

Reliability Test Report

Light Engine: 1-10W Encapsulated Cones and Cylinders

Driver: PS10 series 125-450mA

Module: BB01CK and BB03FL, HL series

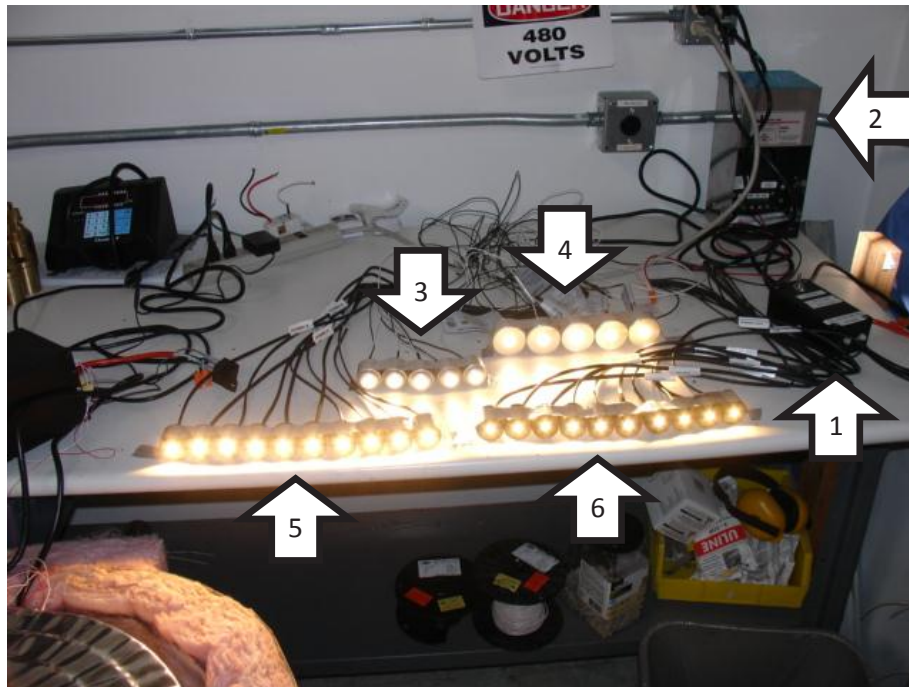
- 1) **On-Off Test. 20 potted Cones and Cylinders were used**
 - a. **Purpose:** to test durability of the system to repeated on-off cycles since majority of failures at SPJ occurred at turn on.
 - b. **Test Condition:** On for 7.7 and off for 14 seconds in room temperature on the bench
 - c. **Success:** Light up at power on every time
 - d. **Failure:** Failure to light up, burn, flash, visibly dim, short input
 - e. **Result: PASS.** After an equivalent period of 2200 years (1 on and off per day) 100% of Permlight Cylinders were still operating and only 70% of "Brand A" modules were running.
 - f. **Failure mode:** No light at turn on for 3 of 10 "Brand A". Reason was unknown due to potting.
 - g. **Detail:** This test was performed with 20 SPJ Cylinders and 10 "Brand A" modules supplied by SPJ. The cylinders included 10 at 450mA and 10 at 125mA to cover the power span. The set of 30 units were all connected to a common electrical source which was an off the shelf magnetic transformer widely used by SPJ (Justin Inc. model GL100). Test started on 3/19/2012 and ran continuously for 135 days turning on and off every 21.7 seconds (Electrical Cycle Test – begin 3/19/12, end 8/1/12 = 135 days = 2200 years in field).

- 2) **Thermal Test. Two potted Cylinders were used**
 - a. **Purpose:** to determine safe LED and driver temperature at up to 60°C/140°F ambient application.
 - b. **Test Condition:** Two cylinders at full power (450mA) overnight at 60°C.
 - c. **Success:** $T_s < 125^\circ\text{C}$ and $T_c < 105^\circ\text{C}$ at 60°C. T_c was measured at the bridge rectifier and correlated to the IC junction.
 - d. **Failure:** $T_s > 125^\circ\text{C}$ and $T_c > 105^\circ\text{C}$ at 60°C
 - e. **Result: PASS.** $T_s = 92^\circ\text{C}$ and $T_c = 93^\circ\text{C}$ at 60°C
 - f. **Detail:** Residential warming oven was used to keep temperature at 60°C for 24 hours.

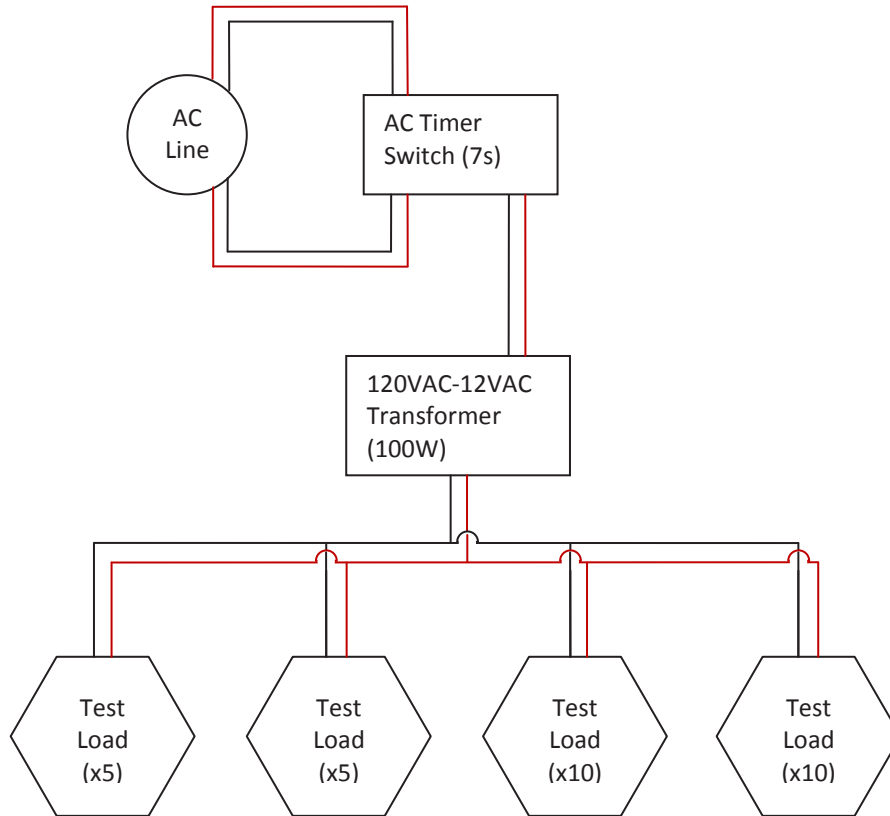
- 3) **Salt Fog (Submersion)Test. 3 Potted Cylinders were placed in 15 grams per gallon of table salt in tap water for extreme acceleration**
- a. **Purpose:** to test for system electrical, optical and mechanical durability in moist and salty environment in an extreme accelerated manner. No particular standard.
 - b. **Test Condition:** Leave 3 units powered up and visually inspect for visible damages or discoloration
 - c. **Success:** Light up at power on every time
 - d. **Failure:** Electrical failure to light up, burn, flash, visibly dim, short input; visible discoloration of optical components, mechanical deformation
 - e. **Result: PASS.** 1st unit failed after 40 days, 2nd unit failed after 56 days, 3rd unit failed after 62 days. All failures were for damaged clear coat. No mechanical or electrical failures were noted.
 - f. **Failure mode:** No light at turn on

Electrical Cycle Stress Test Setup

1. AC Timer Switch (7s)
2. 120VAC-12VAC Transformer (100W)
3. Test Loads ("Brand A", x5)
4. Test Loads ("Brand A", x5)
5. Test Loads (BEH01CK, 450mA, x10)
6. Test Loads (BEH01CK, 125mA, x10)

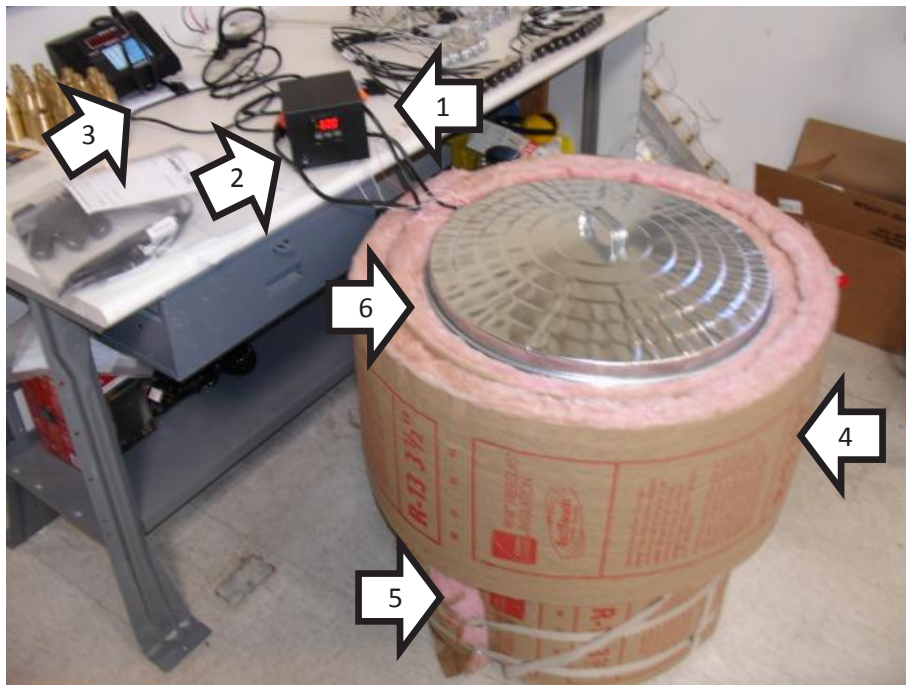


Electrical Cycle Stress Test Wiring Diagram



Thermal Cycle Stress Test Setup

1. Switch
2. Thermal control device
3. 15W 12VDC Driver
4. Thermal Chamber
5. Oven (inside chamber)
6. Thermocouple (inside chamber)



Thermal Cycle Stress Test Wiring Diagram

