Metalithic Systems Exploits Real-Time

The Xilinx Reconfigurable Computing Developer's Program is promoting the commercial use of FPGAs in Rapid Reconfiguration (RR, also known as reconfigurable computing) applications. These systems add significant value by dynamically changing FPGA designs, in real-time, while the system is operating. Applications that can exploit the benefits of the RR concept include graphics and image processing, audio processing and data communications.
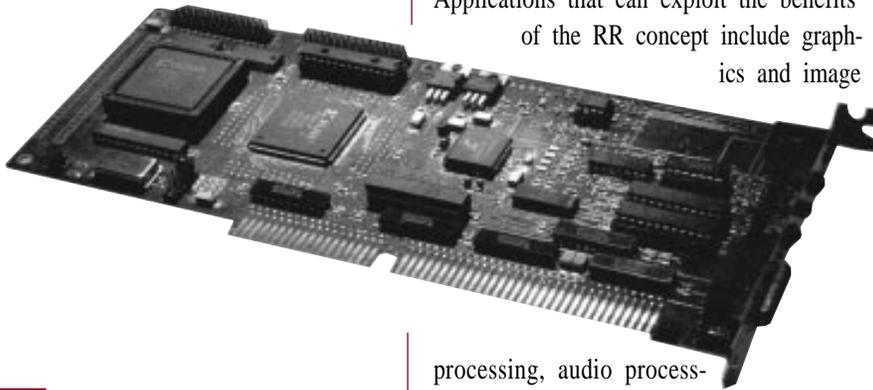
In recognition of the unique achievements of Metalithic System Inc. (Sausalito, California), Xilinx presented the company with its inaugural "RR Company of the Quarter" award. Metalithic Systems (MSI) was one of the first companies to realize the potential of RR, and has released a commercial product that has RR benefits which vastly improve the music industry's state-of-the-art.

MSI's *Digital Wings* audio processing system uses FPGAs in one of its first mass-market commercial applications. *Digital Wings* is a complete audio authoring system that operates in the Windows environment on a PC. It delivers 128 tracks, allowing a random access edit environment with a programmable algorithmic synthesizer that supports pan, level, fade, parametric EQ, echo, chorus, reverb and stereo effects.

The *Digital Wings for Audio* product — a system consisting of a single add-in board for the PC and related software — was announced and demonstrated at the NAMM (National Association of Music Marketers) convention in Anaheim this January. (NAMM is the "COMDEX" of the music industry.) Their closest competitor was displaying a 48-track, 9-board system costing more than 50 times as much. Enthusiastic editorial interest in MSI and *Digital Wings* has resulted in feature articles planned for upcoming editions of

Using Decoupling Capacitors

As CMOS devices have become faster and as the number of outputs increases, good decoupling is vital to reliable circuit operation. Current pulses with a 1 ns rise or fall-time must be treated like GHz signals. In fact, digital printed circuit board designers could learn something from looking inside a UHF-TV tuner.

The standard "rule of thumb" for decoupling-modern CMOS ICs is to mount one low-inductance, decoupling capacitor of 0.01 to 0.1 µF very close to each V_{CC} pin. This provides the fast changing dynamic supply current, especially when capacitively-loaded outputs are switching.

The big power-supply capacitor, and even the 100 µF board-decoupling capacitor, cannot perform this function. First, big capacitors have an unavoidable internal series-inductance that makes them incapable of supplying fast-changing current pulses with nanosecond rise and fall-times. Second, those capacitors are typically positioned too far away from the devices that need access to an instant current reservoir. Even a good power/ground distribution network has unacceptable inductance over distances of several inches.

For example, assume a device has 40 outputs switching simultaneously (or within a few nanoseconds of each other), with each output

Reconfigurability for Audio Processing

Pro Sound News, EQ, Electronic Musician and *Mix*. MSI left the convention with commitments for tens of thousands of systems. *Digital Wings* will be distributed through retail stores later this spring.

MSI's proprietary "nanoprocessor technology" uses Xilinx XC3090 and XC4005 FPGAs to reconfigure the system's hardware on-the-fly. Hardware changes with the needs of the system. In one instant it handles a specific communication function, in the next it is configured as a multi-processor to do complex pattern recognition, and in the next it's a microcontroller handling a specialized peripheral. Reconfigurable FPGAs perform all these functions, significantly reducing system cost while accelerating system performance.

Congratulations are due to the whole MSI development team. For more information on the *Digital Wings* product, contact Metalithic Systems at 415-332-2690. ◆

For more on Xilinx Programmable Logic and our RR efforts, please see our web site at http://www.xilinx.com

driving a 100 pF load. With an output swing of 4 V and all outputs switching in the same direction, each such transition consumes 0.016 μCoulomb. If four decoupling capacitors of 0.01 μF have to supply this charge, they will drop their voltage by $0.016/0.04 = 0.4$ V. That is barely acceptable. Four 0.1 μF decoupling capacitors would be preferred, since they reduce this drop by an order of magnitude. Capacitors larger than 0.1μF tend to have more series-inductance, and are actually inferior for this application.

Another way to look at dynamic current requirements is to start with power dissipation. A 3-watt device clocked at 40 MHz does not consume a steady 600 mA, but might consume 3 A for 5 ns, and very little for the rest of the time. As explained above, to provide the 0.015 μCoulombs (3 A x 5 ns) requires at least four 0.01 μF decoupling capacitors, and 0.1μF would be better.

The need for V_{CC} decoupling varies with the amount of internal logic, the number of outputs that switch simultaneously and their capacitive load. The rule of one low-inductance 0.01 to 0.1 μF capacitor at each V_{CC} pin is still a good guideline. ◆