XICATO

Xicato Product Reliability Update

Version 20130820

Overview

In 2008 the IES (Illuminating Engineering Society) issued LM-80-08 *Measuring Lumen Maintenance of LED Light Sources.* More recently, they issued TM-21-11 *Projecting Long Term Lumen Maintenance of LED Light Sources.* In late 2011 the United States Department of Energy, Energy Star Program, issued testing and reporting guidance on how to address successor LED packages and product "series"[1]. These three documents provide the foundational guidance for Xicato reliability testing and lumen maintenance reporting. For color maintenance, in 2012 Xicato developed its own methodology to project long term color maintenance of its LED light sources. Finally, in February 2013 Xicato announced a comprehensive product warranty, which covers catastrophic failure, lumen maintenance, and color consistency for 5 years (operating 24/7/365 this equates to 44,000 hrs.).

Xicato's product reliability program has four key elements:

1. Xicato LED Chip Qualification Reliability Testing

Xicato requires that its suppliers conduct extensive stress testing of LED's to ensuring that their product meets the reliability standards required for our products. This includes HTOL, RTOL, LTOL, WHTOL, PTMCL, TMCL, TMSK, HTSL, LTSL, Mechanical shock, Vibration, Solderability, Autoclave, and MSL. Table 1 summarizes typical tests applied.

2. Product Development

During product development and prior to launch, modules are subjected to a minimum of 1000 hours of Wet High Temperature Operating Life (WHOTL) testing. WHTOL testing is the industry standard method of accelerated stress testing at 85˚C and 85% relative humidity. Modules are also subjected to repetitive temperature cycling between 25°C and 95°C.

Xicato modules are designed for protection against access to hazardous parts inside the module, protection of the components inside the module against ingress of solid foreign objects, and protection of the components inside the module against the ingress of water. Modules are tested and certified to IEC 60529 (note that this rating does not negate the need for the luminaire itself to be IP rated). Table 2 summarizes the above tests.

[1] http://www.energystar.gov/products/specs/sites/products/files/ENERGY_STAR_Final_Lumen_Maintenance_Guidance_0.pdf

3. Production Product Testing

Production products are placed into long-term testing. Xicato tests products at LM-80's highest test temperature (85°C), and at the module's highest rated operating current (e.g. 1050mA). Test duration is for a minimum of 6,000 hours. Testing is done internally and externally. A summary of testing is presented in Table 3, including any deviations to LM-80.

4. Specification Data, Reporting and Application

Xicato's performance specification data is presented in each module family's respective product data sheet. Minimum specifications are L70/50,000 hours. for lumen maintenance and C3/50,000 hours for color maintenance, when operating at 90°C Tc. "L" as in "L70" is a typical industry convention for lumen maintenance. "C" as in "C3" is a convention Xicato recommends to industry. It addresses an LED module's maintained color point compared to its original color point, as measured using CIE 1976 color space (u',v'). The "3" refers to less than .003 Δ u',v', when compared to the original color point.

Prior to TM-21 it was customary for LED manufacturers to report "B" (average) values on reliability reports and product data sheets (e.g. L70/B50/50,000 hours.). This "B" convention is also common with conventional lamps where a product data sheet lifetime value refers to the time when 50% of the lamp population catastrophically fails. The new standard for reliability data reporting is found in TM-21 (section 5.2.6) and is the notation "L_{xx} *(9k)"* prefacing the projected hours to be claimed. For example, *"*L_{70} *(9k)=50,000 hrs."* is a product that is projected to produce at least 70% of its original light output at 50,000 hrs, based on 9,000 hrs of LM-80 testing. It addresses an average of a population of light sources. Consistent with TM-21, Xicato's color maintenance specification is also an average of a population of modules.

Available reliability test reports are presented below in Table 1. To project lumen maintenance, Xicato uses the TM-21 calculator[2] on all tests. A minimum of 9,100 hours is required to project to 50,000 hours using TM-21 for sample sizes of 10 (5.5 x the number of hours tested).

To ensure the quality and performance of Xicato modules are maximized, Xicato recommends its customers participate in the Luminaire Thermal Validation Program. Refer to the website for additional information. If customers have questions about module reliability within a luminaire and given conditions, they should contact their supplier or their Account Manager.

[2] www.energystar.gov/TM-21calculator

Table 1. Typical operating life, mechanical, and environmental tests performed by LED suppliers.

Stress Test	**Stress Conditions**	**Stress Duration**
Wet High Temperature Operating Life (WHTOL)	85°C/85%RH, IF = max. DC	1000 hours
High Temperature Operating Life (HTOL)	85°C, IF = max. DC	1000 hours
Room Temperature Operating Life (RTOL)	55°C, IF = max. DC	1000 hours
Low Temperature Operating Life (LTOL)	-40°C, IF = max. DC	1000 hours
High Temperature Storage Life (HTSL)	150°C, non-operating	1000 hours
Low Temperature Storage Life (LTSL)	-55°C, non-operating	1000 hours
Powered Temperature Cycle (PTMCL)	-40°C to 120°C, 18 minutes dwell, 42 minutes transfer (2 hour cycle), 5 minutes ON/5 minutes OFF, IF = 700mA	500 cycles
Non-Operating Thermal Shock (TMSK)	-40°C to 110°C, 20 minutes dwell, <10s transfer	500 cycles
Non-Operating Temperature Cycle (TMCL)	-40°C to 120°C, 15 minutes dwell/15 minute transfer	500 cycles
Solder Heat Resistance	Three Pb-free reflow solder profiles, (SHR) included in JEDEC Level 1 tests	
Variable Vibration Frequency	10-2000-10Hz, log or linear sweep rate, 20G for approximately 1 minute, 1.5mm, each applied three times per axis over 6 hours	
Variable Vibration	10-55-10Hz, 1.5mm excursion, 55-2000Hz, 1 octave per minute, Frequency 10G, three times per axis	
Random Vibration	6G RMS, 10-2000Hz, 10 minutes per axis	
Mechanical Shock	1500G, 0.5ms pulse, 5 shocks each 6 axis	
Autoclave	121°C, 100%RH, 15psig	96 hours
JEDEC Level 1 MSL	Precondition at 85°C and 85%RH for 168 hours, followed by three Pb-free reflow solder profiles. First reflow needs to be completed between 15 minutes and 4 hours after 85°C/85% 168 hour stress is completed.	
Electrostatic Discharges	R=1.5kΩ, C=100pF Test voltage=2kV	3 times

Table 2. Typical Product Development Tests Performed on Xicato Products

Test	**Standard**	**Test Specifications**
WHTOL (Wet High Temperature Operating Life) or Steady-State Temperature Humidity Bias Life Test	JEDEC Standard JESD22-A101C	Ambient environment: 85˚C/ 85% RH Forward current: 0.7A, 1.05A Cycle Bias: 1 hour on, 1 hour off Duration of test: 1000 hrs. (min.) Typical measurement interval (hrs.): 50, 100, 200, 500, 1000, then every 1000 hrs.
Temperature cycling		25˚C to 95˚C 1000+ cycles
IP66	IEC 60529	• No ingress of dust; complete protection against contact. • Water projected in powerful jets (12.5mm nozzle) against the enclosure from any direction shall have no harmful effects.

Table 3. Production Product Long Term Testing

Tested Module (Test Report)	Testing Details	Projected Lumen Maintenance (85°C)	Product Families by Similarity
XSM8030-1300-B (5009)	External LM-80 compliant (55°C, 85°C, 100°C) 9,100 hrs. 11 samples 0 catastrophic failures	L_{86} (9.1k)=50,000 hrs.	XSM80XX-1300-C XSM80XX-1000-B/C XSM80XX-700-B/C XSM80XX-400-B/C XSM95XX 1000-B/C XSM95XX 700-B/C
XSM8030-2000-B (2203)	Internal 85°C 9,938 hrs. 6 samples 0 catastrophic failures	L_{84} (9.9k)=50,000 hrs.	XSM80XX-2000-C XSM95XX-1300-C XSM80XX-1300-C XSM80XX-1000-B/C XSM80XX-700-B/C XSM80XX-400-B/C XSM95XX 1000-B/C XSM95XX 700-B/C
XLM8030-4000-B (5081)	Internal 85°C 6,106 hrs. 5 samples 0 catastrophic failures	L_{101} (6.1k)=35,000 hrs.	XLM95XX-3000-B XLM80XX-3000-B
XSM8030-3000-C (5119)	Internal 85°C 6,058 hrs. 4 samples 0 catastrophic failures	L_{86} (6.1k)= 35,000 hrs.	XSM9527-2000-C
XSM9530-1000-B (1130)	Internal 85°C 10,119 hrs. 6 samples 0 catastrophic failures	L_{102} (10k)=50,000 hrs.	XSM95XX 700-B/C
XLM9530-3000-B (5088)	Internal 85°C 6,063 hrs. 6 samples 0 catastrophic failures	L_{99} (6.1k)=35,000 hrs.	