



July 17, 2017

**Bridgelux LM80 Report: 10,000 Hours Test Data
Bridgelux Vero 29 LED Array: BXRC-30E10K0**

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This LM80 test as per IES LM-80-08/IES-LM-80-15 approved method was initiated in January 2016 and 10,000 hours life test was completed in July 2017.

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Number of LED Light Sources Tested

- 10 arrays tested at actual case temperature 85°C (nominal 85°C)
- 10 arrays tested at actual case temperature 105°C (nominal 105°C)

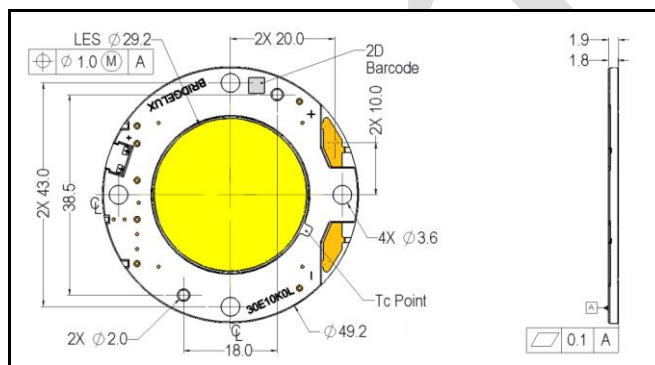
Samples have been selected to be representative of the overall population being tested. AQL “Zero Based Acceptance Sampling Plan” has been used to pick samples from a typical lot size of 250 units. The AQL level is 4%.

Description of LED Light Sources

Bridgelux Vero LED array: BXRC-30E10K0

- Color Temperature: 3000K

Figure 1: Drawing of BXRC-30E10K0 array



This report covers the following products:



All Vero Series Array products with part number:

BXRC-(A)(B)(C)(D)-(E)-7(F) [-SE]

where,

- (A) 2 digits for Nominal CCT: 17, 20, ..., 65 for 1750, 2000, ..., 6500 K
- (B) 1 letter for CRI: B, C, E, G, H for 65, 70, 80, 90 minimal, H for 97 typical, A for Class A



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- (C) 3 digits for Flux Indicator: 100, 10H for 1000 lm; 200, 20H for 2000 lm; 400, 40H for 4000 lm; 10K, 1KH for 10000 lm
 - (D) 1 digit for Color Targeting Designator: 0 for cold and 1 for hot targeted
 - (E) 1 letter for Array Configuration
 - (F) 1 digit for CCT Bin Options: 2, 3, 4 for 2, 3, 4 SDCM
- [-SE] Vero SE Designator (Omitted if not SE)

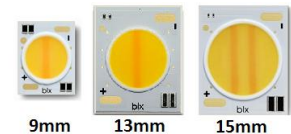


All V Series Array products with part number:

BXRE-(A)(B)(C)(D)-(E)-7(F)

where,

- (A) 2 digits for Nominal CCT: 17, 20, ..., 65 for 1750, 2000, ..., 6500 K
- (B) 1 letter for CRI: B, C, E, G for 65, 70, 80, 90 minimal, H for 97 typical, A for Class A
- (C) 3 digits for Flux Indicator: 080, 08H for 800 lm; 100, 10H for 1000 lm; 200, 20H for 2000 lm; 400, 40H for 4000 lm; 650, 65H for 6500 lm
- (D) 1 digit for Color Targeting Designator: 0 for Cold Targeted, 1 for Hot Targeted, C for Décor Series Showcase Target
- (E) 1 letter for Array Configuration
- (F) 1 digit for CCT Bin Options: 2, 3, 4 for 2, 3, 4 SDCM



All Vesta Series Dim-To-Warm Array products with part number:

BXRV-DR-1830(A)-(B)-(C)-(D)

where,

- (A) 1 letter for Minimal CRI: G, H for 90, 95 CRI
- (B) 4 digits for Form Factor Designator: 1000, 2000, 3000 for 9, 13, 15 mm LES
- (C) 1 letter for Array Configuration
- (D) 2 digits for CCT Bin Options: 13 for 3 SDCM

All product models in above coverage list exhibit:

- Same or smaller LED package size, compared with the tested LED package
- Equal or fewer LED dies, compared with the tested LED package
- Minimum die edge to die edge spacing greater than or equal to that of the tested LED package
- Electrical power density less than or equal to the tested LED package
- Average current density per LED die less than or equal to the tested LED
- Identical materials used
- Identical construction processes used

Description of Auxiliary Equipment

- Photometry Tester: Automated LED array tester
- Temperature control systems to achieve and maintain required conditions
- Software controlled power supply to provide regulated constant currents to drive LED light sources in life testing

Automated LED array tester: The tester is capable of testing an entire board with up to 12 samples. The tester consists of a spectrometer, handler, power supplies and a computer.

Sample preparation: Devices under Test (DUT) are soldered to PCBs which are mounted on metallic plates. These plates are mounted on heat sinks to maintain test temperatures required by the LM80 test method.

All necessary steps are taken to ensure the uniformity of temperature and environmental conditions to meet LM80 test requirements.

Operating Cycle**Test Condition**

Drive Current: Constant current, 3960 mA per LED package
Current density is 369.2 mA/mm² per LED die.

Typical Voltage: 78.4V per DUT

Ambient Conditions

Temperature of the air surrounding DUTs is controlled to be less than 5°C below the case temperature as required by LM80 specification.



Table 1: Sample case temperature and ambient conditions

Surrounding Temperature	Actual Case Temperature	Nominal Case Temperature	Relative Humidity
83°C	85°C	85°C	<60%
103°C	105°C	105°C	<60%

Airflow is kept to minimum to maintain the required temperature uniformity as defined in the LM80 requirements document.

Case Temperature

Nominal 85°C and 105°C; actual case temperatures not lower by more than 2 °C during life testing

Physical Condition of DUTs at each Photometry Measurement

- No cracks
- No discoloration
- No electrical discontinuity

LED Light Source Monitoring Interval

Measurements have been taken after the following durations for Tc of both 85°C and 105 °C:

0, 1000, 2000, 3000, 4000, 5000, 6000, 7000, 8000, 9000 and 10000 hours

Initial Photometry Measurement

Table 2: Initial luminous flux, forward voltage and correlated color temperature at photometric measurement current

First set (samples tested at actual case temperature 85°C)

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Average	Median	Standard Deviation	Max	Mn
Initial Flux, lm	28351.9	27808.8	27947.4	28571.7	28066.0	28627.3	28255.7	28407.5	28357.8	28526.4	28292.0	28354.8	273.1	28627.3	27808.8
Forward Voltage, V	78.1	78.7	78.5	78.2	79.5	78.2	77.9	78.6	78.3	77.9	78.4	78.3	0.5	79.5	77.9
CCT, K	3091.6	3082.9	3097.4	3102.4	3093.7	3096.6	3089.9	3125.1	3088.2	3106.1	3097.4	3095.1	11.9	3125.1	3082.9

Second set (samples tested at actual case temperature 105°C)

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Average	Median	Standard Deviation	Max	Mn
Initial Flux, lm	28073.1	28425.3	28295.3	28305.1	27909.7	27941.8	28284.5	28803.5	28006.5	28301.2	28234.6	28289.9	267.7	28803.5	27909.7
Forward Voltage, V	77.7	78.5	77.8	78.7	78.3	78.7	77.8	78.5	78.4	78.2	78.2	78.4	0.4	78.7	77.7
CCT, K	3110.6	3127.3	3102.1	3107.4	3130.7	3108.8	3107.0	3084.5	3123.0	3133.9	3113.5	3109.7	15.2	3133.9	3084.5





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Ambient temperature during lumen and chromaticity measurements was maintained at 25°C ±2°C.

Lumen Maintenance

Ambient temperature during lumen measurements was maintained at 25°C ±2°C

Table 3: Lumen maintenance at actual case temperature 85°C

Hours	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Average	Median	Standard Deviation	Max	Min
0	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	0.0%	100.0%	100.0%
1000	98.6%	98.5%	98.3%	98.5%	98.6%	98.6%	98.9%	98.6%	99.1%	98.5%	98.6%	98.6%	0.2%	99.1%	98.3%
2000	98.9%	98.5%	98.7%	98.6%	98.9%	98.6%	98.9%	98.1%	99.3%	98.7%	98.7%	98.7%	0.3%	99.3%	98.1%
3000	98.9%	98.7%	98.4%	98.8%	99.1%	98.8%	98.3%	97.9%	98.3%	97.8%	98.5%	98.6%	0.5%	99.1%	97.8%
4000	98.1%	98.0%	97.8%	98.3%	98.2%	98.5%	98.1%	97.5%	97.7%	97.9%	98.0%	98.1%	0.3%	98.5%	97.5%
5000	98.5%	98.1%	98.2%	98.9%	98.6%	98.5%	98.6%	98.0%	98.3%	98.1%	98.4%	98.4%	0.3%	98.9%	98.0%
6000	98.4%	98.5%	98.1%	98.5%	98.5%	98.5%	99.3%	98.1%	98.2%	98.0%	98.4%	98.4%	0.4%	99.3%	98.0%
7000	98.1%	97.8%	97.8%	98.3%	98.4%	98.3%	98.5%	98.1%	98.5%	97.8%	98.2%	98.2%	0.3%	98.5%	97.8%
8000	97.9%	97.7%	97.7%	97.9%	97.9%	97.9%	98.1%	97.7%	97.7%	97.8%	97.8%	97.8%	0.1%	98.1%	97.7%
9000	97.6%	97.7%	97.8%	97.8%	97.7%	98.1%	97.6%	97.6%	97.5%	97.4%	97.7%	97.6%	0.2%	98.1%	97.4%
10000	97.9%	97.8%	97.4%	97.7%	97.4%	98.1%	97.7%	97.7%	97.6%	97.6%	97.7%	97.7%	0.2%	98.1%	97.4%

Figure 2: Lumen maintenance at actual case temperature 85°C

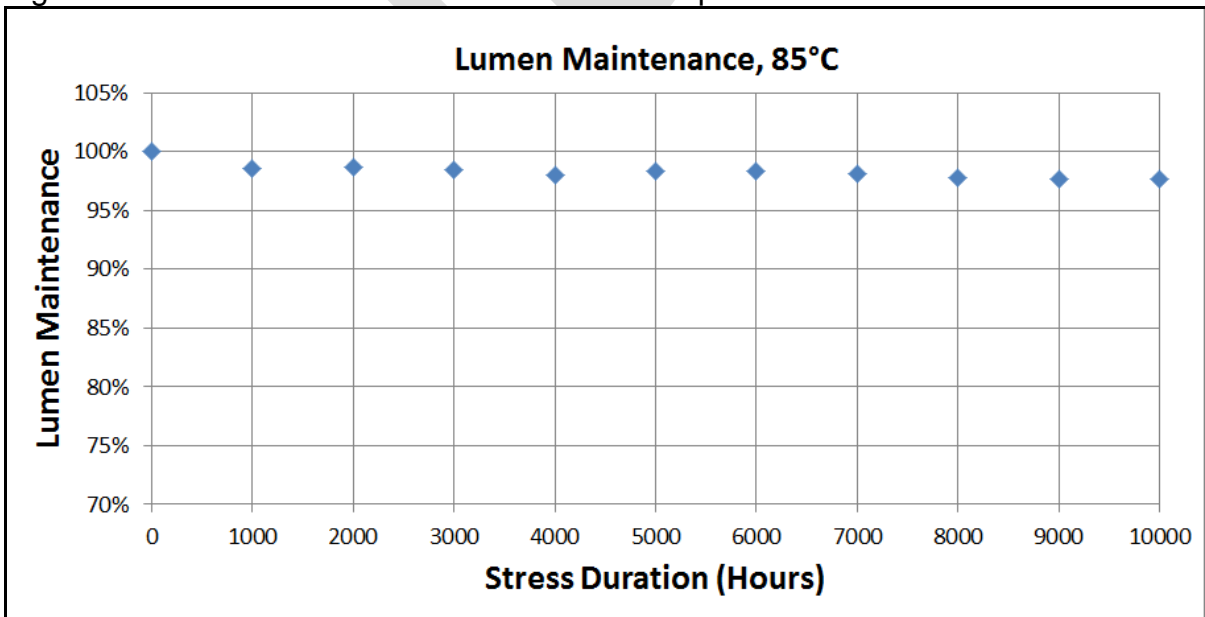
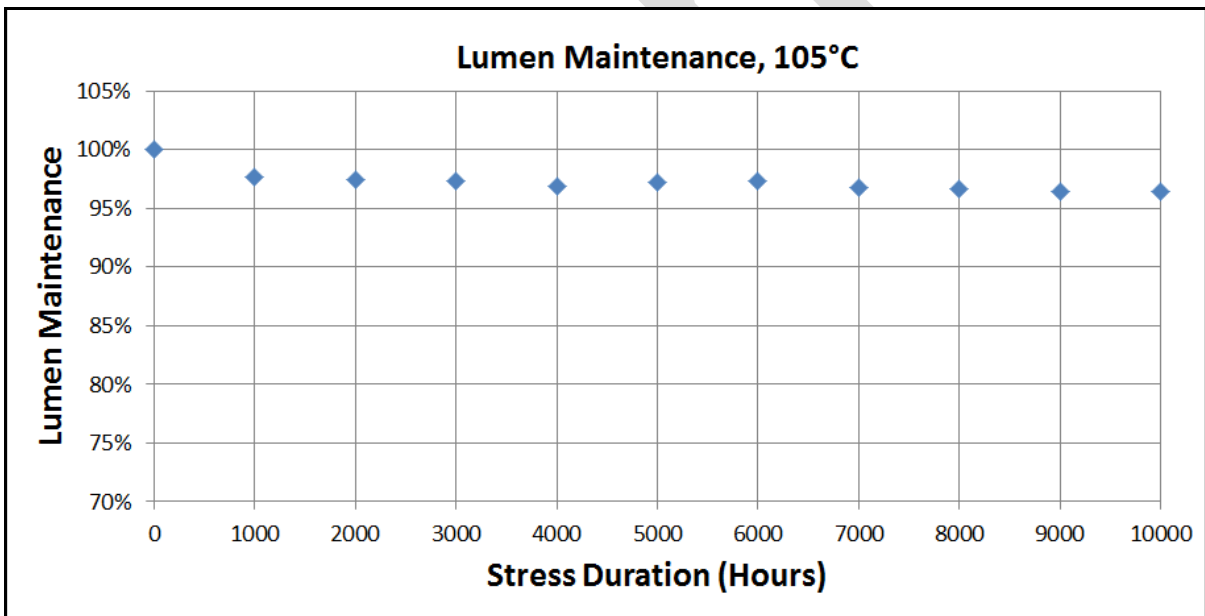


Table 4: Lumen maintenance at actual case temperature 105°C

Hours	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Average	Median	Standard Deviation	Max	Min
0	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.00%	100.0%	0.0%	100.0%	100.0%
1000	97.7%	97.8%	97.5%	96.6%	98.0%	97.6%	97.6%	98.0%	98.2%	98.1%	97.70%	97.8%	0.5%	98.2%	96.6%
2000	97.8%	97.6%	97.0%	96.6%	98.2%	97.2%	97.3%	97.6%	97.8%	97.6%	97.47%	97.6%	0.4%	98.2%	96.6%
3000	97.1%	97.1%	97.1%	96.9%	97.9%	97.2%	97.5%	97.3%	97.7%	97.3%	97.31%	97.2%	0.3%	97.9%	96.9%
4000	96.6%	97.4%	96.8%	97.0%	97.4%	96.7%	96.3%	96.7%	96.9%	96.9%	96.85%	96.8%	0.4%	97.4%	96.3%
5000	96.7%	97.4%	97.1%	97.0%	98.1%	97.2%	96.8%	97.2%	97.2%	97.1%	97.19%	97.2%	0.4%	98.1%	96.7%
6000	96.6%	97.5%	97.5%	97.5%	97.9%	97.0%	96.8%	97.9%	97.3%	97.3%	97.33%	97.4%	0.4%	97.9%	96.6%
7000	96.3%	97.5%	97.5%	97.6%	96.9%	96.3%	96.1%	96.8%	96.5%	96.8%	96.82%	96.8%	0.5%	97.6%	96.1%
8000	96.4%	97.9%	97.9%	97.9%	96.5%	96.1%	95.1%	96.4%	96.1%	96.3%	96.67%	96.4%	0.9%	97.9%	95.1%
9000	96.5%	98.0%	97.6%	97.7%	95.9%	95.4%	95.2%	96.4%	95.9%	96.4%	96.49%	96.4%	1.0%	98.0%	95.2%
10000	96.9%	97.6%	97.4%	97.4%	96.0%	95.5%	94.9%	96.4%	96.1%	96.2%	96.44%	96.3%	0.9%	97.6%	94.9%

Figure 3: Lumen maintenance at actual case temperature 105°C





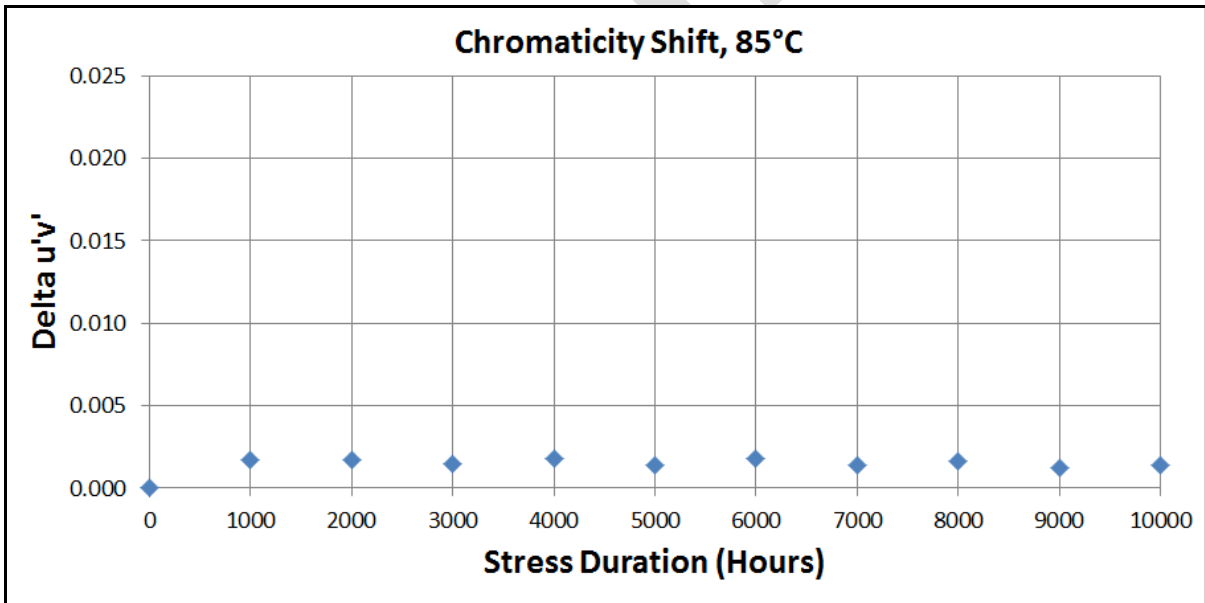
Chromaticity Shift

Ambient temperature during chromaticity measurements was maintained at 25°C ±2°C

Table 5: Chromaticity shift (Delta u'v') at actual case temperature 85°C

Hours	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Average	Median	Standard Deviation	Max	Min
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1000	0.0019	0.0019	0.0019	0.0019	0.0020	0.0018	0.0015	0.0014	0.0014	0.0014	0.0017	0.0019	0.0002	0.0020	0.0014
2000	0.0019	0.0019	0.0018	0.0018	0.0018	0.0019	0.0017	0.0016	0.0016	0.0015	0.0017	0.0018	0.0001	0.0019	0.0015
3000	0.0016	0.0016	0.0014	0.0015	0.0016	0.0015	0.0015	0.0014	0.0013	0.0015	0.0015	0.0015	0.0001	0.0016	0.0013
4000	0.0019	0.0018	0.0018	0.0017	0.0020	0.0018	0.0019	0.0018	0.0017	0.0016	0.0018	0.0018	0.0001	0.0020	0.0016
5000	0.0013	0.0015	0.0013	0.0013	0.0014	0.0014	0.0014	0.0013	0.0013	0.0013	0.0014	0.0013	0.0001	0.0015	0.0013
6000	0.0019	0.0020	0.0017	0.0016	0.0020	0.0018	0.0019	0.0018	0.0018	0.0017	0.0018	0.0018	0.0001	0.0020	0.0016
7000	0.0014	0.0016	0.0013	0.0013	0.0015	0.0012	0.0015	0.0016	0.0015	0.0014	0.0014	0.0014	0.0001	0.0016	0.0012
8000	0.0016	0.0018	0.0015	0.0016	0.0017	0.0015	0.0017	0.0015	0.0017	0.0016	0.0016	0.0016	0.0001	0.0018	0.0015
9000	0.0014	0.0014	0.0012	0.0012	0.0013	0.0010	0.0012	0.0012	0.0014	0.0013	0.0013	0.0013	0.0001	0.0014	0.0010
10000	0.0015	0.0016	0.0013	0.0013	0.0015	0.0014	0.0013	0.0012	0.0014	0.0013	0.0014	0.0013	0.0001	0.0016	0.0012

Figure 4: Chromaticity shift (Delta u'v') at actual case temperature 85°C



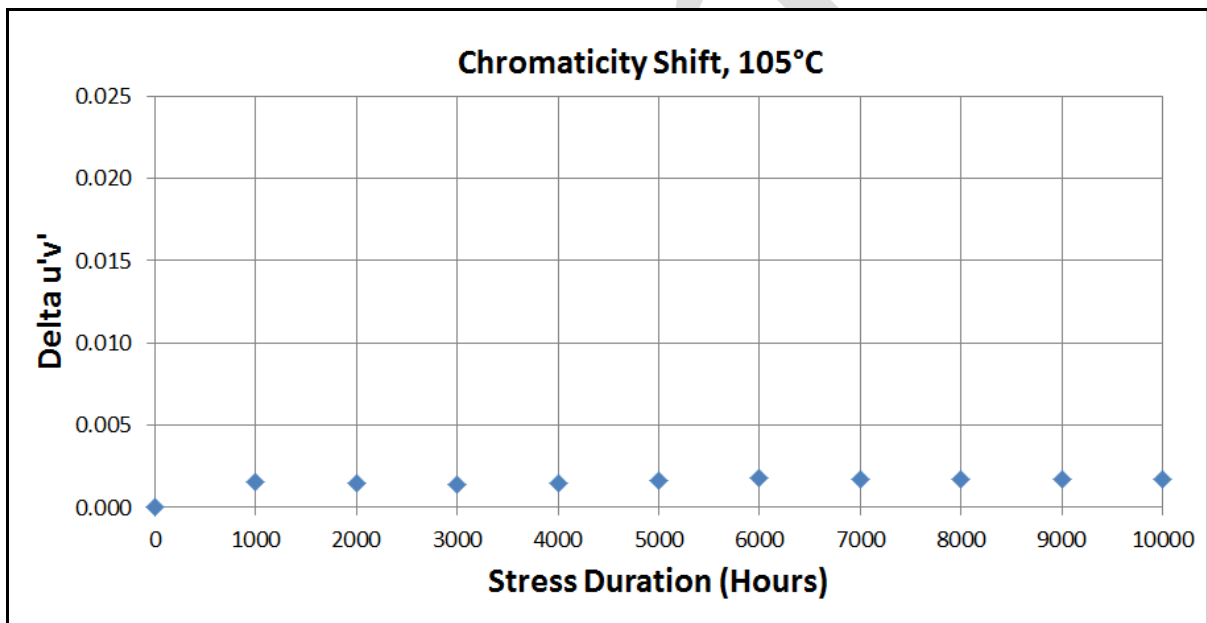


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Report Number: BL-LM80-Vero29-7G-2X

Table 6: Chromaticity shift (Delta u'v') at actual case temperature 105°C

Hours	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Average	Median	Standard Deviation	Max	Min
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1000	0.0016	0.0014	0.0018	0.0018	0.0014	0.0014	0.0015	0.0016	0.0015	0.0015	0.0016	0.0015	0.0001	0.0018	0.0014
2000	0.0017	0.0015	0.0017	0.0017	0.0014	0.0012	0.0015	0.0014	0.0014	0.0013	0.0015	0.0015	0.0002	0.0017	0.0012
3000	0.0012	0.0012	0.0014	0.0015	0.0013	0.0014	0.0016	0.0016	0.0014	0.0014	0.0014	0.0014	0.0001	0.0016	0.0012
4000	0.0016	0.0016	0.0018	0.0020	0.0013	0.0013	0.0014	0.0013	0.0013	0.0013	0.0015	0.0014	0.0003	0.0020	0.0013
5000	0.0014	0.0014	0.0016	0.0020	0.0016	0.0016	0.0017	0.0017	0.0015	0.0016	0.0016	0.0016	0.0002	0.0020	0.0014
6000	0.0021	0.0022	0.0026	0.0029	0.0012	0.0013	0.0014	0.0016	0.0012	0.0014	0.0018	0.0015	0.0006	0.0029	0.0012
7000	0.0020	0.0021	0.0023	0.0026	0.0013	0.0013	0.0014	0.0017	0.0011	0.0014	0.0017	0.0015	0.0005	0.0026	0.0011
8000	0.0018	0.0020	0.0024	0.0025	0.0012	0.0012	0.0016	0.0018	0.0014	0.0014	0.0017	0.0017	0.0005	0.0025	0.0012
9000	0.0018	0.0018	0.0021	0.0024	0.0012	0.0012	0.0017	0.0018	0.0014	0.0015	0.0017	0.0017	0.0004	0.0024	0.0012
10000	0.0019	0.0020	0.0021	0.0025	0.0011	0.0012	0.0015	0.0017	0.0015	0.0016	0.0017	0.0016	0.0004	0.0025	0.0011

Figure 5: Chromaticity shift (Delta u'v') at actual case temperature 105°C



Observation of LED Light Source Failures

No optical, electrical or mechanical failure of any LED light source was found during life testing.





Photometric Measurement Uncertainty

The tester is calibrated annually and the calibration data ensures <1.3% uncertainty of measurement.

Gauge Study Results

Gauge study shows the following results:

R&R: 0.15% (5.15-sigma)
Standard Deviation: 0.03%

Equipment List

1)

Description: DC Power Supply
Manufacturer: Vektrex
Model: SS200
Last Calibration Date: 09/16/16
Next Calibration Due Date: 09/16/17

2)

Description: Source Measure Unit
Manufacturer: Keithley
Model: 2430
Last Calibration Date: 09/13/16
Next Calibration Due Date: 09/13/17

3)

Description: Digital Thermometer
Manufacturer: Pico
Model: TC08
Last Calibration Date: 09/13/16
Next Calibration Due Date: 09/13/17

4)

Description: Digital Multimeter
Manufacturer: Fluke
Model: 179
Last Calibration Date: 09/13/16
Next Calibration Due Date: 09/13/17



Lab Accreditation Certificate



CERTIFICATE OF ACCREDITATION

This is to attest that

BRIDGELUX, INC
46430, FREMONT BOULEVARD
FREMONT, CALIFORNIA 94538

Testing Laboratory TL-514

has met the requirements of AC89, *IAS Accreditation Criteria for Testing Laboratories*, and has demonstrated compliance with ISO/IEC Standard 17025:2005, *General requirements for the competence of testing and calibration laboratories*. This organization is accredited to provide the services specified in the scope of accreditation maintained on the IAS website (www.iasonline.org).

This certificate is valid up to December 1, 2017.



This accreditation certificate supersedes any IAS accreditation bearing an earlier effective date. The certificate becomes invalid upon suspension, cancellation or revocation of accreditation. See www.iasonline.org for current accreditation information, or contact IAS at 562-364-8201.



C.P. Ramani
C.P. Ramani, P.E., C.B.O
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Telephone	925-583-8716
Effective Date of Scope	April 12, 2017
Accreditation Standard	ISO/IEC 17025:2005

Lighting Energy Star

CIE Pub. 13.3:1995	Method of measuring and specifying color rendering properties of light sources
CIE Pub. 15:2004	Colorimetry
IES LM-58	Spectroradiometric measurement methods for light sources
IES LM-80-08	Measuring lumen maintenance of LED light sources
IES LM-80-15	Measuring luminous flux and color maintenance of led packages, arrays, and modules
IES LM-82-12	Characterization of LED light engines and LED lamps for electrical and photometric properties as a function of temperature
IESNA LM-79	Electrical and photometric measurements of solid-state lighting products

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