

Easing Design Challenges with CoolRunner-II CPLDs

The CoolRunner-II CPLD Starter Kit promotes ease of use.

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You shake your head in frustration as you stare at the flat line on the oscilloscope. For the umpteenth time, you shuffle through the data sheets on the table and check the input waveforms and pin connections. The clock ticks past six; with a sigh, you reach for the phone. Another late evening with soldering irons, neon-colored scope traces, and takeout pizza. What a way to spend a Friday night.

Prototyping with a new device doesn't have to be such a headache. Imagine a full-featured design kit that is easy to use and inexpensive. It would have a number of different visual outputs, LEDs for status values, numeric displays for counters and state machines, and character displays for text messages. It would have several I/O ports to test interface standards and peripherals, and user interface buttons and switches. It would be easy to get power readings. It would interface to a PC so the software guys could interact with it. And it would be cheap enough to not even cause a blip on the budget.

Working together, Xilinx and Digilent Inc. have partnered to create the new CoolRunner™-II Starter Kit, making what you once imagined a reality.

One feature built into the CoolRunner-II CPLD Starter Kit is real-time power measurement and reporting. XMeter is a program that reads power measurements for the 1.8-V power supply and charts the data in real time.

CoolRunner-II CPLD Low-Power Features

At the heart of the CoolRunner-II CPLD Starter Kit is a 256-macrocell CoolRunner-II CPLD, an ultra-low power programmable logic device. The CoolRunner-II family has quiescent power as low as 13 μA and a number of design features that help reduce dynamic power as well. Let's briefly discuss two of these features, the clock divider and DataGATE.

CoolRunner-II devices, starting from the 128-macrocell device, have a built-in clock divider circuit. This component allows you to not only save user logic but also lower power by reducing the frequency of a clock that may not need to run at full speed. The clock divider provides divisions of 2, 4, 6, 8, 10, 12, 14, and 16 and outputs directly onto a global clock net. If used in conjunction with dual-edge triggered registers, you can obtain odd values of division.

DataGATE is effectively an input 3-state. When signals toggle at an I/O pin, current flows at the I/O transistors as well as in all of the traces within the CPLD. There are many situations where you can ignore specific I/Os, such as in idle states or don't-care conditions. In these situations, you can disable unnecessary inputs to save current.

DataGATE is also useful for signals that have slow rise or fall times. The largest amount of power consumed in the I/O transistors occurs when the voltage at the pin is roughly one-half of V_{CCIO} . You can use DataGATE to periodically enable an input to sample its state and then disable it to save power. Without DataGATE, very slow switching signals will waste multiple milliamps of current.

CoolRunner-II CPLD Kit Features

The CoolRunner-II CPLD Starter Kit has eight peripheral module expansion ports, each with four I/O pins. Each of

these ports is capable of accepting any of 29 peripheral modules (PMods). The board itself has two push buttons, and the kit comes with three PMods to get you started quickly: quad switches, a PS/2 connector, and a dual seven-segment display.

PMods offer total flexibility without the expense of time and money. This means no more time wasted soldering devices onto a breadboard, no more paying for an on-board Ethernet PHY that you'll never use, and no need to purchase an expensive programming cable or design software. Simply buy the modules that you need for your project and plug them into any of the I/O expansion ports. Update the pin constraints in your design file and you're ready to go.

A number of PMods cover the user interface. There are simple switches (such as quad switches, buttons, or a rotary switch) and more complex PMods (such as the PS/2 adapter that facilitates connection to a standard PS/2 keyboard). An RS232 adapter even allows data transfer using a UART.

For display purposes, there are several LEDs on the board itself, along with the provided dual seven-segment display. For more detailed display options, there is a 16 x 2-character display PMod.

Here is a short list of available PMods:

- Analog to digital: two 12-bit 1 MSPS A/D
- Digital to analog: two 12-bit 1 MSPS D/A
- 16-Mb SPI flash
- Infrared light detector
- H-bridge for DC motor drive
- Speaker/headphone amplifier
- Servo-motor connector

XMeter: Built-In Power Measurement

One of the greatest features of a CoolRunner-II CPLD is its low power operation. One of our more popular demonstrations is the "fruit-powered" demo, where we run the device from the electrical current generated by a few pieces of grapefruit.

But fruit won't replace the AAA battery, so you need a way to exactly determine the operating lifetime for your design. Power estimators have their place, but measuring the real thing is critical.

One feature built into the CoolRunner-II CPLD Starter Kit is real-time power measurement and reporting. XMeter is a program that reads power measurements for the 1.8-V power supply and charts the data in real time. Figure 1 shows the XMeter program in operation. The sample design was consuming 200 μA at full frequency; when DataGATE was enabled, the current dropped down to ~86 μA .

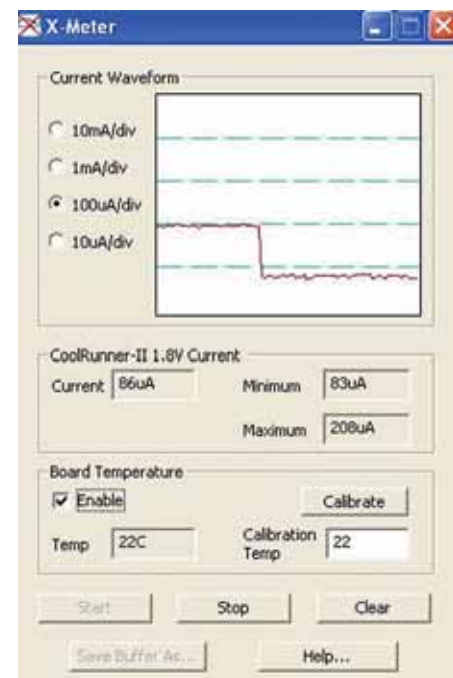


Figure 1 – XMeter showing DataGATE power savings

Note that DataGATE power savings are entirely design-dependant. You can implement DataGATE in a number of different ways based on your design requirements, so expected power savings will vary from this example.

XMeter makes it easy to load up different versions of your code and determine which one has the optimum power consumption profile, taking the guesswork out of power optimization.

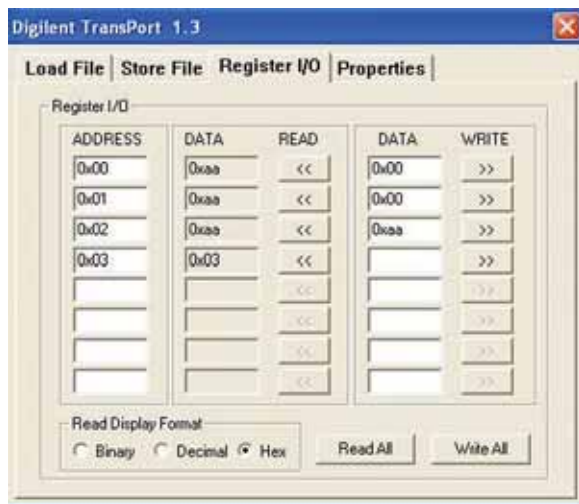


Figure 2 – PC application communicating with CoolRunner-II CPLD

PC-to-Kit Communication

The programming cable provided with the kit is a standard USB to mini-USB cable available at any electronics store. Chances are one was included with your digital camera or cell phone. JTAG communication between the PC and the

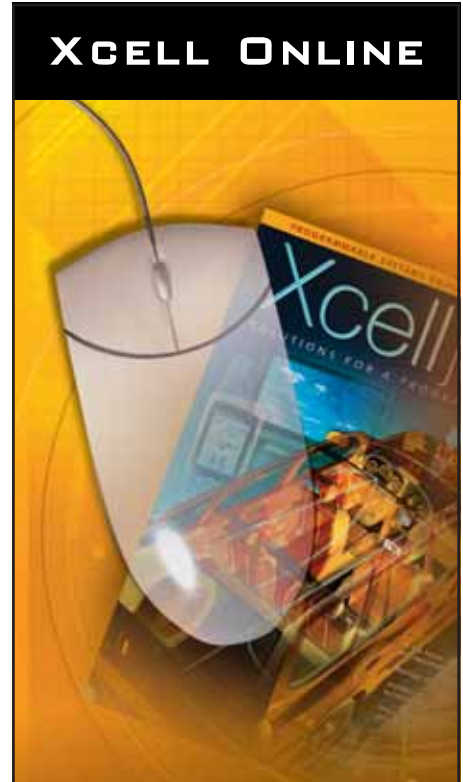
board is handled through a Cypress EZ-USB chip, so to program the board you would use Digilent’s Export programming software. (The board supports programming from iMPACT, but this requires a separate Xilinx programming cable not included in the kit.)

The advantage of this communication method is that an application programming interface (API) allows you to create your own PC-based programs and communicate directly with the CPLD. Figure 2 shows a program that allows you to read from and write to registers within the CoolRunner-II CPLD.

Conclusion

The CoolRunner-II CPLD Starter Kit is optimized for low power operation and removes many roadblocks for prototyping. Ease of use is covered by pre-built modules that can be plugged into the board without warming up the solder gun. The suggested resale price of this kit is

less than \$50. Every chip on the board was selected for low power and power measurement is built-in, so easy power benchmarking and design evaluation is covered. This kit offers low power, low cost, high functionality, ease of use, and no compromises. Get your evenings back. ●●



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- Order the CoolRunner-II CPLD Starter Kit.
- Read about DataGATE power consumption savings in the white paper, “The Real Value of CoolRunner-II DataGATE.”
- See a complete list of available PMods.
- Download the Digilent Adept SDK API and transport design.