White Paper

FPGA Integration Increases Flexibility, Reduces Cost in Consumer Applications

Introduction

Consumer electronics (CE) product developers are increasingly turning to programmable logic-based solutions to respond to the rapidly changing needs of consumers, and deliver new features and capabilities. This trend is caused by the recent proliferation of low-cost programmable logic offerings such as Altera® Cyclone™ series FPGAs and MAX® II CPLDs. This white paper describes how Pinnacle Systems, a leader in digital video solutions, leveraged programmable logic flexibility to address cost and board space reduction needs while delivering significant product differentiation in their Studio MovieBox Deluxe product. By using a programmable logic-based approach, Pinnacle Systems reduced their custom logic utilization and corresponding component cost by two-thirds, and integrated several ASSPs into a cost-effective consumer video appliance.

Custom Solutions for Differentiation

The common platforms used by CE product developers are ASSPs, ASICs, and programmable logic. ASSPs are not custom solutions, and provide no opportunity to differentiate, which is critical to sustaining the average selling price of the consumer product. Also, they generally implement standardized functions that are already commoditized in the market. Furthermore, ASSPs are not generally available for new, differentiated functions. The two remaining alternatives, ASICs and programmable logic, allow the CE product developer to differentiate the consumer product based on hardware modifications. Table 1 shows the relative advantages and disadvantages of ASICs and FPGAs.

Table 1. Customizable Hardware Platforms for CE Products

Factors	ASICs	FPGAs
Development schedule	Long	Short
Unit cost	Low	Low
NRE	Yes	No
Inventory exposure	Yes	No
Control over availability	No	Yes

ASICs provide very low per-component prices, but the relative advantage over programmable logic is rapidly disappearing. For example, in 2000, the cost of implementing a 64-bit, 66-MHz PCI function in a programmable logic device was prohibitive at approximately US$2.50. Today, that cost has been reduced to approximately US$0.70. Furthermore, the long ASIC development time required deters rapid innovation in markets that are quickly saturated by similar products. Custom ASICs also require increasingly higher minimum unit orders which creates inventory obligations and associated financial risks in highly uncertain markets.

As a result, CE product developers realize that programmable logic-based solutions, which enable rapid and flexible development and additional product innovation with minimal additional engineering resources, are increasingly desirable for their products. Low-cost PLDs such as Cyclone series FPGAs and MAX series CPLDs are currently employed in a wide variety of CE products, including digital televisions, DVD players, handheld media players, set-top boxes, “smart home” networks, and computer peripherals.

Leveraging Reconfigurability to Add Product Differentiation

CE product manufacturers who incorporate programmable logic in their products can rapidly develop new features by modifying the PLD design and reconfiguring the device to implement the new functions. This capability enables them to offer multiple versions of the same product at introduction, affords them options to develop new products in response to changing market demands with minimal additional engineering effort, and provides upgrades to existing products in the field. Therefore, CE product developers can take advantage of low-cost ASSPs for well-established functions, while relying on programmable logic to deliver product differentiating capabilities. These differentiating

capabilities can include features such as video or audio enhancements, security functions, user-programmable functions, or completely different modes of operation.

PLD users have several options to reconfigure these devices, especially for low-cost offerings that use SRAM cells to store configuration data. Configuration data must be downloaded to SRAM cells each time the device powers up. In Cyclone series FPGAs, developers can use active serial (AS), passive serial (PS), or JTAG interfaces to download configuration data to the devices. Table 2 shows these options.

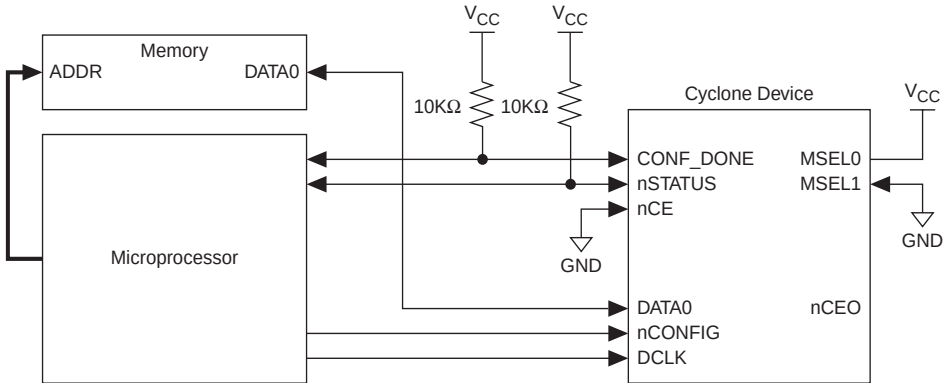
Table 2. Altera FPGA Configuration Schemes

Configuration Schemes	Description
Active Serial configuration	Configuration using Altera serial configuration devices
Passive Serial configuration	Configuration using: ● Altera configuration devices ● Intelligent host (microprocessor) ● Download cable
JTAG-based configuration	Configuration via JTAG pins using: ● Download cable ● Intelligent host (microprocessor) ● Jam™ Standard Test and Programming Language (STAPL) ● SignalTap® II Embedded Logic Analyzer

In the AS configuration scheme, Altera FPGAs are configured with serial configuration devices. Serial configuration devices are low-cost devices with non-volatile memory that feature a simple four-pin interface and small form factor. These features make serial configuration devices an ideal solution for easy FPGA configuration. In the PS scheme, an external host (configuration device, embedded processor, or host PC) controls configuration. In JTAG-based configuration schemes, the JTAG circuitry shifts configuration data into the Cyclone device. Each of these schemes allow for configuring multiple Altera FPGAs, and in all cases, the Altera Quartus® II development software automatically generates all required programming files.

Figure 1 shows the PS configuration scheme using an external host. This scheme is most used when the system designer utilizes an intelligent controller, such as an external microprocessor, to configure the FPGA. The designer can reconfigure the FPGA while it is deployed in the field within a product with this scheme. The operation of the FPGA can be modified or even completely changed simply by updating the configuration data that the host loads into it. CE product developers can take advantage of this capability to deliver significant product differentiation.

Figure 1. Passive Serial Configuration of a Cyclone Device



One example of this kind of innovation is the Studio MovieBox Deluxe from Pinnacle Systems, which relies on a Cyclone FPGA to perform its core functionality (Figure 2).

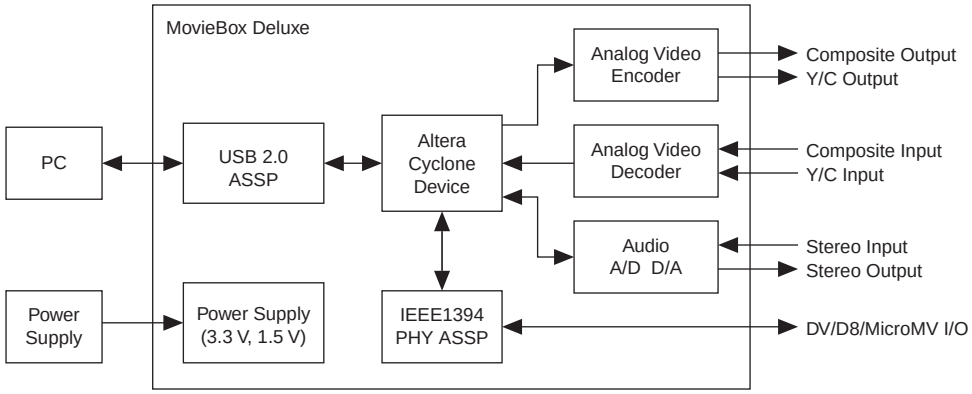
Figure 2. Pinnacle System's Studio MovieBox Deluxe

The Studio MovieBox Deluxe is a device that enables multiple video formats from analog and digital sources to be imported into a personal computer for editing with Pinnacle Studio 9 software. Many consumers have video content stored on analog tapes, while others have content stored using a device that includes an IEEE 1394 (or FireWire) interface, without having the same interface integrated into their personal computer. The Studio MovieBox Deluxe connects all of these disparate types of video sources to a personal computer using a USB 2.0 interface. After editing, the Studio MovieBox Deluxe can connect the PC to a TV, VCR, or digital camcorder for movie playback and/or storage.

FPGA Integrates Fixed-Function ASSPs Into a Reconfigurable Whole

Pinnacle's Studio MovieBox Deluxe has several interfaces, including RCA and S-video inputs and outputs for analog devices, as well as IEEE 1394 and USB 2.0 connectors for digital devices and PCs. Correspondingly, inside the Studio MovieBox Deluxe are ASSPs to handle these interfaces and a Cyclone FPGA that manages all of the interaction between these ASSPs. Figure 3 shows a block diagram of the Studio MovieBox Deluxe design.

Figure 3. Block Diagram of Studio MovieBox Deluxe Design



The Studio MovieBox Deluxe operates in one of a limited number of modes, depending on which video source is being used. Since the Studio MovieBox Deluxe only needs to operate in one of these modes at any given time, Pinnacle decided to leverage the FPGA reconfigurability such that the design configures the Cyclone device to function only in the required mode, depending on which cables are connected to the appliance. The time required to reconfigure the FPGA, which occurs within milliseconds, is undetectable by the user.

The resulting FPGA design uses far fewer logic resources, nearly one-third the amount, than it would have if Pinnacle had used a non-reconfigurable device. Similarly, their logic component costs were one-third what they would have

been if they did not use this reconfiguration-based architecture. Pinnacle used the smallest Cyclone FPGA, about one-fifth of their total bill of materials, which was well within their budget. To further reduce costs, Pinnacle's engineering team hosted the FPGA's configuration files in the PC device driver for the Studio MovieBox Deluxe. This scheme removed the need to include configuration memory devices in the Studio MovieBox Deluxe hardware itself, reducing board space, component count, and corresponding costs.

Ease RoHS Transition With Altera Lead-Free Products

Altera maintains one of the most extensive lead-free product offerings in the industry, with over 1200 products in lead-free packages. As a preeminent supplier of environmentally friendly programmable logic solutions, Altera has shipped over 25 million lead-free products since 2002. Altera's lead-free devices comply with the maximum concentration restrictions, as required in the EU Directive on the Restriction of Hazardous Substances ("RoHS Directive") No.2002/95 with respect to lead (Pb), mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB), and polybrominated diphenyl ethers (PBDE). Help ease your RoHS transition by integrating non-compliant ASSPs with Altera's PLDs.

Conclusion

By taking advantage of FPGA reconfigurability, Pinnacle kept their manufacturing costs to a minimum. Pinnacle's exhaustive evaluation of the alternatives revealed that no other component solution would have enabled them to achieve either their cost targets or meet their aggressive development schedule better than the Cyclone FPGA-based design.

Resources

For additional information, refer to the following resources on the Altera website.

- Pinnacle Systems' Studio MovieBox Deluxe in Altera's Customer Showcase
  www.altera.com/corporate/cust_successes/customer_showcase/pinnacle/csh-pinnacle_lp.html
- More System Integration Solutions
  www.altera.com/technology/integration/int-index.html
- Consumer Applications of Programmable Logic
  www.altera.com/corporate/cust_successes /customer_showcase/view_industry/csh-vindustry-consumer.jsp
- Altera Consumer End Markets
  www.altera.com/end-markets/consumer/csm-index.html
- Information on Altera Programmable Logic Devices
  www.altera.com/products/devices/dev-index.jsp

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