## Introduction

360° Test Labs has been retained to perform tests and measurements upon supplied T4-type LED strip fixtures and lamps for direct comparison against previously-tested T5 fluorescent fixtures/lamps, as shown below (note that the LED lamps are T4 size rather than T5 size):

The ten lamps provided and tested were all manufactured by Brand of the UK:

- 3 model _10 500 mm-length, Pure White with Clear shroud;
- 3 model _11 500 mm-length, Pure White with Pearl shroud;
- 1 model _02 300 mm-length, Pure White with Clear shroud;
- 1 model _03 300 mm-length, Pure White with Pearl shroud;
- 1 model _24 300 mm-length, Warm White with Clear shroud; and
- 1 model _30 300 mm-length, Warm White with Pearl shroud.

Ten power cords were also provided (without plugs).

All of the fixtures provided are rated to operate from 110VAC, 50/60 Hz. There was no voltage range mentioned in the Installation Instructions sheet such as 100 to 130 VAC; but we did find a voltage tolerance of ±5% (104.5 to 115.5VAC) on the single-page datasheet downloadable from the www.brand.co.uk web site.

During our tests, our applied voltage was 124VAC +/- 2 volts, 60 Hz, since this would be the nominal voltage applied throughout most of North America.

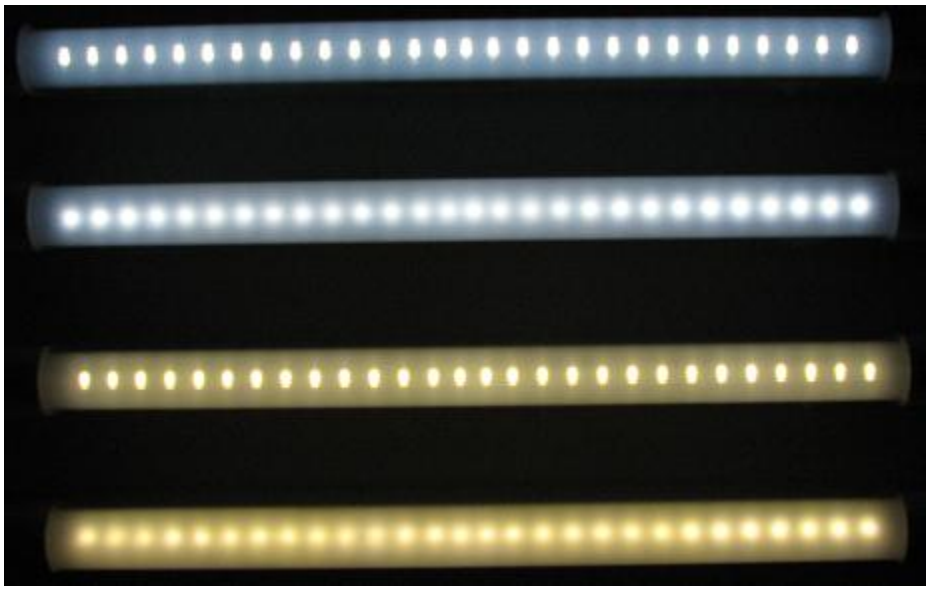
External and internal inspections were conducted to:

1. measure light output (in Lumens, Lux, or Foot Candles) and approximate color temperatures (in K°);
2. measure fixture operating temperatures (at several locations)
3. determine general fixture build, circuit component quality, lamp construction, fit and connections, including cord;
4. validate "End of Life" circuitry (if any); and
5. compare available specifications against the competing product, as well as the previously-tested T5 fixtures/lamps.

The following describes our findings.

**Illuminated Lamp Appearance**

Four basic types of lamps were provided, which included two different kinds of shrouds, Clear and Pearl, and two different color temperatures, Pure White and Warm White. The following photo of the 300 mm models shows the difference in appearance when looking at each lamp type (the equivalent 500mm model number is also listed for the Pure White lamps).



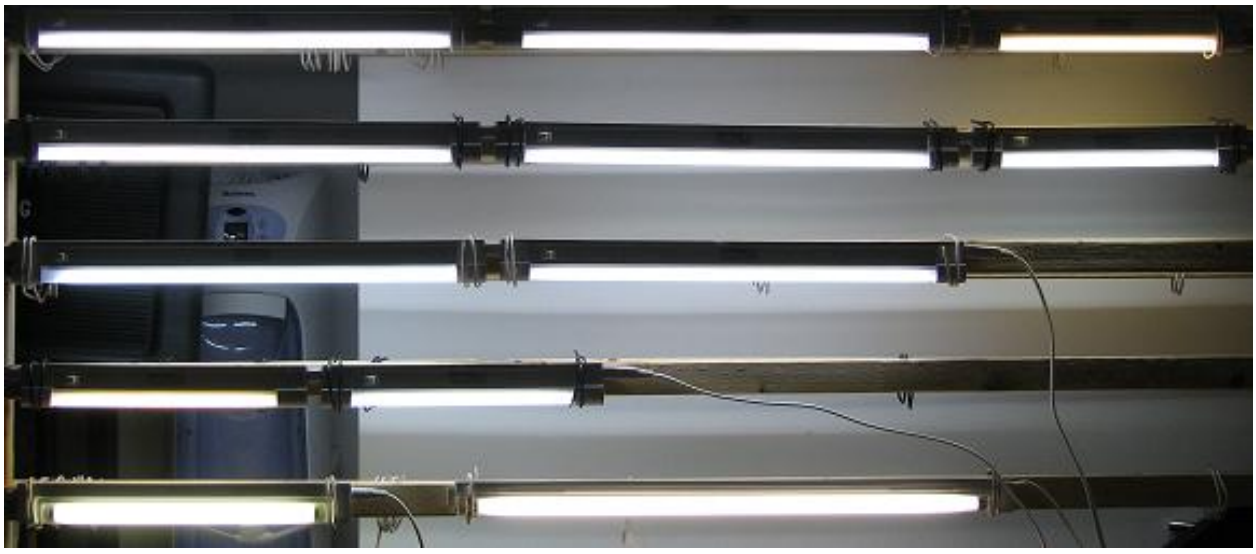
**Model _02 (or _10): Pure White, Clear Shroud**

**Model _03 (or _11): Pure White, Pearl Shroud**

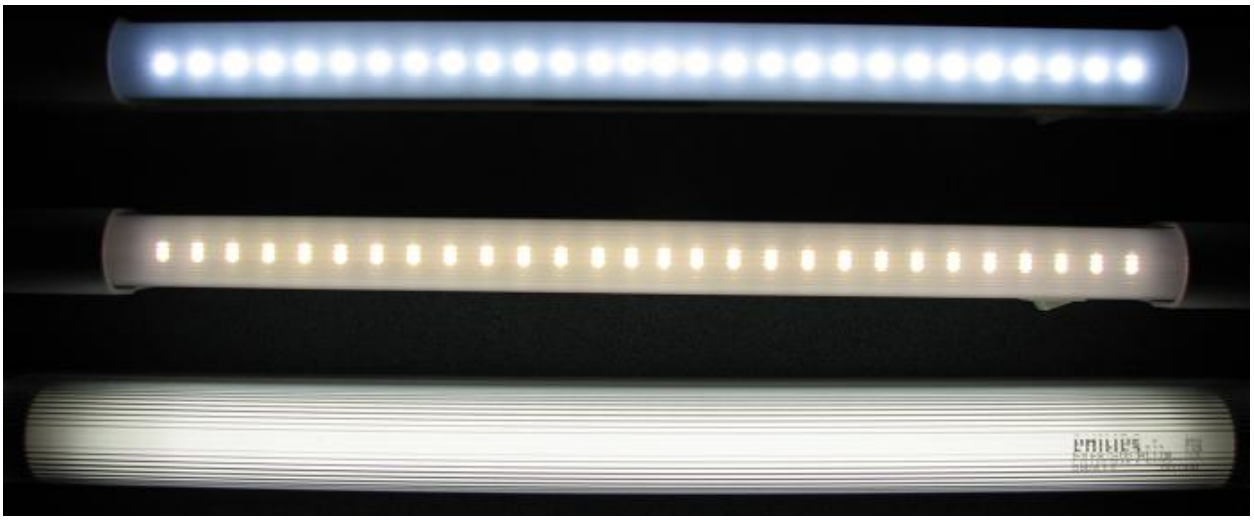
**Model _24: Warm White, Clear Shroud**

**Model _30: Warm White, Pearl Shroud**

The following photo shows all of the lamp samples undergoing life testing on our custom-built rack module. The two lamps on the bottom are a Brand-2 14 watt fluorescent fixture, and a Brand-3 21 watt fluorescent fixture, both set up to provide a comparison of fluorescent fixtures to the six types of LED fixtures. The LED fixtures, however, are a size T4 whereas the two fluorescent fixtures are slightly larger diameter and are T5 types. It can be seen that the fluorescent lamps appear slightly brighter, from the side view. The fluorescent lamp fixtures are also somewhat longer than the LED fixtures.



The following photo is of the two types of 300 mm LED fixtures provided, plus the Brand-2 14 watt fluorescent fixture, looking straight down on the fixtures.



**Brand LED lamps models _03, _24 and Brand-2 14 watt, 120VAC fluorescent fixtures.**

The difference in lamp luminance was visibly noticeable although less so in the photo. The difference in physical size of the illuminated area is obvious. The following table presents our measurements of the luminosity of all of the fixtures, plus the two fluorescent fixtures, in Lux values. We found the luminance to vary measurably between the three 500 mm fixtures of the same model number by as much as 30%, although this difference was not easily noticeable by eye.

| Fixture | Bulb Type | Illuminance (Lux) | Comments |
|---|---|---|---|
| **Brand-2W3** | Bulb-1 | 4400 | Brand-2 14 watt, 120VAC fluorescent |
| **Brand-3W2** | Bulb-2 | 6000 | Brand-3 21 watt, 120VAC fluorescent; bulb is labeled "Cool White" although it more-closely approximates "Warm White" |
| **_11 (A)** | LED | 2480 | 500 mm "Pure White", Pearl shroud |
| **_11 (B)** | LED | 2850 | 500 mm "Pure White", Pearl shroud |
| **_11 ©** | LED | 3450 | 500 mm "Pure White", Pearl shroud |
| **_30 (D)** | LED | 3050 | 300 mm "Warm White", Pearl shroud |
| **_03 (E)** | LED | 2800 | 300 mm "Pure White", Pearl shroud |
| **_10 (F)** | LED | 3250 | 500 mm "Pure White", Clear shroud |
| **_10 (G)** | LED | 3400 | 500 mm "Pure White", Clear shroud |
| **_10 (H)** | LED | 3100 | 500 mm "Pure White", Clear shroud |
| **_02 (I)** | LED | 3100 | 300 mm "Pure White", Clear shroud |
| **_24 (J)** | LED | 3500 | 300 mm "Warm White", Clear shroud |

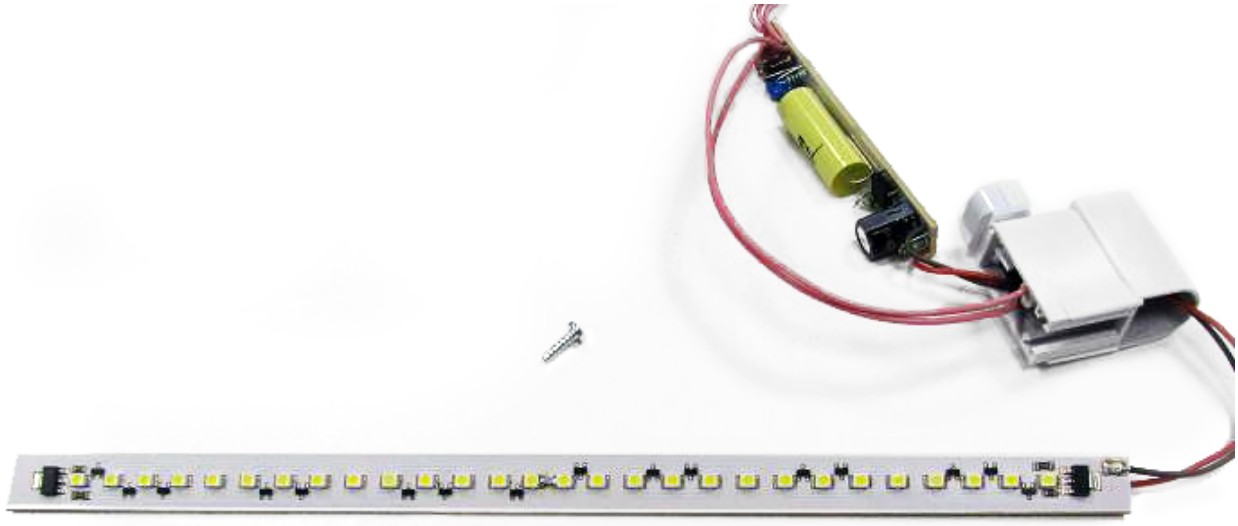
**Note:** luminance measurements taken at 3 inches from center of shroud.

Note that the two fluorescent fixtures are considerably “brighter” than any of the LED fixtures.

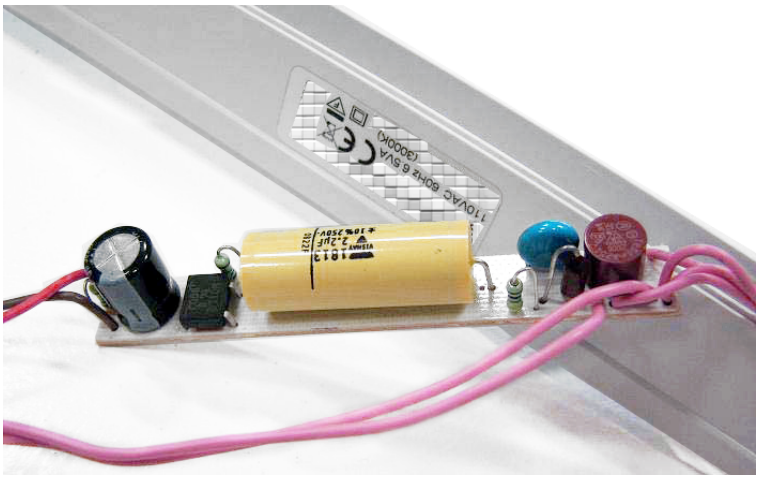
**Fixture Operating Temperature**
Engineers attached thermocouples to the center of the back side of two 500 mm fixtures, and two 300 mm fixtures, all of which had been operating continuously for several weeks. We found the temperature of the two 300 mm fixtures to be 87 to 89 degrees Fahrenheit, while the two 500 mm fixtures were about 82° F. The ambient temperature was about 72° F.

**Fixture Construction**
Engineers disassembled one each 300 mm and 500 mm fixture to examine the internal circuitry. During the last manufacturing step, the fixtures are glued together, which makes disassembly without damage all but impossible. The following photos show the internal PC boards of the 300 mm fixture.

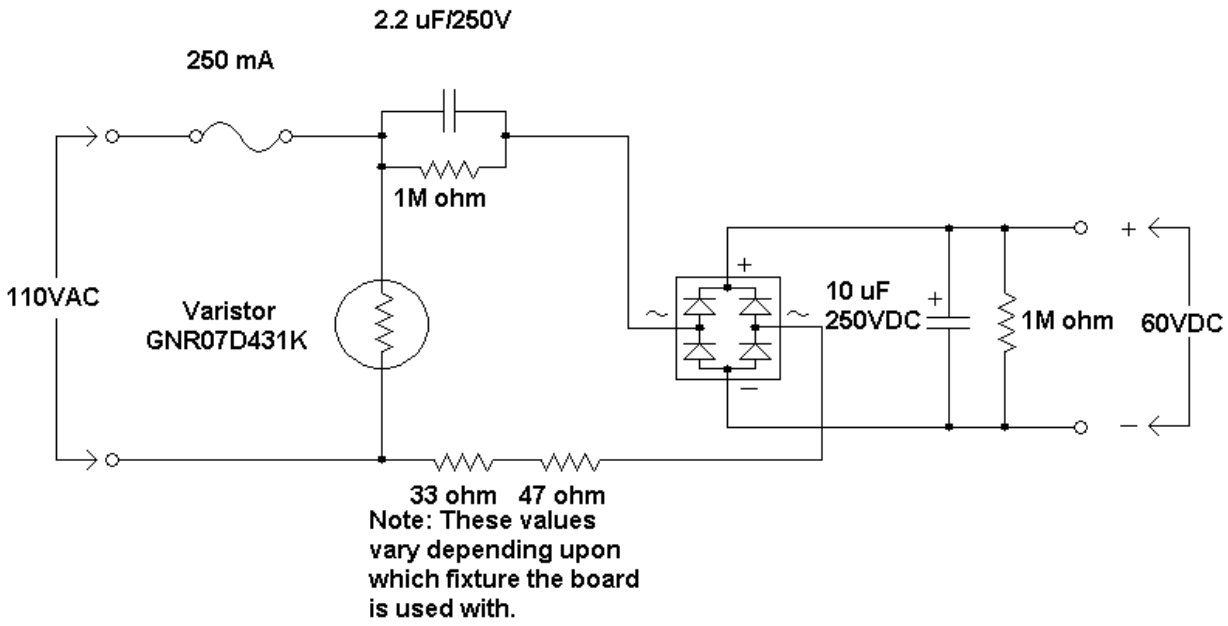
**Internal view of the _24 300 mm fixture.**



**LED PC board and separate power supply board of _24 300 mm fixture. The LED board for the 300 mm fixture is a single piece, but the 500 mm fixtures have two PC boards, each holding 26 LEDs. There are 28 LEDs on the 300 mm board shown above.**



**Close-up view of the power supply board. The power supply is a simple bridge rectifier, using a 2.2 uF non-polarized capacitor to drop the AC input voltage so that the DC output voltage is about 60 VDC with an AC input voltage of about 124VAC; see the schematic below. The 1M ohm resistors simply discharge the capacitors when the fixture is turned off, for safety.**




**Schematic of Power Supply board**

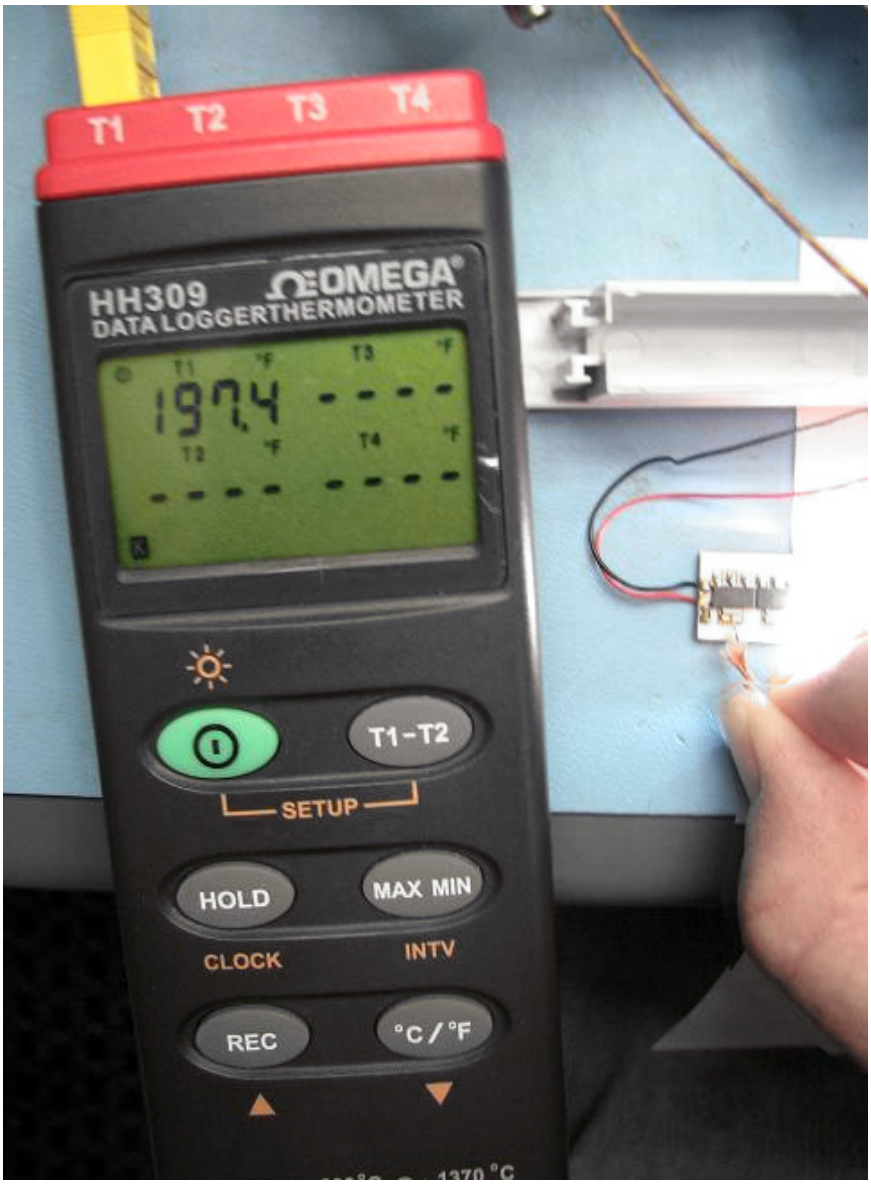
In the schematic above, note that the basic overcurrent protection is provided by a 250 milliampere fuse. Overvoltage protection from power line spikes (such as lightning strikes) is provided by the varistor; however, this varistor will not begin clamping a spike until the spike magnitude exceeds about 430 VAC.

The value of the two series resistors in the other side of the AC line input appear to change depending upon which LED PC board the board is to drive. For example, there are two power supply boards within a 500 mm fixture, each driving one of the two LED PC boards. Although both of the LED PC boards within the 500 mm fixture have 26 LEDs total, the two boards do not have exactly the same circuit in that one has more discrete SMD transistors and more SMD resistors than the other LED board (the single LED board within the 300 mm _24 fixture holds 28 total LEDs). Thus, one of the 500 mm Power Supply boards had a 33 and 47 ohm resistor, as shown above; but the other had a 24 and 100 ohm resistor. The PS boards were otherwise identical.

Engieers did not attempt to reverse-engineer the LED boards; thus, we were unable to ascertain whether there is any “end-of-life” protection circuitry, but since these are LEDs rather than fluorescent lamp filaments, it seems highly unlikely that there is such a circuit. In any event, the 250 milliampere fuse protects against overcurrent situations such as a shorted component within the power supply or overcurrent from the LED boards.

**Excessive Operating Temperature?**

Engineers noticed that the power transistors mounted on the end of the 300 mm fixture’s LED board are operating at a fairly high temperature, as seen in the following photo.




**Tab of power transistor is at least 197°F (91.9°C). This high operating temperature could reduce the life span of the transistor, causing reliability problems of the fixture, particularly if the fixture is mounted such that the ambient temperature is higher than during these measurements (72° F).**

Both transistor tabs on this end of the board were measured at 193 to 197° F; the devices on the other end of the board seemed to be somewhat cooler at 184 to 187° F. The ambient temperature was about 72° F. If the fixtures are mounted over a breakfast bar where steam or heat raises the ambient temperature of the fixtures, then the transistor tab temperature will rise by the same amount. Thus, if the fixtures reach 110° F, then the transistor tab temperatures would be about 38 degrees Fahrenheit higher than measured here in the open.

**Power Cycling and Lifetime Tests**

Engineers set up two model _11, two model _10 (both 500 mm fixtures), one model _30 and one model _10 (both 300 mm fixtures) on a power-cycling source. 120VAC was switched on and off automatically at about 21 seconds on, 6 seconds off.

In addition, a single model _11, _10 (500 mm), _03 and _24 (300 mm) fixture were set up with continuous 120VAC applied. The power-cycled fixtures were operated a total of 766 hours without failure (approximately 102,133 on-off cycles). The other four fixtures were operated approximately 811 hours continuously without a failure. Several fixtures on either test setup were removed for brief periods of time to undergo further examination or other tests, but were always returned to the same test bed.

**Power Consumption**

The 300 mm fixtures are rated at 6.5VA while the 500 mm fixtures are rated at 12VA. We were unable to measure individual LED currents, but were able to measure each of the two LED PC boards to be drawing 54 milliamperes at 60 volts. This is 3.24 watts per board, or a total of 6.5 watts for both boards (52 total LEDs) altogether. The construction of the LED PC boards is such that it appears as if there are two independent “strings” of 26 LEDs each, connected in parallel. If this is the case, then each string of LEDs is drawing half of the total 54 milliamperes, or about 27 milliamperes. Thus, the current through each LED, with 124VAC applied, is evidently 27 milliamperes. If the AC line voltage were reduced to the specified 110VAC, then the DC voltage would drop accordingly, and the resulting DC current through each LED would drop to 24 milliamperes.

**Conclusion**

The Brand T4-type LED strip lamp fixtures are not quite as “bright” as an equivalent-length T5 fluorescent lamp fixture, but will provide much longer lifetime as well as consume significantly less electrical power. The construction quality is reasonably good, as is the quality of the electronic components found within the 300 and 500 mm fixtures. The electrical design might be slightly on the marginal side due to the apparent high transistor tab temperature that we found on a 500 mm fixture, particularly if the fixture is mounted in a location where the ambient temperature can rise significantly higher than the normal room temperature of about 72° F.

Both the 300 mm and 500 mm fixtures provide the claimed “redundancy” in that, in the case of the 300 mm fixture, there are two independent “strings” of LEDs such that if one string should open, the other will continue operating. Similarly, the 500 mm fixtures contain two completely independent strings of LEDs, each with its own power supply. Each string consists of two independent strings of 13 LEDs. An LED failure in the 300 mm fixture will cause half of the fixture to go dark; an LED failure within the 500 mm fixture will cause only a quarter of its LEDs to go dark, however.