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Simplifying the FPGA Configuration Design Process

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This paper focuses on how Xilinx Platform Flash PROMs simplify FPGA configuration design for system and board designers. There are several alternatives for configuring FPGAs; however, these alternative configuration solutions often require significant up-front design effort and time. Platform Flash is designed specifically for the configuration of Xilinx FPGAs — with the total solution in mind, including both hardware and software support.

Introduction

In today's competitive marketplace, Xilinx FPGA design tools and silicon are instrumental in helping designers minimize the time from product concept to reality. After synthesizing and simulating the design, the last step is configuring the FPGA. Xilinx offers in-system programmable Platform Flash configuration memories (PROMs) designed to simplify the configuration process. These configuration PROMs feature a seamless connection to Xilinx FPGAs.

There are several alternative solutions for configuring FPGAs. In some FPGA applications, the requirements dictate the need for alternative configuration solutions that may involve commodity flash or embedded processors. However, these alternative solutions often require significant up-front effort for design and programming, whereas the Platform Flash is designed specifically for the configuration of Xilinx FPGAs with the total solution in mind, including both hardware and software support.

Configuration is More than Connectivity

FPGA configuration involves more than just the connection to a PROM. The total solution involves software, hardware, and silicon. The total solution cost includes board space, configuration speed, source of supply, other value-added features, and of course ease of use. If these factors are not thoroughly considered from the beginning, then the final design can incur additional costs, or worse, a delay in the production release of the end product.

Total Cost of Ownership

Total cost of ownership needs to be viewed as the cost incurred from the beginning of the project to beyond the manufacturing cycle to include such aspects as field testing and product upgradeability. Xilinx Platform Flash PROMs feature the lowest total cost of ownership:

- The cost difference between a commodity flash PROM versus a Platform Flash PROM is negligible when compared to overall board cost. In fact, Xilinx Platform Flash PROMs are competitively priced with all non-volatile memories in the market, including commodity flash PROMs.

- During the prototyping phase, Platform Flash has significant advantages over commodity flash PROMs because Xilinx offers a complete, low-cost solution:

  - Platform Cable USB: $150.

  - iMPACT programming software: $0. iMPACT software is included free of charge with Xilinx ISE tools.

  - Award-winning support: included. Support for Xilinx configuration PROMs is included in standard Xilinx support agreements.

- Production costs are significantly reduced by utilizing the boundary-scan (JTAG) capability of Xilinx FPGAs and Platform Flash PROMs (along with other JTAG devices on the board) for low-cost boundary-scan testing and programming. A separate cable header or additional hardware and software are not required for Platform Flash as is the case for BPI (parallel flash) and SPI flash solutions. Commodity flash devices do not offer JTAG interfaces; therefore, customers cannot utilize low-cost boundary-scan testing. In most cases, expensive automatic test equipment (ATE) is required for testing and in-system programming of commodity flash memories.

- Xilinx offers application notes, hardware and software solutions to ensure proper field upgradeability. The Platform Cable USB along with iMPACT programming software is often used to do field updates. Xilinx also offers embedded solutions as well, supporting updates handled remotely or via Platform Cable USB. Commodity flash devices do not offer the same level of support nor completeness of solution as provided by Xilinx Platform Flash.

Board Space

While standard SPI PROMs are typically offered in the smallest form factor — 1- to 4-Mbit SPI PROMs are usually offered in the SOIC-8L (5 x 6 mm) package and 8-Mbit (and larger) devices are usually offered in the SOIC-16L (10 x 6 mm) package — Platform Flash PROMs are a close second. 1-, 2-, and 4-Mbit Platform Flash PROMs are offered in the TSOP-20L (6.5 x 6.4 mm) package and 8-, 16-, and 32-Mbit PROMs in the TFBGA-48 (8 x 9 mm) package.

Parallel commodity flash devices have large packages to provide the additional control, address, and I/O pins. These additional signals increase board layout complexity and cost because the board design requires additional layers to deal with the additional routing.

Although SPI PROMs have an advantage in board space, Platform Flash is a close second with only a 12 mm^2 difference in area. This difference is insignificant when compared to the overall system board space.

Configuration Speed

Parallel commodity flash devices are typically the fastest memories in the market and are offered in either x8 or x16 configurations. The theoretical data transfer rate can be as fast as 800 Mb/s (50 MHz x 16 I/O), but there are limitations when configuring a Xilinx FPGA.

Depending upon the FPGA family, Xilinx FPGAs can be configured in x1, x8, or x16 modes. Before Spartan™-3E or Virtex™-5 devices, configuring a Xilinx FPGA with a commodity flash PROM required using a CPLD device to format the FPGA bitstream (refer to [Ref 1], [Ref 2] and [Ref 3]), resulting in degraded data transfer rates due to the additional translation logic.

The maximum configuration speed is 6 MHz when using Spartan-3E device with a parallel commodity flash. In contrast, Platform Flash features a maximum transfer rate of 264 Mb/s (33 MHz x 8 I/O) with Spartan-3E devices.

Although Virtex-5 devices configuration can run as fast as 40 MHz with a parallel commodity flash, due to the variability of the master FPGA CCLK, typical performance is less than 28 MHz.

Parallel commodity flash appears faster, but given the limitations of CCLK, the practical transfer rate is significantly less than that of Platform Flash. SPI devices, burdened with the requirements of the serial protocol and the four-wire interface, are significantly slower than either Platform Flash and parallel flash solutions.

Source of Supply

Although there are a number of commodity flash vendors, there are two potential pitfalls:

- Nuances in the interface protocol offered by each vendor that can limit their interoperability. For example, a STMicroelectronics SPI is not fully compatible with an Atmel SPI PROM.

- Long lead times or expedited-delivery charges during times of short supply. Xilinx answers the supply conundrum by holding a large inventory of Platform Flash in inventory, allowing Xilinx to react quickly to increased demand.

Value-Added Features

Platform Flash offers an array of value-added features not found in commodity flash: compression, JTAG support, design revisioning, easy access to unused memory, and power-up reliability.

Compression

The higher density Platform Flash PROM devices have built-in decompression, which on average, can allow for 50% more configuration data storage in the same memory space. The Xilinx patented compression technology, closely matched to the FPGA architecture, can help the end user reduce cost in two ways:

- Reduce component costs by storing a larger bitstream into a lower density Platform Flash PROM device. For example, a Virtex-4 LX60 design requiring more than 17 Mbits of configuration data can fit into a 16-Mbit XCF16P instead of requiring a 32-Mbit XCF32P PROM.

- Reduce component count by fitting a design into one PROM as opposed to two, or more. For example, a Virtex-4 LX160 requires more than 40 Mbits of configuration data, normally requiring a 32-Mbit and an 8-Mbit PROM, but compression enables the design to fit into a single 32-Mbit XCF32P.

JTAG

The JTAG interface allows for low-cost board-level boundary-scan testing for opens and shorts, as well as easy programming during prototyping and in production.

Design Revisioning

Revisioning allows one board to have many functions. Platform Flash PROMs (XCF08P, XCF16P, and XCF32P) have blocks of memories that can be written and read independently of one another. The logic to switch between each block is built into Platform Flash, thus reducing design time and cost. Although commodity flash devices have similar feature called sectors, additional glue logic and software may be required to program and access design revisions stored in different sectors.

Access to Unused Memory

Most FPGA bitstreams do not fill all of the memory of a PROM. Designers can access unused memory within a Platform Flash PROM through the JTAG interface. Thus, any unused memory is available for processor scratch pad or boot code (refer to [Ref 4],[Ref 5], and [Ref 6]).

> **Note:** Unused memory within commodity flash PROMs can also be accessed, but additional logic and software to access the unused memory is needed.

Power-up Reliability

Platform Flash PROMs are specifically designed to synchronize with the FPGA at power up without additional glue logic.

Ease of Use

Platform Flash is the only glueless configuration solution designed to work seamlessly with all past and present Xilinx FPGAs, cables, and software. Moreover, Platform Flash is backed by an award-winning support team. No other configuration memory supplier can offer such a total support solution for all phases of the design, from prototyping to production.

Conclusion

Designers have a number of choices when selecting how to best configure their FPGAs. The Xilinx Platform Flash solution simplifies the configuration design process, lowers development and test costs, allowing designers to spend more time developing the system application.

Platform Flash is an innovative configuration memory with value-added features enabling greater flexibility and performance for Virtex and Spartan FPGAs. Platform Flash is used in a myriad of applications, ranging from commercial products, such as Plasma TVs and laser printers, to industrial products, such as network routers and automobile control consoles. Using the Platform Flash system-level drop-in solution for FPGA configuration simplifies the design process and improves time to market.

References

1. XAPP079, *Configuring Xilinx FPGAs Using an XC9500 CPLD and Parallel PROM*
2. XAPP137, *Configuring Virtex FPGAs from Parallel EPROMs with a CPLD*
3. XAPP178, *Configuring Spartan-II FPGAs from Parallel EPROMs*
4. XAPP482, *MicroBlaze Platform Flash/PROM Boot Loader and User Data Storage*
5. XAPP544, *Using Xilinx XCF02S/XCF04S JTAG PROMs for Data Storage Applications*
6. XAPP694, *Reading User Data from Configuration PROMS*

Revision History

The following table shows the revision history for this document.

Date	Version	Revision
08/04/06	1.0	Initial Xilinx release.
08/07/06	1.0.1	Minor edits.