Customer Application

FLEX 8000 Devices "Grab" Vitana's Fancy

A Leader in Three-Dimensional Imaging

Vitana Corporation, based in Ottawa, offers two- and three-dimensional imaging products as integrated solutions in the resource, industrial design, parts inspection, volume measurement, contour analysis, and medical imaging industries. Vitana is a leader in three-dimensional imaging and has experience in laser-based imaging, digital signal processing (DSP), and high-speed digital design.

The company's flagship product, ShapeGrabber, is a second-generation laser-scanning system that fits into a standard PC. The job of hardware engineer Andrew Nelson was to design the high-speed digital video circuitry to control and implement the complex DSP algorithms that make ShapeGrabber the finest-quality imaging system available.

Performance & Reconfigurability Challenges

From the onset, Nelson knew that ShapeGrabber would be a single card, packed with features. Although the core of DSP functionality was provided by a Texas Instruments floating-point DSP device (a TMS320C44), he determined that if he had a support device for video peak detection and sub-pixel interpolation, he could meet the goal of providing real-time video DSP for three-dimensional imaging. Therefore, the first challenge was to identify a device that would allow him to build high-speed digital filters.

In addition to real-time video processing, the other major performance requirement was high host/embedded transfer rates (> 80 Mbytes per second). To meet this requirement, Nelson decided on a peripheral component interconnect (PCI) bus master/slave interface and a high-speed local bus to support data transfers between the DSP devices on the ShapeGrabber card.

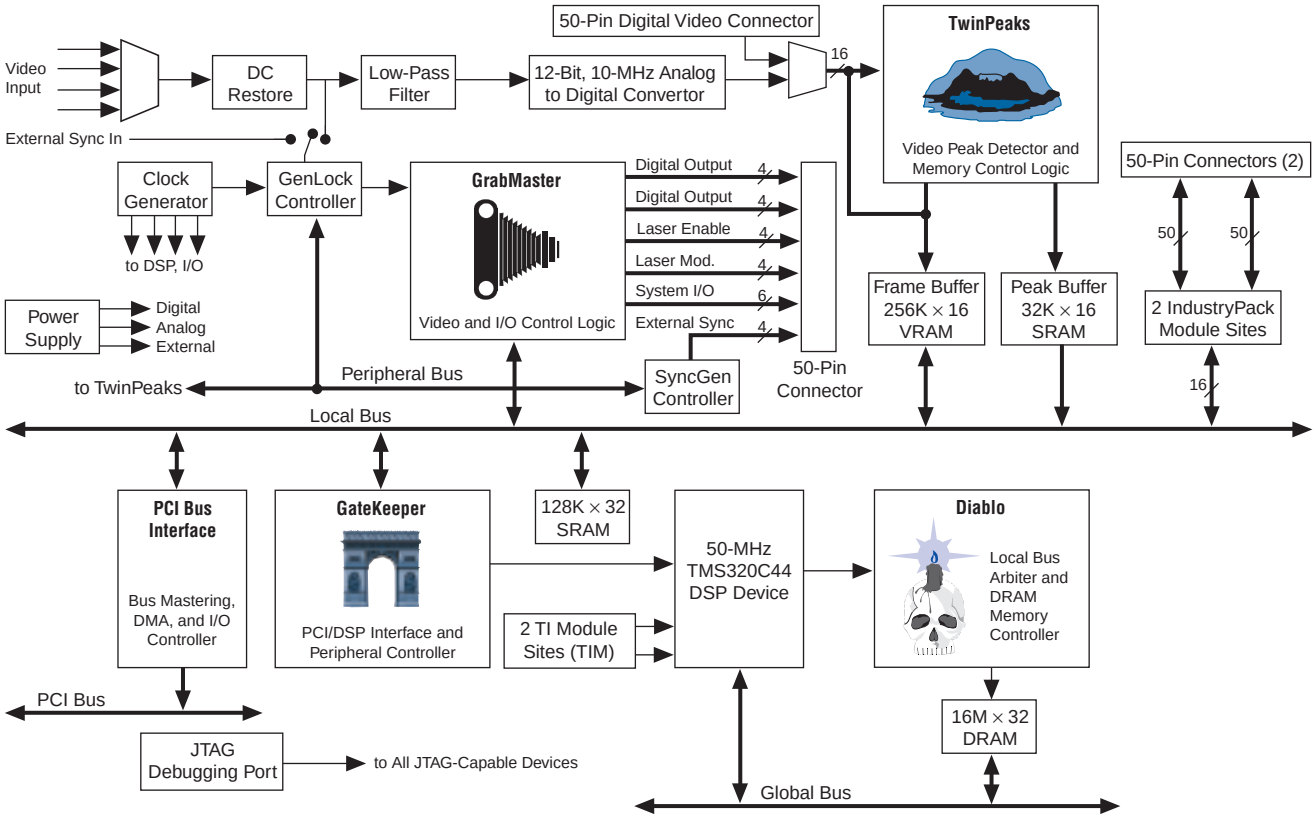
Finally, as Vitana planned to provide easy upgrades to its customers in the field, it was imperative that these devices be reconfigurable or reprogrammable in-system. In-circuit reconfigurability (ICR) would also provide the benefit of quick and easy prototyping iterations.

Industry:	Imaging	
End Product:	ShapeGrabber Laser Scanning System	
Design Application:	DSP Video Circuitry	
Altera Products:	**Device**	**Function**
	EPF81188A "TwinPeaks"	Video peak detector & sub-pixel interpolator
	EPF8452A "GateKeeper"	PCI to TMS32C44
	EPF8452A "GrabMaster"	Video & I/O control logic
	EPF8282A "Diablo"	TMS320C44 local bus arbiter & memory controller

Three Types of Devices

Nelson evaluated three types of devices for his design: gate arrays, off-the-shelf programmable filters, and programmable logic devices (PLDs). Although gate arrays could be less expensive in large quantities, their long development times and inflexibility ultimately made them unsuitable for the project. In addition, none of the programmable filters Nelson considered were flexible enough for his needs. In particular, these filters could not implement the different types of filters for the upgrades and product modifications he envisioned.

ShapeGrabber Block Diagram



Nelson had some previous experience with programmable anti-fuse devices; however, the need to configure the devices in-circuit in the field precluded his use of these one-time-programmable devices. He also considered using field-programmable gate arrays (FPGAs) with segmented routing, but ultimately decided against them out of concern for their poor routability and his need to guarantee timing and fitting with each design iteration through future upgrades. The PLDs that met all of his needs from the initial examination were Altera FLEX 8000 devices.

The Implementation

When creating the designs for the FLEX 8000 devices, Nelson began by grouping functions and assigning descriptive names and icons to the devices that would perform the functions. It didn't take long before the TwinPeaks, GateKeeper, GrabMaster, and Diablo devices had lives of their own. The devices and their functionality are summarized below.

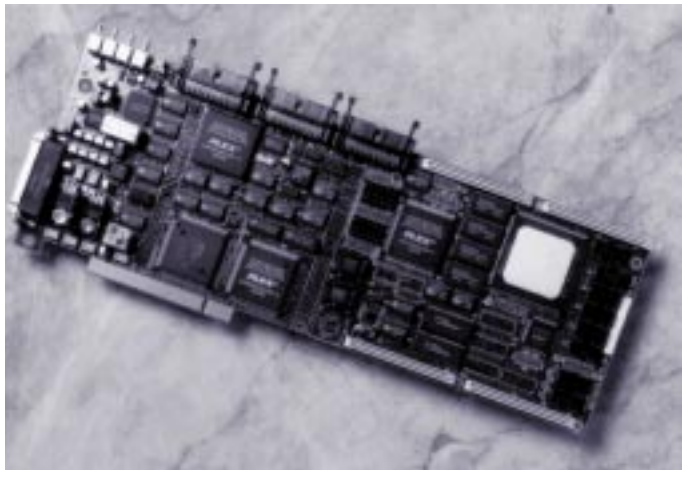
Of the four designs, Nelson found TwinPeaks to be by far the most challenging. He designed TwinPeaks to be a video preprocessor, with the intention of having the device perform peak detection and validation external to the DSP device, freeing up more of its processing time. He chose the EPF81188A device for this design, which included two FIR filters. The peak locator was a 16-bit, 8-tap filter and the peak location validator was a 14-bit, 3-tap filter. Both filters ran at video rates. The TwinPeaks design also contained the sub-pixel interpolator, which interpolates the position of the peak to 1/64 of a pixel. If these functions had been placed in the DSP device, according to Nelson, they would have consumed 80% of the device's functionality. But by using the EPF81188A as a DSP coprocessor, he was able to meet the speed requirements.

Development Time

The first-generation ShapeGrabber had used anti-fuse-based devices. It had taken the design team about two painful months to build that version-painful both in terms of design and cost because the devices had to be thrown away after each iteration. However, using Altera's MAX+PLUS II software, Nelson designed the second-generation ShapeGrabber in less than a day, and completed full simulation of the entire design in the following two weeks.

To create the design, Nelson used MAX+PLUS II version 6.0, which supports the library of parameterized modules (LPM). This solution permitted him to create custom building blocks that were not limited by conventional logic sizes. Because the LPM functions were optimized for any target device he chose, he was able to concentrate on the design without worrying about the lower-level implementation details. MAX+PLUS II version 6.0 also had better device fitting support, as evidenced when the software fit designs faster and easier than the previous version.

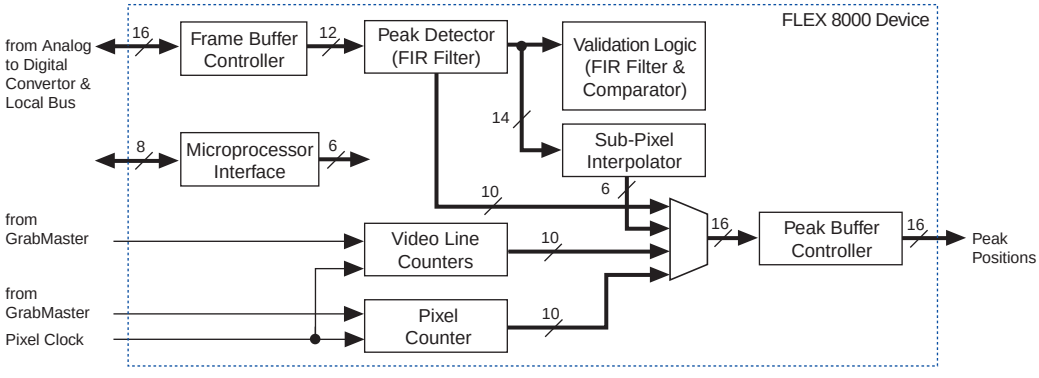
FLEX 8000 devices support in-circuit reconfigurability (ICR), which vastly decreased the amount of time it took Nelson to prototype ShapeGrabber. He could make a design change, implement it, and physically test it in minutes. Using ICR and the Altera Hardware Description Language (AHDL), Nelson was able to make, simulate, and fully test 10 to 20 design changes a day. With these rapid prototyping features, Vitana's time-to-market decreased significantly.



In-Field Upgrades via ICR & the PCI Bus

One of the features Nelson had planned for this generation of ShapeGrabber was the ability to perform in-field upgrades and modifications to meet special customer needs. He accomplished this by reconfiguring the FLEX 8000 devices via the PCI bus. He wrote a software driver that resides on the host platform and converts a FLEX 8000 programming file to configuration data. The driver also downloads the configuration data to the appropriate FLEX 8000 device via the PCI bus upon startup. All that is required for upgrades or modifications is a single new programming file that can be sent to the customer electronically.

TwinPeaks Block Diagram



Some of the modifications Nelson is planning include changing the filtering in the TwinPeaks design. For example, instead of peak detection, he may consider valley detection, or performing low-pass or high-pass filtering on the video signal. In any case, ICR gives Vitana a greater ability to service customers in the field.

Conclusion

"Having worked with a number of device architectures and design packages, I can truly say that using FLEX 8000 devices along with the MAX+PLUS II software were the ideal choices for creating our product," said Nelson. "ShapeGrabber meets our goal of being the most advanced three-dimensional imaging product worldwide."

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—Andrew Nelson
Hardware Engineer

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