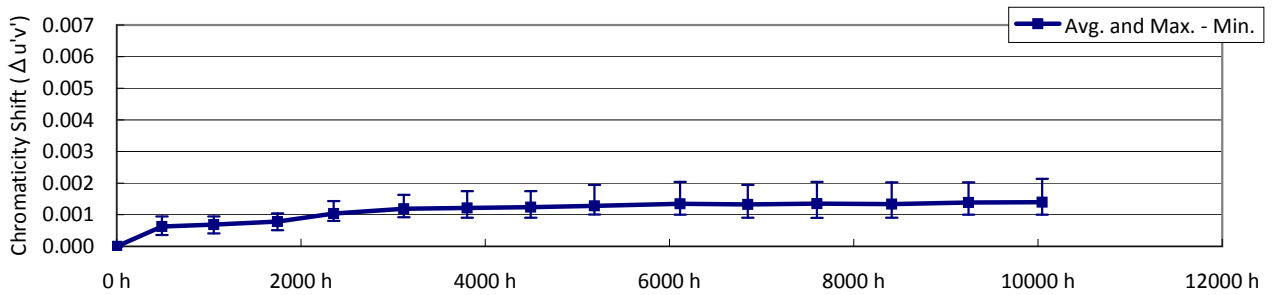
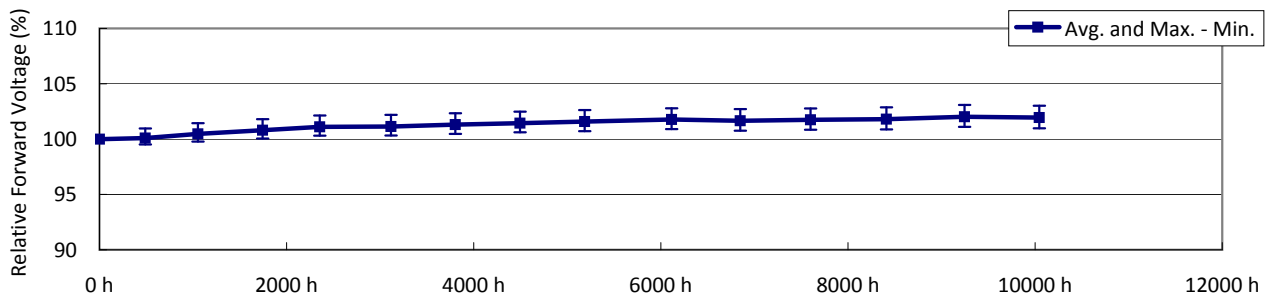
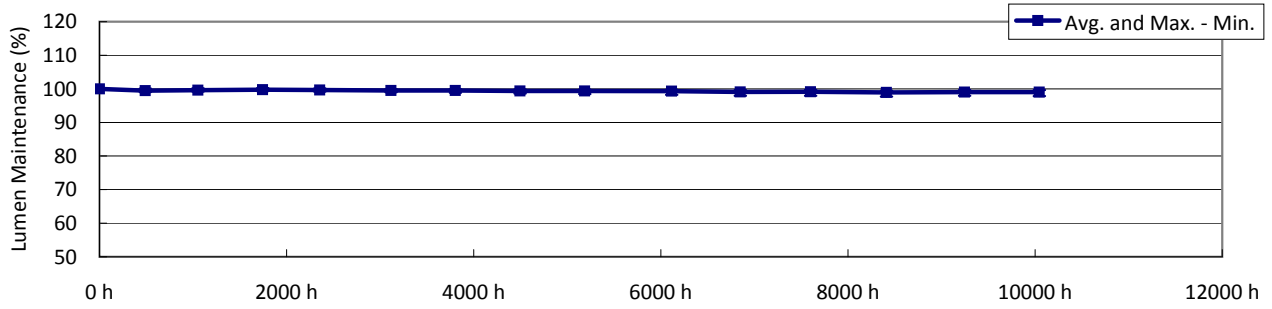


**Data Set 2 : 55 °C, 150 mA**

Actual Case Temperature [T <sub>S</sub> ]	57.0 °C
Actual Ambient Temperature [T <sub>A</sub> ]	55.7 °C
Drive Current [I <sub>F</sub> ]	150 mA
Measurement Current	150 mA

NOTES:

T<sub>S</sub> and T<sub>A</sub> were measured during initial setup.



**Data Set 2 : 55 °C, 150 mA**

Actual Case Temperature [T <sub>S</sub> ]	57.0 °C
Actual Ambient Temperature [T <sub>A</sub> ]	55.7 °C
Drive Current [I <sub>F</sub> ]	150 mA
Measurement Current	150 mA

NOTES:

T<sub>S</sub> and T<sub>A</sub> were measured during initial setup.

**TABLE 2-1**  
Initial Characteristics

LED No.	Luminous flux	Forward voltage	CCT	CIE1931		CIE1976							
	Φ <sub>V</sub> [lm]	V <sub>F</sub> [V]	T <sub>CP</sub> [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 <sub>s</sub> ]	57.0 °C
Actual Ambient Temperature [T <sub>A</sub> ]	55.7 °C
Drive Current [I <sub>F</sub> ]	150 mA
Measurement Current	150 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> 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	6849 h	7600 h	8411 h	9246 h	10045 h
1	100.0	99.4	99.6	99.7	99.7	99.5	99.5	99.4	99.5	99.3	99.2	99.3	99.1	99.0	98.7
2	100.0	99.2	99.6	99.6	99.5	99.4	99.4	99.3	99.4	99.4	99.3	99.3	99.1	99.2	99.0
3	100.0	99.4	99.8	99.8	99.7	99.6	99.6	99.6	99.7	99.8	99.5	99.6	99.4	99.4	99.4
4	100.0	99.1	99.4	99.3	99.4	99.2	99.2	99.3	99.3	99.4	99.1	99.0	98.8	99.0	99.2
5	100.0	99.6	99.9	99.9	99.9	99.8	99.8	99.8	99.6	99.7	99.5	99.4	99.2	99.4	99.6
6	100.0	99.6	99.7	99.8	99.8	99.7	99.7	99.7	99.5	99.4	99.1	99.1	98.9	99.0	99.6
7	100.0	99.5	99.6	99.6	99.7	99.4	99.5	99.4	99.2	98.9	98.7	98.7	98.6	98.7	99.2
8	100.0	99.7	99.9	100.0	100.0	99.7	99.8	99.6	99.5	99.2	99.0	99.1	99.1	99.2	99.1
9	100.0	100.1	100.2	100.2	100.1	100.0	99.9	99.7	99.6	99.2	99.1	99.2	99.1	99.1	98.9
10	100.0	99.8	100.1	100.2	100.2	99.9	99.9	99.8	99.8	99.5	99.4	99.5	99.5	99.3	99.0
11	100.0	99.0	99.2	99.4	99.4	99.2	99.2	99.1	99.1	99.0	98.7	98.7	98.5	98.5	98.2
12	100.0	99.4	99.6	99.7	99.7	99.5	99.5	99.5	99.5	99.5	99.3	99.4	99.2	99.2	99.0
13	100.0	99.2	99.4	99.5	99.5	99.3	99.3	99.4	99.4	99.5	99.4	99.4	99.2	99.2	99.0
14	100.0	99.1	99.2	99.4	99.3	99.2	99.3	99.4	99.2	99.3	99.2	99.2	99.1	99.0	98.9
15	100.0	99.5	99.7	99.8	99.8	99.6	99.6	99.2	99.2	99.5	99.4	99.3	99.3	99.4	99.4
16	100.0	99.6	99.7	99.8	99.8	99.6	99.6	98.9	99.2	99.2	99.0	99.0	98.8	98.9	99.3
17	100.0	99.4	99.6	99.7	99.7	99.5	99.6	99.4	99.2	99.1	98.8	98.8	98.7	98.9	99.3
18	100.0	99.8	99.8	99.9	99.9	99.7	99.6	99.5	99.3	99.2	98.8	98.9	98.6	99.0	99.0
19	100.0	99.6	99.6	99.8	99.5	99.0	98.8	98.6	98.5	98.2	97.9	97.9	97.7	98.0	97.9
20	100.0	99.3	99.5	99.6	99.5	99.4	99.3	99.2	99.2	99.1	98.7	98.8	98.6	98.8	98.6
21	100.0	99.3	99.5	99.8	99.6	99.5	99.5	99.4	99.3	99.3	99.0	99.1	98.9	99.0	98.6
22	100.0	99.6	99.7	99.9	99.8	99.7	99.7	99.7	99.7	99.7	99.5	99.6	99.3	99.6	99.2
23	100.0	99.2	99.2	99.3	99.2	99.1	99.1	99.0	99.1	99.2	99.1	99.2	98.8	99.1	98.9
24	100.0	99.7	99.7	99.9	99.8	99.7	99.7	99.6	99.7	99.7	99.7	99.7	99.4	99.6	99.6
25	100.0	99.2	99.3	99.4	99.4	99.2	99.2	99.2	99.1	99.1	98.9	98.8	98.5	98.7	98.7
n	25	25	25	25	25	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	99.1	99.1	98.9	99.0	99.0
Med.	100.0	99.4	99.6	99.8	99.7	99.5	99.5	99.4	99.3	99.3	99.1	99.2	99.1	99.0	99.0
σ	0.00	0.26	0.26	0.24	0.24	0.26	0.26	0.29	0.28	0.32	0.37	0.38	0.39	0.36	0.42
Min.	100.0	99.0	99.2	99.3	99.2	99.0	98.8	98.6	98.5	98.2	97.9	97.9	97.7	98.0	97.9
Max.	100.0	100.1	100.2	100.2	100.2	100.0	99.9	99.8	99.8	99.8	99.7	99.7	99.5	99.6	99.6

**TM-21 Projection**

Time	4494 h	5185 h	6115 h	6849 h	7600 h	8411 h	9246 h	10045 h							
ln(Avg.)	-0.0062	-0.0064	-0.0071	-0.0090	-0.0088	-0.0107	-0.0096	-0.0099							

Test duration used	4494 h	to	10045 h
B	0.9973		
α	7.9103E-07		
R <sup>2</sup>	0.8106		
Calculated L <sub>70</sub> (10K)	447000	hours	
Reported L <sub>70</sub> (10K)	> 60300	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 <sub>s</sub> ]	57.0 °C
Actual Ambient Temperature [T <sub>A</sub> ]	55.7 °C
Drive Current [I <sub>F</sub> ]	150 mA
Measurement Current	150 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> 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	6849 h	7600 h	8411 h	9246 h	10045 h
1	100.0	100.8	101.2	101.5	101.8	101.8	102.0	102.1	102.2	102.4	102.3	102.4	102.4	102.7	102.6
2	100.0	100.6	100.9	101.2	101.5	101.4	101.6	101.8	101.8	102.0	101.8	101.9	101.9	102.2	102.1
3	100.0	100.9	101.4	101.8	102.0	102.2	102.3	102.5	102.6	102.7	102.7	102.8	102.8	103.1	103.0
4	100.0	100.6	101.0	101.2	101.5	101.5	101.6	101.7	101.9	102.1	101.9	102.0	102.1	102.3	102.2
5	100.0	101.0	101.4	101.8	102.1	102.2	102.3	102.4	102.6	102.7	102.7	102.7	102.8	103.1	103.0
6	100.0	101.0	101.4	101.8	102.1	102.2	102.3	102.5	102.6	102.8	102.7	102.8	102.9	103.0	103.0
7	100.0	100.9	101.3	101.7	102.1	102.1	102.3	102.4	102.6	102.7	102.7	102.8	102.8	103.1	103.0
8	100.0	100.8	101.1	101.5	101.8	101.8	102.0	102.1	102.3	102.4	102.3	102.4	102.4	102.7	102.6
9	100.0	100.9	101.4	101.8	102.1	102.1	102.3	102.4	102.6	102.8	102.7	102.7	102.8	103.0	102.9
10	100.0	100.9	101.4	101.7	102.0	102.0	102.3	102.4	102.6	102.8	102.6	102.7	102.7	103.0	102.9
11	100.0	99.6	99.9	100.2	100.5	100.4	100.6	100.7	100.9	101.0	100.9	101.0	101.0	101.2	101.2
12	100.0	99.6	100.0	100.3	100.7	100.6	100.9	101.0	101.2	101.4	101.3	101.3	101.3	101.6	101.6
13	100.0	99.6	100.0	100.3	100.6	100.6	100.7	100.9	101.1	101.3	101.2	101.3	101.3	101.5	101.5
14	100.0	99.5	99.8	100.1	100.4	100.3	100.5	100.6	100.8	101.0	100.8	100.9	101.0	101.2	101.1
15	100.0	99.6	100.0	100.3	100.6	100.7	100.8	101.0	101.2	101.3	101.2	101.3	101.4	101.6	101.5
16	100.0	99.7	100.0	100.3	100.7	100.7	100.9	101.0	101.2	101.4	101.2	101.3	101.4	101.7	101.5
17	100.0	99.7	100.0	100.4	100.7	100.7	100.9	101.1	101.2	101.5	101.3	101.4	101.5	101.6	101.6
18	100.0	99.6	100.0	100.4	100.7	100.7	100.9	101.1	101.2	101.5	101.3	101.4	101.5	101.7	101.6
19	100.0	99.6	100.0	100.4	100.7	100.7	100.9	101.0	101.2	101.4	101.3	101.3	101.5	101.7	101.6
20	100.0	99.5	99.8	100.1	100.3	100.3	100.5	100.6	100.7	100.9	100.8	100.8	100.9	101.1	101.0
21	100.0	99.7	100.1	100.4	100.7	100.8	101.0	101.1	101.3	101.5	101.3	101.5	101.5	101.7	101.7
22	100.0	99.6	100.0	100.3	100.6	100.7	100.9	101.0	101.2	101.3	101.3	101.4	101.4	101.6	101.6
23	100.0	99.5	99.8	100.1	100.4	100.5	100.6	100.7	100.8	101.0	100.9	101.0	101.0	101.2	101.2
24	100.0	99.6	100.0	100.4	100.6	100.7	100.9	101.0	101.2	101.4	101.3	101.4	101.4	101.7	101.6
25	100.0	99.7	99.9	100.2	100.4	100.5	100.7	100.8	100.9	101.0	101.0	101.0	101.0	101.3	101.2
n	25	25	25	25	25	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	101.7	101.7	101.8	102.0	101.9
Med.	100.0	99.7	100.0	100.4	100.7	100.7	100.9	101.1	101.2	101.5	101.3	101.4	101.5	101.7	101.6
σ	0.00	0.62	0.66	0.68	0.69	0.70	0.70	0.68	0.69	0.69	0.71	0.70	0.70	0.71	0.71
Min.	100.0	99.5	99.8	100.1	100.3	100.3	100.5	100.6	100.7	100.9	100.8	100.8	100.9	101.1	101.0
Max.	100.0	101.0	101.4	101.8	102.1	102.2	102.3	102.5	102.6	102.8	102.7	102.8	102.9	103.1	103.0

**Data Set 2 : 55 °C, 150 mA**

Actual Case Temperature [T <sub>s</sub> ]	57.0 °C
Actual Ambient Temperature [T <sub>A</sub> ]	55.7 °C
Drive Current [I <sub>F</sub> ]	150 mA
Measurement Current	150 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> were measured during initial setup.

**TABLE 2-4**  
Chromaticity Shift

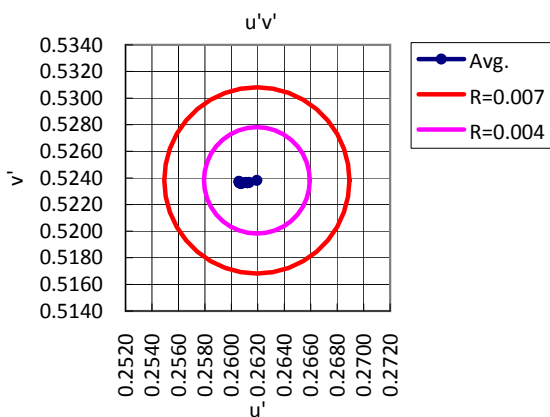
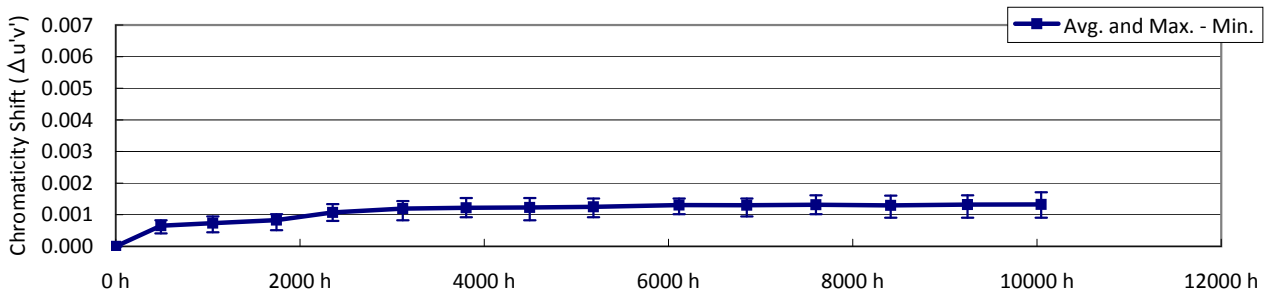
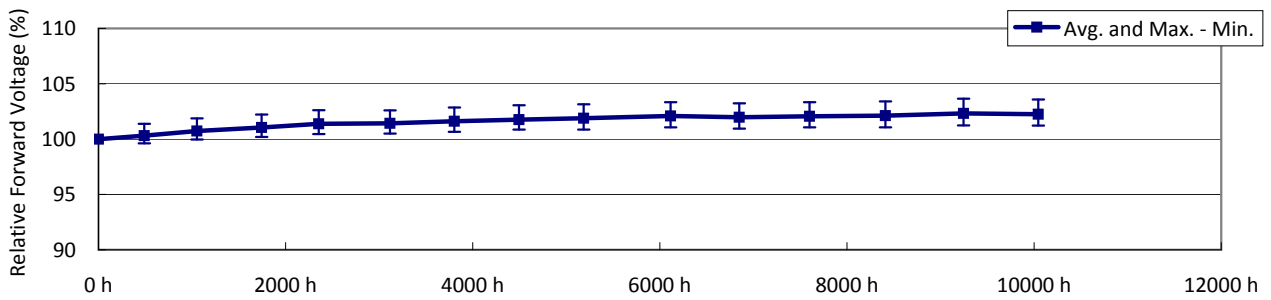
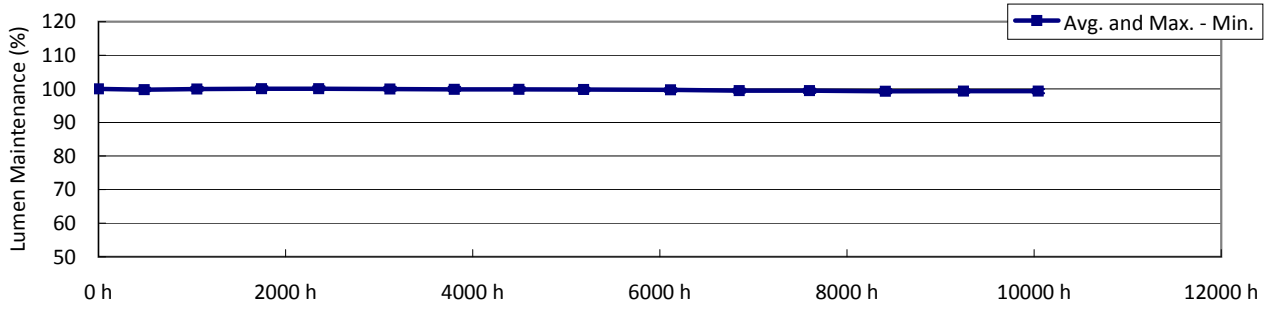
LED No.	Chromaticity Shift Δu'v'														
	0 h	490 h	1053 h	1744 h	2354 h	3116 h	3803 h	4494 h	5185 h	6115 h	6849 h	7600 h	8411 h	9246 h	10045 h
1	0.0000	0.0004	0.0005	0.0006	0.0008	0.0010	0.0010	0.0011	0.0011	0.0012	0.0012	0.0012	0.0012	0.0013	0.0013
2	0.0000	0.0004	0.0005	0.0006	0.0008	0.0009	0.0010	0.0009	0.0010	0.0011	0.0010	0.0011	0.0011	0.0011	0.0012
3	0.0000	0.0004	0.0005	0.0005	0.0008	0.0009	0.0009	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0011
4	0.0000	0.0004	0.0004	0.0005	0.0008	0.0009	0.0009	0.0009	0.0010	0.0010	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	0.0011	0.0011	0.0011	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	0.0013	0.0014	0.0014	0.0015	0.0013
7	0.0000	0.0007	0.0008	0.0009	0.0010	0.0012	0.0012	0.0012	0.0013	0.0013	0.0013	0.0013	0.0013	0.0014	0.0014
8	0.0000	0.0005	0.0006	0.0007	0.0009	0.0010	0.0010	0.0011	0.0011	0.0011	0.0011	0.0012	0.0011	0.0012	0.0011
9	0.0000	0.0004	0.0005	0.0007	0.0010	0.0012	0.0013	0.0014	0.0013	0.0014	0.0015	0.0014	0.0015	0.0014	0.0015
10	0.0000	0.0004	0.0005	0.0006	0.0008	0.0009	0.0009	0.0010	0.0010	0.0011	0.0011	0.0011	0.0011	0.0011	0.0012
11	0.0000	0.0006	0.0006	0.0008	0.0011	0.0012	0.0012	0.0013	0.0014	0.0015	0.0015	0.0015	0.0016	0.0017	0.0017
12	0.0000	0.0007	0.0008	0.0009	0.0011	0.0012	0.0012	0.0013	0.0013	0.0014	0.0015	0.0015	0.0014	0.0014	0.0015
13	0.0000	0.0007	0.0008	0.0009	0.0011	0.0013	0.0013	0.0013	0.0014	0.0014	0.0014	0.0014	0.0014	0.0013	0.0014
14	0.0000	0.0007	0.0007	0.0008	0.0010	0.0011	0.0011	0.0012	0.0012	0.0013	0.0013	0.0013	0.0012	0.0013	0.0013
15	0.0000	0.0008	0.0008	0.0009	0.0012	0.0013	0.0014	0.0014	0.0012	0.0015	0.0014	0.0015	0.0015	0.0015	0.0015
16	0.0000	0.0008	0.0008	0.0009	0.0012	0.0014	0.0013	0.0012	0.0013	0.0013	0.0013	0.0013	0.0013	0.0014	0.0012
17	0.0000	0.0009	0.0009	0.0010	0.0013	0.0015	0.0014	0.0015	0.0015	0.0015	0.0015	0.0016	0.0015	0.0016	0.0014
18	0.0000	0.0007	0.0007	0.0008	0.0011	0.0013	0.0013	0.0013	0.0013	0.0014	0.0014	0.0014	0.0014	0.0015	0.0015
19	0.0000	0.0007	0.0008	0.0009	0.0014	0.0016	0.0017	0.0017	0.0019	0.0020	0.0019	0.0020	0.0020	0.0020	0.0021
20	0.0000	0.0006	0.0007	0.0008	0.0010	0.0012	0.0012	0.0013	0.0013	0.0014	0.0013	0.0014	0.0013	0.0014	0.0014
21	0.0000	0.0007	0.0008	0.0009	0.0011	0.0012	0.0013	0.0014	0.0014	0.0015	0.0015	0.0015	0.0014	0.0016	0.0016
22	0.0000	0.0007	0.0007	0.0008	0.0011	0.0012	0.0012	0.0013	0.0013	0.0014	0.0014	0.0015	0.0015	0.0015	0.0016
23	0.0000	0.0007	0.0007	0.0009	0.0010	0.0012	0.0013	0.0012	0.0013	0.0013	0.0014	0.0013	0.0013	0.0014	0.0015
24	0.0000	0.0006	0.0007	0.0008	0.0010	0.0011	0.0011	0.0012	0.0012	0.0013	0.0013	0.0013	0.0013	0.0014	0.0014
25	0.0000	0.0007	0.0007	0.0008	0.0010	0.0012	0.0013	0.0012	0.0013	0.0014	0.0013	0.0013	0.0013	0.0014	0.0014
n	25	25	25	25	25	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	0.0013	0.0014	0.0013	0.0014	0.0014
Med.	0.0000	0.0007	0.0007	0.0008	0.0010	0.0012	0.0012	0.0012	0.0013	0.0014	0.0013	0.0013	0.0013	0.0014	0.0014
σ	0.0000	0.0002	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Min.	0.0000	0.0004	0.0004	0.0005	0.0008	0.0009	0.0009	0.0009	0.0010	0.0010	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	0.0019	0.0020	0.0020	0.0020	0.0021

**Data Set 3 : 55 °C, 180 mA**

Actual Case Temperature [T <sub>S</sub> ]	57.5 °C
Actual Ambient Temperature [T <sub>A</sub> ]	56.3 °C
Drive Current [I <sub>F</sub> ]	180 mA
Measurement Current	180 mA

NOTES:

T<sub>S</sub> and T<sub>A</sub> were measured during initial setup.



**Data Set 3 : 55 °C, 180 mA**

Actual Case Temperature [T <sub>s</sub> ]	57.5 °C
Actual Ambient Temperature [T <sub>A</sub> ]	56.3 °C
Drive Current [I <sub>F</sub> ]	180 mA
Measurement Current	180 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> were measured during initial setup.

**TABLE 3-1**  
Initial Characteristics

LED No.	Luminous flux	Forward voltage	CCT	CIE1931		CIE1976							
	Φ <sub>v</sub> [lm]	V <sub>F</sub> [V]	T <sub>CP</sub> [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 <sub>s</sub> ]	57.5 °C
Actual Ambient Temperature [T <sub>A</sub> ]	56.3 °C
Drive Current [I <sub>F</sub> ]	180 mA
Measurement Current	180 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> 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	6849 h	7600 h	8411 h	9246 h	10045 h
1	100.0	99.8	100.0	100.2	100.2	100.0	100.0	99.9	99.9	99.8	99.6	99.7	99.5	99.5	99.2
2	100.0	100.0	100.3	100.4	100.3	100.0	100.0	100.0	100.2	100.2	100.0	100.0	99.9	99.8	99.6
3	100.0	99.5	99.8	99.9	99.9	99.7	99.6	99.7	99.8	99.8	99.6	99.5	99.6	99.4	99.3
4	100.0	99.5	99.6	99.7	99.7	99.5	99.4	99.6	99.6	99.6	99.5	99.2	99.2	99.0	99.0
5	100.0	99.6	99.8	99.9	100.0	99.8	99.7	99.8	99.7	99.6	99.5	99.3	99.3	99.4	99.5
6	100.0	99.5	99.7	99.7	99.8	99.6	99.6	99.8	99.5	99.3	99.1	99.1	99.0	99.0	99.4
7	100.0	99.6	99.7	99.8	99.9	99.6	99.7	99.7	99.4	99.2	98.9	98.9	98.8	98.9	99.3
8	100.0	99.8	100.0	100.1	100.2	100.0	100.1	100.0	99.7	99.6	99.3	99.4	99.1	99.4	99.3
9	100.0	100.3	100.5	100.7	100.7	100.5	100.5	100.3	100.2	99.9	99.7	99.8	99.5	99.6	99.4
10	100.0	100.3	100.6	100.7	100.7	100.6	100.6	100.4	100.3	100.2	99.9	100.0	99.7	99.7	99.4
11	100.0	99.8	100.1	100.2	100.2	100.2	100.1	100.1	100.0	100.0	99.8	99.8	99.6	99.6	99.3
12	100.0	99.4	99.6	99.7	99.7	99.7	99.5	99.6	99.6	99.6	99.4	99.5	99.1	99.3	99.0
13	100.0	99.5	99.6	99.7	99.7	99.7	99.6	99.7	99.6	99.7	99.4	99.5	99.2	99.4	99.2
14	100.0	99.9	99.9	100.0	100.0	100.0	99.9	100.0	99.9	100.0	99.8	99.8	99.4	99.6	99.5
15	100.0	99.6	99.5	99.6	99.6	99.5	99.4	99.5	99.3	99.3	99.0	99.1	98.7	99.0	99.0
16	100.0	99.8	99.9	100.0	100.2	100.0	99.9	100.0	99.7	99.6	99.4	99.4	99.3	99.3	99.9
17	100.0	99.4	99.6	99.7	99.8	99.6	99.5	99.5	99.3	99.1	98.9	98.8	98.7	98.8	99.2
18	100.0	99.9	100.2	100.3	100.3	100.2	100.1	99.9	99.8	99.5	99.3	99.2	99.2	99.2	99.3
19	100.0	100.1	100.4	100.6	100.6	100.5	100.4	100.3	100.2	100.0	99.8	99.7	99.6	99.6	99.5
20	100.0	99.9	100.3	100.4	100.4	100.4	100.2	100.1	100.1	100.0	99.8	99.7	99.6	99.6	99.4
21	100.0	99.4	99.7	99.8	99.8	99.6	99.6	99.6	99.5	99.4	99.2	99.3	99.0	99.0	98.7
22	100.0	99.5	99.7	99.9	99.9	99.8	99.7	99.7	99.9	99.9	99.7	99.7	99.4	99.5	99.2
23	100.0	99.3	99.5	99.6	99.6	99.5	99.4	99.4	99.7	99.7	99.4	99.4	99.1	99.2	99.1
24	100.0	99.7	99.9	100.0	100.0	99.9	99.8	99.8	100.0	99.9	99.6	99.5	99.4	99.4	99.5
25	100.0	99.8	100.0	100.1	100.0	99.9	99.9	99.9	99.9	99.8	99.5	99.4	99.2	99.2	99.4
n	25	25	25	25	25	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	99.5	99.5	99.3	99.3	99.3
Med.	100.0	99.7	99.9	100.0	100.0	99.9	99.8	99.8	99.8	99.7	99.5	99.5	99.3	99.4	99.3
σ	0.00	0.28	0.31	0.34	0.32	0.34	0.34	0.27	0.29	0.29	0.30	0.32	0.31	0.27	0.24
Min.	100.0	99.3	99.5	99.6	99.6	99.5	99.4	99.4	99.3	99.1	98.9	98.8	98.7	98.8	98.7
Max.	100.0	100.3	100.6	100.7	100.7	100.6	100.6	100.4	100.3	100.2	100.0	100.0	99.9	99.8	99.9

**TM-21 Projection**

Time	4494 h	5185 h	6115 h	6849 h	7600 h	8411 h	9246 h	10045 h							
ln(Avg.)	-0.0015	-0.0022	-0.0029	-0.0052	-0.0053	-0.0072	-0.0067	-0.0070							

Test duration used	4494 h	to	10045 h
B	1.0032		
α	1.0957E-06		
R <sup>2</sup>	0.9029		
Calculated L <sub>70</sub> (10K)	328000	hours	
Reported L <sub>70</sub> (10K)	> 60300	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 <sub>s</sub> ]	57.5 °C
Actual Ambient Temperature [T <sub>A</sub> ]	56.3 °C
Drive Current [I <sub>F</sub> ]	180 mA
Measurement Current	180 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> 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	6849 h	7600 h	8411 h	9246 h	10045 h
1	100.0	101.1	101.5	101.8	102.1	102.1	102.4	102.6	102.6	102.8	102.7	102.8	102.9	103.1	103.0
2	100.0	101.3	101.8	102.1	102.6	102.5	102.8	102.9	103.1	103.3	103.1	103.2	103.3	103.5	103.5
3	100.0	101.1	101.5	101.8	102.2	102.2	102.4	102.6	102.7	102.9	102.8	102.8	102.9	103.1	103.0
4	100.0	101.1	101.5	101.8	102.1	102.2	102.4	102.5	102.6	102.9	102.7	102.8	102.8	103.1	103.0
5	100.0	100.9	101.3	101.6	101.9	101.9	102.2	102.2	102.3	102.6	102.4	102.5	102.6	102.8	102.7
6	100.0	101.1	101.4	101.7	102.1	102.1	102.3	102.4	102.6	102.8	102.6	102.8	102.8	103.0	103.0
7	100.0	100.8	101.1	101.4	101.8	101.7	101.9	102.0	102.1	102.4	102.2	102.3	102.3	102.4	102.4
8	100.0	101.1	101.4	101.7	102.1	102.0	102.2	102.4	102.6	102.7	102.6	102.7	102.8	103.0	102.8
9	100.0	101.4	101.8	102.2	102.6	102.6	102.9	103.1	103.1	103.3	103.2	103.3	103.4	103.7	103.6
10	100.0	101.4	101.9	102.2	102.6	102.6	102.8	102.9	103.1	103.3	103.2	103.3	103.3	103.6	103.5
11	100.0	99.8	100.2	100.6	100.9	101.0	101.2	101.3	101.5	101.7	101.6	101.7	101.7	102.0	101.9
12	100.0	99.7	100.2	100.5	100.8	100.9	101.0	101.2	101.3	101.5	101.4	101.5	101.5	101.7	101.7
13	100.0	99.8	100.2	100.5	100.8	100.9	101.0	101.2	101.3	101.5	101.5	101.5	101.5	101.7	101.7
14	100.0	99.9	100.3	100.6	101.0	101.1	101.2	101.4	101.5	101.7	101.6	101.7	101.7	101.9	101.9
15	100.0	99.8	100.3	100.6	101.0	101.1	101.2	101.4	101.5	101.7	101.6	101.7	101.7	101.9	101.8
16	100.0	99.8	100.2	100.6	100.9	101.0	101.1	101.3	101.4	101.7	101.5	101.6	101.7	101.9	101.8
17	100.0	99.6	100.0	100.2	100.5	100.5	100.7	100.9	100.9	101.1	100.9	101.1	101.1	101.2	101.2
18	100.0	99.7	100.1	100.4	100.7	100.8	100.9	101.1	101.2	101.4	101.2	101.4	101.4	101.6	101.6
19	100.0	99.7	100.2	100.5	100.8	100.9	101.1	101.3	101.4	101.7	101.6	101.6	101.7	101.9	101.9
20	100.0	99.8	100.3	100.6	100.9	101.1	101.2	101.4	101.5	101.7	101.6	101.7	101.8	102.0	101.9
21	100.0	99.7	100.1	100.4	100.6	100.7	100.8	101.0	101.1	101.2	101.2	101.2	101.3	101.5	101.4
22	100.0	99.8	100.3	100.6	100.9	101.0	101.2	101.3	101.4	101.6	101.6	101.6	101.7	101.9	101.9
23	100.0	99.7	100.1	100.3	100.6	100.7	100.9	101.0	101.1	101.3	101.2	101.3	101.3	101.5	101.4
24	100.0	99.8	100.3	100.6	101.0	101.1	101.3	101.4	101.5	101.7	101.6	101.7	101.8	102.0	101.9
25	100.0	99.9	100.3	100.7	101.0	101.1	101.3	101.3	101.6	101.7	101.6	101.8	101.8	102.0	101.9
n	25	25	25	25	25	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	102.0	102.1	102.1	102.3	102.3
Med.	100.0	99.8	100.3	100.6	101.0	101.1	101.2	101.4	101.5	101.7	101.6	101.7	101.8	102.0	101.9
σ	0.00	0.68	0.68	0.69	0.72	0.68	0.71	0.70	0.71	0.72	0.71	0.71	0.72	0.73	0.72
Min.	100.0	99.6	100.0	100.2	100.5	100.5	100.7	100.9	100.9	101.1	100.9	101.1	101.1	101.2	101.2
Max.	100.0	101.4	101.9	102.2	102.6	102.6	102.9	103.1	103.1	103.3	103.2	103.3	103.4	103.7	103.6

**Data Set 3 : 55 °C, 180 mA**

Actual Case Temperature [T <sub>s</sub> ]	57.5 °C
Actual Ambient Temperature [T <sub>A</sub> ]	56.3 °C
Drive Current [I <sub>F</sub> ]	180 mA
Measurement Current	180 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> were measured during initial setup.

**TABLE 3-4**  
Chromaticity Shift

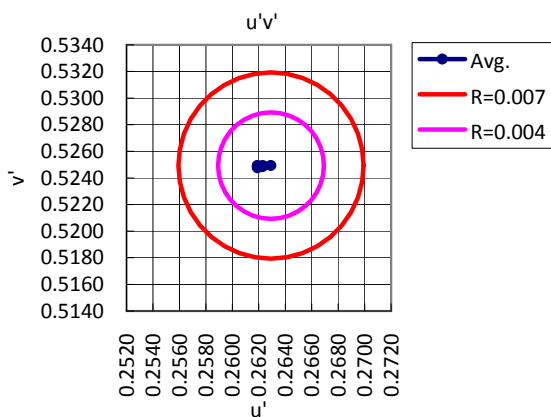
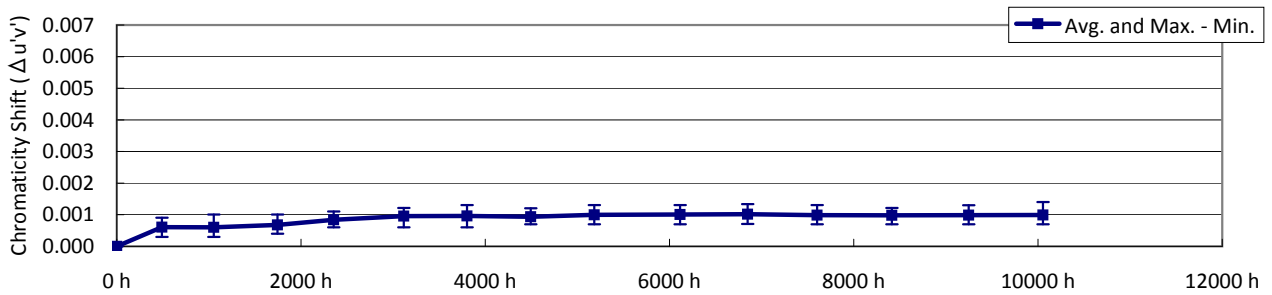
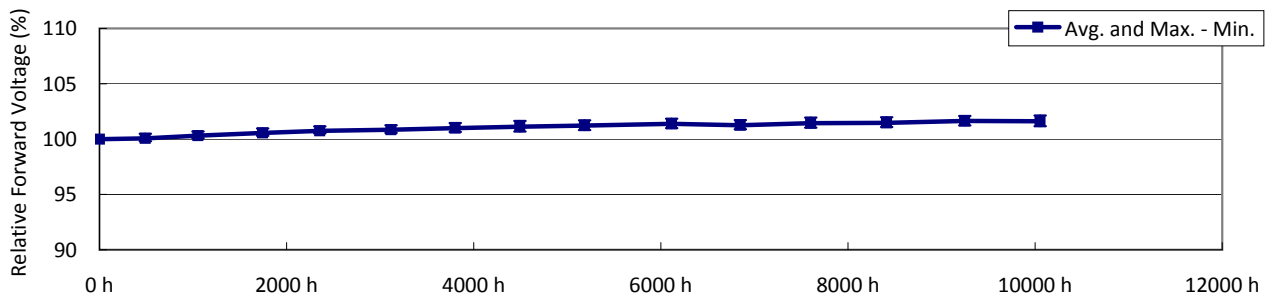
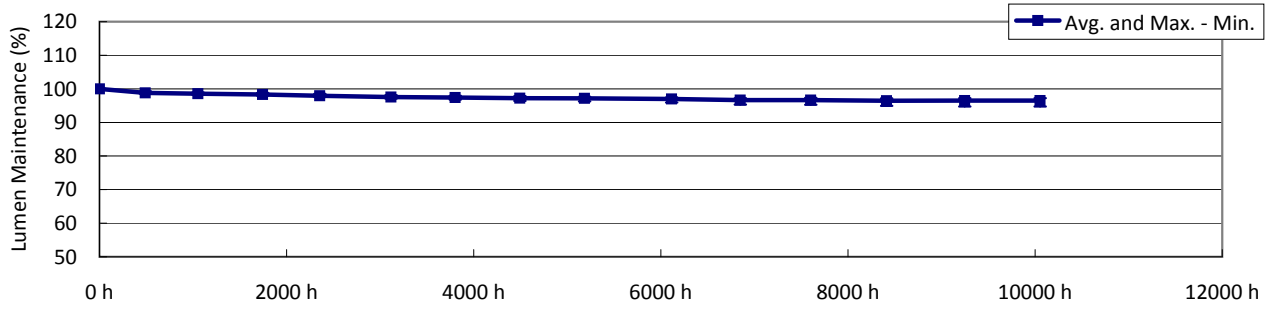
LED No.	Chromaticity Shift Δu'v'														
	0 h	490 h	1053 h	1744 h	2354 h	3116 h	3803 h	4494 h	5185 h	6115 h	6849 h	7600 h	8411 h	9246 h	10045 h
1	0.0000	0.0004	0.0005	0.0005	0.0008	0.0010	0.0010	0.0010	0.0010	0.0011	0.0010	0.0011	0.0010	0.0011	0.0012
2	0.0000	0.0005	0.0006	0.0007	0.0008	0.0008	0.0009	0.0008	0.0010	0.0010	0.0010	0.0011	0.0011	0.0011	0.0012
3	0.0000	0.0004	0.0005	0.0006	0.0008	0.0009	0.0010	0.0010	0.0010	0.0011	0.0011	0.0011	0.0011	0.0011	0.0012
4	0.0000	0.0004	0.0005	0.0005	0.0009	0.0010	0.0009	0.0009	0.0009	0.0010	0.0009	0.0010	0.0009	0.0009	0.0009
5	0.0000	0.0004	0.0006	0.0006	0.0009	0.0010	0.0010	0.0010	0.0010	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012
6	0.0000	0.0007	0.0008	0.0008	0.0010	0.0012	0.0012	0.0011	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0011
7	0.0000	0.0005	0.0006	0.0007	0.0009	0.0011	0.0011	0.0010	0.0011	0.0011	0.0011	0.0011	0.0011	0.0012	0.0011
8	0.0000	0.0005	0.0005	0.0006	0.0009	0.0010	0.0010	0.0010	0.0010	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
9	0.0000	0.0004	0.0004	0.0006	0.0008	0.0009	0.0010	0.0010	0.0010	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
10	0.0000	0.0005	0.0005	0.0006	0.0008	0.0009	0.0010	0.0009	0.0010	0.0010	0.0011	0.0011	0.0011	0.0011	0.0012
11	0.0000	0.0007	0.0007	0.0009	0.0011	0.0013	0.0013	0.0014	0.0013	0.0014	0.0014	0.0014	0.0014	0.0014	0.0015
12	0.0000	0.0007	0.0008	0.0009	0.0011	0.0012	0.0012	0.0012	0.0012	0.0012	0.0013	0.0012	0.0013	0.0013	0.0013
13	0.0000	0.0008	0.0009	0.0010	0.0012	0.0013	0.0013	0.0014	0.0014	0.0015	0.0014	0.0015	0.0014	0.0014	0.0014
14	0.0000	0.0007	0.0008	0.0009	0.0012	0.0013	0.0013	0.0014	0.0014	0.0014	0.0014	0.0014	0.0013	0.0014	0.0013
15	0.0000	0.0008	0.0008	0.0010	0.0013	0.0014	0.0013	0.0014	0.0014	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015
16	0.0000	0.0008	0.0009	0.0010	0.0012	0.0013	0.0013	0.0014	0.0014	0.0015	0.0015	0.0015	0.0015	0.0016	0.0015
17	0.0000	0.0008	0.0009	0.0010	0.0013	0.0014	0.0015	0.0015	0.0015	0.0015	0.0015	0.0016	0.0015	0.0016	0.0015
18	0.0000	0.0008	0.0009	0.0010	0.0012	0.0013	0.0014	0.0014	0.0014	0.0015	0.0015	0.0014	0.0015	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	0.0014	0.0014	0.0014	0.0014	0.0015
20	0.0000	0.0007	0.0008	0.0009	0.0012	0.0013	0.0013	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0015	0.0014
21	0.0000	0.0007	0.0008	0.0009	0.0012	0.0013	0.0014	0.0014	0.0014	0.0015	0.0015	0.0015	0.0016	0.0016	0.0017
22	0.0000	0.0008	0.0008	0.0009	0.0012	0.0013	0.0013	0.0014	0.0014	0.0014	0.0014	0.0014	0.0013	0.0014	0.0013
23	0.0000	0.0007	0.0008	0.0008	0.0012	0.0012	0.0013	0.0013	0.0013	0.0014	0.0013	0.0014	0.0013	0.0014	0.0014
24	0.0000	0.0007	0.0008	0.0010	0.0011	0.0013	0.0013	0.0013	0.0013	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
25	0.0000	0.0008	0.0009	0.0010	0.0012	0.0014	0.0014	0.0014	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015
n	25	25	25	25	25	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	0.0013	0.0013	0.0013	0.0013	0.0013
Med.	0.0000	0.0007	0.0008	0.0009	0.0011	0.0013	0.0013	0.0013	0.0013	0.0014	0.0014	0.0014	0.0013	0.0014	0.0013
σ	0.0000	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Min.	0.0000	0.0004	0.0004	0.0005	0.0008	0.0008	0.0009	0.0008	0.0009	0.0010	0.0009	0.0010	0.0009	0.0009	0.0009
Max.	0.0000	0.0008	0.0009	0.0010	0.0013	0.0014	0.0015	0.0015	0.0015	0.0015	0.0015	0.0016	0.0016	0.0016	0.0017

**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 <sub>s</sub> ]	84.7 °C
Actual Ambient Temperature [T <sub>A</sub> ]	83.6 °C
Drive Current [I <sub>F</sub> ]	65 mA
Measurement Current	65 mA

## NOTES:

 T<sub>s</sub> and T<sub>A</sub> were measured during initial setup.

**TABLE 4-1**  
 Initial Characteristics

LED No.	Luminous flux	Forward voltage	CCT	CIE1931		CIE1976							
	Φ <sub>v</sub> [lm]	V <sub>F</sub> [V]	T <sub>CP</sub> [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 <sub>s</sub> ]	84.7 °C
Actual Ambient Temperature [T <sub>A</sub> ]	83.6 °C
Drive Current [I <sub>F</sub> ]	65 mA
Measurement Current	65 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> 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	6848 h	7602 h	8413 h	9248 h	10053 h
1	100.0	98.8	98.6	98.3	97.9	97.6	97.4	97.4	97.3	97.1	96.8	96.9	96.7	96.6	96.5
2	100.0	98.6	98.4	98.2	97.7	97.5	97.4	97.3	97.3	97.3	97.0	97.1	96.9	97.0	96.8
3	100.0	98.8	98.3	98.1	97.7	97.4	97.3	97.2	97.2	97.2	96.8	96.9	96.7	96.9	96.8
4	100.0	98.5	98.2	98.0	97.7	97.5	97.3	97.2	97.2	97.3	96.7	96.8	96.6	96.8	96.7
5	100.0	98.8	98.4	98.1	97.8	97.6	97.4	97.3	97.1	97.2	96.8	96.8	96.7	97.0	97.1
6	100.0	98.7	98.6	98.3	98.0	97.7	97.6	97.6	97.3	97.2	96.8	96.8	96.7	96.8	97.2
7	100.0	98.6	98.5	98.0	97.6	97.3	97.2	97.1	96.8	96.5	96.2	96.2	96.1	96.1	96.6
8	100.0	99.0	98.9	98.6	98.1	97.7	97.6	97.6	97.2	96.8	96.7	96.7	96.6	96.5	96.7
9	100.0	99.0	98.8	98.6	98.2	97.7	97.7	97.6	97.3	96.9	96.7	96.8	96.6	96.3	96.4
10	100.0	98.8	98.8	98.5	98.2	97.8	97.8	97.8	97.6	97.3	97.2	97.3	97.2	97.0	97.0
11	100.0	98.9	98.6	98.4	97.9	97.6	97.4	97.1	97.2	97.1	96.8	96.8	96.7	96.5	96.4
12	100.0	98.7	98.4	98.2	97.8	97.3	97.3	97.0	97.1	97.0	96.7	96.8	96.6	96.6	96.3
13	100.0	98.6	98.4	98.1	97.7	97.3	97.2	96.9	97.1	97.1	96.7	96.9	96.7	96.8	96.4
14	100.0	98.6	98.4	98.0	97.6	97.2	97.1	96.8	96.9	96.9	96.6	96.8	96.5	96.8	96.4
15	100.0	98.8	98.4	98.0	97.6	97.1	96.8	96.4	96.3	95.9	95.4	95.3	94.9	95.0	94.7
16	100.0	98.9	98.6	98.3	98.0	97.6	97.4	97.2	97.1	96.9	96.6	96.7	96.5	96.7	97.0
17	100.0	99.0	98.7	98.4	98.1	97.7	97.5	97.3	97.1	96.8	96.5	96.4	96.3	96.3	96.8
18	100.0	99.1	98.9	98.8	98.5	98.1	97.9	97.6	97.4	97.0	96.6	96.3	96.1	95.9	96.1
19	100.0	99.3	98.7	98.4	97.9	97.5	97.2	96.8	96.6	96.1	95.3	95.3	95.0	94.8	94.8
20	100.0	99.0	98.9	98.8	98.5	98.1	97.9	97.6	97.5	97.1	96.7	96.4	96.2	95.9	95.9
21	100.0	98.7	98.7	98.4	98.1	97.8	97.6	97.4	97.5	97.4	97.1	97.2	97.0	97.2	96.8
22	100.0	98.8	98.7	98.4	98.0	97.7	97.6	97.3	97.5	97.4	97.2	97.3	97.1	97.2	97.0
23	100.0	98.5	98.3	98.1	97.6	97.3	97.1	96.8	97.1	96.9	96.6	96.4	96.2	96.4	96.2
24	100.0	98.7	98.6	98.3	97.9	97.5	97.3	97.0	97.3	97.0	96.7	96.6	96.3	96.6	96.6
25	100.0	98.9	98.5	98.2	97.8	97.5	97.4	97.2	97.3	97.1	96.9	96.8	96.6	96.8	97.1
n	25	25	25	25	25	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	96.6	96.7	96.5	96.5	96.5
Med.	100.0	98.8	98.6	98.3	97.9	97.6	97.4	97.2	97.2	97.1	96.7	96.8	96.6	96.6	96.6
σ	0.00	0.19	0.20	0.23	0.26	0.25	0.27	0.33	0.30	0.36	0.44	0.50	0.53	0.60	0.62
Min.	100.0	98.5	98.2	98.0	97.6	97.1	96.8	96.4	96.3	95.9	95.3	95.3	94.9	94.8	94.7
Max.	100.0	99.3	98.9	98.8	98.5	98.1	97.9	97.8	97.6	97.4	97.2	97.3	97.2	97.2	97.2

**TM-21 Projection**

Time	4493 h	5184 h	6115 h	6848 h	7602 h	8413 h	9248 h	10053 h							
ln(Avg.)	-0.0281	-0.0287	-0.0307	-0.0341	-0.0340	-0.0361	-0.0356	-0.0357							

Test duration used	4493 h	to	10053 h
B	0.9785		
α	1.5426E-06		
R <sup>2</sup>	0.8718		
Calculated L <sub>70</sub> (10K)	217000	hours	
Reported L <sub>70</sub> (10K)	> 60300	hours	

Curve-fit equation:

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

Lumen maintenance life equation:

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

**Data Set 4 : 85 °C, 65 mA**

Actual Case Temperature [T <sub>s</sub> ]	84.7 °C
Actual Ambient Temperature [T <sub>A</sub> ]	83.6 °C
Drive Current [I <sub>F</sub> ]	65 mA
Measurement Current	65 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> 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	6848 h	7602 h	8413 h	9248 h	10053 h
1	100.0	100.4	100.7	100.9	101.1	101.2	101.4	101.5	101.6	101.8	101.6	101.8	101.9	102.0	102.1
2	100.0	100.3	100.5	100.7	100.8	101.0	101.1	101.3	101.3	101.5	101.3	101.5	101.5	101.7	101.7
3	100.0	100.3	100.6	100.9	101.1	101.2	101.4	101.6	101.7	101.8	101.7	101.9	101.9	102.1	102.1
4	100.0	100.3	100.5	100.7	100.9	101.0	101.1	101.3	101.3	101.5	101.2	101.4	101.4	101.5	101.6
5	100.0	100.3	100.6	100.8	101.0	101.2	101.3	101.5	101.5	101.7	101.6	101.8	101.8	102.0	102.0
6	100.0	100.3	100.5	100.7	100.8	101.0	101.1	101.2	101.2	101.4	101.2	101.4	101.4	101.5	101.5
7	100.0	100.5	100.6	101.0	101.2	101.2	101.5	101.6	101.7	101.8	101.7	101.9	102.0	102.1	102.1
8	100.0	100.4	100.7	100.9	101.1	101.2	101.4	101.5	101.7	101.8	101.7	101.8	101.9	102.1	102.0
9	100.0	100.3	100.6	100.8	101.0	101.2	101.3	101.5	101.6	101.7	101.6	101.8	101.8	102.0	102.0
10	100.0	100.2	100.6	100.7	100.9	101.0	101.1	101.2	101.3	101.4	101.2	101.5	101.5	101.6	101.5
11	100.0	99.8	100.1	100.4	100.6	100.7	100.8	100.9	101.1	101.3	101.1	101.3	101.3	101.5	101.5
12	100.0	99.9	100.2	100.4	100.7	100.8	100.9	101.0	101.1	101.3	101.2	101.4	101.4	101.6	101.5
13	100.0	99.9	100.1	100.4	100.5	100.6	100.8	100.9	101.0	101.2	101.1	101.2	101.2	101.4	101.4
14	100.0	99.9	100.1	100.4	100.6	100.7	100.9	101.0	101.1	101.2	101.1	101.4	101.3	101.6	101.5
15	100.0	99.8	100.1	100.4	100.6	100.7	100.9	100.9	101.0	101.2	101.1	101.4	101.4	101.6	101.5
16	100.0	99.8	100.1	100.3	100.6	100.7	100.8	100.9	101.1	101.3	101.1	101.3	101.4	101.5	101.5
17	100.0	99.8	100.1	100.4	100.6	100.7	100.8	100.9	101.1	101.2	101.1	101.4	101.3	101.6	101.5
18	100.0	99.9	100.1	100.4	100.5	100.6	100.7	100.8	100.8	101.0	100.9	101.1	101.1	101.3	101.2
19	100.0	100.0	100.1	100.4	100.6	100.7	100.9	101.0	101.1	101.3	101.2	101.4	101.4	101.6	101.5
20	100.0	99.9	100.1	100.4	100.6	100.6	100.8	100.8	100.9	101.0	100.9	101.1	101.1	101.3	101.3
21	100.0	99.9	100.1	100.3	100.5	100.6	100.6	100.7	100.8	101.0	100.9	101.0	101.1	101.2	101.2
22	100.0	99.8	100.1	100.4	100.5	100.6	100.8	100.9	101.0	101.2	101.1	101.3	101.3	101.5	101.4
23	100.0	99.8	100.2	100.5	100.6	100.7	100.8	101.0	101.1	101.3	101.1	101.4	101.4	101.6	101.5
24	100.0	99.9	100.2	100.4	100.6	100.7	100.8	101.0	101.1	101.3	101.2	101.4	101.4	101.6	101.5
25	100.0	99.8	100.1	100.4	100.6	100.7	100.8	100.9	101.1	101.2	101.1	101.3	101.4	101.5	101.5
n	25	25	25	25	25	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	101.2	101.4	101.5	101.6	101.6
Med.	100.0	99.9	100.2	100.4	100.6	100.7	100.9	101.0	101.1	101.3	101.2	101.4	101.4	101.6	101.5
σ	0.00	0.24	0.24	0.23	0.22	0.24	0.26	0.29	0.27	0.27	0.25	0.26	0.27	0.25	0.28
Min.	100.0	99.8	100.1	100.3	100.5	100.6	100.6	100.7	100.8	101.0	100.9	101.0	101.1	101.2	101.2
Max.	100.0	100.5	100.7	101.0	101.2	101.2	101.5	101.6	101.7	101.8	101.7	101.9	102.0	102.1	102.1

**Data Set 4 : 85 °C, 65 mA**

Actual Case Temperature [T <sub>s</sub> ]	84.7 °C
Actual Ambient Temperature [T <sub>A</sub> ]	83.6 °C
Drive Current [I <sub>F</sub> ]	65 mA
Measurement Current	65 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> were measured during initial setup.

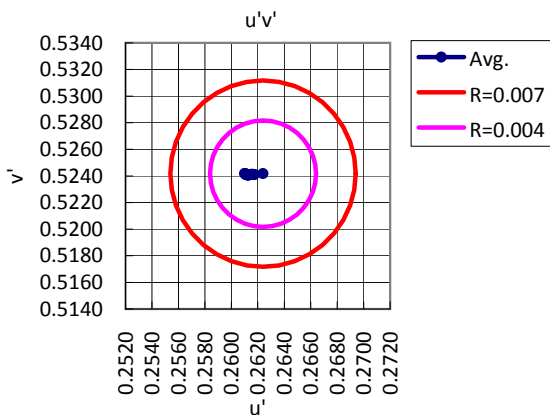
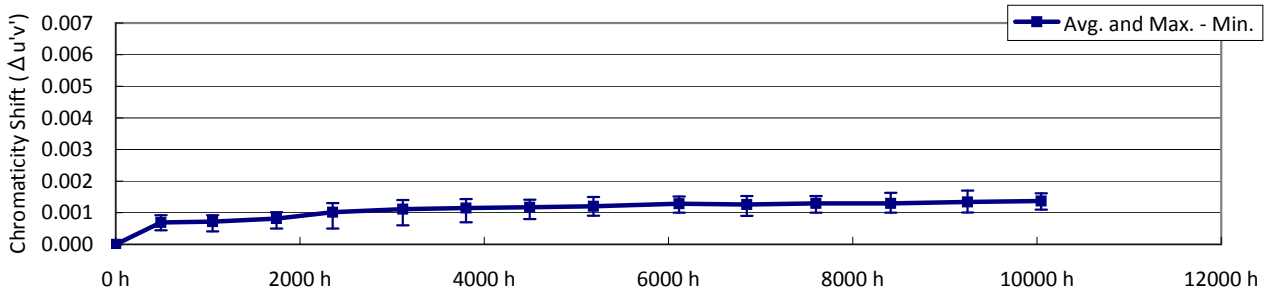
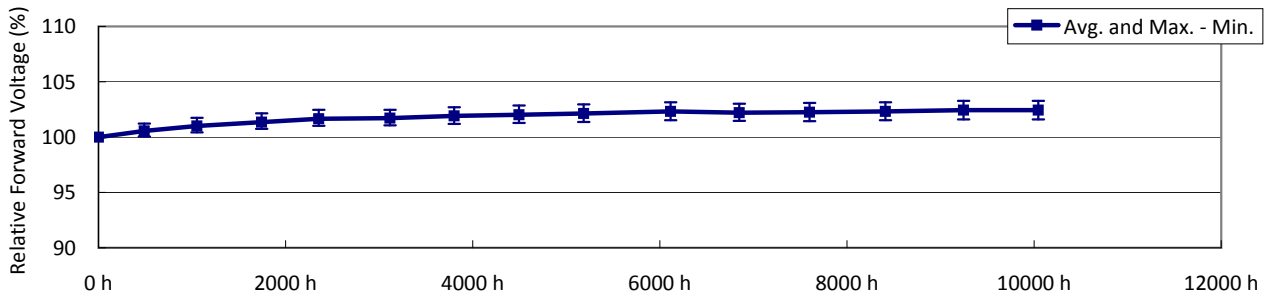
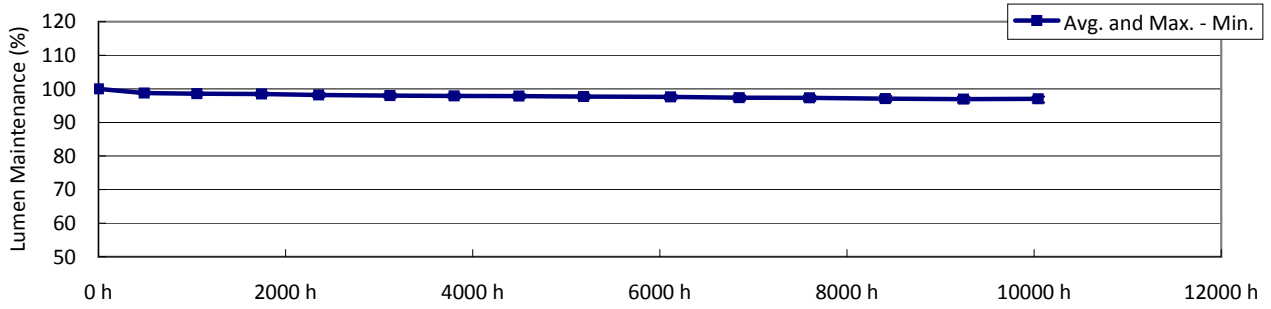
**TABLE 4-4**  
Chromaticity Shift

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	6848 h	7602 h	8413 h	9248 h	10053 h
1	0.0000	0.0003	0.0003	0.0004	0.0006	0.0007	0.0007	0.0007	0.0007	0.0007	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	0.0007	0.0007	0.0007	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	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	0.0007	0.0008	0.0008	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	0.0008	0.0008	0.0008	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	0.0008	0.0008	0.0009	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	0.0011	0.0010	0.0010	0.0010	0.0009
8	0.0000	0.0005	0.0005	0.0006	0.0008	0.0009	0.0008	0.0008	0.0009	0.0009	0.0009	0.0010	0.0009	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	0.0008	0.0008	0.0008	0.0007	0.0008
10	0.0000	0.0004	0.0003	0.0004	0.0006	0.0006	0.0006	0.0007	0.0007	0.0007	0.0007	0.0007	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	0.0011	0.0011	0.0011	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	0.0010	0.0010	0.0010	0.0010	0.0011
13	0.0000	0.0006	0.0007	0.0007	0.0008	0.0011	0.0010	0.0009	0.0010	0.0010	0.0011	0.0011	0.0010	0.0009	0.0010
14	0.0000	0.0008	0.0007	0.0008	0.0009	0.0011	0.0010	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0012
15	0.0000	0.0008	0.0008	0.0009	0.0010	0.0011	0.0011	0.0011	0.0012	0.0012	0.0012	0.0012	0.0012	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	0.0013	0.0013	0.0012	0.0013	0.0012
17	0.0000	0.0008	0.0008	0.0009	0.0011	0.0012	0.0012	0.0011	0.0012	0.0013	0.0013	0.0012	0.0012	0.0012	0.0011
18	0.0000	0.0007	0.0007	0.0009	0.0009	0.0011	0.0011	0.0010	0.0011	0.0010	0.0011	0.0010	0.0010	0.0010	0.0010
19	0.0000	0.0007	0.0006	0.0007	0.0009	0.0010	0.0010	0.0010	0.0011	0.0011	0.0011	0.0010	0.0010	0.0011	0.0010
20	0.0000	0.0008	0.0008	0.0008	0.0010	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0010	0.0011	0.0010	0.0010
21	0.0000	0.0007	0.0008	0.0007	0.0009	0.0010	0.0010	0.0009	0.0010	0.0011	0.0011	0.0010	0.0010	0.0011	0.0011
22	0.0000	0.0007	0.0007	0.0008	0.0009	0.0010	0.0011	0.0010	0.0011	0.0011	0.0011	0.0011	0.0011	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	0.0012	0.0011	0.0011	0.0011	0.0011
24	0.0000	0.0007	0.0007	0.0008	0.0010	0.0011	0.0012	0.0011	0.0012	0.0013	0.0012	0.0012	0.0012	0.0013	0.0014
25	0.0000	0.0007	0.0006	0.0007	0.0009	0.0010	0.0011	0.0011	0.0011	0.0012	0.0011	0.0011	0.0011	0.0012	0.0012
n	25	25	25	25	25	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	0.0010	0.0010	0.0010	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	0.0011	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	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	0.0007	0.0007	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	0.0013	0.0013	0.0012	0.0013	0.0014

**Data Set 5 : 85 °C, 150 mA**

Actual Case Temperature [T <sub>S</sub> ]	86.2 °C
Actual Ambient Temperature [T <sub>A</sub> ]	84.3 °C
Drive Current [I <sub>F</sub> ]	150 mA
Measurement Current	150 mA

NOTES:  
T<sub>S</sub> and T<sub>A</sub> were measured during initial setup.





**Data Set 5 : 85 °C, 150 mA**

Actual Case Temperature [T <sub>S</sub> ]	86.2 °C
Actual Ambient Temperature [T <sub>A</sub> ]	84.3 °C
Drive Current [I <sub>F</sub> ]	150 mA
Measurement Current	150 mA

## NOTES:

 T<sub>S</sub> and T<sub>A</sub> were measured during initial setup.

**TABLE 5-1**  
 Initial Characteristics

LED No.	Luminous flux	Forward voltage	CCT	CIE1931		CIE1976							
	Φ <sub>V</sub> [lm]	V <sub>F</sub> [V]	T <sub>CP</sub> [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 <sub>s</sub> ]	86.2 °C
Actual Ambient Temperature [T <sub>A</sub> ]	84.3 °C
Drive Current [I <sub>F</sub> ]	150 mA
Measurement Current	150 mA

**NOTES:**

 T<sub>s</sub> and T<sub>A</sub> 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	6849 h	7600 h	8411 h	9246 h	10045 h
1	100.0	98.8	98.6	98.5	98.3	98.0	97.9	97.9	97.9	97.7	97.4	97.5	97.2	97.0	96.9
2	100.0	98.7	98.4	98.3	98.0	97.8	97.9	98.0	98.1	98.1	98.0	98.0	97.8	97.7	97.6
3	100.0	98.4	98.1	98.1	97.8	97.6	97.6	97.6	97.5	97.6	97.5	97.4	97.3	97.0	97.0
4	100.0	98.6	98.4	98.5	98.0	97.9	97.9	98.0	97.9	97.9	97.8	97.7	97.6	97.3	97.5
5	100.0	98.7	98.6	98.6	98.2	98.0	98.1	98.1	97.9	97.9	97.7	97.6	97.5	97.2	97.6
6	100.0	98.5	98.2	98.1	97.8	97.6	97.6	97.5	97.3	97.1	96.9	96.8	96.6	96.5	97.0
7	100.0	98.6	98.4	98.3	98.0	97.7	97.6	97.5	97.2	96.9	96.7	96.5	96.3	96.1	96.3
8	100.0	99.1	98.9	98.8	98.7	98.4	98.3	98.2	98.1	97.9	97.6	97.6	97.4	97.5	97.7
9	100.0	99.0	98.8	98.6	98.5	98.2	97.9	97.8	97.6	97.3	97.0	97.1	96.7	96.6	96.4
10	100.0	99.1	98.9	98.8	98.7	98.4	98.2	98.0	98.0	97.7	97.5	97.6	97.1	97.0	96.6
11	100.0	98.8	98.1	97.9	97.6	97.3	97.2	97.2	97.1	97.0	96.8	96.7	96.4	96.1	95.9
12	100.0	98.7	98.6	98.6	98.2	98.1	98.0	98.0	98.1	97.9	97.8	97.8	97.6	97.4	97.4
13	100.0	98.6	98.4	98.3	98.0	97.8	97.7	97.6	97.8	97.7	97.5	97.5	97.3	96.9	97.1
14	100.0	98.5	98.4	98.2	97.9	97.6	97.4	97.3	97.5	97.3	97.0	96.8	96.7	96.1	96.2
15	100.0	98.6	98.4	98.3	98.0	97.8	97.7	97.7	97.7	97.5	97.3	97.2	97.1	96.8	97.2
16	100.0	98.6	98.3	98.1	97.9	97.6	97.4	97.3	97.1	96.8	96.5	96.3	96.2	95.9	96.6
17	100.0	98.6	98.4	98.3	98.0	97.8	97.7	97.7	97.4	97.2	97.0	96.9	96.7	96.7	97.2
18	100.0	99.2	99.0	99.0	98.7	98.6	98.5	98.4	98.0	97.8	97.7	97.7	97.4	97.5	97.7
19	100.0	99.2	99.0	98.9	98.6	98.3	98.3	98.2	97.8	97.7	97.5	97.5	97.1	97.3	97.2
20	100.0	98.9	98.9	98.9	98.6	98.3	98.2	98.1	97.8	97.7	97.4	97.4	97.0	96.9	96.7
21	100.0	99.0	98.9	98.6	98.6	98.4	98.4	98.3	98.3	98.2	98.1	98.0	97.9	97.6	97.6
22	100.0	98.8	98.7	98.6	98.3	98.2	98.0	97.9	97.6	97.7	97.5	97.4	97.0	96.8	96.7
23	100.0	98.5	98.4	98.3	98.0	97.9	97.8	97.8	97.7	97.8	97.5	97.4	97.2	97.2	97.1
24	100.0	98.8	98.6	98.5	98.2	98.0	98.0	98.0	97.8	97.9	97.6	97.5	97.3	97.3	97.3
25	100.0	98.9	98.6	98.5	98.2	97.9	97.8	97.7	97.5	97.5	97.2	97.1	96.8	96.7	96.8
n	25	25	25	25	25	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	97.4	97.3	97.1	96.9	97.0
Med.	100.0	98.7	98.6	98.5	98.2	97.9	97.9	97.9	97.8	97.7	97.5	97.4	97.1	97.0	97.1
σ	0.00	0.23	0.27	0.29	0.32	0.31	0.32	0.31	0.33	0.38	0.41	0.43	0.45	0.50	0.49
Min.	100.0	98.4	98.1	97.9	97.6	97.3	97.2	97.2	97.1	96.8	96.5	96.3	96.2	95.9	95.9
Max.	100.0	99.2	99.0	99.0	98.7	98.6	98.5	98.4	98.3	98.2	98.1	98.0	97.9	97.7	97.7

**TM-21 Projection**

Time	4494 h	5185 h	6115 h	6849 h	7600 h	8411 h	9246 h	10045 h							
ln(Avg.)	-0.0219	-0.0232	-0.0243	-0.0266	-0.0273	-0.0296	-0.0312	-0.0303							

Test duration used	4494 h	to	10045 h
B	0.9858		
α	1.7227E-06		
R <sup>2</sup>	0.9517		
Calculated L <sub>70</sub> (10K)	199000	hours	
Reported L <sub>70</sub> (10K)	> 60300	hours	

Curve-fit equation:

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

Lumen maintenance life equation:

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

**Data Set 5 : 85 °C, 150 mA**

Actual Case Temperature [T <sub>s</sub> ]	86.2 °C
Actual Ambient Temperature [T <sub>A</sub> ]	84.3 °C
Drive Current [I <sub>F</sub> ]	150 mA
Measurement Current	150 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> 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	6849 h	7600 h	8411 h	9246 h	10045 h
1	100.0	101.1	101.6	102.0	102.3	102.4	102.6	102.7	102.9	103.0	102.9	103.0	103.0	103.2	103.1
2	100.0	101.0	101.5	101.8	102.1	102.1	102.3	102.4	102.6	102.7	102.6	102.7	102.7	102.8	102.8
3	100.0	101.2	101.6	102.0	102.4	102.5	102.6	102.8	102.9	103.1	103.0	103.0	103.1	103.3	103.3
4	100.0	101.0	101.5	101.8	102.1	102.1	102.3	102.4	102.5	102.7	102.5	102.6	102.7	102.8	102.8
5	100.0	100.8	101.3	101.5	101.8	101.8	102.0	102.1	102.2	102.4	102.3	102.3	102.4	102.5	102.5
6	100.0	101.1	101.6	102.0	102.3	102.3	102.6	102.7	102.9	103.0	102.9	103.0	103.1	103.2	103.2
7	100.0	101.0	101.4	101.7	102.0	102.0	102.2	102.3	102.4	102.6	102.5	102.6	102.6	102.7	102.7
8	100.0	101.2	101.6	102.0	102.4	102.3	102.6	102.7	102.8	103.0	102.9	102.9	103.0	103.2	103.2
9	100.0	101.2	101.7	102.1	102.5	102.5	102.7	102.9	103.0	103.1	103.0	103.1	103.1	103.3	103.3
10	100.0	101.1	101.6	102.0	102.3	102.3	102.5	102.7	102.8	103.0	102.9	102.9	103.0	103.1	103.1
11	100.0	100.2	100.7	101.1	101.4	101.5	101.7	101.7	101.8	102.1	102.0	101.9	102.1	102.2	102.2
12	100.0	100.2	100.6	100.9	101.2	101.2	101.5	101.5	101.6	101.8	101.7	101.7	101.8	101.9	101.9
13	100.0	100.2	100.7	101.1	101.4	101.4	101.6	101.7	101.8	102.1	101.9	102.0	102.1	102.2	102.2
14	100.0	100.2	100.7	101.0	101.4	101.5	101.7	101.8	101.9	102.1	102.0	102.0	102.0	102.2	102.2
15	100.0	100.2	100.7	101.1	101.4	101.5	101.6	101.8	101.9	102.1	102.0	102.0	102.1	102.2	102.2
16	100.0	100.2	100.6	101.0	101.3	101.4	101.5	101.7	101.8	102.0	102.0	102.0	102.0	102.1	102.2
17	100.0	100.2	100.6	100.9	101.2	101.3	101.4	101.4	101.6	101.9	101.7	101.7	101.8	101.9	102.0
18	100.0	100.2	100.7	101.0	101.3	101.4	101.6	101.8	101.9	102.1	101.9	102.0	102.0	102.1	102.1
19	100.0	100.1	100.5	100.9	101.1	101.2	101.3	101.5	101.5	101.7	101.6	101.6	101.7	101.8	101.9
20	100.0	100.1	100.4	100.7	101.0	101.1	101.2	101.3	101.4	101.5	101.5	101.4	101.5	101.6	101.6
21	100.0	100.2	100.6	101.0	101.3	101.4	101.6	101.7	101.8	102.0	101.9	101.9	102.0	102.2	102.2
22	100.0	100.3	100.7	101.0	101.3	101.4	101.6	101.7	101.8	101.9	101.9	101.9	102.0	102.1	102.1
23	100.0	100.2	100.6	100.9	101.2	101.3	101.5	101.6	101.7	101.9	101.7	101.8	101.9	102.0	102.0
24	100.0	100.3	100.8	101.1	101.4	101.5	101.7	101.8	101.9	102.1	102.0	102.0	102.1	102.2	102.3
25	100.0	100.3	100.8	101.2	101.4	101.5	101.8	101.8	101.9	102.1	102.0	102.0	102.1	102.2	102.2
n	25	25	25	25	25	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	102.2	102.3	102.3	102.4	102.4
Med.	100.0	100.3	100.7	101.1	101.4	101.5	101.7	101.8	101.9	102.1	102.0	102.0	102.1	102.2	102.2
σ	0.00	0.45	0.46	0.47	0.50	0.46	0.47	0.50	0.51	0.51	0.49	0.51	0.51	0.52	0.51
Min.	100.0	100.1	100.4	100.7	101.0	101.1	101.2	101.3	101.4	101.5	101.5	101.4	101.5	101.6	101.6
Max.	100.0	101.2	101.7	102.1	102.5	102.5	102.7	102.9	103.0	103.1	103.0	103.1	103.1	103.3	103.3

**Data Set 5 : 85 °C, 150 mA**

Actual Case Temperature [T <sub>s</sub> ]	86.2 °C
Actual Ambient Temperature [T <sub>A</sub> ]	84.3 °C
Drive Current [I <sub>F</sub> ]	150 mA
Measurement Current	150 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> were measured during initial setup.

**TABLE 5-4**  
Chromaticity Shift

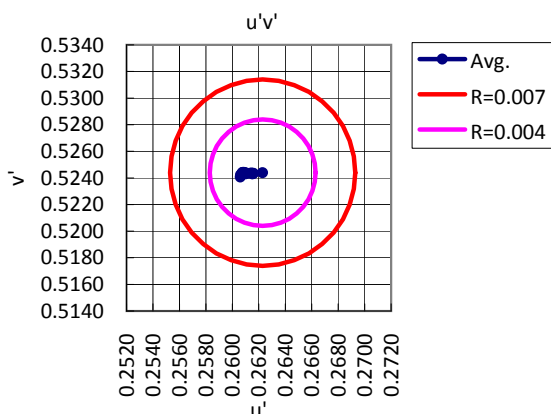
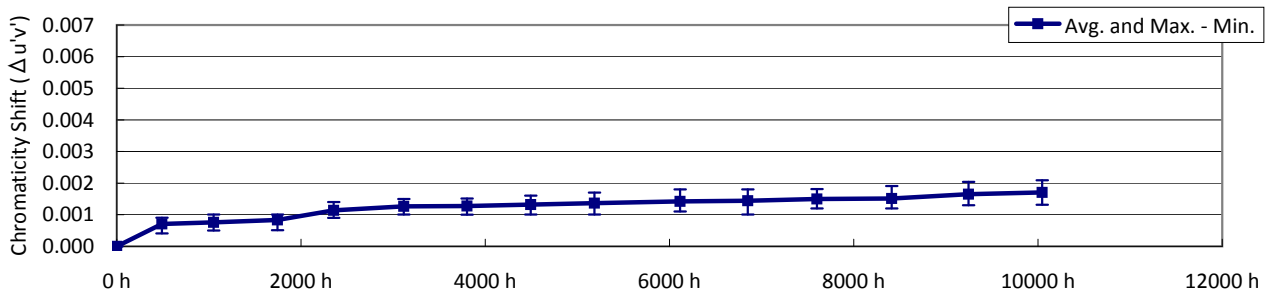
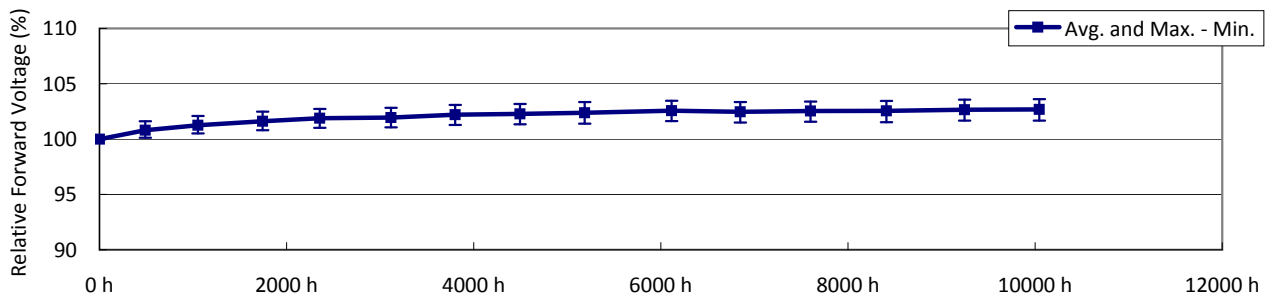
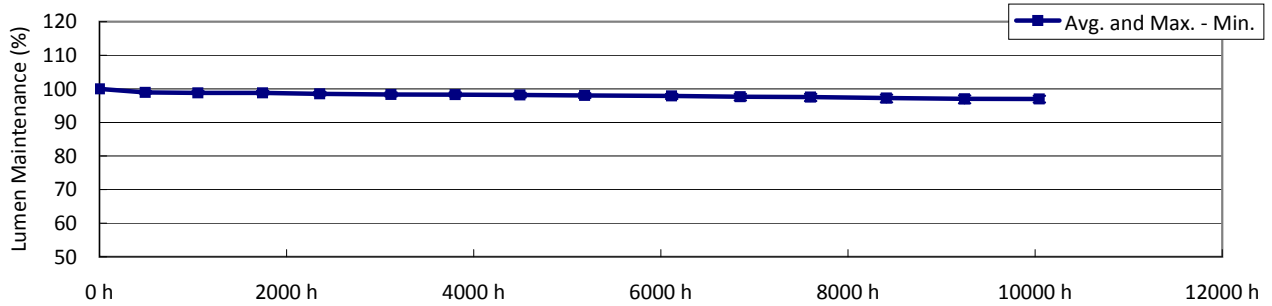
LED No.	Chromaticity Shift Δu'v'														
	0 h	490 h	1052 h	1744 h	2354 h	3116 h	3802 h	4494 h	5185 h	6115 h	6849 h	7600 h	8411 h	9246 h	10045 h
1	0.0000	0.0004	0.0005	0.0006	0.0008	0.0009	0.0010	0.0009	0.0010	0.0011	0.0011	0.0011	0.0010	0.0012	0.0012
2	0.0000	0.0005	0.0004	0.0005	0.0005	0.0006	0.0007	0.0008	0.0009	0.0010	0.0009	0.0010	0.0010	0.0011	0.0011
3	0.0000	0.0005	0.0005	0.0006	0.0008	0.0009	0.0009	0.0009	0.0010	0.0010	0.0010	0.0010	0.0010	0.0011	0.0012
4	0.0000	0.0005	0.0005	0.0006	0.0007	0.0008	0.0009	0.0009	0.0009	0.0011	0.0009	0.0010	0.0010	0.0010	0.0011
5	0.0000	0.0005	0.0006	0.0006	0.0008	0.0009	0.0009	0.0009	0.0010	0.0011	0.0010	0.0011	0.0011	0.0011	0.0011
6	0.0000	0.0007	0.0007	0.0008	0.0010	0.0011	0.0012	0.0012	0.0013	0.0013	0.0014	0.0014	0.0013	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	0.0012	0.0011	0.0012	0.0012	0.0011
8	0.0000	0.0005	0.0006	0.0007	0.0009	0.0010	0.0010	0.0010	0.0010	0.0011	0.0011	0.0011	0.0011	0.0011	0.0012
9	0.0000	0.0006	0.0006	0.0007	0.0009	0.0010	0.0010	0.0010	0.0010	0.0011	0.0011	0.0011	0.0012	0.0011	0.0012
10	0.0000	0.0005	0.0006	0.0007	0.0009	0.0009	0.0010	0.0010	0.0011	0.0011	0.0011	0.0011	0.0011	0.0012	0.0012
11	0.0000	0.0007	0.0005	0.0006	0.0009	0.0009	0.0010	0.0010	0.0011	0.0011	0.0011	0.0012	0.0011	0.0011	0.0012
12	0.0000	0.0008	0.0008	0.0009	0.0011	0.0013	0.0013	0.0013	0.0013	0.0014	0.0013	0.0014	0.0014	0.0014	0.0015
13	0.0000	0.0008	0.0008	0.0010	0.0011	0.0012	0.0012	0.0012	0.0013	0.0014	0.0013	0.0014	0.0014	0.0014	0.0015
14	0.0000	0.0008	0.0008	0.0009	0.0011	0.0013	0.0013	0.0014	0.0014	0.0014	0.0015	0.0015	0.0015	0.0015	0.0016
15	0.0000	0.0008	0.0008	0.0009	0.0011	0.0012	0.0013	0.0013	0.0013	0.0014	0.0014	0.0014	0.0014	0.0015	0.0015
16	0.0000	0.0009	0.0009	0.0010	0.0012	0.0013	0.0014	0.0014	0.0014	0.0015	0.0015	0.0015	0.0016	0.0016	0.0016
17	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0014	0.0014	0.0015	0.0015	0.0015	0.0015	0.0015	0.0017	0.0016
18	0.0000	0.0008	0.0008	0.0009	0.0011	0.0012	0.0012	0.0013	0.0012	0.0013	0.0013	0.0013	0.0014	0.0014	0.0013
19	0.0000	0.0007	0.0008	0.0009	0.0011	0.0012	0.0012	0.0013	0.0013	0.0014	0.0013	0.0013	0.0013	0.0014	0.0014
20	0.0000	0.0008	0.0008	0.0009	0.0012	0.0011	0.0012	0.0013	0.0013	0.0014	0.0014	0.0014	0.0014	0.0015	0.0016
21	0.0000	0.0007	0.0008	0.0010	0.0012	0.0013	0.0013	0.0013	0.0013	0.0014	0.0014	0.0015	0.0014	0.0015	0.0016
22	0.0000	0.0008	0.0008	0.0009	0.0011	0.0013	0.0013	0.0013	0.0013	0.0015	0.0014	0.0015	0.0015	0.0016	0.0016
23	0.0000	0.0008	0.0008	0.0009	0.0011	0.0012	0.0012	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0014	0.0014
24	0.0000	0.0007	0.0008	0.0009	0.0011	0.0012	0.0012	0.0013	0.0013	0.0014	0.0014	0.0015	0.0015	0.0014	0.0015
25	0.0000	0.0009	0.0009	0.0009	0.0012	0.0013	0.0013	0.0014	0.0014	0.0015	0.0015	0.0015	0.0015	0.0016	0.0016
n	25	25	25	25	25	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	0.0013	0.0013	0.0013	0.0013	0.0014
Med.	0.0000	0.0007	0.0008	0.0009	0.0011	0.0012	0.0012	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0014	0.0014
σ	0.0000	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Min.	0.0000	0.0004	0.0004	0.0005	0.0005	0.0006	0.0007	0.0008	0.0009	0.0010	0.0009	0.0010	0.0010	0.0010	0.0011
Max.	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0014	0.0014	0.0015	0.0015	0.0015	0.0015	0.0016	0.0017	0.0016

**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 <sub>s</sub> ]	88.1 °C
Actual Ambient Temperature [T <sub>A</sub> ]	86.3 °C
Drive Current [I <sub>F</sub> ]	180 mA
Measurement Current	180 mA

## NOTES:

 T<sub>s</sub> and T<sub>A</sub> were measured during initial setup.

**TABLE 6-1**  
 Initial Characteristics

LED No.	Luminous flux	Forward voltage	CCT	CIE1931		CIE1976							
	Φ <sub>v</sub> [lm]	V <sub>F</sub> [V]	T <sub>CP</sub> [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 <sub>s</sub> ]	88.1 °C
Actual Ambient Temperature [T <sub>A</sub> ]	86.3 °C
Drive Current [I <sub>F</sub> ]	180 mA
Measurement Current	180 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> 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	6849 h	7600 h	8411 h	9246 h	10045 h
1	100.0	98.9	98.9	99.0	98.6	98.5	98.5	98.4	98.3	98.2	98.1	98.0	97.8	97.5	97.2
2	100.0	98.8	98.7	98.7	98.5	98.4	98.3	98.3	98.4	98.4	98.1	98.0	97.7	97.5	97.3
3	100.0	98.8	98.5	98.6	98.4	98.4	98.2	98.1	98.2	98.2	97.8	98.0	97.6	97.5	97.5
4	100.0	98.9	98.5	98.5	98.3	98.2	98.0	98.0	98.0	98.0	97.6	97.4	97.1	97.0	97.1
5	100.0	99.1	98.9	99.0	98.9	98.7	98.6	98.5	98.5	98.4	98.1	98.0	97.7	97.7	97.9
6	100.0	98.8	98.6	98.6	98.4	98.3	98.2	98.2	98.0	97.8	97.6	97.4	97.2	96.9	97.2
7	100.0	98.8	98.7	98.6	98.4	98.1	98.2	98.1	97.7	97.5	97.4	97.3	97.2	97.0	97.4
8	100.0	99.0	98.9	98.9	98.6	98.3	98.4	98.2	97.8	97.4	97.2	97.0	96.8	96.5	96.2
9	100.0	99.1	99.1	99.1	98.8	98.4	98.6	98.4	98.1	97.7	97.6	97.5	97.3	96.9	96.6
10	100.0	99.2	99.2	99.2	98.9	98.6	98.7	98.5	98.3	98.1	98.0	98.0	97.8	97.4	97.2
11	100.0	99.0	99.0	99.0	98.8	98.5	98.6	98.5	98.4	98.3	98.1	98.1	97.9	97.6	97.4
12	100.0	99.0	98.9	99.0	98.6	98.4	98.4	98.3	98.3	98.2	98.0	97.9	97.7	97.5	97.4
13	100.0	98.9	98.7	98.7	98.4	98.1	98.2	98.0	98.0	97.9	97.6	97.5	97.2	97.0	97.0
14	100.0	98.8	98.4	98.4	98.0	97.7	97.7	97.4	97.3	97.2	97.0	96.8	96.4	96.1	96.2
15	100.0	98.7	98.5	98.4	98.1	97.9	97.9	97.8	97.7	97.5	97.3	97.1	96.4	96.6	96.8
16	100.0	98.7	98.5	98.4	98.1	97.8	97.8	97.7	97.3	97.0	96.6	96.4	96.0	95.7	95.9
17	100.0	98.8	98.6	98.6	98.4	98.1	98.1	98.1	97.8	97.4	97.2	97.0	96.8	96.6	97.0
18	100.0	99.1	99.0	98.9	98.5	98.3	98.3	98.2	97.9	97.7	97.5	97.3	97.1	96.9	96.9
19	100.0	99.3	99.2	99.2	98.9	98.6	98.6	98.5	98.2	97.9	97.7	97.6	97.2	96.9	96.8
20	100.0	99.3	99.3	99.4	99.1	98.9	98.9	98.9	98.7	98.5	98.5	98.5	98.3	98.0	97.9
21	100.0	99.2	99.2	99.1	98.8	98.7	98.7	98.6	98.5	98.4	98.3	98.3	98.0	97.7	97.5
22	100.0	98.8	98.8	98.9	98.5	98.2	98.2	98.0	98.1	97.9	97.7	97.6	97.2	96.8	96.5
23	100.0	98.6	98.5	98.7	98.2	98.0	98.0	97.8	97.9	97.9	97.6	97.5	97.2	96.9	96.7
24	100.0	98.8	98.6	98.7	98.2	98.0	98.0	97.8	97.7	97.6	97.4	97.2	96.7	96.3	96.3
25	100.0	98.9	98.8	98.9	98.5	98.4	98.3	98.2	98.2	98.0	97.8	97.7	97.5	97.3	97.5
n	25	25	25	25	25	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	97.7	97.6	97.3	97.0	97.0
Med.	100.0	98.9	98.8	98.9	98.5	98.3	98.3	98.2	98.1	97.9	97.6	97.5	97.2	97.0	97.1
σ	0.00	0.19	0.26	0.27	0.28	0.29	0.30	0.33	0.37	0.41	0.44	0.50	0.55	0.55	0.53
Min.	100.0	98.6	98.4	98.4	98.0	97.7	97.7	97.4	97.3	97.0	96.6	96.4	96.0	95.7	95.9
Max.	100.0	99.3	99.3	99.4	99.1	98.9	98.9	98.9	98.7	98.5	98.5	98.5	98.3	98.0	97.9

**TM-21 Projection**

Time	4494 h	5185 h	6115 h	6849 h	7600 h	8411 h	9246 h	10045 h							
ln(Avg.)	-0.0183	-0.0197	-0.0213	-0.0236	-0.0246	-0.0278	-0.0302	-0.0304							

Test duration used	4494 h	to	10045 h
B	0.9926		
α	2.3567E-06		
R <sup>2</sup>	0.9821		
Calculated L <sub>70</sub> (10K)	148000	hours	
Reported L <sub>70</sub> (10K)	> 60300	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 <sub>s</sub> ]	88.1 °C
Actual Ambient Temperature [T <sub>A</sub> ]	86.3 °C
Drive Current [I <sub>F</sub> ]	180 mA
Measurement Current	180 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> 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	6849 h	7600 h	8411 h	9246 h	10045 h
1	100.0	101.6	102.1	102.4	102.7	102.8	103.0	103.2	103.3	103.4	103.3	103.4	103.4	103.5	103.5
2	100.0	101.6	102.1	102.5	102.7	102.8	103.1	103.1	103.2	103.5	103.3	103.4	103.4	103.6	103.6
3	100.0	101.4	101.9	102.2	102.4	102.6	102.8	102.8	103.0	103.1	103.0	103.1	103.1	103.2	103.2
4	100.0	101.6	102.1	102.5	102.7	102.8	103.0	103.1	103.3	103.4	103.3	103.3	103.4	103.5	103.6
5	100.0	101.2	101.6	101.9	102.2	102.2	102.4	102.5	102.6	102.8	102.7	102.8	102.8	102.9	102.9
6	100.0	101.2	101.6	101.9	102.1	102.3	102.4	102.4	102.5	102.7	102.6	102.7	102.7	102.8	102.7
7	100.0	101.5	101.9	102.4	102.6	102.7	103.0	103.1	103.3	103.4	103.3	103.3	103.3	103.5	103.5
8	100.0	101.4	101.8	102.1	102.3	102.4	102.7	102.7	102.8	103.0	102.8	102.9	103.0	103.0	103.0
9	100.0	101.5	102.0	102.4	102.7	102.8	103.0	103.1	103.2	103.5	103.3	103.3	103.4	103.5	103.5
10	100.0	101.5	102.1	102.4	102.7	102.8	103.0	103.1	103.2	103.4	103.3	103.4	103.4	103.5	103.5
11	100.0	100.3	100.7	101.0	101.3	101.4	101.6	101.7	101.7	102.0	101.8	101.9	101.9	102.0	102.1
12	100.0	100.4	100.8	101.2	101.5	101.5	101.8	102.0	102.0	102.2	102.1	102.2	102.2	102.3	102.3
13	100.0	100.3	100.7	101.1	101.3	101.4	101.7	101.7	101.8	102.0	101.9	102.0	102.0	102.1	102.1
14	100.0	100.5	101.0	101.3	101.7	101.7	102.0	102.1	102.2	102.4	102.3	102.4	102.3	102.5	102.5
15	100.0	100.5	101.0	101.3	101.6	101.6	101.9	102.0	102.1	102.3	102.2	102.3	102.2	102.4	102.4
16	100.0	100.1	100.5	100.8	101.0	101.1	101.3	101.3	101.4	101.6	101.5	101.6	101.5	101.7	101.7
17	100.0	100.4	100.9	101.3	101.6	101.7	102.0	102.0	102.2	102.2	102.2	102.4	102.4	102.5	102.5
18	100.0	100.4	100.9	101.2	101.5	101.5	101.8	101.8	101.9	102.1	102.0	102.1	102.1	102.2	102.3
19	100.0	100.3	100.6	100.9	101.1	101.2	101.4	101.4	101.6	101.7	101.6	101.6	101.7	101.8	101.8
20	100.0	100.3	100.8	101.2	101.5	101.6	101.8	101.9	102.0	102.2	102.1	102.2	102.2	102.3	102.3
21	100.0	100.4	100.9	101.2	101.5	101.6	101.8	101.9	102.0	102.2	102.1	102.2	102.2	102.3	102.3
22	100.0	100.3	100.8	101.2	101.4	101.5	101.7	101.8	101.8	102.1	102.0	102.1	102.1	102.2	102.2
23	100.0	100.4	100.9	101.3	101.5	101.6	101.9	102.0	102.1	102.3	102.2	102.3	102.3	102.4	102.5
24	100.0	100.4	101.0	101.4	101.6	101.7	102.0	102.0	102.1	102.3	102.2	102.3	102.3	102.4	102.5
25	100.0	100.5	101.0	101.4	101.6	101.7	102.0	102.1	102.2	102.3	102.3	102.4	102.3	102.5	102.6
n	25	25	25	25	25	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	102.5	102.5	102.6	102.7	102.7
Med.	100.0	100.5	101.0	101.3	101.6	101.7	102.0	102.0	102.2	102.3	102.2	102.4	102.3	102.5	102.5
σ	0.00	0.55	0.56	0.57	0.58	0.59	0.59	0.59	0.61	0.60	0.59	0.57	0.60	0.59	0.59
Min.	100.0	100.1	100.5	100.8	101.0	101.1	101.3	101.3	101.4	101.6	101.5	101.6	101.5	101.7	101.7
Max.	100.0	101.6	102.1	102.5	102.7	102.8	103.1	103.2	103.3	103.5	103.3	103.4	103.4	103.6	103.6



**Data Set 6 : 85 °C, 180 mA**

Actual Case Temperature [T <sub>s</sub> ]	88.1 °C
Actual Ambient Temperature [T <sub>A</sub> ]	86.3 °C
Drive Current [I <sub>F</sub> ]	180 mA
Measurement Current	180 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> were measured during initial setup.

**TABLE 6-4**  
Chromaticity Shift

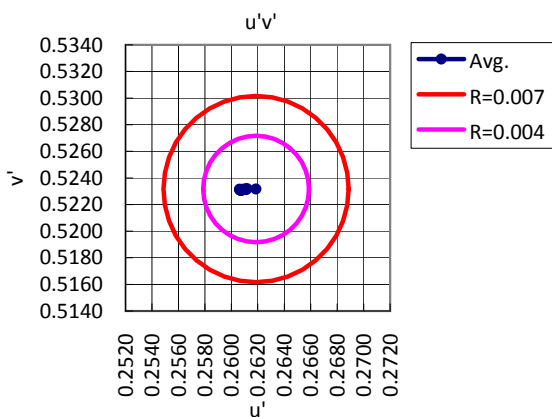
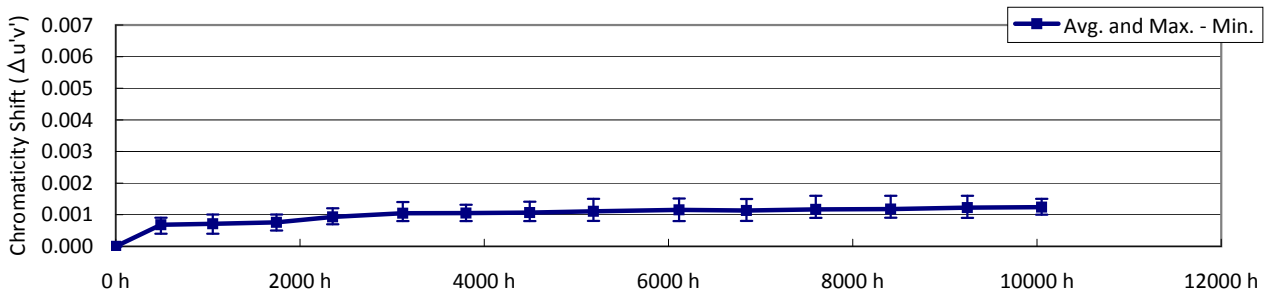
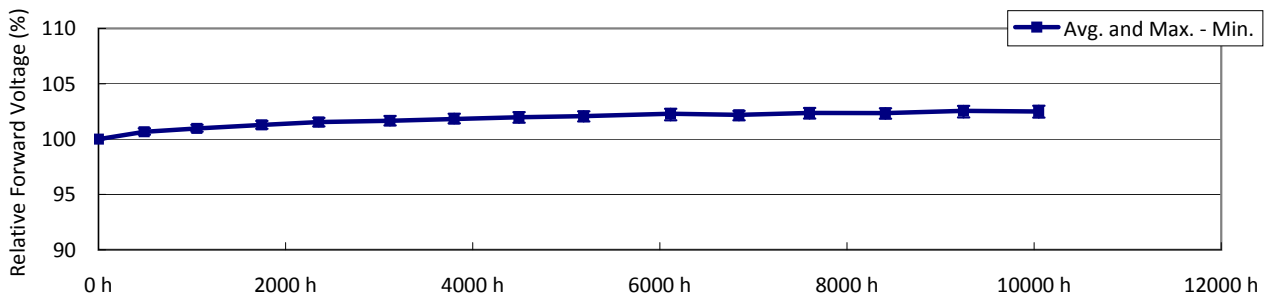
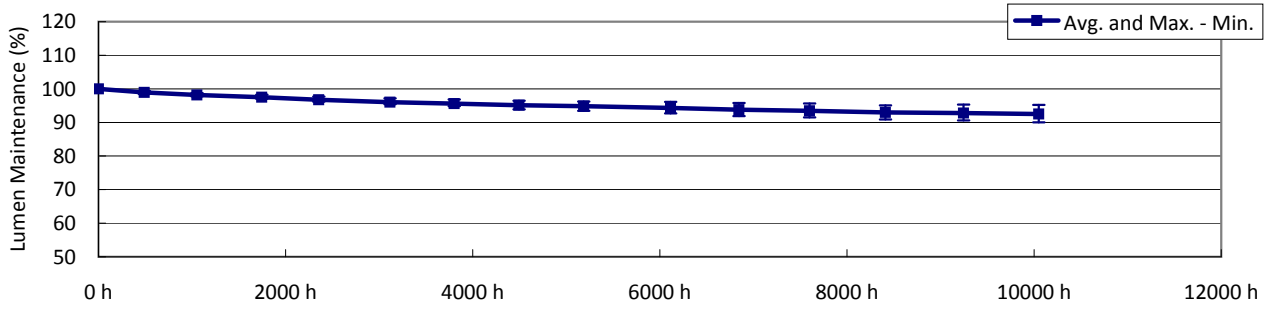
LED No.	Chromaticity Shift Δu'v'														
	0 h	490 h	1052 h	1744 h	2354 h	3116 h	3802 h	4494 h	5185 h	6115 h	6849 h	7600 h	8411 h	9246 h	10045 h
1	0.0000	0.0005	0.0005	0.0007	0.0010	0.0011	0.0011	0.0012	0.0012	0.0012	0.0013	0.0014	0.0014	0.0017	0.0018
2	0.0000	0.0005	0.0005	0.0006	0.0009	0.0010	0.0010	0.0011	0.0012	0.0012	0.0013	0.0013	0.0013	0.0015	0.0016
3	0.0000	0.0005	0.0006	0.0006	0.0009	0.0011	0.0011	0.0010	0.0010	0.0011	0.0010	0.0012	0.0013	0.0014	0.0015
4	0.0000	0.0005	0.0006	0.0006	0.0010	0.0011	0.0010	0.0011	0.0011	0.0012	0.0012	0.0012	0.0012	0.0013	0.0013
5	0.0000	0.0005	0.0006	0.0007	0.0010	0.0011	0.0011	0.0012	0.0013	0.0013	0.0013	0.0014	0.0014	0.0015	0.0016
6	0.0000	0.0006	0.0006	0.0007	0.0009	0.0011	0.0011	0.0012	0.0012	0.0012	0.0013	0.0013	0.0014	0.0016	0.0015
7	0.0000	0.0006	0.0007	0.0008	0.0011	0.0012	0.0012	0.0013	0.0013	0.0013	0.0014	0.0014	0.0014	0.0016	0.0017
8	0.0000	0.0005	0.0005	0.0006	0.0009	0.0011	0.0011	0.0011	0.0011	0.0012	0.0013	0.0013	0.0014	0.0015	0.0015
9	0.0000	0.0004	0.0005	0.0005	0.0009	0.0010	0.0010	0.0011	0.0011	0.0013	0.0012	0.0013	0.0013	0.0016	0.0018
10	0.0000	0.0005	0.0006	0.0006	0.0009	0.0010	0.0011	0.0011	0.0012	0.0012	0.0012	0.0013	0.0012	0.0014	0.0016
11	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0015	0.0015	0.0016	0.0016	0.0016	0.0016	0.0016	0.0017	0.0017
12	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0015	0.0016	0.0016	0.0017	0.0017	0.0018	0.0017	0.0018	0.0019
13	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0014	0.0014	0.0014	0.0015	0.0015	0.0015	0.0016	0.0017	0.0017
14	0.0000	0.0008	0.0009	0.0010	0.0012	0.0014	0.0013	0.0015	0.0015	0.0015	0.0015	0.0016	0.0016	0.0017	0.0018
15	0.0000	0.0008	0.0009	0.0010	0.0013	0.0014	0.0015	0.0015	0.0016	0.0017	0.0016	0.0017	0.0016	0.0018	0.0019
16	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0015	0.0016	0.0017	0.0018	0.0017	0.0018	0.0018	0.0019	0.0019
17	0.0000	0.0009	0.0010	0.0010	0.0014	0.0015	0.0015	0.0016	0.0016	0.0017	0.0018	0.0018	0.0018	0.0020	0.0019
18	0.0000	0.0008	0.0008	0.0009	0.0012	0.0013	0.0013	0.0013	0.0013	0.0014	0.0014	0.0014	0.0015	0.0015	0.0016
19	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0014	0.0014	0.0015	0.0015	0.0016	0.0016	0.0016	0.0017	0.0017
20	0.0000	0.0008	0.0009	0.0010	0.0013	0.0014	0.0014	0.0014	0.0015	0.0015	0.0015	0.0016	0.0015	0.0016	0.0017
21	0.0000	0.0008	0.0008	0.0009	0.0012	0.0013	0.0013	0.0013	0.0014	0.0014	0.0014	0.0015	0.0015	0.0016	0.0016
22	0.0000	0.0008	0.0008	0.0009	0.0013	0.0014	0.0015	0.0016	0.0016	0.0017	0.0018	0.0018	0.0019	0.0020	0.0021
23	0.0000	0.0007	0.0008	0.0009	0.0011	0.0012	0.0013	0.0013	0.0013	0.0014	0.0014	0.0015	0.0015	0.0016	0.0016
24	0.0000	0.0008	0.0008	0.0009	0.0012	0.0014	0.0013	0.0013	0.0014	0.0014	0.0015	0.0015	0.0016	0.0017	0.0017
25	0.0000	0.0008	0.0009	0.0009	0.0012	0.0014	0.0013	0.0013	0.0014	0.0014	0.0015	0.0015	0.0015	0.0016	0.0017
n	25	25	25	25	25	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	0.0014	0.0015	0.0015	0.0016	0.0017
Med.	0.0000	0.0008	0.0008	0.0009	0.0012	0.0013	0.0013	0.0013	0.0014	0.0014	0.0014	0.0015	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	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	0.0010	0.0012	0.0012	0.0013	0.0013
Max.	0.0000	0.0009	0.0010	0.0010	0.0014	0.0015	0.0015	0.0016	0.0017	0.0018	0.0018	0.0018	0.0019	0.0020	0.0021

**Data Set 7 : 105 °C, 65 mA**

Actual Case Temperature [T <sub>S</sub> ]	105.2 °C
Actual Ambient Temperature [T <sub>A</sub> ]	103.2 °C
Drive Current [I <sub>F</sub> ]	65 mA
Measurement Current	65 mA

NOTES:

T<sub>S</sub> and T<sub>A</sub> were measured during initial setup.



**Data Set 7 : 105 °C, 65 mA**

Actual Case Temperature [T <sub>s</sub> ]	105.2 °C
Actual Ambient Temperature [T <sub>A</sub> ]	103.2 °C
Drive Current [I <sub>F</sub> ]	65 mA
Measurement Current	65 mA

## NOTES:

 T<sub>s</sub> and T<sub>A</sub> were measured during initial setup.

**TABLE 7-1**  
 Initial Characteristics

LED No.	Luminous flux	Forward voltage	CCT	CIE1931		CIE1976							
	Φ <sub>v</sub> [lm]	V <sub>F</sub> [V]	T <sub>CP</sub> [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 <sub>s</sub> ]	105.2 °C
Actual Ambient Temperature [T <sub>A</sub> ]	103.2 °C
Drive Current [I <sub>F</sub> ]	65 mA
Measurement Current	65 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> 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	6846 h	7599 h	8411 h	9245 h	10050 h
1	100.0	99.0	98.1	97.4	96.5	95.9	95.5	95.1	94.6	94.1	93.4	93.1	92.5	92.1	91.5
2	100.0	98.7	98.2	97.6	96.8	96.2	95.8	95.6	95.4	95.0	94.6	94.4	94.0	93.8	93.4
3	100.0	98.6	97.9	97.2	96.3	95.6	95.3	95.0	94.8	94.3	93.9	93.5	93.1	92.9	92.6
4	100.0	98.5	97.8	97.0	96.2	95.4	95.1	94.7	94.4	93.9	93.4	92.9	92.5	92.2	91.9
5	100.0	98.6	98.0	97.2	96.4	95.7	95.4	95.0	94.7	94.1	93.7	93.3	93.0	92.8	92.7
6	100.0	99.0	98.3	97.7	97.1	96.5	96.1	95.9	95.5	95.0	94.6	94.3	94.1	93.9	94.4
7	100.0	98.8	97.9	97.1	96.4	95.6	95.1	94.7	94.1	93.5	92.9	92.6	92.1	91.8	91.9
8	100.0	99.4	98.7	98.2	97.6	96.8	96.4	95.9	95.2	94.5	93.9	93.6	93.1	93.0	92.8
9	100.0	99.2	98.2	97.5	96.7	95.9	95.3	95.0	94.3	93.7	93.0	92.8	92.2	91.7	91.2
10	100.0	98.9	98.0	97.4	96.6	95.9	95.4	95.0	94.4	93.9	93.2	92.9	92.3	92.0	91.5
11	100.0	99.1	98.3	97.7	96.8	96.1	95.6	95.0	94.9	94.3	93.7	93.5	93.0	92.7	92.0
12	100.0	98.8	98.0	97.4	96.4	95.5	94.8	93.9	93.5	92.7	91.9	91.5	90.9	90.6	90.0
13	100.0	98.9	98.0	97.3	96.5	95.7	95.2	94.6	94.5	94.0	93.3	93.0	92.4	92.1	91.5
14	100.0	99.0	98.2	97.6	96.8	96.0	95.5	95.0	94.8	94.3	93.8	93.4	93.0	92.9	92.6
15	100.0	99.0	98.2	97.5	96.7	95.9	95.3	94.7	94.3	93.7	93.0	92.6	92.1	92.0	91.8
16	100.0	98.8	97.9	97.1	96.4	95.6	95.2	94.7	94.2	93.5	93.2	92.6	92.1	91.8	92.0
17	100.0	98.9	98.2	97.5	96.8	96.1	95.7	95.2	94.7	94.1	93.8	93.3	93.0	92.7	92.8
18	100.0	99.3	98.8	98.3	97.7	97.2	96.9	96.4	96.1	95.7	95.3	95.1	94.8	94.6	94.5
19	100.0	99.2	98.4	97.7	97.0	96.2	95.8	95.2	94.9	94.2	93.7	93.4	92.9	92.5	92.0
20	100.0	99.2	98.4	97.8	97.0	96.3	95.8	95.2	95.0	94.4	93.9	93.6	93.1	92.7	92.1
21	100.0	99.1	98.3	97.8	97.0	96.3	95.9	95.4	95.3	94.8	94.5	94.2	93.7	93.6	93.1
22	100.0	98.9	98.1	97.5	96.8	96.1	95.7	95.2	95.0	94.6	94.2	93.9	93.3	93.1	92.6
23	100.0	98.6	97.9	97.2	96.4	95.7	95.3	94.9	94.7	94.3	93.8	93.5	92.9	92.7	92.3
24	100.0	98.8	98.0	97.4	96.5	96.0	95.7	95.2	95.1	94.8	94.4	94.1	93.6	93.6	93.4
25	100.0	99.2	98.6	98.2	97.7	97.1	96.8	96.5	96.2	96.1	95.8	95.6	95.1	95.3	95.2
n	25	25	25	25	25	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	93.8	93.5	93.0	92.8	92.5
Med.	100.0	98.9	98.2	97.5	96.7	96.0	95.5	95.0	94.8	94.3	93.8	93.4	93.0	92.7	92.3
σ	0.00	0.23	0.26	0.33	0.41	0.46	0.50	0.56	0.61	0.71	0.81	0.86	0.90	1.00	1.12
Min.	100.0	98.5	97.8	97.0	96.2	95.4	94.8	93.9	93.5	92.7	91.9	91.5	90.9	90.6	90.0
Max.	100.0	99.4	98.8	98.3	97.7	97.2	96.9	96.5	96.2	96.1	95.8	95.6	95.1	95.3	95.2

**TM-21 Projection**

Time	4494 h	5185 h	6115 h	6846 h	7599 h	8411 h	9245 h	10050 h							
ln(Avg.)	-0.0498	-0.0532	-0.0585	-0.0640	-0.0675	-0.0727	-0.0750	-0.0781							

Test duration used	4494 h	to	10050 h
B	0.9738		
α	5.2850E-06		
R <sup>2</sup>	0.9886		
Calculated L <sub>70</sub> (10K)	62500	hours	
Reported L <sub>70</sub> (10K)	> 60300	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 <sub>s</sub> ]	105.2 °C
Actual Ambient Temperature [T <sub>A</sub> ]	103.2 °C
Drive Current [I <sub>F</sub> ]	65 mA
Measurement Current	65 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> 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	6846 h	7599 h	8411 h	9245 h	10050 h
1	100.0	100.9	101.2	101.6	101.8	102.0	102.1	102.3	102.4	102.6	102.4	102.6	102.7	102.8	102.8
2	100.0	100.8	101.1	101.5	101.7	101.7	101.9	102.1	102.2	102.4	102.1	102.4	102.4	102.6	102.5
3	100.0	100.8	101.2	101.5	101.8	101.9	102.1	102.2	102.4	102.6	102.4	102.7	102.7	102.8	102.8
4	100.0	101.0	101.3	101.6	101.9	102.1	102.3	102.4	102.5	102.7	102.5	102.8	102.8	103.0	103.0
5	100.0	100.9	101.2	101.5	101.9	102.0	102.1	102.3	102.4	102.6	102.4	102.6	102.7	102.8	102.9
6	100.0	100.8	101.0	101.3	101.5	101.7	101.8	101.9	102.0	102.2	102.1	102.2	102.2	102.4	102.4
7	100.0	100.9	101.2	101.5	101.9	102.0	102.2	102.3	102.4	102.6	102.5	102.6	102.7	102.9	103.0
8	100.0	100.8	101.1	101.3	101.5	101.6	101.8	101.9	102.0	102.2	101.9	102.2	102.1	102.3	102.3
9	100.0	100.9	101.2	101.6	101.9	102.0	102.2	102.3	102.5	102.7	102.5	102.7	102.6	102.9	102.9
10	100.0	100.9	101.3	101.6	101.9	102.0	102.2	102.4	102.5	102.7	102.5	102.7	102.7	103.0	102.9
11	100.0	100.5	100.9	101.2	101.5	101.6	101.7	101.9	102.0	102.3	102.2	102.4	102.3	102.5	102.5
12	100.0	100.5	100.9	101.1	101.4	101.5	101.7	101.9	102.0	102.2	102.2	102.2	102.3	102.5	102.4
13	100.0	100.6	100.8	101.2	101.4	101.6	101.7	101.9	102.0	102.3	102.2	102.4	102.3	102.6	102.5
14	100.0	100.5	100.8	101.2	101.4	101.5	101.6	101.8	102.0	102.2	102.1	102.2	102.2	102.4	102.3
15	100.0	100.6	100.8	101.1	101.4	101.5	101.7	101.8	101.9	102.2	102.1	102.3	102.2	102.4	102.4
16	100.0	100.6	100.8	101.1	101.4	101.5	101.7	101.9	101.9	102.2	102.1	102.3	102.3	102.5	102.4
17	100.0	100.5	100.9	101.1	101.4	101.5	101.7	101.8	102.0	102.1	102.1	102.2	102.2	102.4	102.3
18	100.0	100.4	100.7	101.0	101.2	101.2	101.4	101.5	101.6	101.8	101.8	101.9	101.8	102.1	101.9
19	100.0	100.6	100.8	101.2	101.4	101.6	101.7	101.9	102.0	102.2	102.2	102.4	102.3	102.5	102.4
20	100.0	100.5	100.8	101.1	101.4	101.5	101.7	101.8	102.0	102.2	102.2	102.3	102.3	102.5	102.4
21	100.0	100.6	100.8	101.2	101.4	101.5	101.7	101.9	102.0	102.1	102.1	102.3	102.3	102.5	102.4
22	100.0	100.5	100.8	101.1	101.4	101.5	101.6	101.8	101.9	102.1	102.1	102.3	102.3	102.5	102.4
23	100.0	100.4	100.7	101.1	101.3	101.4	101.7	101.7	101.9	102.1	102.1	102.3	102.3	102.5	102.3
24	100.0	100.5	100.8	101.1	101.4	101.5	101.7	101.8	102.0	102.1	102.1	102.4	102.2	102.4	102.3
25	100.0	100.5	100.7	100.9	101.1	101.3	101.4	101.5	101.6	101.7	101.7	101.9	101.8	102.0	102.0
n	25	25	25	25	25	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	102.2	102.4	102.3	102.5	102.5
Med.	100.0	100.6	100.9	101.2	101.4	101.6	101.7	101.9	102.0	102.2	102.1	102.3	102.3	102.5	102.4
σ	0.00	0.19	0.20	0.22	0.23	0.24	0.24	0.25	0.25	0.27	0.22	0.24	0.25	0.26	0.29
Min.	100.0	100.4	100.7	100.9	101.1	101.2	101.4	101.5	101.6	101.7	101.7	101.9	101.8	102.0	101.9
Max.	100.0	101.0	101.3	101.6	101.9	102.1	102.3	102.4	102.5	102.7	102.5	102.8	102.8	103.0	103.0

**Data Set 7 : 105 °C, 65 mA**

Actual Case Temperature [T <sub>s</sub> ]	105.2 °C
Actual Ambient Temperature [T <sub>A</sub> ]	103.2 °C
Drive Current [I <sub>F</sub> ]	65 mA
Measurement Current	65 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> were measured during initial setup.

**TABLE 7-4**  
Chromaticity Shift

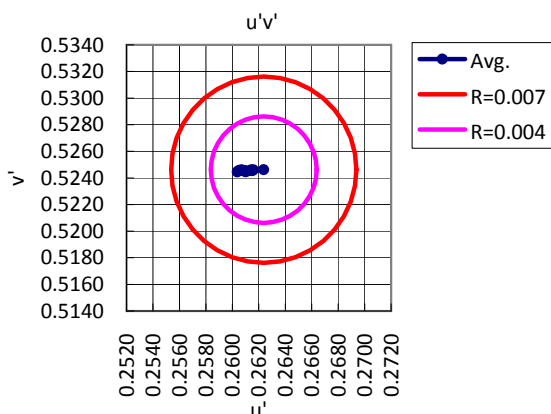
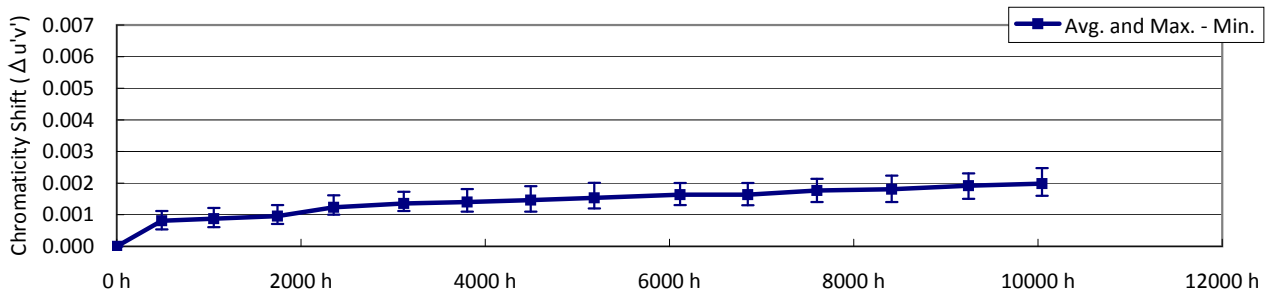
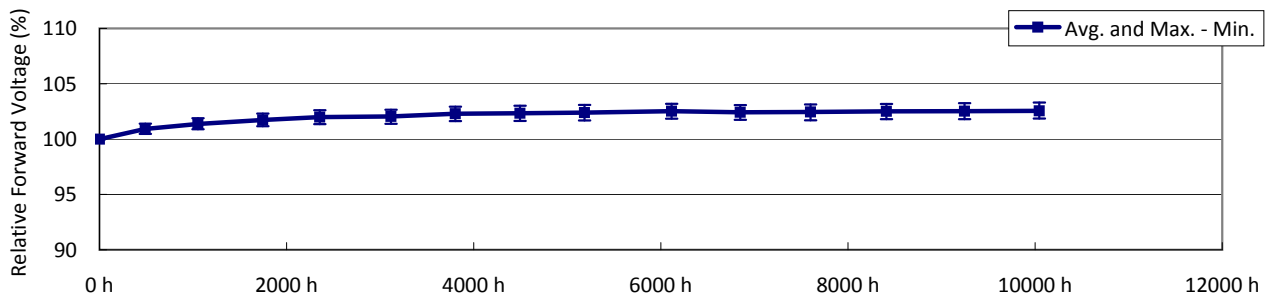
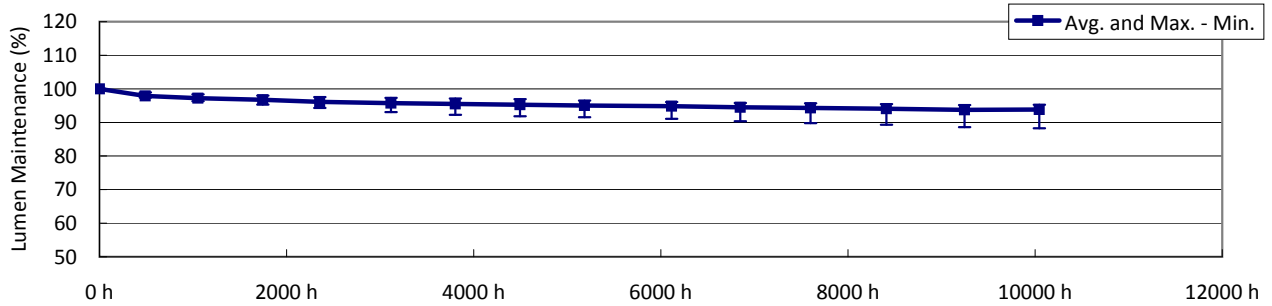
LED No.	Chromaticity Shift Δu'v'														
	0 h	490 h	1053 h	1745 h	2354 h	3116 h	3802 h	4494 h	5185 h	6115 h	6846 h	7599 h	8411 h	9245 h	10050 h
1	0.0000	0.0004	0.0005	0.0005	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0009	0.0009	0.0010
2	0.0000	0.0004	0.0004	0.0006	0.0007	0.0008	0.0008	0.0009	0.0009	0.0010	0.0009	0.0009	0.0010	0.0010	0.0011
3	0.0000	0.0004	0.0005	0.0005	0.0007	0.0009	0.0009	0.0008	0.0009	0.0009	0.0009	0.0009	0.0009	0.0010	0.0010
4	0.0000	0.0005	0.0005	0.0005	0.0007	0.0008	0.0008	0.0008	0.0009	0.0009	0.0008	0.0009	0.0009	0.0010	0.0010
5	0.0000	0.0005	0.0005	0.0006	0.0007	0.0008	0.0009	0.0009	0.0009	0.0010	0.0010	0.0010	0.0010	0.0011	0.0010
6	0.0000	0.0006	0.0006	0.0006	0.0008	0.0009	0.0010	0.0009	0.0010	0.0011	0.0010	0.0010	0.0011	0.0012	0.0010
7	0.0000	0.0006	0.0007	0.0007	0.0009	0.0010	0.0011	0.0011	0.0011	0.0012	0.0011	0.0011	0.0011	0.0012	0.0012
8	0.0000	0.0005	0.0005	0.0006	0.0007	0.0008	0.0008	0.0008	0.0009	0.0009	0.0008	0.0009	0.0010	0.0010	0.0011
9	0.0000	0.0005	0.0005	0.0006	0.0008	0.0009	0.0009	0.0010	0.0010	0.0011	0.0010	0.0011	0.0011	0.0012	0.0012
10	0.0000	0.0005	0.0005	0.0005	0.0007	0.0008	0.0009	0.0009	0.0009	0.0010	0.0009	0.0010	0.0010	0.0011	0.0012
11	0.0000	0.0007	0.0008	0.0008	0.0010	0.0011	0.0011	0.0011	0.0011	0.0012	0.0012	0.0012	0.0012	0.0013	0.0013
12	0.0000	0.0008	0.0008	0.0008	0.0010	0.0010	0.0010	0.0011	0.0011	0.0011	0.0011	0.0012	0.0012	0.0013	0.0013
13	0.0000	0.0007	0.0006	0.0008	0.0009	0.0010	0.0010	0.0010	0.0010	0.0010	0.0011	0.0011	0.0011	0.0012	0.0012
14	0.0000	0.0008	0.0008	0.0009	0.0010	0.0011	0.0011	0.0011	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0013
15	0.0000	0.0008	0.0009	0.0009	0.0011	0.0011	0.0011	0.0012	0.0012	0.0012	0.0012	0.0013	0.0013	0.0013	0.0013
16	0.0000	0.0009	0.0010	0.0010	0.0012	0.0013	0.0013	0.0014	0.0014	0.0015	0.0014	0.0014	0.0015	0.0015	0.0014
17	0.0000	0.0009	0.0010	0.0010	0.0012	0.0014	0.0013	0.0014	0.0015	0.0015	0.0015	0.0016	0.0016	0.0016	0.0015
18	0.0000	0.0008	0.0008	0.0008	0.0010	0.0011	0.0011	0.0011	0.0012	0.0012	0.0012	0.0013	0.0013	0.0013	0.0013
19	0.0000	0.0008	0.0008	0.0009	0.0010	0.0012	0.0012	0.0012	0.0012	0.0013	0.0012	0.0013	0.0013	0.0013	0.0013
20	0.0000	0.0009	0.0009	0.0009	0.0011	0.0012	0.0012	0.0013	0.0012	0.0012	0.0013	0.0013	0.0014	0.0014	0.0014
21	0.0000	0.0009	0.0009	0.0010	0.0012	0.0013	0.0013	0.0013	0.0014	0.0014	0.0014	0.0015	0.0015	0.0014	0.0015
22	0.0000	0.0007	0.0007	0.0008	0.0010	0.0011	0.0011	0.0011	0.0012	0.0012	0.0012	0.0012	0.0011	0.0012	0.0013
23	0.0000	0.0007	0.0008	0.0008	0.0010	0.0012	0.0011	0.0011	0.0011	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012
24	0.0000	0.0008	0.0009	0.0009	0.0010	0.0012	0.0012	0.0012	0.0012	0.0013	0.0013	0.0013	0.0013	0.0013	0.0014
25	0.0000	0.0008	0.0008	0.0009	0.0011	0.0012	0.0012	0.0011	0.0013	0.0013	0.0013	0.0013	0.0011	0.0013	0.0013
n	25	25	25	25	25	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	0.0011	0.0012	0.0012	0.0012	0.0012
Med.	0.0000	0.0007	0.0008	0.0008	0.0010	0.0011	0.0011	0.0011	0.0011	0.0012	0.0012	0.0012	0.0011	0.0012	0.0013
σ	0.0000	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Min.	0.0000	0.0004	0.0004	0.0005	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0009	0.0010
Max.	0.0000	0.0009	0.0010	0.0010	0.0012	0.0014	0.0013	0.0014	0.0015	0.0015	0.0015	0.0016	0.0016	0.0016	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 <sub>S</sub> ]	106.6 °C
Actual Ambient Temperature [T <sub>A</sub> ]	102.9 °C
Drive Current [I <sub>F</sub> ]	150 mA
Measurement Current	150 mA

NOTES:

T<sub>S</sub> and T<sub>A</sub> were measured during initial setup.

**TABLE 8-1**  
Initial Characteristics

LED No.	Luminous flux	Forward voltage	CCT	CIE1931		CIE1976							
	Φ <sub>V</sub> [lm]	V <sub>F</sub> [V]	T <sub>CP</sub> [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 <sub>s</sub> ]	106.6 °C
Actual Ambient Temperature [T <sub>A</sub> ]	102.9 °C
Drive Current [I <sub>F</sub> ]	150 mA
Measurement Current	150 mA

**NOTES:**

 T<sub>s</sub> and T<sub>A</sub> 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	6849 h	7600 h	8411 h	9246 h	10044 h
1	100.0	97.8	97.0	96.8	96.1	95.7	95.6	95.3	95.2	95.0	94.7	94.5	94.1	93.8	93.7
2	100.0	98.0	97.5	97.2	96.8	96.4	96.3	96.2	96.1	95.9	95.5	95.3	95.0	94.7	94.6
3	100.0	97.6	97.1	96.5	96.1	95.6	95.5	95.4	95.4	95.2	95.0	94.9	94.6	94.2	94.3
4	100.0	97.5	97.1	96.4	96.0	95.5	95.4	95.4	95.3	95.1	94.9	94.7	94.4	94.0	94.1
5	100.0	97.7	97.1	96.2	95.5	94.7	94.4	94.3	94.0	93.8	93.6	93.5	93.3	93.2	93.4
6	100.0	97.8	97.2	96.7	96.3	95.9	95.8	95.7	95.4	95.2	95.0	94.9	94.7	94.6	95.0
7	100.0	97.5	96.5	95.9	95.2	94.6	94.5	94.2	93.8	93.4	93.2	92.8	92.6	92.4	92.8
8	100.0	98.0	97.2	96.9	96.2	95.9	95.8	95.5	95.2	94.9	94.6	94.4	94.2	94.1	94.2
9	100.0	98.0	97.3	97.1	96.4	96.2	96.2	95.8	95.6	95.3	95.1	94.9	94.7	94.6	94.6
10	100.0	98.0	97.1	96.8	95.9	95.6	95.4	94.9	94.7	94.4	94.0	93.8	93.5	93.2	93.1
11	100.0	98.1	97.7	97.5	97.0	96.9	96.7	96.4	96.3	96.1	95.7	95.7	95.4	95.1	95.0
12	100.0	97.8	97.1	96.4	95.5	95.0	94.6	94.3	94.3	94.4	94.2	94.1	93.7	93.4	93.4
13	100.0	98.0	97.4	97.0	96.4	96.2	96.0	95.9	95.7	95.7	95.4	95.2	94.9	94.6	94.7
14	100.0	97.4	96.8	96.5	96.0	95.7	95.6	95.4	95.3	95.2	95.0	94.7	94.5	94.2	94.4
15	100.0	98.0	97.3	97.0	96.3	96.0	95.9	95.8	95.7	95.5	95.3	95.1	94.9	94.6	95.0
16	100.0	97.9	97.4	97.1	96.6	96.3	96.2	96.0	95.7	95.4	95.2	95.0	94.8	94.5	95.1
17	100.0	97.9	97.3	96.9	96.4	96.1	96.0	95.8	95.4	95.1	94.8	94.7	94.5	94.4	94.9
18	100.0	98.9	98.4	98.0	97.5	97.3	97.1	96.9	96.5	96.1	95.8	95.7	95.4	95.2	95.3
19	100.0	98.5	98.0	97.7	97.2	97.0	96.9	96.7	96.4	96.0	95.8	95.7	95.5	95.2	95.1
20	100.0	98.0	97.4	97.0	96.4	96.2	95.9	95.6	95.3	95.0	94.7	94.7	94.4	94.1	93.9
21	100.0	98.0	97.4	97.1	96.5	96.3	96.1	95.9	95.6	95.5	95.2	95.2	94.9	94.4	94.4
22	100.0	97.4	96.3	95.3	94.3	93.4	92.6	91.8	91.6	91.1	90.4	89.9	89.3	88.6	88.3
23	100.0	98.0	97.4	97.0	96.1	95.4	95.0	94.6	94.6	94.5	94.0	93.9	93.8	93.4	93.3
24	100.0	97.6	96.4	95.5	94.3	93.1	92.3	92.0	91.6	91.1	90.4	89.8	89.3	88.8	88.6
25	100.0	98.0	97.4	96.9	96.4	96.1	96.0	95.7	95.6	95.5	95.1	95.0	94.8	94.6	94.7
n	25	25	25	25	25	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	94.5	94.3	94.1	93.7	93.8
Med.	100.0	98.0	97.3	96.9	96.3	95.9	95.8	95.6	95.4	95.2	95.0	94.7	94.5	94.2	94.4
σ	0.00	0.34	0.45	0.61	0.75	0.99	1.14	1.22	1.24	1.30	1.41	1.50	1.57	1.65	1.76
Min.	100.0	97.4	96.3	95.3	94.3	93.1	92.3	91.8	91.6	91.1	90.4	89.8	89.3	88.6	88.3
Max.	100.0	98.9	98.4	98.0	97.5	97.3	97.1	96.9	96.5	96.1	95.8	95.7	95.4	95.2	95.3

**TM-21 Projection**

Time	4494 h	5184 h	6114 h	6849 h	7600 h	8411 h	9246 h	10044 h							
ln(Avg.)	-0.0485	-0.0508	-0.0532	-0.0565	-0.0585	-0.0612	-0.0646	-0.0637							

Test duration used	4494 h	to	10044 h
B	0.9653		
α	3.0115E-06		
R <sup>2</sup>	0.9731		
Calculated L <sub>70</sub> (10K)	107000	hours	
Reported L <sub>70</sub> (10K)	> 60300	hours	

Curve-fit equation:

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

Lumen maintenance life equation:

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

**Data Set 8 : 105 °C, 150 mA**

Actual Case Temperature [T <sub>s</sub> ]	106.6 °C
Actual Ambient Temperature [T <sub>A</sub> ]	102.9 °C
Drive Current [I <sub>F</sub> ]	150 mA
Measurement Current	150 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> 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	6849 h	7600 h	8411 h	9246 h	10044 h
1	100.0	101.3	101.8	102.3	102.5	102.6	102.9	102.9	102.9	103.1	103.0	103.1	103.1	103.1	103.1
2	100.0	101.0	101.4	101.7	101.9	102.0	102.2	102.2	102.3	102.4	102.3	102.3	102.3	102.4	102.4
3	100.0	101.3	101.8	102.2	102.5	102.5	102.7	102.9	102.9	103.1	103.0	103.0	103.1	103.1	103.1
4	100.0	101.4	101.9	102.3	102.6	102.7	102.9	103.0	103.1	103.2	103.1	103.1	103.2	103.2	103.3
5	100.0	101.1	101.5	101.9	102.1	102.1	102.3	102.3	102.4	102.5	102.4	102.4	102.4	102.5	102.5
6	100.0	101.4	101.9	102.2	102.5	102.6	102.8	102.8	103.0	103.1	103.0	103.1	103.1	103.1	103.1
7	100.0	101.4	101.8	102.3	102.6	102.6	102.9	102.9	103.0	103.1	103.0	103.1	103.1	103.2	103.2
8	100.0	101.3	101.8	102.3	102.6	102.6	102.9	102.9	103.1	103.2	103.1	103.1	103.2	103.2	103.3
9	100.0	101.2	101.6	102.0	102.2	102.3	102.5	102.5	102.7	102.6	102.6	102.7	102.7	102.7	102.8
10	100.0	101.4	101.8	102.3	102.6	102.6	102.9	103.0	103.1	103.2	103.1	103.1	103.2	103.2	103.2
11	100.0	100.5	100.9	101.2	101.4	101.4	101.6	101.6	101.7	101.8	101.7	101.7	101.8	101.8	101.9
12	100.0	100.8	101.2	101.4	101.7	101.7	102.0	102.0	102.0	102.1	102.0	102.1	102.1	102.1	102.1
13	100.0	100.7	101.1	101.5	101.9	101.9	102.2	102.2	102.3	102.5	102.3	102.3	102.5	102.5	102.5
14	100.0	100.6	101.0	101.3	101.5	101.6	101.8	101.9	101.9	102.0	101.9	101.9	102.0	102.0	102.1
15	100.0	100.7	101.2	101.6	101.9	102.0	102.3	102.3	102.4	102.5	102.4	102.5	102.5	102.5	102.6
16	100.0	100.6	101.0	101.3	101.5	101.6	101.8	101.8	101.8	102.0	101.9	101.9	102.0	102.0	102.0
17	100.0	100.6	101.1	101.4	101.6	101.7	101.9	101.9	102.0	102.1	102.0	102.0	102.2	102.1	102.1
18	100.0	100.5	101.0	101.2	101.5	101.5	101.7	101.8	101.8	101.9	101.9	101.9	102.0	101.9	102.0
19	100.0	100.6	100.9	101.3	101.5	101.5	101.8	101.8	101.9	102.0	101.9	101.9	102.0	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	102.4	102.4	102.5	102.5	102.6
21	100.0	100.8	101.3	101.7	102.0	102.1	102.3	102.3	102.4	102.6	102.5	102.5	102.5	102.5	102.6
22	100.0	100.8	101.1	101.5	101.7	101.8	102.0	102.1	102.1	102.3	102.2	102.2	102.2	102.2	102.3
23	100.0	100.8	101.1	101.5	101.7	101.7	101.9	101.9	102.0	102.2	102.1	102.0	102.0	102.0	102.0
24	100.0	100.8	101.3	101.8	102.0	102.1	102.4	102.4	102.4	102.6	102.5	102.5	102.6	102.6	102.6
25	100.0	100.7	101.2	101.6	101.9	102.0	102.2	102.3	102.4	102.5	102.4	102.4	102.4	102.5	102.6
n	25	25	25	25	25	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	102.4	102.5	102.5	102.5	102.6
Med.	100.0	100.8	101.2	101.6	101.9	102.0	102.3	102.3	102.4	102.5	102.4	102.4	102.5	102.5	102.6
σ	0.00	0.32	0.35	0.39	0.41	0.42	0.43	0.43	0.46	0.45	0.45	0.47	0.45	0.48	0.48
Min.	100.0	100.5	100.9	101.2	101.4	101.4	101.6	101.6	101.7	101.8	101.7	101.7	101.8	101.8	101.9
Max.	100.0	101.4	101.9	102.3	102.6	102.7	102.9	103.0	103.1	103.2	103.1	103.1	103.2	103.2	103.3

**Data Set 8 : 105 °C, 150 mA**

Actual Case Temperature [T <sub>s</sub> ]	106.6 °C
Actual Ambient Temperature [T <sub>A</sub> ]	102.9 °C
Drive Current [I <sub>F</sub> ]	150 mA
Measurement Current	150 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> were measured during initial setup.

**TABLE 8-4**  
Chromaticity Shift

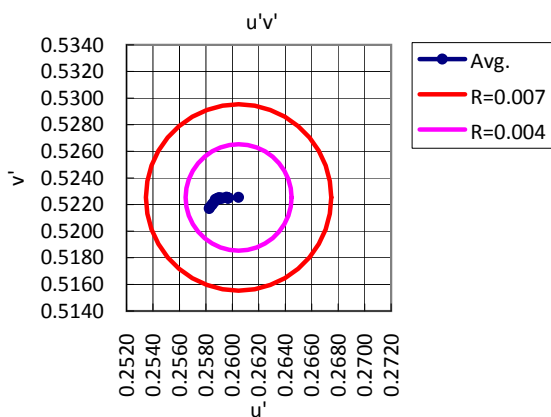
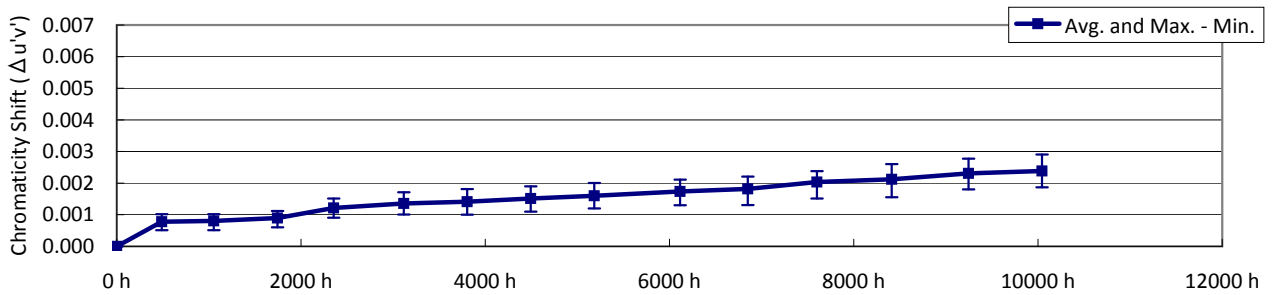
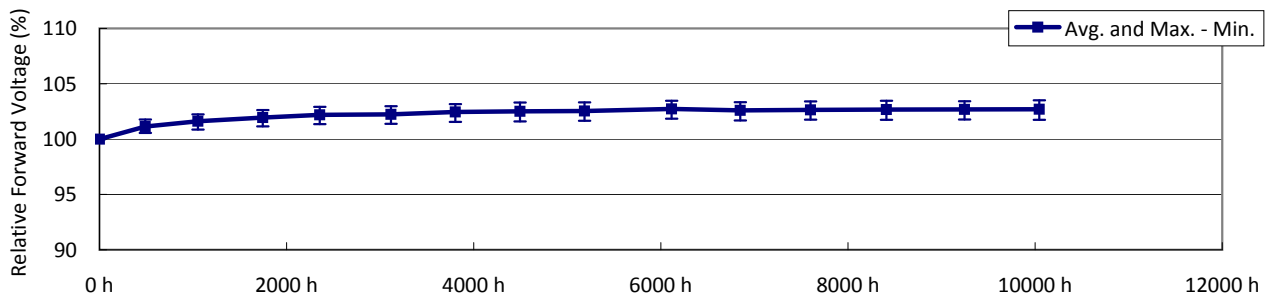
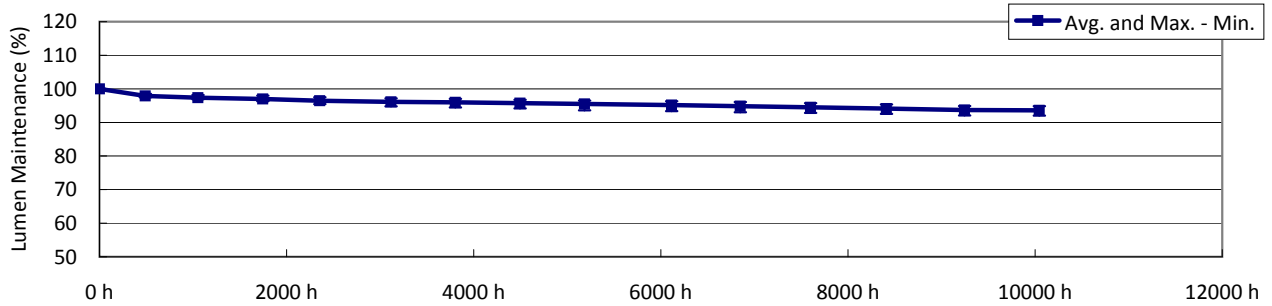
LED No.	Chromaticity Shift Δu'v'														
	0 h	489 h	1053 h	1745 h	2355 h	3116 h	3803 h	4494 h	5184 h	6114 h	6849 h	7600 h	8411 h	9246 h	10044 h
1	0.0000	0.0005	0.0006	0.0007	0.0010	0.0011	0.0011	0.0012	0.0013	0.0014	0.0013	0.0015	0.0015	0.0016	0.0018
2	0.0000	0.0006	0.0006	0.0007	0.0010	0.0011	0.0011	0.0013	0.0013	0.0014	0.0014	0.0015	0.0016	0.0017	0.0017
3	0.0000	0.0006	0.0007	0.0007	0.0011	0.0012	0.0013	0.0013	0.0014	0.0015	0.0015	0.0017	0.0017	0.0018	0.0019
4	0.0000	0.0006	0.0007	0.0008	0.0010	0.0011	0.0011	0.0011	0.0013	0.0013	0.0013	0.0014	0.0014	0.0015	0.0017
5	0.0000	0.0006	0.0007	0.0007	0.0010	0.0011	0.0011	0.0012	0.0012	0.0013	0.0014	0.0015	0.0015	0.0016	0.0017
6	0.0000	0.0007	0.0008	0.0009	0.0011	0.0013	0.0013	0.0013	0.0014	0.0015	0.0015	0.0015	0.0016	0.0017	0.0016
7	0.0000	0.0007	0.0009	0.0009	0.0013	0.0013	0.0015	0.0014	0.0016	0.0016	0.0016	0.0017	0.0017	0.0018	0.0017
8	0.0000	0.0007	0.0007	0.0008	0.0010	0.0012	0.0013	0.0013	0.0014	0.0016	0.0015	0.0017	0.0017	0.0018	0.0019
9	0.0000	0.0006	0.0007	0.0008	0.0011	0.0012	0.0013	0.0014	0.0014	0.0016	0.0015	0.0017	0.0017	0.0019	0.0019
10	0.0000	0.0007	0.0007	0.0008	0.0011	0.0012	0.0012	0.0013	0.0014	0.0015	0.0015	0.0016	0.0016	0.0017	0.0018
11	0.0000	0.0009	0.0009	0.0011	0.0013	0.0015	0.0016	0.0017	0.0017	0.0018	0.0018	0.0020	0.0019	0.0021	0.0021
12	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0014	0.0015	0.0016	0.0017	0.0017	0.0018	0.0019	0.0020	0.0021
13	0.0000	0.0008	0.0010	0.0010	0.0012	0.0013	0.0014	0.0015	0.0015	0.0016	0.0016	0.0018	0.0018	0.0019	0.0020
14	0.0000	0.0011	0.0012	0.0013	0.0016	0.0017	0.0018	0.0019	0.0020	0.0020	0.0020	0.0021	0.0022	0.0023	0.0023
15	0.0000	0.0009	0.0010	0.0010	0.0013	0.0014	0.0014	0.0015	0.0016	0.0017	0.0016	0.0017	0.0017	0.0018	0.0018
16	0.0000	0.0011	0.0011	0.0012	0.0015	0.0016	0.0017	0.0017	0.0018	0.0019	0.0019	0.0021	0.0022	0.0023	0.0024
17	0.0000	0.0011	0.0011	0.0011	0.0015	0.0016	0.0016	0.0017	0.0017	0.0019	0.0019	0.0020	0.0020	0.0023	0.0021
18	0.0000	0.0007	0.0007	0.0008	0.0011	0.0012	0.0012	0.0013	0.0013	0.0015	0.0014	0.0016	0.0017	0.0018	0.0019
19	0.0000	0.0009	0.0009	0.0011	0.0013	0.0015	0.0015	0.0015	0.0016	0.0017	0.0017	0.0018	0.0018	0.0019	0.0020
20	0.0000	0.0009	0.0010	0.0011	0.0014	0.0015	0.0016	0.0017	0.0018	0.0019	0.0019	0.0020	0.0021	0.0021	0.0022
21	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0015	0.0015	0.0016	0.0017	0.0017	0.0018	0.0019	0.0021	0.0022
22	0.0000	0.0009	0.0009	0.0010	0.0013	0.0015	0.0016	0.0016	0.0017	0.0018	0.0019	0.0020	0.0021	0.0022	0.0025
23	0.0000	0.0009	0.0010	0.0011	0.0013	0.0014	0.0015	0.0015	0.0015	0.0016	0.0016	0.0017	0.0018	0.0018	0.0019
24	0.0000	0.0010	0.0011	0.0011	0.0013	0.0014	0.0014	0.0015	0.0016	0.0016	0.0017	0.0018	0.0019	0.0020	0.0020
25	0.0000	0.0008	0.0010	0.0010	0.0013	0.0014	0.0015	0.0015	0.0015	0.0016	0.0017	0.0018	0.0018	0.0020	0.0021
n	25	25	25	25	25	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	0.0016	0.0018	0.0018	0.0019	0.0020
Med.	0.0000	0.0008	0.0009	0.0010	0.0013	0.0014	0.0014	0.0015	0.0015	0.0016	0.0016	0.0017	0.0018	0.0019	0.0019
σ	0.0000	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Min.	0.0000	0.0005	0.0006	0.0007	0.0010	0.0011	0.0011	0.0011	0.0012	0.0013	0.0013	0.0014	0.0014	0.0015	0.0016
Max.	0.0000	0.0011	0.0012	0.0013	0.0016	0.0017	0.0018	0.0019	0.0020	0.0020	0.0020	0.0021	0.0022	0.0023	0.0025

**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 <sub>S</sub> ]	107.3 °C
Actual Ambient Temperature [T <sub>A</sub> ]	105.1 °C
Drive Current [I <sub>F</sub> ]	180 mA
Measurement Current	180 mA

## NOTES:

 T<sub>S</sub> and T<sub>A</sub> were measured during initial setup.

**TABLE 9-1**  
 Initial Characteristics

LED No.	Luminous flux	Forward voltage	CCT	CIE1931		CIE1976							
	Φ <sub>V</sub> [lm]	V <sub>F</sub> [V]	T <sub>CP</sub> [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 <sub>s</sub> ]	107.3 °C
Actual Ambient Temperature [T <sub>A</sub> ]	105.1 °C
Drive Current [I <sub>F</sub> ]	180 mA
Measurement Current	180 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> 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	6849 h	7600 h	8411 h	9246 h	10044 h
1	100.0	97.9	97.3	97.1	96.5	96.1	96.0	95.8	95.7	95.3	95.0	94.9	94.6	94.1	93.8
2	100.0	97.9	97.4	97.2	96.8	96.5	96.5	96.2	96.2	95.9	95.6	95.3	94.8	94.4	94.2
3	100.0	97.9	97.5	97.3	96.9	96.5	96.6	96.3	96.4	96.3	96.1	95.7	95.4	94.9	94.8
4	100.0	97.8	97.2	96.8	96.5	96.2	96.1	95.8	96.0	95.9	95.7	95.3	95.1	94.7	94.9
5	100.0	97.9	97.2	96.7	96.2	95.7	95.5	95.0	94.8	94.3	93.8	93.2	92.7	92.1	92.1
6	100.0	97.5	96.9	96.6	96.1	95.7	95.6	95.3	95.0	94.7	94.2	93.9	93.5	93.2	93.6
7	100.0	97.5	96.9	96.6	96.1	95.7	95.6	95.4	94.9	94.5	94.0	93.6	93.2	92.8	93.1
8	100.0	97.9	97.1	96.3	95.5	94.8	94.5	94.2	93.6	93.6	93.2	93.0	92.7	92.4	92.5
9	100.0	98.0	97.3	96.5	95.8	95.1	94.7	94.5	93.9	93.4	93.0	92.9	92.6	92.2	92.0
10	100.0	97.9	97.5	97.1	96.6	96.2	96.1	95.9	95.5	95.0	94.6	94.3	93.9	93.3	93.1
11	100.0	98.3	98.0	97.8	97.2	97.0	96.8	96.6	96.5	96.2	95.9	95.7	95.3	94.8	94.5
12	100.0	97.9	97.4	97.2	96.6	96.4	96.0	95.9	95.8	95.4	95.1	94.9	94.5	94.0	93.7
13	100.0	97.6	97.1	96.8	96.2	96.1	95.8	95.6	95.5	95.3	95.0	94.8	94.4	94.0	93.9
14	100.0	98.1	97.7	97.4	97.0	96.8	96.5	96.4	96.3	96.0	95.7	95.4	95.1	94.8	94.7
15	100.0	97.8	97.3	97.0	96.4	96.2	96.0	95.8	95.6	95.3	95.0	94.8	94.5	94.2	94.3
16	100.0	97.4	96.9	96.5	96.1	95.8	95.6	95.5	95.1	94.6	94.3	94.0	93.6	93.3	93.7
17	100.0	97.9	97.5	97.1	96.7	96.2	96.1	95.9	95.6	95.1	94.9	94.5	94.3	93.9	94.3
18	100.0	98.0	97.2	96.7	96.2	95.8	95.7	95.4	94.9	94.5	94.1	93.8	93.4	92.9	92.8
19	100.0	98.4	97.8	97.5	97.1	96.8	96.7	96.5	96.1	95.8	95.5	95.1	94.8	94.3	94.1
20	100.0	98.5	98.2	98.0	97.5	97.2	97.0	96.7	96.5	96.1	95.8	95.4	95.1	94.5	94.2
21	100.0	98.2	97.7	97.4	96.9	96.8	96.5	96.4	96.1	95.9	95.5	95.2	94.7	94.3	93.8
22	100.0	98.0	97.5	97.2	96.7	96.5	96.3	96.1	95.9	95.7	95.4	95.1	94.7	94.3	93.8
23	100.0	97.6	97.0	96.6	96.0	95.8	95.6	95.5	95.2	95.0	94.6	94.2	93.6	93.1	92.6
24	100.0	97.8	97.3	96.9	96.4	96.1	95.9	95.9	95.5	95.4	95.0	94.5	94.0	93.6	93.3
25	100.0	97.5	97.0	96.6	96.1	95.8	95.6	95.4	95.0	94.6	94.2	93.6	93.1	92.5	92.2
n	25	25	25	25	25	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	94.9	94.5	94.1	93.7	93.6
Med.	100.0	97.9	97.3	97.0	96.5	96.2	96.0	95.8	95.6	95.3	95.0	94.8	94.4	94.0	93.8
σ	0.00	0.27	0.34	0.42	0.47	0.57	0.60	0.62	0.74	0.78	0.82	0.84	0.86	0.87	0.85
Min.	100.0	97.4	96.9	96.3	95.5	94.8	94.5	94.2	93.6	93.4	93.0	92.9	92.6	92.1	92.0
Max.	100.0	98.5	98.2	98.0	97.5	97.2	97.0	96.7	96.5	96.1	95.8	95.4	95.1	94.5	94.2

**TM-21 Projection**

Time	4494 h	5184 h	6114 h	6849 h	7600 h	8411 h	9246 h	10044 h							
ln(Avg.)	-0.0434	-0.0460	-0.0493	-0.0528	-0.0563	-0.0604	-0.0651	-0.0662							

Test duration used	4494 h	to	10044 h
B	0.9770		
α	4.3695E-06		
R <sup>2</sup>	0.9920		
Calculated L <sub>70</sub> (10K)	76300	hours	
Reported L <sub>70</sub> (10K)	> 60300	hours	

Curve-fit equation:

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

Lumen maintenance life equation:

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

**Data Set 9 : 105 °C, 180 mA**

Actual Case Temperature [T <sub>s</sub> ]	107.3 °C
Actual Ambient Temperature [T <sub>A</sub> ]	105.1 °C
Drive Current [I <sub>F</sub> ]	180 mA
Measurement Current	180 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> 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	6849 h	7600 h	8411 h	9246 h	10044 h
1	100.0	101.7	102.1	102.5	102.8	102.8	103.1	103.2	103.2	103.4	103.3	103.3	103.4	103.4	103.4
2	100.0	101.4	101.9	102.2	102.5	102.4	102.6	102.7	102.7	102.9	102.7	102.8	102.9	102.9	102.9
3	100.0	101.7	102.2	102.6	102.9	103.0	103.1	103.3	103.3	103.5	103.3	103.4	103.5	103.4	103.5
4	100.0	101.7	102.2	102.6	102.9	102.9	103.2	103.2	103.3	103.5	103.3	103.4	103.4	103.4	103.5
5	100.0	101.5	101.9	102.2	102.5	102.4	102.7	102.7	102.7	102.9	102.8	102.7	102.8	102.8	102.9
6	100.0	101.6	102.1	102.5	102.8	102.8	103.1	103.1	103.1	103.4	103.2	103.2	103.3	103.3	103.3
7	100.0	101.6	102.1	102.5	102.8	102.8	103.0	103.1	103.1	103.3	103.1	103.2	103.3	103.3	103.3
8	100.0	101.8	102.2	102.6	102.8	102.8	103.0	103.1	103.2	103.3	103.1	103.2	103.3	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	103.3	103.3	103.4	103.4	103.3
10	100.0	101.4	101.8	102.2	102.4	102.4	102.6	102.7	102.7	102.9	102.7	102.8	102.8	102.8	102.7
11	100.0	100.6	101.0	101.3	101.6	101.6	101.8	101.9	101.9	102.1	101.9	102.0	102.0	102.0	102.0
12	100.0	100.8	101.2	101.6	101.7	101.8	101.9	102.0	102.0	102.1	102.0	102.1	102.1	102.1	102.1
13	100.0	101.0	101.5	101.8	102.1	102.2	102.4	102.4	102.5	102.7	102.6	102.6	102.7	102.6	102.6
14	100.0	100.6	100.9	101.2	101.4	101.4	101.6	101.6	101.7	101.8	101.7	101.8	101.8	101.8	101.8
15	100.0	100.9	101.5	101.8	102.0	102.1	102.3	102.4	102.5	102.6	102.5	102.6	102.6	102.6	102.6
16	100.0	100.9	101.4	101.8	102.0	102.1	102.3	102.3	102.4	102.6	102.4	102.5	102.4	102.5	102.5
17	100.0	100.9	101.4	101.7	101.9	102.0	102.2	102.4	102.3	102.6	102.4	102.5	102.5	102.5	102.6
18	100.0	100.9	101.4	101.8	102.0	102.1	102.3	102.4	102.4	102.6	102.4	102.5	102.5	102.5	102.5
19	100.0	100.9	101.4	101.7	102.0	102.0	102.2	102.2	102.3	102.4	102.4	102.3	102.4	102.4	102.4
20	100.0	100.6	101.0	101.1	101.4	101.4	101.5	101.6	101.7	101.9	101.7	101.8	101.7	101.8	101.7
21	100.0	100.9	101.4	101.7	101.9	102.0	102.2	102.3	102.2	102.5	102.4	102.4	102.4	102.5	102.5
22	100.0	100.9	101.4	101.8	102.0	102.1	102.3	102.4	102.3	102.6	102.5	102.5	102.6	102.6	102.7
23	100.0	100.9	101.4	101.7	101.9	102.1	102.3	102.3	102.3	102.5	102.4	102.5	102.5	102.5	102.5
24	100.0	100.8	101.3	101.6	101.7	101.9	102.0	102.0	102.0	102.2	102.1	102.2	102.2	102.2	102.2
25	100.0	101.0	101.4	101.7	101.9	102.0	102.2	102.3	102.2	102.5	102.4	102.4	102.4	102.4	102.5
n	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Avg.	100.0	101.1	101.6	102.0	102.2	102.2	102.4	102.5	102.5	102.7	102.6	102.6	102.7	102.7	102.7
Med.	100.0	100.9	101.4	101.8	102.0	102.1	102.3	102.4	102.4	102.6	102.5	102.5	102.6	102.6	102.6
σ	0.00	0.41	0.43	0.45	0.49	0.47	0.49	0.50	0.51	0.50	0.49	0.50	0.52	0.50	0.52
Min.	100.0	100.6	100.9	101.1	101.4	101.4	101.5	101.6	101.7	101.8	101.7	101.8	101.7	101.8	101.7
Max.	100.0	101.8	102.2	102.6	102.9	103.0	103.2	103.3	103.3	103.5	103.3	103.4	103.5	103.4	103.5

**Data Set 9 : 105 °C, 180 mA**

Actual Case Temperature [T <sub>s</sub> ]	107.3 °C
Actual Ambient Temperature [T <sub>A</sub> ]	105.1 °C
Drive Current [I <sub>F</sub> ]	180 mA
Measurement Current	180 mA

NOTES:

T<sub>s</sub> and T<sub>A</sub> 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	6849 h	7600 h	8411 h	9246 h	10044 h
1	0.0000	0.0005	0.0005	0.0006	0.0009	0.0010	0.0010	0.0012	0.0013	0.0014	0.0014	0.0017	0.0017	0.0021	0.0021
2	0.0000	0.0005	0.0005	0.0006	0.0009	0.0010	0.0010	0.0011	0.0012	0.0013	0.0013	0.0015	0.0016	0.0018	0.0019
3	0.0000	0.0007	0.0007	0.0008	0.0010	0.0012	0.0012	0.0013	0.0014	0.0015	0.0015	0.0017	0.0017	0.0019	0.0021
4	0.0000	0.0006	0.0006	0.0007	0.0010	0.0011	0.0012	0.0013	0.0013	0.0015	0.0015	0.0017	0.0017	0.0019	0.0020
5	0.0000	0.0006	0.0007	0.0008	0.0012	0.0014	0.0015	0.0016	0.0017	0.0018	0.0020	0.0023	0.0024	0.0027	0.0027
6	0.0000	0.0007	0.0008	0.0008	0.0011	0.0013	0.0013	0.0014	0.0016	0.0016	0.0018	0.0021	0.0021	0.0024	0.0024
7	0.0000	0.0006	0.0007	0.0007	0.0011	0.0012	0.0013	0.0014	0.0014	0.0015	0.0016	0.0016	0.0017	0.0020	0.0019
8	0.0000	0.0005	0.0006	0.0007	0.0011	0.0013	0.0014	0.0015	0.0016	0.0017	0.0017	0.0019	0.0020	0.0022	0.0022
9	0.0000	0.0005	0.0005	0.0006	0.0010	0.0012	0.0012	0.0013	0.0013	0.0015	0.0016	0.0020	0.0021	0.0023	0.0025
10	0.0000	0.0006	0.0006	0.0007	0.0010	0.0011	0.0013	0.0014	0.0015	0.0017	0.0018	0.0022	0.0023	0.0026	0.0027
11	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0015	0.0016	0.0017	0.0018	0.0019	0.0022	0.0022	0.0023	0.0026
12	0.0000	0.0008	0.0008	0.0009	0.0011	0.0014	0.0014	0.0015	0.0016	0.0017	0.0017	0.0019	0.0020	0.0020	0.0021
13	0.0000	0.0009	0.0010	0.0011	0.0014	0.0015	0.0016	0.0017	0.0018	0.0019	0.0020	0.0021	0.0021	0.0023	0.0023
14	0.0000	0.0009	0.0010	0.0011	0.0014	0.0015	0.0016	0.0017	0.0018	0.0019	0.0020	0.0021	0.0022	0.0023	0.0024
15	0.0000	0.0009	0.0010	0.0011	0.0014	0.0015	0.0015	0.0016	0.0017	0.0017	0.0017	0.0019	0.0020	0.0021	0.0021
16	0.0000	0.0010	0.0010	0.0011	0.0014	0.0015	0.0016	0.0017	0.0018	0.0019	0.0020	0.0022	0.0024	0.0025	0.0026
17	0.0000	0.0010	0.0010	0.0011	0.0015	0.0017	0.0018	0.0018	0.0019	0.0021	0.0021	0.0023	0.0025	0.0026	0.0026
18	0.0000	0.0010	0.0010	0.0011	0.0015	0.0017	0.0018	0.0019	0.0020	0.0021	0.0022	0.0023	0.0025	0.0026	0.0026
19	0.0000	0.0010	0.0010	0.0011	0.0014	0.0015	0.0015	0.0016	0.0016	0.0017	0.0018	0.0019	0.0019	0.0020	0.0021
20	0.0000	0.0009	0.0009	0.0011	0.0014	0.0015	0.0016	0.0017	0.0018	0.0020	0.0022	0.0024	0.0026	0.0028	0.0029
21	0.0000	0.0008	0.0008	0.0009	0.0012	0.0013	0.0012	0.0014	0.0015	0.0017	0.0018	0.0021	0.0023	0.0026	0.0026
22	0.0000	0.0008	0.0009	0.0009	0.0011	0.0013	0.0014	0.0015	0.0015	0.0017	0.0019	0.0021	0.0022	0.0024	0.0026
23	0.0000	0.0008	0.0008	0.0009	0.0013	0.0014	0.0015	0.0016	0.0017	0.0019	0.0021	0.0023	0.0025	0.0026	0.0027
24	0.0000	0.0009	0.0009	0.0010	0.0013	0.0014	0.0014	0.0015	0.0016	0.0017	0.0018	0.0021	0.0022	0.0023	0.0025
25	0.0000	0.0009	0.0008	0.0009	0.0012	0.0013	0.0013	0.0014	0.0015	0.0017	0.0018	0.0020	0.0021	0.0022	0.0024
n	25	25	25	25	25	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	0.0018	0.0020	0.0021	0.0023	0.0024
Med.	0.0000	0.0008	0.0008	0.0009	0.0012	0.0014	0.0014	0.0015	0.0016	0.0017	0.0018	0.0021	0.0021	0.0023	0.0024
σ	0.0000	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	0.0003	0.0003
Min.	0.0000	0.0005	0.0005	0.0006	0.0009	0.0010	0.0010	0.0011	0.0012	0.0013	0.0013	0.0015	0.0016	0.0018	0.0019
Max.	0.0000	0.0010	0.0010	0.0011	0.0015	0.0017	0.0018	0.0019	0.0020	0.0021	0.0022	0.0024	0.0026	0.0028	0.0029