Embedded Design Using Programmable Gate Arrays

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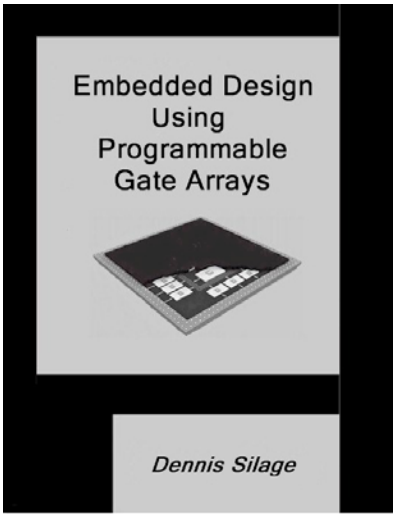

Embedded Design Using Programmable Gate Arrays describes the analysis and design of modern embedded processing systems using the Xilinx Spartan-3E™ field programmable gate array (FPGA). The FPGA has traditionally provided support for embedded design by implementing customized peripherals, controller and datapath constructs and finite state machines (FSM). Although microprocessor-based computer systems have usually been used for the design of larger scale embedded systems, the paradigm of the FPGA now challenges that notion of such a fixed architecture especially with the constraints of *real-time*.

This new paradigm in embedded design utilizes the Verilog hardware description language (HDL) behavioral synthesis of controller and datapath constructs and the FSM for digital signal processing (DSP), communications and control with the FPGA, external interface *hard core* peripherals, custom internal *soft core* peripherals and the *soft core processor*.

Embedded Design Using Programmable Gate Arrays features the Xilinx Spartan-3E FPGA on the Digilent Basys Board and the Spartan-3E Starter Board evaluation hardware, the Xilinx Integrated Synthesis Environment (ISE) WebPACK™ electronic design automation (EDA) software tool in the Verilog HDL, the Xilinx CORE Generator for LogiCORE™ blocks and the auxiliary EDA software for the Xilinx PicoBlaze™ soft core processor. The complete Xilinx ISE WebPACK projects and Verilog HDL modules as described in the Chapters are available as Archived Project Files.

Embedded Design Using Programmable Gate Arrays is intended as a supplementary text and laboratory manual for undergraduate students in a contemporary course in digital logic and embedded systems. Professionals who have not had an exposure to the fine grained FPGA, the

Verilog HDL, an EDA software tool or the new paradigm of the controller and datapath and the FSM will find that this text facilitates an expansive experience with the tenets of DSP, communications and control in embedded design. The Reference section at the end of each Chapter contains a list of suitable undergraduate and graduate texts and reference books.

KEY FEATURES

- A complete description of the Xilinx ISE WebPACK™ v9.2i electronic design automation environment suitable for undergraduate and graduate students and professionals
- Intended as a supplementary text and laboratory manual for undergraduate students in a contemporary course in digital logic and embedded systems
- Professionals can benefit from the *hands-on* experience of real-time embedded projects in DSP, digital communications and digital control for the Spartan-3E Starter Board
- Introduces the controller and datapath construct and the FSM in the Verilog HDL for high-speed embedded design using the soft core peripherals and the Xilinx LogiCORE blocks
- Describes the Xilinx PicoBlaze 8-bit soft core processor architecture, software development tools and applications for the Spartan-3E Starter Board
- Provides an Archived Project File for the complete Xilinx ISE WebPACK™ projects described in the text with new projects available for download with further development

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Chapter 1: **Verilog Hardware Description Language:** Verilog syntax and concepts, structural and behavioral models in the Verilog HDL, FSM, controller and datapath construct, C to Verilog translation, FPGA and microprocessor comparison

Chapter 2: **Verilog Design Automation:** Xilinx ISE WebPACK, Xilinx CORE Generator, Xilinx Floorplanner, Xilinx Simulator, Xilinx Architecture Wizard, Xilinx LogiCORE blocks, warnings and errors in synthesis

Chapter 3: **Programmable Gate Array Hardware:** Digilent Basys Board, Spartan-3E Starter Board, evaluation board hardware components, digital-to-analog converters, analog-to-digital converters, auxiliary ports and peripherals

Chapter 4: **Digital Signal Processing, Communications and Control:** sampling and quantization, discrete time sequences, discrete frequency response, DSP embedded system, FIR digital filter, FIR Compiler LogiCORE block, Sine-Cosine Look-Up Table LogiCORE block, DTMF generator, Direct Digital Synthesis Compiler LogiCORE block, frequency generator, FSK, PSK and QPSK modulators, LFSR, RS-232 standard UART, Manchester encoder-decoder, pulse width modulation, DC servomotor speed control

Chapter 5: **Embedded Soft Core Processors:** FPGA soft core processors, Xilinx PicoBlaze development tools, architecture and reference projects

AUTHOR BIOGRAPHY

Dennis Silage (Philadelphia, PA) is a Professor in the Department of Electrical and Computer Engineering at Temple University. He has a Ph.D. in Electrical Engineering from the University of Pennsylvania. He is a senior member of the IEEE and director of the System Chip Design Center *www.temple.edu/scdc*, which researches the application of Xilinx field programmable gate arrays in digital signal processing and digital communication.