Light emitting diodes (LEDs) deliver emitted light in response to current being made to flow through them, but then you already knew that, right??

If we define that the light output of an LED is measured in foot lamberts (fl), the number of fl obtained versus the number of milliamperes supplied can vary greatly between individual devices. For example, please consider these two actual LEDs that I once tested using a Model 1980A photometer made by Photo Research Company. Specifically, the instrument we used was Serial Number C1066.

One LED produces many more fl of light per mA of current flow than the other one does.

Note that these three charts for the two diodes are actually all from the same data. They differ only in the degree of y-axis scale compression which was done to make it easier to visualize the differences between the two LEDs over a wide dynamic range.

Now however, if we normalize these two diodes' curves, in this case by normalizing the brighter LED to the dimmer one, we find surprisingly close tracking between the pair of fl versus mA curves.

LED #3 is intrinsically much brighter than LED #2. However, if we normalize the above curves, we get:
It should be now noted, and then borne in mind forever, that although this apparent relationship is somewhat seductive and perhaps even suggestive of particular methods for designing a variable brightness, multiple-LED display, it is in fact an utterly **USELESS** relationship for that purpose. We need look at that last statement a little more closely.

Although individual LEDs differ in their operational curves as seen above, they can be purchased in matched sets thus obviating the above differences. Having been thus purchased, their apparent brightness is best controlled by pulse width modulating their operating currents at the particular peak current levels for which their FL outputs are defined. This can give us very precise control of apparent FL outputs versus current pulse widths.

An LED’s light output in FL can be demonstrated as being linearly proportional to the duty cycle by which its current pulse width is modulated for a specific but constant peak value of diode mA. To do this, output light was examined visually and examined objectively using that same photometer as before.

An LED pulsing setup was constructed as follows:

![LED pulsing setup diagram]

The apparent brightness of the LED varies as a function of the duty cycle of the drive waveform.
Pulsed current and DC current were applied to matched LEDs which were then viewed side by side. When their light outputs were the same, the DC current and the average of the pulsed currents were compared to each other. They were always equal.

A Model 1980A photometer set for a viewing angle of one degree can be used to measure the LED output in fL in response to the LED’s DC current in mA in the DC configuration shown above. Then, a pulse generator can be configured to deliver as many peak mA to the LED as there were mA of DC above.

It is then found by fL measurements vs pulse width that the fL seen by both the human eye and by the photometer is in direct and linear proportion to the pulse width duty cycle.

Get the most from your LED design with the best drivers: See Power Electronics News Special Report here.

Also see:
- Testing high brightness LEDs in a production environment
- Use LEDs as photodiodes