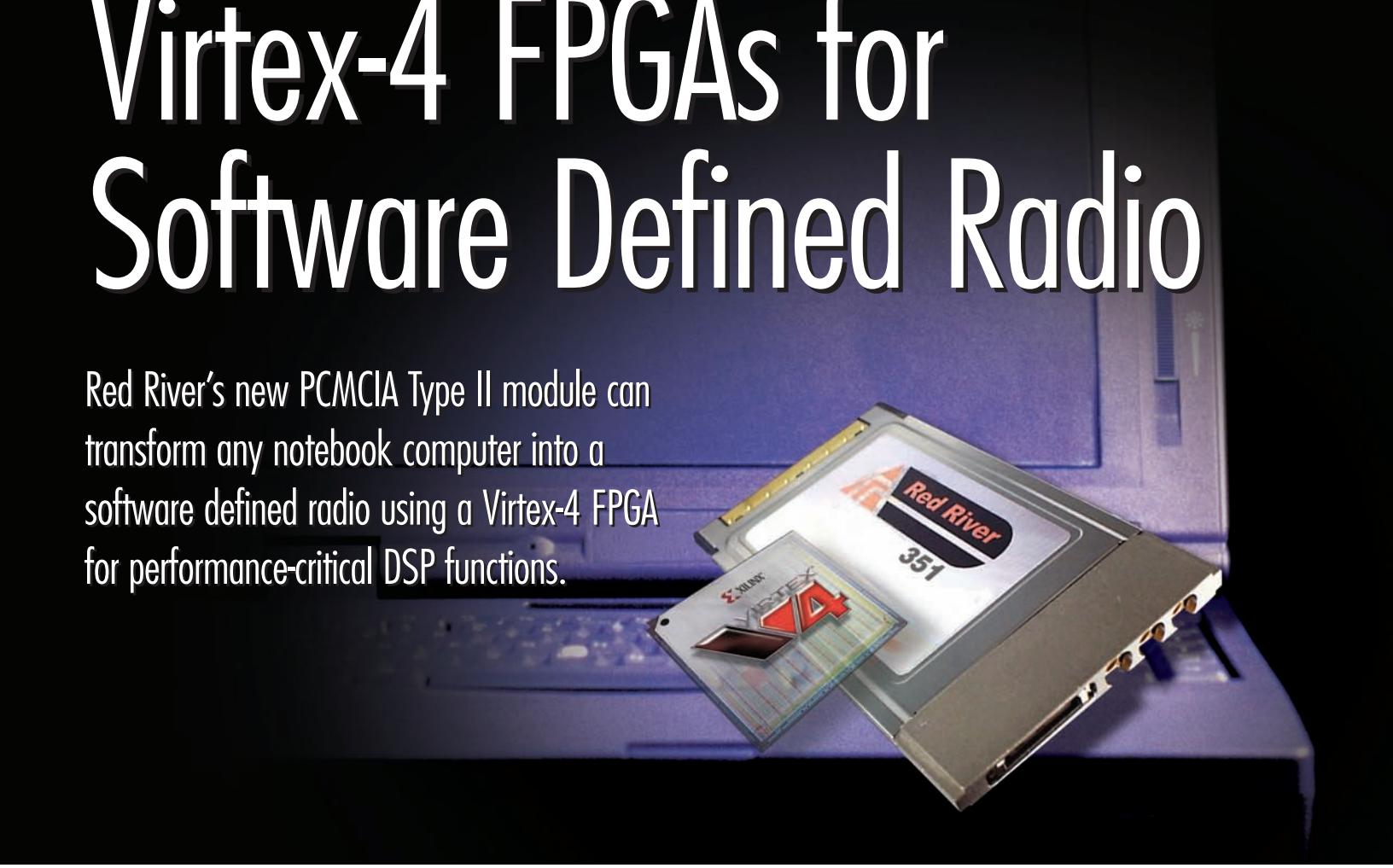
# Virtex-4 FPGAs for Software Defined Radio

Red River's new PCMCIA Type II module can transform any notebook computer into a software defined radio using a Virtex-4 FPGA for performance-critical DSP functions.

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Established in 1996, Red River specializes in high-performance signal processing and data communication solutions for the embedded systems market, especially software defined radio applications.

Our main challenge in serving the software defined radio market is to have a hardware platform that meets the demands of multiple configurations. Some customers are looking for a complete, pre-built radio solution; others are looking to add custom features to a radio platform. These disparate requirements place great demands on us to find a common programmable silicon solution that meets both needs.

The Xilinx® Virtex-4™ FPGA family allows us to do exactly that – provide different customer solutions at the lowest cost. Advanced features such as FIFO logic, embedded PowerPC™, RocketIO™ transceivers, and Ethernet MAC, as well as advanced power and packaging technology, makes Virtex-4 devices a perfect choice for us.

**Model 351 (Pocket Change)**

Our next-generation product, the Model 351, or "Pocket Change," transforms any portable computer into a high-performance multi-channel software defined radio transceiver. The Pocket Change CardBus PC Card accepts two analog input signals through MMCX coaxial connectors on the outside edge of the card. The receiver input is AC-coupled to a 14-bit (80 MSPS) A/D converter. The transmitter output is supplied through a 14-bit (100 MSPS) D/A converter. Most of the digital logic is supplied using a Virtex-4 FPGA device.

When we began developing the Model 351, we investigated various offerings on the market and finally decided to use Virtex-4 FPGAs. The Virtex-4 FPGA family provides the flexibility and features that support both our needs and the requirements of our customers.

The Model 351 design comprises a Virtex-4 FPGA connected to an A/D converter, a D/A converter, and a dedicated PCI bus controller (for the CardBus interface to the host computer) (Figure 1). Although it is targeted at our traditional software defined radio customers, the Model 351 is also suitable for signal acquisition or generation, signal intelligence collection, transceiver modem algorithm prototyping, frequency hop signal generation, or portable signal recorder/playback applications.

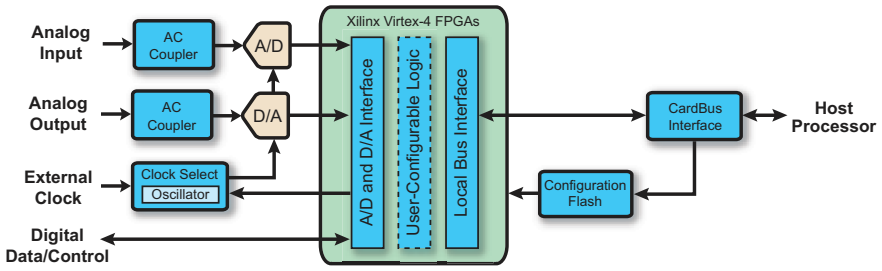


*Figure 1 – Model 351 block diagram*

### Customization and Flexibility

Initially we considered using dedicated digital upconverter/downconverter chips to implement the Model 351 transceiver function. However, many of our customers prefer the flexibility of inserting custom functions into their designs. The customization requirement pushed us to use programmable technology.

By selecting a leading programmable logic architecture, we can address the customization needs of a broad set of customers. Xilinx ISE™ development software provides our customers a familiar design environment to embed custom DSP functions in the uncommitted logic of the Virtex-4 FPGA.

Another benefit from using Virtex-4 FPGAs is that we can offer multiple products using one common hardware platform. This has helped reduce hardware development time and simplify inventory management.

### Power and Space Efficiency

One of the challenges in CardBus PC Card development is to select a device that meets the PCMCIA functional specification and the tight power restriction of 3.3W. We were impressed with the power efficiency of the Virtex-4 family, as it consumes half the power of comparable logic solutions.

Virtex-4 FPGAs give us significant features and performance while still meeting the tight power budget of our design. In addition, PCMCIA imposes severe height restrictions in order to fit into the Type II module form factor. The Virtex-4 FF668 package offering is one of the few FPGA packages that meet the height requirements.

### Advanced Features and Performance

One key requirement for a software defined radio application is high-performance DSP capability. The performance requirement is driven by the need to support multiple signal channels in real time.

Virtex-4 FPGAs are capable of performing multi-channel digital upconversion and downconversion across the entire Model 351 analog bandwidth. The Virtex-4 device can also perform Fast Fourier Transforms (FFTs) for spectral analysis of incoming signal data.

The Virtex-4 FPGA provides the "heavy lifting" to process digital information between the host computer and the A/D or D/A converter. The signal processing power comes directly from the SX platform. Virtex-4 devices can achieve high-DSP performance by taking advantage of massive parallelism within each FPGA. For math-intensive algorithms (like DUC/DDC applications in a software defined radio), the high number of DSP slices – multiply/add/accumulate engines – that can run up to 500 MHz provides the kind of performance only previously available in fixed ASIC technology.

Our designs also make extensive use of the internal block memories in the FPGA to provide multi-queue FIFO capabilities. The FIFOs are used to buffer data between the A/D or D/A converters and the local bus for DMA operations, providing performance-intensive processing without involving the host CPU in memory transfers. This gives our products the ability to flexibly handle digital radio data without completely consuming the CPU performance of the host computer. With the highest-performance internal block RAM and unique integrated FIFO logic, Virtex-4 FPGAs give us the FIFO quantity and performance that we need to keep up with the bandwidth of the analog components and host interface.

### Three Platforms Satisfy Multiple Requirements

The three Virtex-4 platforms (LX, SX, and FX) give us unique capabilities for several upcoming products. For customers wanting to add custom logic functionality, we use the LX platform. LX offers the choice of many different gate densities within the same package footprint, allowing us to use the same base design to support many different customer needs.

We have some designs that necessitate tremendous additional DSP capability for math-intensive processing, including signal modulation and demodulation. For these applications, we see the SX platform as a natural fit. SX devices give us by far the largest amount of DSP performance.

For some of our other designs, we are implementing the advanced system-level block functionality of the FX platform – PowerPC running VxWorks, RocketIO transceivers for optical and PCI Express interfacing, and gigabit Ethernet MAC cores. Because Virtex-4 devices give us three platforms to choose from, we can offer different capabilities across our product line.

### Conclusion

Software defined radio products must address a broad application space, which presents a challenge when selecting component features. The three Virtex-4 platforms give us the feature choice and performance that we require to field a family of solutions for both fixed and mobile installations.

The upcoming Model 351 demonstrates cutting-edge capabilities in an extremely small, power-efficient module that operates in a standard notebook computer. Visit *www.red-river.com* for more information about the Model 351 and other Red River products.