Using an 8051 Core and Virtex QPRO FPGAs in MILITARY APPLICATIONS

A Swedish company develops unique military products using Xilinx VirtexXCV300 FPGAs and a high speed 8051 core.

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CelsiusTech Electronics AB specializes in advanced electronic military systems. In May 1999, they evaluated the feasibility of using FPGAs and IP modules for their new designs. Five microcontrollers were evaluated, and the Dolphin Flip8051-PR AllianceCORE product along with Xilinx Virtex QPRO FPGAs were selected as the perfect solution.

Dolphin's Flip8051-PR is available for use in the Xilinx Virtex, Virtex-E, Virtex QPRO, and Spartan-II devices. The Virtex QPRO family is fully qualified for military use and offers a wide range of devices up to 2-million gate densities. The Flip8051-PR 8051 microcontroller core is known as the fastest 8051 Virtual Component for ASIC applications, running an average of eight times faster than the legacy i8051, and it gives you enormous flexibility, something a standard device can't offer. This combination of speed, flexibility, density, ease of use, and military qualification was an easy choice.

Developing a Radar Warning Receiver

One of the systems currently being developed by CelsiusTech is a Radar Warning Receiver (RWR) system, used in a supersonic combat aircraft (see Figure 1). The system receives, detects, identifies, and warns the pilot of hostile radar signals without warning the enemy. The front-end unit of the RWR system needs a compact and reliable IP module control processor, such as the 8051 family microcontroller. Since this front-end unit is mounted external to the supersonic aircraft, it is subjected to severe mechanical, thermal, and electromagnetic conditions.

The RWR system includes the RWRW front-end unit, Central RWR Computer, and Ground Maintenance Computer (see Figure 1). The front-end unit is composed of:

- FLIP8051-PR IP module with internal ROM and RAM integrated into the FPGAs using block RAM and distributed RAM features.
- Microwave Receiver Subsystem, DSP Function block.
- Two serial links: a standard 8051 UART and an in-house High Speed Serial Transmitter/Receiver module.

Easy Integration of the Core

The Flip8051-PR core was easy to implement in a Virtex XCV300 FPGA and it was successfully integrated with all the sub-modules of the RWR

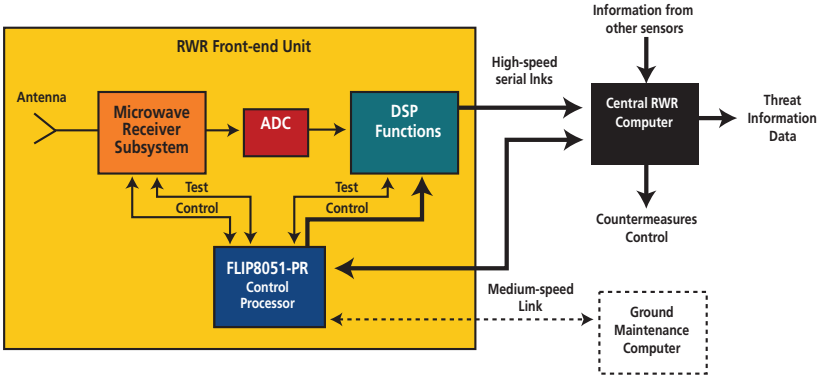

Figure 1 - Radar Warning Receiver (RWR) system.

system within a short time. The core provided key advantages such as:

- Code compatibility with legacy i8051.
- Easy access to Special Function Register (SFR) space.
- Demultiplexed address/data bus for memory interface.
- Choice of bidirectional/unidirectional I/O.
- Bus Monitor function for simulation.

The design team at CelsiusTech found the core's SFR Bus Interface especially helpful because it allowed them to easily add peripherals to the core (see Figure 2). The SFR bus gives a lot of flexibility, especially when designing systems that include many on-chip peripherals.

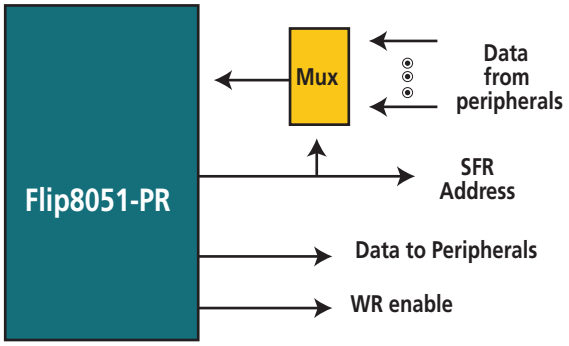

Figure 2 - SFR Bus Interface.

CelsiusTech has also used the FLIP8051-PR in several other applications, incorporating highly application-specific peripheral functions.

Using the Bus Monitor for Core Validation

Before implementing the applications in the FPGAs, the systems were fully simulated and verified using a Bus Monitor function provided by Dolphin. The Bus Monitor interacts with a simulation tool such as Model Technology's V-System and generates text messages of disassembled instructions so errors can be observed and easily fixed (see Figures 3 and 4).

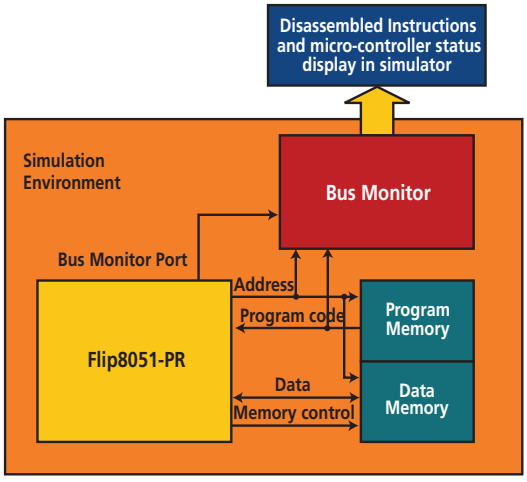

Figure 3 - Typical use of the Bus Monitor functionality.

The Flip8051-PR core has a dedicated port used by the Bus Monitor behavioral model for tracing code execution and disassembly in real time. In addition, the dedicated port monitors the microcontroller interrupt status.

Once simulations were verified, the design was downloaded into the Xilinx Virtex V300 FPGA and integrated into the evaluation board (see Figure 5). The core worked successfully on the first attempt and the CelsiusTech team was able to incorporate additional peripherals on the same evaluation board.

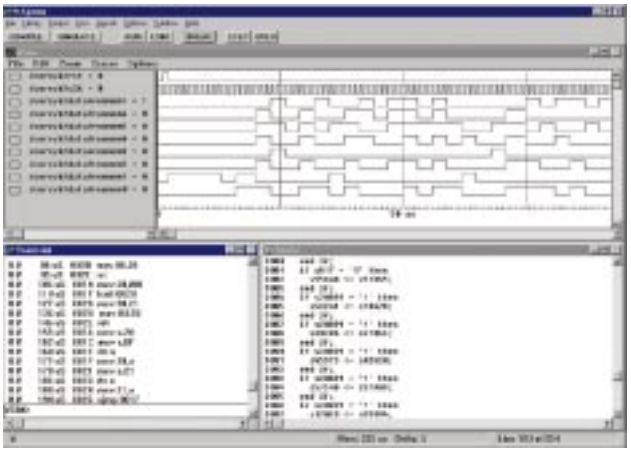

Figure 4 - Screen dump of Bus Monitor Model Technology's V-System.

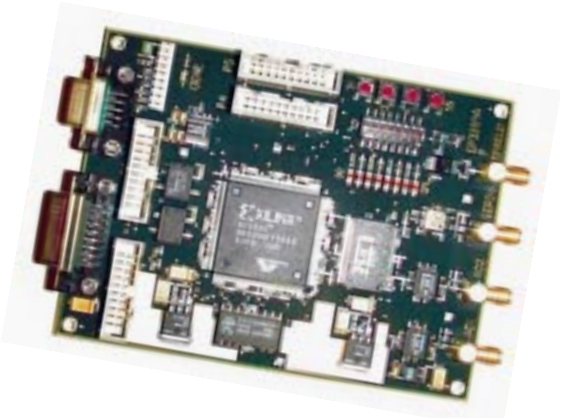

Figure 5 - CelsiusTech Evaluation Board.

"The need for support from Dolphin has been less than originally anticipated, mainly because the FLIP8051-PR has proved to be a mature design of high quality," said Lars Albihn, senior design engineer at CelsiusTech. By using a proven AllianceCORE product from Dolphin in a Xilinx FPGA, CelsiusTech was able to save both time and money while benefiting from the technical expertise of Dolphin.

Software Tools

Dolphin has partnered with Raisonance (www.raisonance.fr) to provide a full software tool suite, the Flip8051-Rkit. The tool suite consists of a C compiler, an assembler, a linker, a real time OS, a ROM monitor, and a simulator.

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The simulator facilitates simulation of both standard 8051 peripherals and user specific peripherals.

Conclusion

Based on the successful evaluation and deployment of the Flip8051-PR core in their systems, CelsiusTech concluded that using IP modules is the best method for their system design on FPGAs. Thanks to features such as high-speed execution, SFR Bus Interface, and Bus Monitor, the FLIP8051-PR in a Xilinx FPGA has proved to be a reliable, flexible and easy to use Virtual Component. It is an ideal solution that adds the expertise from Dolphin to the flexibility and system level features of Xilinx FPGAs thus, reducing the overall time-to-market. Σ

For more information and a datasheet of the Flip8051-PR core, see the Xilinx IP Center, a comprehensive resource for system level intellectual property and services: www.xilinx.com/ipcenter

Dolphin Integration, is a Xilinx AllianceCORE partner in Europe with expertise in digital, analog, and mixed signal circuits. They provide IP solutions for processors, telecom, and multimedia systems.

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