Integrating Power and Control Offers Flexibility and Simplicity for Lighting Applications

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In uncertain economic times, the message given to design engineers is clear: save money. In LED lighting designs, that message needs to be even clearer, as the LEDs themselves take up a large portion of the bill-of-materials (BOM). One particular new device to the market helps provide a necessary cost-down solution, Cypress's PowerPSoC, the world's first embedded power controller.

PowerPSoC provides an unprecedented level of integration for customers, containing four channels of internal current sense amplifiers rated at 6 MHz, four 2 MHz hysteretic controllers independently configurable as buck, boost, or buck-boost, and four low-side n-FETs rated at 1A, 32V each. Not to be content with only the output stage, PowerPSoC also includes a 32V internal input regulator. The simple advantage this supplies to lighting customers is cost. In Figure 1, we see a standard lighting design. The figure can appear somewhat intimidating and complex but can actually be condensed to three simple sections. First off, everything electronic requires some form of regulation off the 12V-32V line. Secondly, the LED strings require a regulated current provided by a controller IC. Finally, an intelligent controller will provide dimming and communication, as well as any other additional feature needed in the system. In PowerPSoC, the regulation, current control, and intelligent controller are all combined into one semiconductor device.

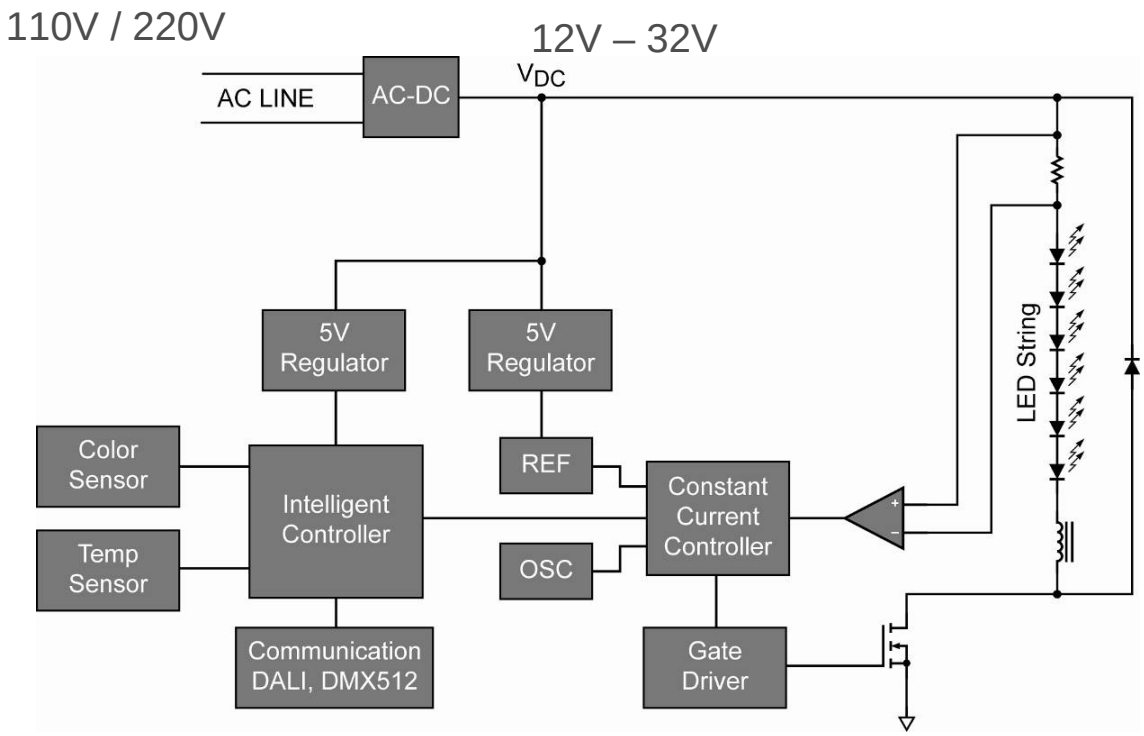

Figure 1. Standard, Single-Channel Lighting Design

To fully grasp the integration potential, the picture needs to be expanded from one channel of LED control to four. Many LED fixtures require multiple channels to intelligently modify color, correlated color temperature, and intensity. Figure 2 shows a four channel system.

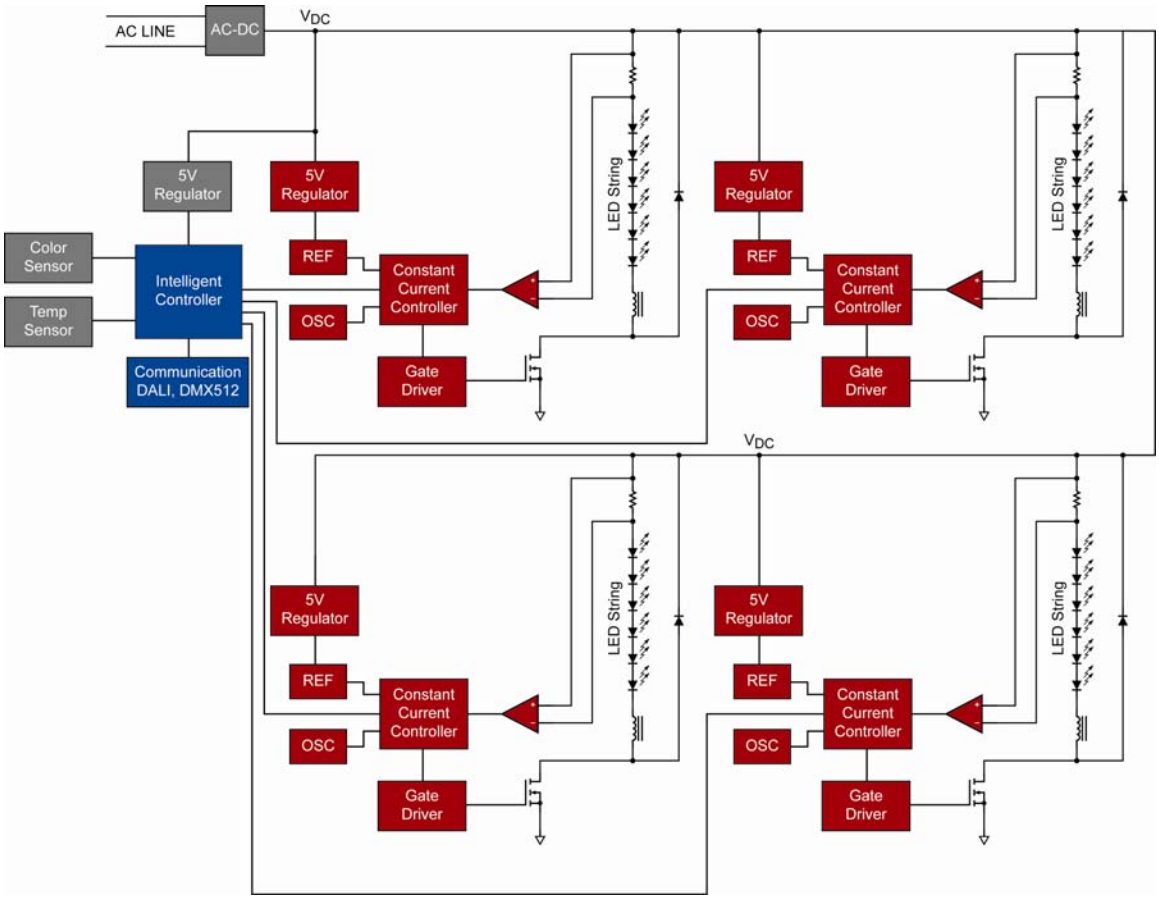

Figure 2. Standard 4-Channel Lighting Design

In the system above, we see the need for one constant current control loop per LED channel, so although only one intelligent controller is necessary, additional cost is incurred. PowerPSoC fully integrates these additional constant current controllers, shown in the highlighted section of Figure 3.

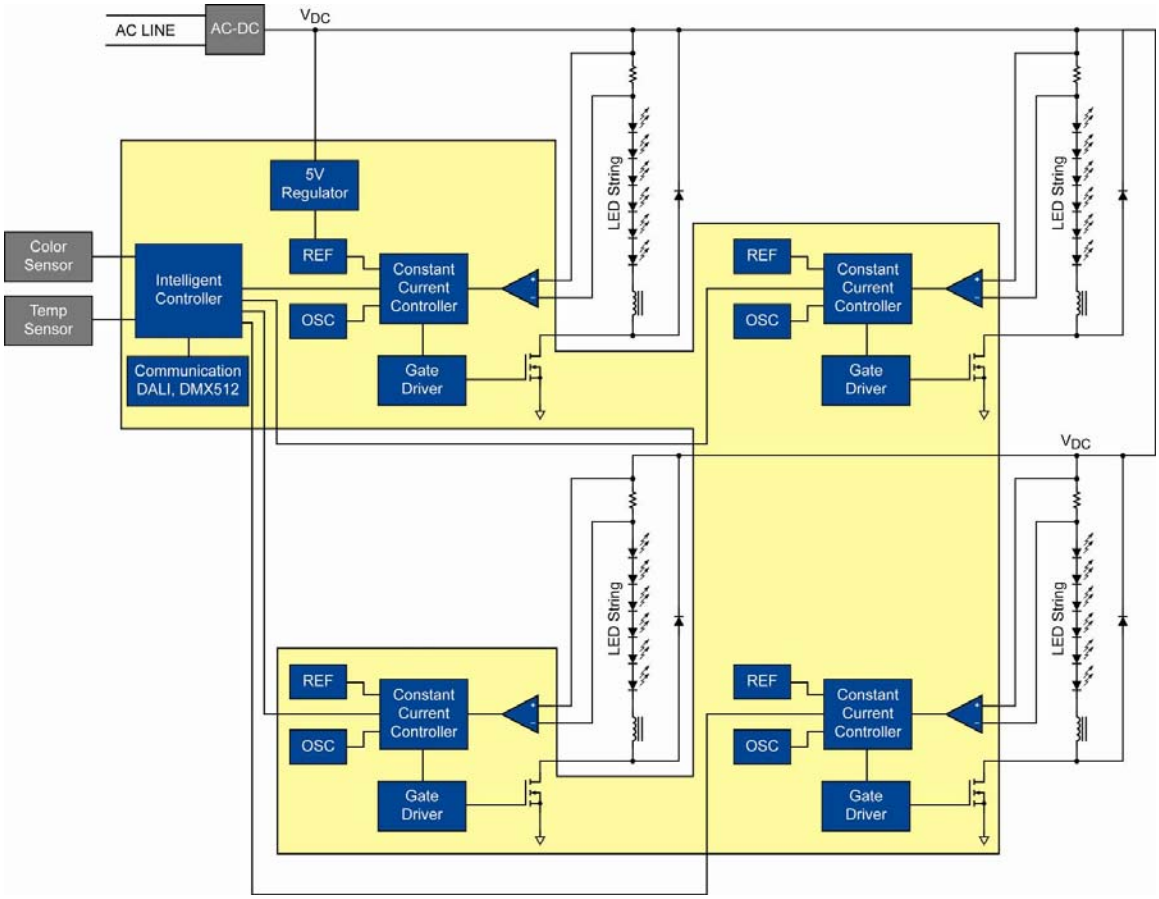

Figure 3: 4-channel Lighting Design with PowerPSoC. A single PowerPSoC device integrates all the devices within the shaded area.

The integration potential of PowerPSoC is readily apparent. Virtually the entire four channel LED system is collapsed into the one device. Since each of these constant current channels can cost multiple dollars, the BOM savings can be significant.

Cost isn't the only advantage. Flexibility from a design standpoint is what comes from utilizing an embedded controller over discrete options. For example, the internal hysteretic controllers have adjustable settings for the reference voltages, essentially meaning that the constant current for the lighting system can be digitally modified instead of having to change out an external sense resistor. Another example uses dedicated function pins connected to an external temperature sensor such as one shown in Figure 1 to trip the onboard hysteretic controller in case of a thermal runaway condition. Flexibility also means that a lighting engine can be laid out for multiple lighting fixtures, as PowerPSoC is available in pin compatible devices from 1 to 4 channels. This can save multiple hours of engineering redesign effort, and means that base projects can be used in separate application spaces, from white light in office environments to mixed color entertainment downlights.

Acknowledging that many lighting designers are new to the semiconductor market, PowerPSoC was created to be a simple device to use. For one channel of power control, PowerPSoC takes three PSoC Designer user modules (pre-configured, pre-characterized blocks of code to simplify implementation of common functions) and three lines of "C" code. Shown below in Figure 4 is the PSoC Designer layout for PowerPSoC. The power section is laid out in an intuitive way for engineers who are familiar with constant current feedback loops.

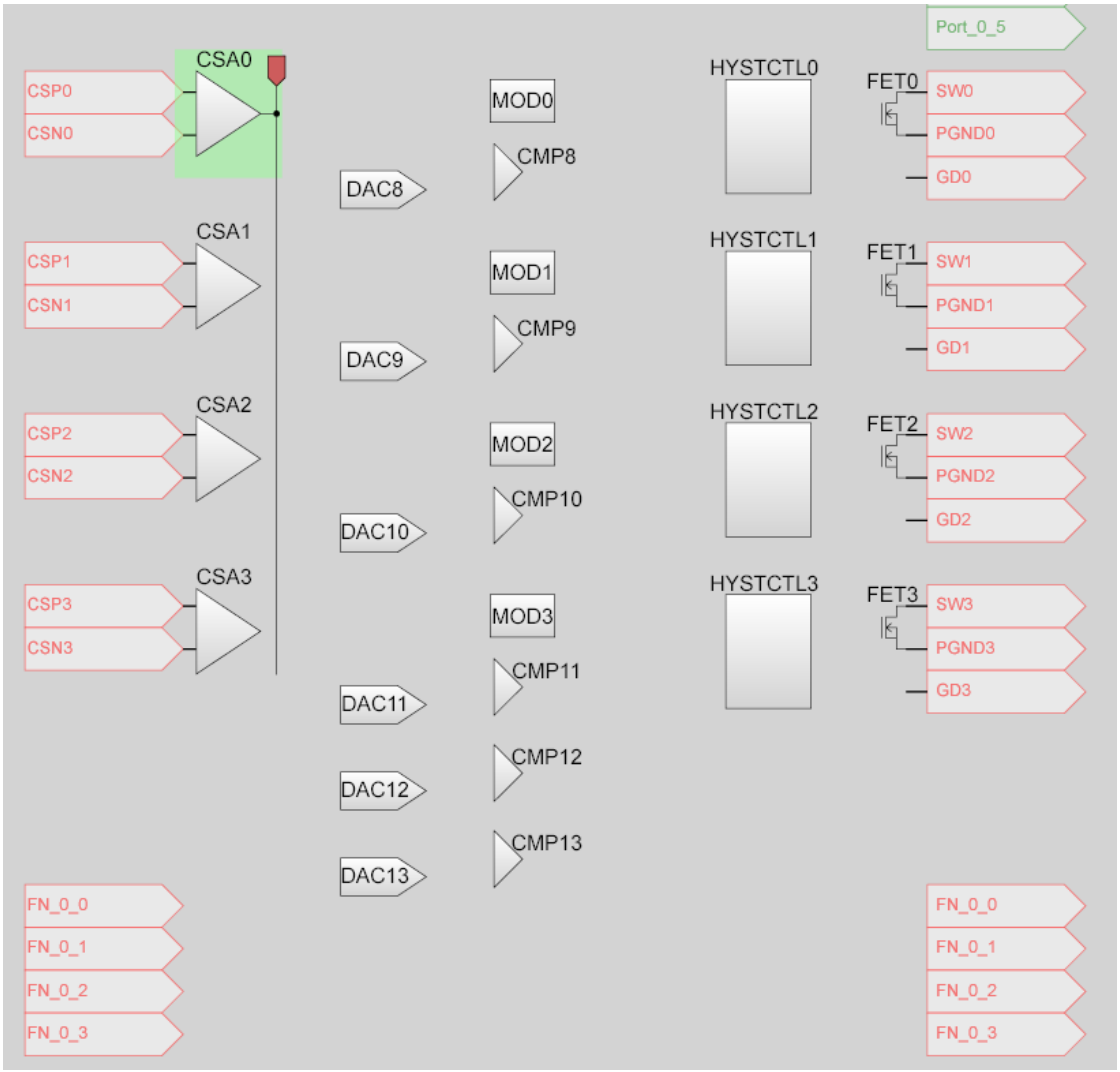

Figure 4: Intuitive design software interface

User Modules are preconfigured blocks of code that include APIs and register settings. To set up the first user module required for a power channel, an engineer must drag and drop a current sense amplifier onto the required placement shown above. The current sense amplifier has some adjustable settings, most notably the gain settings, another way of independently modifying the constant current of the system.

The second user module is the Modulator, another solid advantage of PowerPSoC over competitive devices, most of which only offer a small number of hardware 8-10 bit PWMs. PowerPSoC offers four hardware 16-bit Dimmers, which can be configured as either a PWM or two other options, the first being Cypress's PrISM spread spectrum signal, which reduces radiated EMI in a lighting system by up to 70 dB, and the second being Cypress's Hardware Density Modulated PWM (DMM), a 12-bit dithered PWM.

The final user module is the Hysteretic Controller, which connects to the Current Amplifer and Modulator, as well as the internal n-FET. These are what can then be configurable for buck, boost, or buck-boost applications.

The "C" code necessary? Three START commands. It doesn't get much simpler than that for designers.

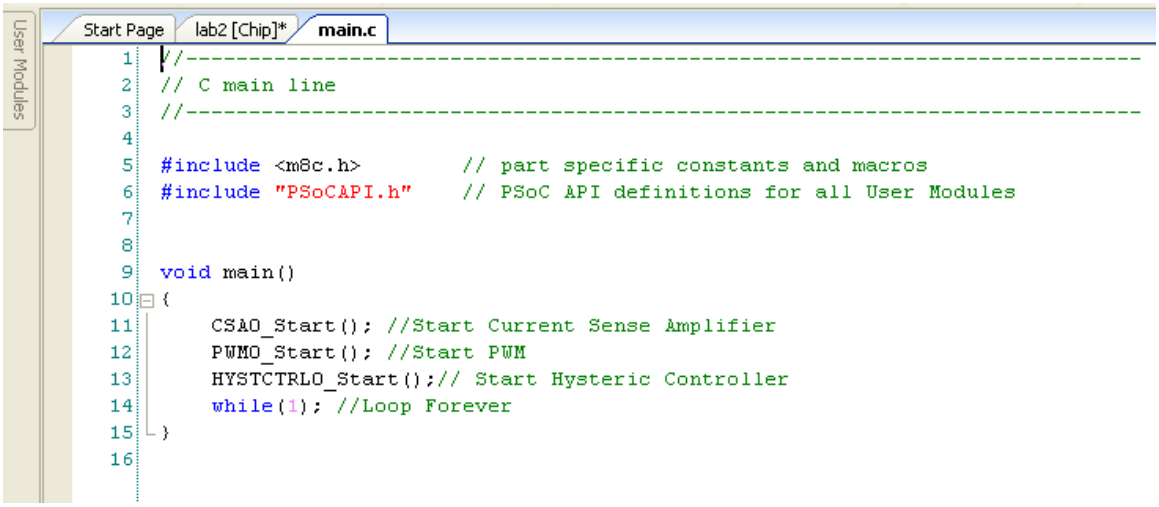

Figure 5: Only three lines of C code are necessary to turn on an LED channel.

Outside of the power channels discussed and shown above, PowerPSoC includes additional digital and analog resources for functions such as digital communication protocols such as DMX512 and DALI, and user interfaces such as Cypress's patented CapSense touch control technology.

Between saving customers costs on their bill-of-materials, providing greater design flexibility, and even allowing for additional functionality, PowerPSoC is a strong new entry into the burgeoning lighting market. It can be the brains and brawn of a light engine, handling the communication, dimming, input voltage, and constant current control. As lighting designers continue to work on how to utilize the potential of LEDs, PowerPSoC is the perfect fit for the creative and cost conscious.

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