Kinkajou γ Prototype Development Report 30 March – 4 April 2004

LED

The Luxeon Star LXHL-LW6C now costs $24, and is back ordered until 20 April. Once the team determines the number of spare Kinkajous to make and the number of spare LEDs to have on hand, we can place the order. The “forward voltage” of this chip varies, in two samples measured, from 6.1V to 7.0V.

Driver circuits

Tim McNerny has requested 4 square inches of circuit board space for the LED driver. Although the driver won’t require access to the heat sink for cooling, there will be a thermistor to sense LED base temperature by contacting the heatsink near the LED. I will attempt to locate the board adjacent to the heatsink, probably as shown in the package illustration. The driver will provide 700mA so long as the base temperature remains below some safe value, and will reduce the current thereafter, attempting to maintain the safe temperature. It will modulate the LED as a signal of low battery voltage, and power down at some lower threshold. It will provide reverse-polarity protection and provide diagnostic information (operating time and number of operations).

Temperature control

I tested a new heatsink design, better adapted to manufacture by extrusion. Instead of pin fins, this has conventional extruded fins 2mm thick and 25mm long, on 8mm pitch. Two lengths were tested, both 43mm high. The longer one, having 23 fins, stabilized at 30C with no fan or chimney (21C ambient). The thermal resistance is therefore 1.8 C/W. The shorter (6 fins) stabilized at 41C, giving 4.1 C/W. The required heatsink performance can be calculated by adding the chip-to-base resistance (11C/W), multiplying by the 5 W power, and adding to ambient to find the expected chip temperature, and comparing this to an acceptable value of 135C. Even the 6 fin heatsink will produce a chip temperature of 125C, but light output is greater at lower temperatures, so I will try to get ~20 fins into the design.

Illumination intensity

The lab light meter (an EXTECH 401025) was received and put in service. It allows 1-Lux resolution for comparing light levels from different sources, optics, and spacing of optical components. The previous comparison between the Kinkajou and the Fisher Price Viewmaster projector was repeated, with the following results:

With both projectors illuminating a 20cm-wide area,
F-P Viewmaster: 435 lux at center
Kinkajou: 369 lux at center

Although both projectors had light values fall off at the edges, the effect was much less noticeable with the Kinkajou, and the F-P projector had severe color banding.

Condenser lenses

Since the condenser lens in the toy projector (a pair of plastic plano-convex lenses (f~19mm) is so much less expensive than that in the Kinkajou, I tested the plastic lens with the LED. Although the LED needed to be ~17mm from the lens to match the light to the projector lens aperture, the new light meter showed that the maximum light was transmitted when the distance was only 10mm, even though this caused light to fall outside the projector lens. This can be understood as the lens intercepting a larger solid angle from the LED, even though some of that light is wasted because the focal length is too long.

Similar modification of optical spacing increased the illumination from the Kinkajou optics to increase to 522 lux. Substituting the F-P lenses, this value was only 361 lux. These results imply that the F-P lens can work almost as well as the Kinkajou is actually working, but the optical cell must be longer by 15mm.

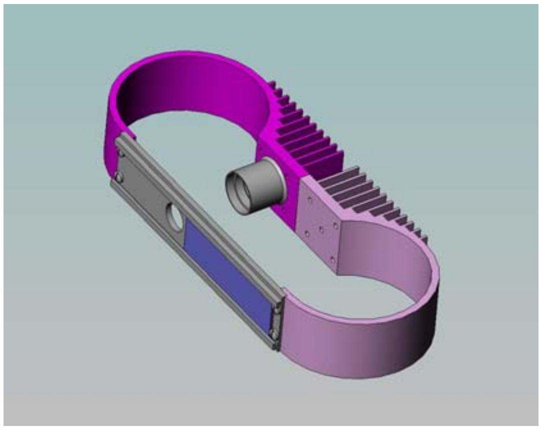
LED life test.

The life test begun last week accumulated 100 hours of constant illumination. At that time, an intermittent operation switch was added to the setup, giving one interruption every 2 seconds for a 90% duty cycle. As a result, the base temperature dropped to 31C (at 700mA, 6.1V) An additional 70h have been accumulated.

New Package Design

I've begun constructing a solid model of some of the packaging concepts I want to explore. These are shown in the illustration:

1. Unitized heatsink and housing. The two ends of the housing are identical slices of an aluminum extrusion, with fins. They are joined in the center by a bolted bridge strip, and across the front by another bolted extrusion. The large extrusions are a "solid extruded shape" (which means they are neither "hollow" nor "semi-hollow") fitting into a 7" diameter circle. The fins will be designed for 2C/W.
2. Asymmetrical optics. Use of identical extrusions results in a joint on the centerline. The optics can be on one side, the circuit board on the other.
3. Sliding door to protect the projector lens. The front panel extrusion has channels to capture a sliding door.
4. Cylindrical condenser lens housing can be machined in a bar-fed lathe.
5. Focus mechanism. Not shown yet on the model, I'm considering moving the film gate rather than the projector lens for focus adjustment. This will simplify the lens mounting and seal dust out. The projection lens will be fixed in a hole in the front plate, by a spring ring or adhesive. The film gate will be two polished metal plates, one of which attaches to the front plate by a long flexural part. A thumbscrew through the plate adjusts the gate's position.



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