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1.5 Operating Cycle

Samples are driven with a constant direct current (DC)

1.6 Ambient Conditions

For lumen maintenance test, samples were operated in thermal chambers with minimal ambient airflow. For long term reliability test, the case temperature was controlled by mounting several thermocouples on a sample reliability stress board at the designated thermal measurement point, as shown in APPENDIX. The ambient temperature T_A was measured by several thermocouples at a distance of 5 mm above the reliability test board. The relative humidity within chamber was less than 65%.

For photometry measurement, temperature was set to $25\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, RH <65%.

1.7 Photometry Measurement Uncertainty

The uncertainty of the light output measurements is $U=1.59\%$ ($K=2$), at the 95% confidence level. The uncertainty of the correlated color temperature measurements is $U=21\text{K}$ ($K=2$), at the 95% confidence level. This calibration results traceable to the NATIONAL INSTITUTE OF METROLOGY (NIM).

1.8 Sample Set

Sampling Method:

LED samples for IESNA LM-80 testing consist of units built from a minimum of three manufacturing lots with each manufacturing lot built from different wafer lots built on non-consecutive days.

These manufacturing lots are picked to represent a wide parametric distribution.

Each Sample is soldered to all of the reliability stress boards for a given set of IESNA LM-80 tests.

Sample Size:

Total 75Pcs;

Each Ts test condition 25Pcs

The 75pcs samples tested at Ts 45 °C, 55 °C and Ts 85 °C were received at 2013-03-20 and tested during 2013-03-22 to 2014-04-30. The samples were numbered from 1 to 25, 26 to 50 and 51 to 75.

Data Set 1: 45 °C, 60mA

Part Number:	RF-HI13
Number of Units:	25
Actual Case Temperature(T _S):	T _S =44.7 °C
Actual Ambient Temperature(T _A):	T _A =43.4 °C
Life Test Drive Current:	I _F = 60mA
Measurement Current:	I _F = 60mA

Data Set 2: 55°C, 60mA

Part Number:	RF-HI13
Number of Units:	25
Actual Case Temperature(T _S):	T _S =54.3 °C
Actual Ambient Temperature(T _A):	T _A =53.6 °C
Life Test Drive Current:	I _F = 60mA
Measurement Current:	I _F = 60mA

Data Set 3: 85 °C, 60mA

Part Number:	RF-HI13
Number of Units:	25
Actual Case Temperature(T _S):	T _S =84.3 °C
Actual Ambient Temperature(T _A):	T _A =83.4 °C
Life Test Drive Current:	I _F = 60mA
Measurement Current:	I _F = 60mA

2 - SUMMARY OF TEST RESULT

Data Set:	Data Set 1, 45 °C, 60mA
Number of Units:	25
Failures Observed:	0
Test Interval and Test Duration:	0h,1000h,2000h,3000h,4000h,5000h,6000h,7000h,8000h,9000h
Average. Lumen Maintenance at 6000 hours:	96.83%
Average Chromaticity Shift at 6000 hours (0.0015
Average. Lumen Maintenance at 9000 hours:	95.00%
Average Chromaticity Shift at 9000 hours (0.0022
Reported TM-21 L ₇₀ Lifetime:	>54,000 hours

Data Set:	Data Set 2, 55°C, 60mA
Number of Units:	25
Failures Observed:	0
Test Interval and Test Duration:	0h,1000h,2000h,3000h,4000h,5000h,6000h,7000h,8000h,9000h
Average. Lumen Maintenance at 6000 hours:	96.32%
Average Chromaticity Shift at 6000 hours :	0.0015
Average. Lumen Maintenance at 9000 hours:	94.06%
Average Chromaticity Shift at 9000 hours :	0.0023
Reported TM-21 L ₇₀ Lifetime	>54,000 hours

Data Set:	Data Set 3, 85 °C, 60mA
Number of Units:	25
Failures Observed:	0
Test Interval and Test Duration:	0h,1000h,2000h,3000h,4000h,5000h,6000h,7000h,8000h,9000h
Average. Lumen Maintenance at 6000 hours:	95.93%
	0.0017
Average. Lumen Maintenance at 9000 hours:	93.09%
Average Chromaticity Shift at 9000 hours :	0.0025
Reported TM-21 L ₇₀ Lifetime	47,000 hours

3 - Test Data

3.1 Data Set 1, 45 °C, 60mA (Lumen Maintenance)

No.	V _F (V)		Lumen Maintenance (%)								
	0hr(Initial)		1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs
1	3.121	18.80	99.95	99.57	98.72	97.77	96.70	96.60	96.38	95.90	95.48
2	3.136	18.61	99.89	99.62	98.76	97.64	96.94	96.88	96.51	96.08	94.68
3	3.090	18.45	100.11	99.73	98.75	97.89	96.96	96.86	96.48	95.77	94.80
4	3.075	18.30	100.00	99.73	98.69	97.81	96.89	96.78	96.67	96.07	95.25
5	3.136	19.34	100.10	99.53	98.86	97.62	96.79	96.74	96.33	95.66	94.88
6	3.074	19.84	100.05	99.55	98.79	98.08	97.18	97.08	96.77	96.07	95.31
7	3.093	19.42	99.85	99.43	98.51	97.73	96.81	96.70	96.45	95.88	95.31
8	3.064	19.29	99.95	99.69	98.81	97.98	96.68	96.63	96.42	95.96	95.23
9	3.156	19.23	99.90	99.48	98.75	97.82	96.72	96.67	96.46	95.94	94.44
10	3.061	19.82	99.95	99.45	98.89	97.73	96.92	96.82	96.52	96.01	94.85
11	3.115	18.05	99.83	99.50	98.50	97.67	96.84	96.79	96.51	95.96	94.96
12	3.131	19.54	99.85	99.54	98.57	97.80	97.08	96.93	96.67	96.16	95.14
13	3.133	18.90	100.11	99.47	98.78	97.67	97.14	97.04	96.83	96.24	95.34
14	3.118	18.75	99.95	99.47	98.93	98.08	97.23	97.12	96.91	96.37	95.95
15	3.110	19.78	99.85	99.54	98.89	98.08	97.07	96.97	96.71	95.85	94.89
16	3.156	19.83	99.90	99.50	98.54	97.93	96.72	96.62	96.52	95.97	94.86
17	3.062	19.57	99.90	99.74	98.82	98.01	97.09	96.99	96.78	96.01	94.63
18	3.109	19.43	100.10	99.43	98.71	97.74	96.96	96.91	96.60	95.93	94.90
19	3.109	19.60	100.05	99.44	98.83	97.86	96.99	96.89	96.58	95.97	94.80
20	3.110	19.06	99.95	99.42	98.95	97.85	96.96	96.90	96.80	96.27	95.38
21	3.106	19.66	100.10	99.64	98.83	98.02	97.15	97.00	96.80	95.73	94.76
22	3.092	19.81	99.95	99.65	98.84						

3.2 Data Set 1, 45 °C, 60mA (Chromaticity Shift)

No.			CCT(K)									
	Ohr(Initial)			1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs
1	0.2584	0.5309	2771	0.0002	0.0003	0.0005	0.0009	0.0013	0.0014	0.0015	0.0019	0.0022
2	0.2587	0.5301	2769	0.0001	0.0004	0.0007	0.0010	0.0013	0.0016	0.0020	0.0022	0.0023
3	0.2590	0.5293	2766	0.0001	0.0002	0.0005	0.0008	0.0009	0.0012	0.0015	0.0020	0.0022
4	0.2575	0.5305	2791	0.0004	0.0004	0.0005	0.0009	0.0013	0.0013	0.0013	0.0017	0.0018
5	0.2582	0.5261	2798	0.0004	0.0006	0.0008	0.0013	0.0014	0.0016	0.0017	0.0018	0.0021
6	0.2571	0.5268	2818	0.0003	0.0004	0.0005	0.0007	0.0011	0.0011	0.0014	0.0016	0.0018
7	0.2564	0.5269	2832	0.0003	0.0003	0.0004	0.0007	0.0010	0.0012	0.0014	0.0019	0.0022
8	0.2590	0.5263	2779	0.0002	0.0004	0.0006	0.0010	0.0014	0.0016	0.0018	0.0020	0.0022
9	0.2598	0.5271	2759	0.0002	0.0006	0.0008	0.0013	0.0015	0.0016	0.0017	0.0022	0.0023
10	0.2594	0.5271	2767	0.0006	0.0008	0.0010	0.0012	0.0013	0.0014	0.0014	0.0016	0.0022
11	0.2592	0.5296	2759	0.0003	0.0007	0.0009	0.0014	0.0016	0.0018	0.0020	0.0020	0.0021
12	0.2582	0.5266	2795	0.0005	0.0007	0.0009	0.0012	0.0014	0.0015	0.0017	0.0020	0.0022
13	0.2584	0.5299	2775	0.0004	0.0006	0.0009	0.0011	0.0015	0.0017	0.0019	0.0021	0.0022
14	0.2582	0.5309	2776	0.0003	0.0007	0.0008	0.0011	0.0016	0.0018	0.0018	0.0022	0.0023
15	0.2591	0.5278	2770	0.0006	0.0005	0.0007	0.0013	0.0015	0.0017	0.0019	0.0021	0.0022
16	0.2600	0.5289	2746	0.0005	0.0008	0.0009	0.0013	0.0014	0.0017	0.0018	0.0018	0.0018
17	0.2588	0.5268	2781	0.0003	0.0004	0.0006	0.0012	0.0016	0.0017	0.0018	0.0022	0.0021
18	0.2586	0.5286	2776	0.0004	0.0004	0.0007	0.0010	0.0015	0.0018	0.0018	0.0022	0.0025
19	0.2575	0.5271	2808	0.0004	0.0007	0.0009	0.0013	0.0015	0.0016	0.0017	0.0020	0.0025
20	0.2593	0.5306	2753	0.0005	0.0006	0.0008	0.0010	0.0011	0.0012	0.0014	0.0016	0.0021
21	0.2578	0.5262	2804	0.0005	0.0008	0.0010	0.0014	0.0015	0.0016	0.0018	0.0022	0.0023
22	0.2579	0.5286	2792	0.0004	0.0009	0.0011	0.0012	0.0013	0.0013	0.0015	0.0019	0.0020
23	0.2591	0.5297	2762	0.0004	0.0004	0.0005	0.0012	0.0015	0.0017	0.0019	0.0021	0.0025
24	0.2586	0.5295	2772	0.0002	0.0005	0.0006	0.0009	0.0011	0.0015	0.0016	0.0018	0.0023
25	0.2588	0.5294	2769	0.0001	0.0002	0.0004	0.0009	0.0011	0.0015	0.0018	0.0019	0.0022
Ave.	0.2585											

3.3 Data Set 2, 55°C, 60mA (Lumen Maintenance) 3

No.	V _F (V)		Lumen Maintenance (%)								
	Ohr(Initial)		1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs
26	3.109	19.38	99.90	99.23	98.56	97.57	96.49	96.39	96.08	95.20	94.01
27	3.097	19.38	100.05	99.33	98.71	97.78	96.34	96.28	96.08	95.25	94.53
28	3.117	19.55	100.10	99.44	98.57	97.34	96.21	96.16	95.91	95.09	93.96
29	3.113	19.06	99.95	99.42	98.58	97.43	96.38	96.27	95.59	94.96	93.65
30	3.122	19.74	100.00	99.54	98.73	97.57	96.35	96.20	96.00	95.64	94.63
31	3.107	19.60	99.80	99.49	98.47	97.45	96.33	96.17	95.92	95.31	93.88
32	3.137	18.99	99.79	99.26	98.31	97.37	96.47	96.42	96.21	95.52	94.47
33	3.123	18.57	99.84	99.30	98.71	97.79	96.77	96.55	96.45	95.75	94.78
34	3.105	19.64	99.85	99.34	98.37	97.40	96.28	96.13	95.88	95.06	93.84
35	3.109	18.61	100.05	99.36	98.39	97.74	96.67	96.51	96.29	95.49	94.68
36	3.069	19.42	100.00	99.38	98.46	97.48	96.19	96.09	95.83	95.01	93.98
37	3.144	19.75	100.05	99.44	98.58	97.72	96.66	96.30	96.00	95.24	94.33
38	3.135	18.90	99.89	99.42	98.62	97.78	96.51	96.35	96.24	95.24	93.76
39	3.113	19.70	99.95	99.49	98.53	97.77	96.24	96.19	95.99	95.48	93.96
40	3.106	19.62	100.00	99.44	98.78	97.71	96.79	96.43	96.13	95.21	93.83
41	3.101	19.52	99.74	99.44	98.46	97.49	96.16	96.06	95.85	95.08	93.70
42	3.136	18.97	99.89	99.42	98.68	97.47	96.26	96.20	95.94	95.47	94.31
43	3.152	19.29	100.00	99.27	98.39	97.30	96.16	96.06	95.80	95.08	93.68
44	3.119	19.57	99.90	99.54	98.31	97.34	96.53	96.47	95.96	94.99	93.97
45	3.131	18.97	99.84	99.47	98.31	97.31	96.57	96.47	96.15	95.31	94.10
46	3.112	19.32	99.90	99.38	98.34	97.36	96.43	96.38	95.86	94.93	93.74
47	3.119	18.57	99.78	99.30	98.38	97.42	96.61	96.50	96.28	95.05	94.13
48	3.106	19.25	100.05	99.32	98.39	97.40	96.57	96.52	96.26	95.12	93.71
49	3.152	19.67									

3.4 Data Set 2, 55°C, 60mA (Chromaticity Shift)

No.			CCT(K)									
	0hr(Initial)			1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs
26	0.2584	0.5275	2787	0.0004	0.0007	0.0009	0.0012	0.0015	0.0015	0.0017	0.0023	0.0024
27	0.2583	0.5281	2785	0.0003	0.0008	0.0009	0.0014	0.0015	0.0017	0.0020	0.0021	0.0024
28	0.2585	0.5280	2782	0.0004	0.0007	0.0008	0.0013	0.0016	0.0016	0.0019	0.0022	0.0025
29	0.2570	0.5257	2826	0.0004	0.0006	0.0007	0.0014	0.0016	0.0017	0.0019	0.0021	0.0024
30	0.2602	0.5302	2737	0.0003	0.0004	0.0007	0.0010	0.0013	0.0015	0.0017	0.0020	0.0021
31	0.2595	0.5294	2754	0.0003	0.0004	0.0006	0.0010	0.0014	0.0016	0.0017	0.0019	0.0021
32	0.2593	0.5316	2749	0.0004	0.0006	0.0008	0.0014	0.0015	0.0015	0.0020	0.0022	0.0023
33	0.2591	0.5302	2759	0.0002	0.0004	0.0007	0.0011	0.0014	0.0015	0.0017	0.0021	0.0023
34	0.2595	0.5290	2755	0.0003	0.0006	0.0007	0.0009	0.0011	0.0014	0.0018	0.0022	0.0024
35	0.2593	0.5299	2757	0.0006	0.0009	0.0011	0.0014	0.0014	0.0015	0.0020	0.0022	0.0025
36	0.2568	0.5259	2828	0.0002	0.0008	0.0010	0.0013	0.0014	0.0016	0.0017	0.0019	0.0022
37	0.2584	0.5271	2788	0.0004	0.0006	0.0009	0.0011	0.0013	0.0014	0.0016	0.0021	0.0025
38	0.2595	0.5306	2750	0.0003	0.0005	0.0007	0.0014	0.0015	0.0016	0.0021	0.0022	0.0026
39	0.2594	0.5277	2764	0.0001	0.0005	0.0008	0.0015	0.0016	0.0018	0.0018	0.0020	0.0027
40	0.2587	0.5287	2775	0.0004	0.0007	0.0009	0.0014	0.0015	0.0017	0.0018	0.0019	0.0022
41	0.2586	0.5276	2781	0.0005	0.0008	0.0009	0.0015	0.0016	0.0017	0.0018	0.0022	0.0023
42	0.2583	0.5309	2774	0.0002	0.0003	0.0004	0.0011	0.0015	0.0016	0.0018	0.0020	0.0024
43	0.2583	0.5278	2788	0.0000	0.0001	0.0004	0.0009	0.0012	0.0016	0.0018	0.0020	0.0022
44	0.2583	0.5268	2792	0.0002	0.0004	0.0008	0.0011	0.0016	0.0017	0.0017	0.0021	0.0026
45	0.2588	0.5312	2762	0.0001	0.0004	0.0005	0.0009	0.0012	0.0013	0.0016	0.0020	0.0022
46	0.2567	0.5266	2828	0.0000	0.0002	0.0004	0.0010	0.0011	0.0013	0.0015	0.0022	0.0025
47	0.2577	0.5302	2788	0.0003	0.0006	0.0008	0.0010	0.0012	0.0015	0.0018	0.0020	0.0025
48	0.2592	0.5282	2766	0.0004	0.0005	0.0009	0.0010	0.0012	0.0014	0.0016	0.0019	0.0015
49	0.259333											

