Light Matters

Designing illumination systems with high-brightness LEDs

A powerful new microcontroller, especially well "ARM"ed for LEDs and Solid State Lighting, has entered the market. Perhaps you have heard of, or already use, 32-bit CPUs or microcontrollers (MCUs) based on the ARM architecture. ARM, which is an acronym for Advanced RISC Machine, is a standardized low-power, high-performance CPU/MCU core which is implemented as a standalone processor or subsystem by many of the world's largest semiconductor companies. They are found in 95% of smartphones and myriads of other compute-intensive applications ranging from industrial and medical instruments to communications and vehicle systems. Over 8 billion ARM-based devices were produced in 2012.

The fact that ARM technology is so pervasive (65% of all 32-bit MCUs) is an important advantage beyond cost or performance. They are a common platform which allows engineers and programmers to leverage the large selection of ARM tools and software packages from the ARM software marketplace, known as the Embedded Software Store (**www.embeddedsoftwarestore.com**).

Semiconductor companies that manufacture ARM devices for general use typically enhance the core by adding useful peripherals similar to those found in other MCUs. Until recently, I had not seen an ARM MCU—or any other MCU for that matter—which appeared to be *specifically tailored* to LEDs, human vision or Solid State Lighting. Now Infineon has introduced an LED/Lighting-optimized ARM device family, known as the XMC-1200. These MCUs have an on-chip LED-dedicated co-processor unit called the BCCU (Brightness and Color Control Unit).

The BCCU does some amazing things. For example, let's say you have a set of red, blue and green LEDs, and need to shift their additive color from one point (R_{last}, G_{last}, B_{last}) to another (R_{new}, G_{new}, B_{new}). Depending on the relative intensity change needed from each LED, a different number of steps will have to be traversed between "last" and "new".

Example of Color Walk from RGB_{last} to RGB_{new}

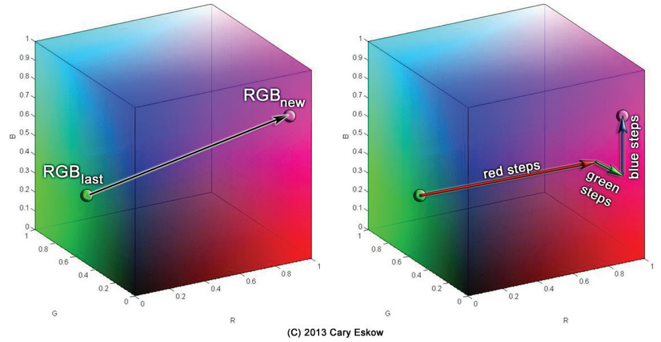

Figure 1 – For smooth color transitions, the BCCU manages RGB ramp rates.

For example, it might require 200 steps of R, 12 steps of G and 37 steps of B. To make the color change appear smooth and even, the ramp rates (rate of change) for each channel would then need to be different, so that all LEDs arrive at their new intensity values simultaneously. The BCCU manages ramp rates automatically.

Another important aspect is dimming. In a previous column, I mentioned that the eye's response to light is logarithmic. The most appealing, visually comfortable dimming curves are often exponential. The BCCU unit addresses this need as well. By supplying the BCCU with a target end-value, it generates a time-varying sequence of pseudo-exponential intensity values, which closely approximate an ideal curve. Even better, to minimize any perceived changes in intensity between steps, a dithering value can be added, to "average out" abrupt intensity changes at step boundaries.

Psuedo-Exponential Dimming and Human Perception

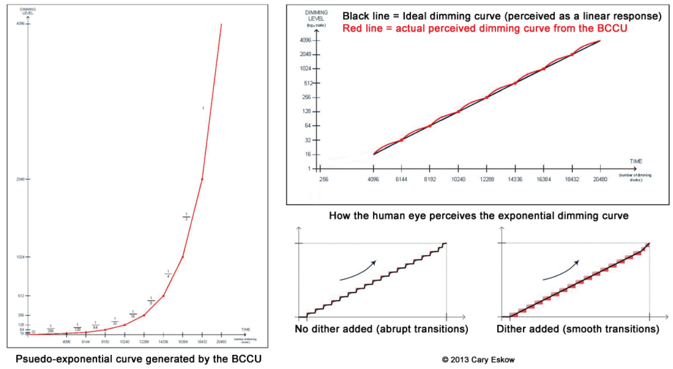

Figure 2 – Some of the integrated dimming functions of the BCCU

Infineon's XMC-1200 has many other LED-oriented features, such as a "packer" which can tune the minimum PWM transition period to the LED driver rise/fall time, a fallout detector to eliminate flicker, etc. And, all of these BCCU functions are executed independently of the ARM core, so the MCU's full bandwidth can be applied to implementing DMX, DALI, WiFi or other communications protocols and application-specific algorithms.

XMC-1200 family MCUs and evaluation boards are very inexpensive, with a free tool called "Dave 3" for development. Many other compatible ARM tools can be found at the Embedded Software Store noted earlier.

For more information on Infineon's LED/Lighting-optimized MCUs, contact Avnet in the Americas, EBV in Europe, or send a note to me at **www.em.avnet.com/LightSpeed**