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## 1 - General Information

### 1.1 Description of LED Light Sources

#### Sample Size:

75 PCS samples were received on 2017-03-17. The samples were numbered from 1 to 25, 26 to 50 and 51 to 75.

Manufacturer:	Shenzhen Refond Optoelectronic Co., Ltd.
Part Number:	3528
Part Type:	LED Package
Drive Level:	DC 30mA
Nominal CCT:	2700K
Power:	0.1W
Average Current Density per LED die:	344mA/mm <sup>2</sup>
Average Power Density per LED die:	1.15 W/mm <sup>2</sup>
CRI:	90
Die Spacing:	N/A

#### 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.

### 1.2 Standards Used:

- ANSI/IES LM-80-15: IES Approved Method for Measuring Lumen Maintenance of LED Light Sources.
- CIE 127:2007: Measurement of LEDs (This standard was not accredited by IAS)
- ENERGY STAR® Requirements for the Use of LM-80 Data (This standard was not accredited by IAS)

### 1.3 Testing Equipment

Device	Manufacture	Model No	Serial No	Calibration date	Calibration due date
0.3m integrating sphere	EVERFINE	Diameter 0.3m	1011119	2018-03-18	2019-03-18
Programmable Test Power for LEDs	EVERFINE	LED300E	1008002	2018-03-26	2019-03-26
High accuracy array spectroradiometer	EVERFINE	HAAS-2000	1012016T	2018-03-18	2019-03-18
Standard Light Source	EVERFINE	D062	1011064	2018-01-15	2019-01-15
Precision digital stabilized DC power supply	EVERFINE	WY605-V110	G115987CJ7321114	2018-03-26	2019-03-26
Multilayer aging machine	BACL	B2-270	20022	2018-03-13	2019-03-13
Digital CC&CV DC Power Supply	EVERFINE	WY5015	11060010	2018-03-26	2019-03-26
Digital CC&CV DC Power Supply	EVERFINE	WY5015	11090008	2017-07-07	2018-07-07
Digital CC&CV DC Power Supply	EVERFINE	WY5015	11060002	2017-07-07	2018-07-07



#### 1.4 Drive Level

Samples are driven with a constant direct current (DC) during maintenance test, photometric and electrical measurement. The current value was regulated to within  $\pm 3$  of the specified value of the manufacturer during maintenance test, and was within  $\pm 0.5$  during photometric and electrical measurement test.

#### 1.5 Ambient Conditions for Maintenance Test

For lumen maintenance test, samples within one data set, were installed on cooling boards in thermal chambers with minimal ambient airflow. The case temperature and ambient temperature was monitored by thermocouples which one was soldered to the <sub>(LED)</sub> location, while the other is mounted at a distance of 5 mm above the TMP location.

During life testing,  $TMP_{LED}$  of the coldest LEDs were maintained at a temperature that was greater than or equal to  $2^{\circ}C$  below the corresponding nominal case temperature. Surrounding air was maintained at a temperature that was greater than or equal to  $5^{\circ}C$  below the corresponding nominal case temperature. Thermocouples were shielded from direct DUT optical radiation and comply with

Samples were connected to DC power supply in series circuits with a constant current. The forward current was regulated to within  $\pm 3$  of the specified value of the manufacturer.

The relative humidity within chamber was kept less than 65 during test.

For photometry measurement, the ambient temperature during test was set to  $25^{\circ}C \pm 2^{\circ}C$ , RH <65.

#### 1.6 Photometric Measurement Method and Uncertainty

Integrating sphere and spectroradiometer is used to measure luminous flux and chromaticity coordinate  $u, v, 2$  measurement was used and sample was driven by DC power supply. The forward current was regulated to within  $\pm 0.5$  of the nominal value. The test system was calibrated by halogen reference lamp. The ambient temperature during test was set to  $25^{\circ}C \pm 2^{\circ}C$ , RH <65. The temperature measurement point was located in the sphere and the temperature was detected by a temperature probe.

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  $U=21K$  (K=2), at the 95 confidence level.

The uncertainty of the temperature is  $U=0.8671^{\circ}C$  (K=2), at the 95 confidence level.

#### 1.7 Statement of Traceability

Bay Area Compliance Laboratories Corp. (Dongguan) attested that all calibration has been performed using suitable standards traceable to National Primary Standards and International System of Units (SI).





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### 2 - Summary of Test Result

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Data Set:	Sample Size	Failures Observed:	Test Interval	Test Duration			Reported TM-21 L <sub>70</sub> Lifetime	Reported TM-21 L <sub>90</sub> Lifetime
1	25	0	1000hrs	6000hrs	2.168E-06			

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### 3.2 Data Set 1, 55°C, 30mA (Forward Voltage)

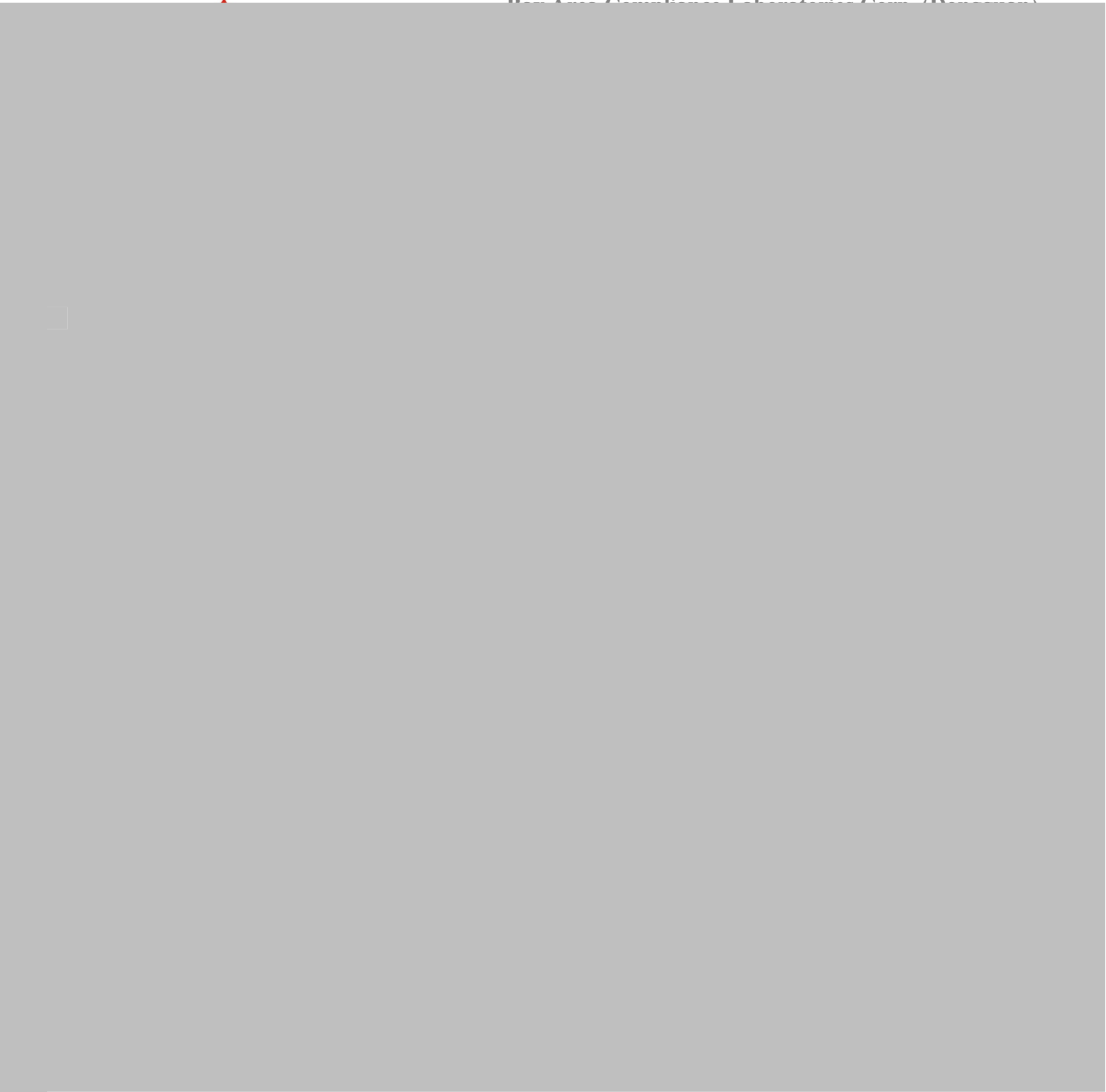
No.	Forward Voltage (V)						
	0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs
1	2.714	2.710	2.709	2.708	2.712	2.710	2.708
2	2.736	2.735	2.730	2.732	2.736	2.732	2.733
3	2.726	2.731	2.729	2.731	2.731	2.735	2.730
4	2.734	2.738	2.734	2.737	2.738	2.738	2.738
5	2.728	2.726	2.721	2.724	2.725	2.724	2.725
6	2.718	2.723	2.718	2.720	2.723	2.726	2.722
7	2.718	2.721	2.717	2.719	2.721	2.721	2.720
8	2.726	2.729	2.724	2.726	2.729	2.727	2.729
9	2.723	2.726	2.720	2.724	2.726	2.725	2.725
10	2.727	2.731	2.724	2.727	2.730	2.728	2.730
11	2.723	2.725	2.720	2.724	2.725	2.724	2.725
12	2.726	2.728	2.721	2.726	2.728	2.727	2.727
13	2.729	2.732	2.726	2.730	2.732	2.731	2.731
14	2.725	2.728	2.724	2.727	2.729	2.728	2.727
15	2.721	2.725	2.721	2.723	2.726	2.725	2.724
16	2.724	2.728	2.721	2.725	2.728	2.726	2.726
17	2.720	2.724	2.718	2.723	2.725	2.724	2.723
18	2.725	2.728	2.725	2.727	2.729	2.728	2.727
19	2.719	2.723	2.718	2.720	2.724	2.722	2.722
20	2.708	2.711	2.707	2.710	2.712	2.712	2.710
21	2.719	2.723	2.718	2.720	2.723	2.722	2.722
22	2.722	2.723	2.720	2.723	2.725	2.724	2.722
23	2.714	2.717	2.712	2.714	2.717	2.721	2.716
24	2.709	2.712	2.709	2.711	2.713	2.712	2.712
25	2.721	2.724	2.720	2.722	2.725	2.728	2.724
Avg.	2.722	2.725	2.720	2.723	2.725	2.725	2.724
Med.	2.723	2.725	2.720	2.724	2.725	2.725	2

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### 3.4 Data Set 2, 85°C, 30mA (Lumen Maintenance)

No.	Lumen Maintenance (%)						
	Ohr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs
26	12.06	100.08	99.83	99.67	99.34	99.09	98.92
27	12.00	99.75	99.42	99.33	99.17	98.92	98.75
28	11.12	100.09	99.91	99.46	99.10	98.83	98.56
29	12.07	99.92	99.67	99.34	99.17	98.92	98.76
30	12.01	99.92	99.75	99.58	99.33	99.00	98.83
31	12.11	99.92	99.75	99.67	99.34	99.09	98.76
32	11.65	99.91	99.74	99.48	99.31	99.06	98.88
33	11.91	100.08	99.92	99.75	99.50	99.16	98.74
34	11.96	100.08	99.75	99.50	99.33	99.08	98.66
35	10.92	99.82	99.54	99.27	98.81	98.44	98.17
36	11.93	100.08	99.83	99.50	99.33	99.08	98.91
37	11.06	100.18	100.09	99.91	99.64	99.46	99.28
38	12.06	100.08	99.67	99.42	99.09	98.84	98.59
39	10.82	100.18	99.82	99.63	99.45	99.26	98.89
40	12.15	100.25	99.92	99.59	99.34	99.18	99.01
41	10.92	100.09	99.91	99.54	99.27	99.08	98.81
42	11.52	100.09	99.83	99.65	99.39	99.22	98.96
43	11.72	99.91	99.66	99.49	99.32	99.15	98.89
44	12.16	100.16	99.84	99.59	99.42	99.18	98.93
45	12.11	100.17	99.83	99.59	99.34	99.09	99.01
46	11.72	99.83	99.57	99.32	98.98	98.81	98.63
47	10.82	100.09	99.91	99.63	99.26	98.89	98.61
48	12.11	99.92	99.67	99.50	99.34	99.26	99.09
49	11.95	100.17	99.83	99.67	99.58	99.33	98.91
50	12.19	100.08	99.84	99.43	99.18	98.85	98.61
Avg.	11.72	100.03	99.78	99.54	99.29	99.05	98.81
Med.	11.95	100.08	99.83	99.54	99.33	99.08	98.83
st dev	0.48	0.1326	0.1431	0.1470	0.1790	0.2085	0.2174
Min.	10.82	99.75	99.42	99.27	98.81	98.44	98.17
Max.	12.19	100.25	100.09	99.91	99.64	99.46	99.28



**3.5 Data Set 2, 85°C, 30mA (Forward Voltage)**

No.	Forward Voltage (V)						
	0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs
26	2.707	2.709	2.706	2.708	2.713	2.712	2.710
27	2.722	2.724	2.720	2.723	2.726	2.726	2.724
28	2.721	2.724	2.720	2.724	2.726	2.726	2.723
29	2.727	2.728	2.725	2.728	2.731	2.730	2.730
30	2.723	2.725	2.723	2.725	2.728	2.728	2.726
31	2.712	2.716	2.711	2.714	2.717	2.717	2.716
32	2.717	2.720	2.717	2.719	2.722	2.722	2.720
33	2.727	2.730	2.727	2.730	2.732	2.731	2.730
34	2.722	2.725	2.721	2.722	2.726	2.726	2.725
35	2.722	2.725	2.723	2.724	2.726	2.726	2.725
36	2.722	2.725	2.721	2.722	2.726	2.726	2.725
37	2.710	2.713	2.750	2.847	2.726	2.851	2.852
38	2.723	2.728	2.750	2.849	2.854	2.852	2.850
39	2.717	2.719	2.716	2.717	2.721	2.723	2.720
40	2.721	2.725	2.721	2.723	2.727	2.727	2.724
41	2.719	2.721	2.718	2.720	2.724	2.727	2.723
42	2.721	2.724	2.719	2.721	2.725	2.725	2.724
43	2.725	2.728	2.725	2.725	2.729	2.731	2.728
44	2.720	2.724	2.720	2.722	2.725	2.737	2.723
45	2.719	2.724	2.718	2.719	2.724	2.725	2.722
46	2.708	2.711	2.707	2.710	2.713	2.714	2.710
47	2.719	2.723	2.719	2.719	2.723	2.723	2.722
48	2.706	2.708	2.706	2.706	2.710	2.710	2.709
49	2.719	2.722	2.717	2.720	2.723	2.723	2.720
50	2.725	2.728	2.725	2.728	2.731	2.731	2.729
Avg.	2.719	2.722	2.721	2.720	2.729	2.735	2.732
Med.	2.721	2.724	2.720	2.728	2.726	2.726	2.724
st dev	0.006	0.006	0.010	0.036	0.027	0.036	0.036
Min.	2.706	2.708	2.706	2.706	2.710	2.710	2.709
Max.	2.727	2.730	2.750	2.849	2.854	2.852	2.852



**3.6 Data Set 2, 85°C, 30mA (Chromaticity Shift)**

No.			CCT(K)						
	Ohr(Initial)			1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs
26	0.2613	0.5256	2732	0.0004	0.0006	0.0008	0.0012	0.0016	0.0018
27	0.2617	0.5254	2724	0.0005	0.0006	0.0008	0.0013	0.0016	0.0017
28	0.2607	0.5230	2756	0.0004	0.0007	0.0009	0.0013	0.0017	0.0018
29	0.2613	0.5252	2734	0.0005	0.0006	0.0008	0.0013	0.0016	0.0018
30	0.2601	0.5247	2763	0.0005	0.0006	0.0008	0.0013	0.0017	0.0018
31	0.2601	0.5246	2762	0.0005	0.0006	0.0008	0.0012	0.0014	0.0017
32	0.2610	0.5229	2750	0.0003	0.0008	0.0009	0.0014	0.0017	0.0019
33	0.2616	0.5258	2724	0.0004	0.0007	0.0008	0.0013	0.0015	0.0018
34	0.2604	0.5245	2757	0.0005	0.0006	0.0008	0.0012	0.0015	0.0017
35	0.2626	0.5237	2712	0.0004	0.0008	0.0011	0.0018	0.0023	0.0025
36	0.2609	0.5240	2747	0.0005	0.0007	0.0009	0.0012	0.0016	0.0017
37	0.2602	0.5233	2766	0.0005	0.0004	0.0005	0.0011	0.0014	0.0013
38	0.2621	0.5252	2717	0.0004	0.0006	0.0007	0.0010	0.0013	0.0016
39	0.2622	0.5232	2724	0.0005	0.0007	0.0010	0.0015	0.0018	0.0021
40	0.2614	0.5254	2731	0.0005	0.0006	0.0008	0.0012	0.0015	0.0017
41	0.2622	0.5217	2730	0.0005	0.0005	0.0006	0.0008	0.0010	0.0013
42	0.2615	0.5229	2739	0.0004	0.0007	0.0008	0.0012	0.0016	0.0017
43	0.2616	0.5241	2733	0.0004	0.0008	0.0009	0.0015	0.0017	0.0020
44	0.2606	0.5254	2747	0.0005	0.0006	0.0008	0.0012	0.0015	0.0018
45	0.2610	0.5246	2744	0.0004	0.0006	0.0007	0.0011	0.0015	0.0017
46	0.2597	0.5227	2779	0.0004	0.0008	0.0009	0.0014	0.0017	0.0019
47	0.2630	0.5251	2698	0.0005	0.0007	0.0009	0.0013	0.0016	0.0018
48	0.2597	0.5247	2771	0.0005	0.0006	0.0008	0.0012	0.0015	0.0017
49	0.2613	0.5252	2734	0.0006	0.0007	0.0009	0.0012	0.0016	0.0017
50	0.2609	0.5252	2742	0.0005	0.0007	0.0008	0.0012	0.0015	0.0017
Avg.	0.2612	0.5243	2741	0.0005	0.0007	0.0008	0.0013	0.0016	0.0018
Med.	0.2613	0.5246	2739	0.0005	0.0006	0.0008	0.0012	0.0016	0.0017
st dev	0.0009	0.0011	20	0.0001	0.0001	0.0001	0.0002	0.0002	0.0002
Min.	0.2597	0.5217	2698	0.0003	0.0004	0.0005	0.0008	0.0010	0.0013
Max.	0.2630	0.5258	2779	0.0006	0.0008	0.0011	0.0018	0.0023	0.0025



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### 3.7 Data Set 3, 105°C, 30mA

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**3.8 Data Set 3, 105°C, 30mA (Forward Voltage)**

No.	Forward Voltage (V)						
	0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs
51	2.722	2.726	2.723	2.726	2.727	2.727	2.725
52	2.720	2.726	2.720	2.723	2.728	2.723	2.725
53	2.727	2.730	2.727	2.728	2.732	2.731	2.731
54	2.720	2.725	2.720	2.722	2.725	2.722	2.723
55	2.725	2.728	2.724	2.728	2.729	2.728	2.726
56	2.723	2.726	2.721	2.725	2.727	2.725	2.725
57	2.710	2.714	2.709	2.713	2.715	2.714	2.713
58	2.727	2.732	2.728	2.731	2.733	2.734	2.731
59	2.721	2.724	2.719	2.723	2.725	2.724	2.722
60	2.720	2.722	2.718	2.720	2.724	2.722	2.720
61	2.718	2.721	2.716	2.720	2.722	2.721	2.720
62	2.722	2.723	2.719	2.721	2.725	2.724	2.722
63	2.718	2.722	2.717	2.720	2.724	2.723	2.721
64	2.723	2.726	2.722	2.726	2.728	2.726	2.726
65	2.726	2.726	2.721	2.724	2.727	2.726	2.724
66	2.729	2.732	2.727	2.730	2.733	2.732	2.731
67	2.723	2.724	2.720	2.723	2.725	2.725	2.722
68	2.730	2.732	2.728	2.734	2.735	2.735	2.732
69	2.720	2.720	2.718	2.721	2.724	2.723	2.721
70	2.735	2.738	2.732	2.737	2.739	2.740	2.737
71	2.727	2.730	2.726	2.730	2.734	2.732	2.730
72	2.720	2.725	2.720	2.723	2.725	2.725	2.723
73	2.725	2.728	2.724	2.728	2.730	2.729	2.728
74	2.724	2.726	2.723	2.725	2.728	2.727	2.726
75	2.721	2.723	2.720	2.722	2.725	2.724	2.724
Avg.	2.723	2.726	2.722	2.725	2.728	2.726	2.725
Med.	2.723	2.726	2.721	2.724	2.727	2.725	2.725
st dev	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Min.	2.710	2.714	2.709	2.713	2.715	2.714	2.713
Max.	2.735	2.738	2.732	2.737	2.739	2.740	2.737





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### 4 - DUT Photo

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#### 4.1

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