WHITE PAPER

Embedded Change Just Happens!

By Oliver Bailey, Timelines Industries, Inc.

Executive Summary

How many times have you said, “I would use an FPGA but I need analog, and I don't have the time or budget for an ASIC and, the project still has requirements that only a microcontroller can fill?” The product release date to production is in the next few weeks; marketing is still adding last minute “features,” and engineering management has made a mandate to reduce the bill of materials. We've all experienced the above scenario in one way or another, usually because of last minute changes, marketing requirements, competitive pressures, or end-user focus groups.

Wouldn't it be nice if a mixed-signal programmable part existed; something with a small form factor, providing the flexibility of the FPGA with the production features of an ASIC, and offering a rapid prototyping visual development environment, quick change implementation, in-field programming, and low power requirements?

An FPGA would work, but I need analog, too!

FPGA's are wonderful devices for serving a mostly digital world. Many of today’s projects don't require the digital horsepower that an FPGA offers and in many cases, a smaller form factor combined with mixed-signal capabilities is more cost effective to deliver, less time consuming to develop, and easier to maintain over the product lifecycle.

But having the configurability of an FPGA combined with the associated rapid prototyping and development tools plays a big role in timely market delivery. Being able to quickly change, test, debug, and go to production are essential requisites from a design viewpoint. And with development moving so quickly, market pressures changing daily, enabling field upgrades is a must. A good example of this type of design is the appliance industry.

New appliances are becoming more intelligent so that manufacturers can market these features and entice customers to higher-priced items. In many cases there is limited space for that added intelligence, and mixed-signal capability is required to handle digital inputs while driving analog outputs to motors and other high current inductors. While most appliances are in a controlled environment, they are internally subjected to harsh conditions, and the amount of space available for these devices is very limited. This is an ideal environment for a very small form factor mixed-signal part with industrial ratings that can be configured quickly to accommodate design changes between models, but where the ability to act both as an MCU and FPGA is required. And when model changes occur, the ability to change firmware quickly is not a luxury but a requirement.

An ASIC would be nice, but I don't have the time for ASIC design and I need to protect my company’s IP and provide a custom component

Having the luxury of a custom ASIC is wonderful when there is plenty of time to get the design completed, and profit margins and volume are high enough to recover the costs. But when time is of the essence, production is just around the corner, and changes are still being made, an ASIC may not be the best answer or the most profitable solution. But even under these circumstances, the need to protect intellectual property remains essential.

Even when conditions don't allow for an ASIC, having the ability to design a custom part can be vital. And if mixed-signal capability is required, the alternatives to an ASIC that provide protection of intellectual property, fast prototyping capabilities and in-field programming are very few. Adding to the mix is the requirement of a small form factor for a simple household appliance as previously mentioned, or in a handheld communications device.

Everyone is using wireless communications in one way or another today; we simply can't afford to be inaccessible anymore. While very different functionally from the household appliance, the requirements are similar. Maximum flexibility, small size, and the highest component integration possible are needed to achieve production goals. The need for quickly implementing changes between product generations, reducing BOM, and protecting IP are a standard part of the overall design process, combined with maximization of product features and the lowest power consumption possible. These requirements are clearly a testament to the needs of mixed-signal products in the smallest form factor.

We would all like a custom ASIC to prevent the competition from understanding our design; a part with highly integrated mixed-signal capability and a small form factor, thus allowing significant IP protection will work just as well. The fewer components that can be seen and identified, the smaller the end product will be, and the harder it will be to reverse engineer.

A microcontroller would be ideal because I can quickly develop in a familiar environment, but I can't find a part with mixed-signal capabilities, small form factor, and rapid development environment.

Microcontrollers are both familiar and easy to use for the embedded developer. But adding mixed-signal requirements, rapid prototyping, and the need to bring products to market faster, the comfort of the microcontroller is quickly overshadowed by its lack of mixed-signal capabilities and lack of rapid prototyping and development tools.

The majority of microcontroller development is still done by hand coding assembly, C, C++, or BASIC. While development environments have come a long way, microcontroller development is still, for the most part, a manual process.

One of the biggest challenges in presenting a mixed-signal part to the existing MCU market is the difference in development environments. Looking at the development tools for FPGA and ASIC devices we find they are not only functionally different, but a different class of tool as well. Interconnecting a gate array or defining the internal bus architecture of an ASIC is a world away from writing C or assembly in an MCU. System architects and system designers are typically the members of the FPGA and ASIC development teams, not the MCUs.

In order to make a mixed-signal part that can readily be used by the existing embedded developer as well as system architect and designer requires tools that bridge these worlds together. Then and only then do the benefits of a small form factor, combined mixed-signal capability, and familiar development tools to the MCU developer make such a part widely accepted.

Existing MCU developers will have to learn more about mixed-signal integration into existing MCU architectures as demand for such mixed-signal devices increases. The requirement to handle mixed signals in smaller spaces and at lower voltages will drive traditional embedded developers to either adopt, or be left behind. Acceptance of such parts will rest on the shoulders of the firms who build and offer these devices.

The Missing Link in the current Embedded market

If we examine how current requirements are becoming more and more demanding of these types of features, we can quickly see that such a device hits almost dead center in the low-to-high range of both product features as well as development tools.

Looking at the emerging embedded market, it becomes very clear that a need exists for products that have the flexibility of an FPGA and customization of an ASIC, while maintaining a small form factor, familiar microcontroller functions, and mixed-signal capabilities. Just as important, the ability to create a development environment familiar to the embedded MCU developer will be crucial to the acceptance of such a product coupled with a continuing downward cost factor.

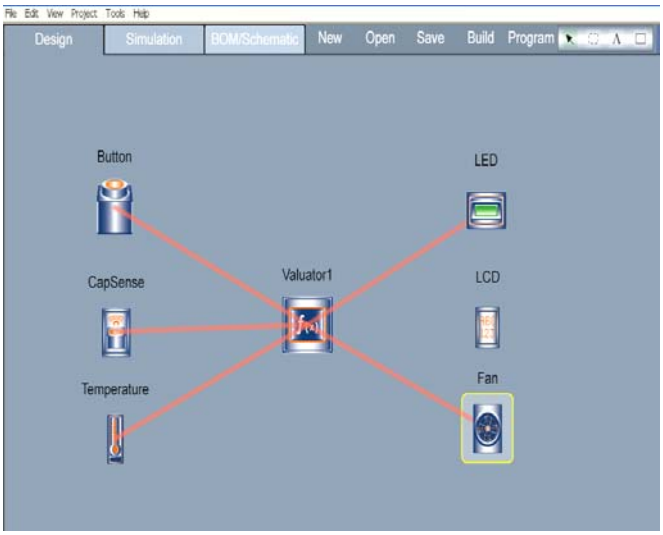
The learning curve for such a device should not be uncomfortably steep, and ideally requires availability of tutorials and other informational aids for the design process. This is the only way to keep transition costs low enough to prevent labor costs from rising, effectively nullifying the potential gains to be had; the reduced form factor, BOM, and mixed-signal capabilities.

Looking at the PSoC®

One such part is the Cypress PSoC, programmable with full mixed-signal capabilities. This device combines a small form factor with an MCU core that offers digital and analog capabilities, internal bus control, and flexible pin assignments. This allows internal cascading mixed-signal components using familiar MCU architecture to supervise tasks and control IO. By offering different form factors, Flash, RAM, and a varying number of mixed-signal blocks combined with visual design tools, the transition costs for existing MCU developers are minimized.

Cypress has chosen to offer design tools with as little direct mixed-signal control as possible, or as much mixed-signal control as needed. For those who are new to the PSoC, Cypress offers PSoC Express™, a tool aimed at existing MCU developers or developers new to mixed-signal development. PSoC Express reduces the learning curve by providing a visual desktop combined with over 130 external components that can be used in a mixed-signal design with no manual coding required. Banked IO, Accelerometers, Push Buttons and PWMs are several examples of variable input and output types.

Figure 1. PSoC Express Interface



After using PSoC Express to start a design, the developer can move the project to PSoC Designer™, a more advanced tool, where both fine-tuning and in-depth mixed-signal development can be accommodated. This permits existing MCU developers to ease their way into mixed-signal development using the PSoC device family, but at a comfortable pace and with best results.

Additional Resources

Download PSoC Express Software: http://www.cypress.com/psocexpress

Request Free PSoC Device Samples: http://www.cypress.com/samplerequest

Purchase PSoC Development Tools: http://www.cypress.com/buyonline

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Cypress Semiconductor
198 Champion Court
San Jose, CA 95134-1709
Phone: 408-943-2600
Fax: 408-943-4730
http://www.cypress.com