Prototyping Applications with the Spartan-3A DSP Starter Platform

The new Spartan-3A DSP Starter Platform includes expansion capabilities for low-cost and easy-to-use application development.

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Have you ever had a great idea for the next killer FPGA application but struggled to find the right prototyping hardware that would allow you to prove out your concept? You're not alone. Finding the perfect development platform is not easy. Boards are often designed more for demonstration than development, leaving designers with little flexibility and limited access to FPGA I/O pins.

With the recent introduction of the Xilinx® Spartan™-3A DSP FPGA family, Xilinx has created a unique, low-cost, prototype-friendly starter platform to ease your application development. Through the EXP expansion interface included on the board, you can add application-specific daughtercards to customize the board's feature set for your prototype needs.

In this article, I'll review the EXP standard, showing you why it's FPGA-friendly and able to meet your most demanding expansion needs. We'll look at several of the EXP modules currently available and see how they can be used to easily create video, embedded, and communications processing applications around the Spartan-3A DSP. You'll see how the EXP specification, the Spartan-3A DSP Starter Platform, and the EXP add-on modules can combine to quickly and cost-effectively provide you with a useful prototype system.

The EXP Expansion Standard

The new Spartan-3A DSP Starter Platform (*www.xilinx.com/s3adspstarter*) includes a standard set of features as shown in Figure 1. Parallel flash and SPI memory are provided for configuration, while DDR2 memory is available for high-performance mass storage. A Gigabit Ethernet PHY and serial port support standard communications links, while clocks, switches, LEDs, and some general-purpose user I/O round out the board interfaces. The remaining FPGA user I/O pins – 168 in total – route to two connectors. These connectors are configured to meet the EXP expansion slot standard, which was designed specifically for FPGA development boards.

Most industry-standard buses, such as PCI, PMC, PCMCIA, or PC-104, implement an address and data bus structure, which is ideal for processor-based systems but limiting for the wide range of FPGA applications. Instead, FPGA development boards require a more generic, universal I/O structure where you can define I/Os as they are needed. Therefore, the EXP specification provides a great deal of flexibility by limiting the number of fixed signal definitions, allowing a more free-form I/O assignment as determined by your end application.

The EXP specification defines a 120-pin connector, with 84 user I/Os and a mix of power and grounds. The standard EXP configuration uses two connectors in a full EXP module configuration for a total of 168 user I/Os. Half EXP module formats are also available, using just a single EXP connector. Two half EXP modules can be connected to a full EXP-configured baseboard.

The Spartan-3A DSP FPGA SelectIO™ interface supports many popular single-ended and differential standards. Table 1 shows the number of pins available at each EXP connector, along with a breakdown of the single-ended and differential pairs sup-

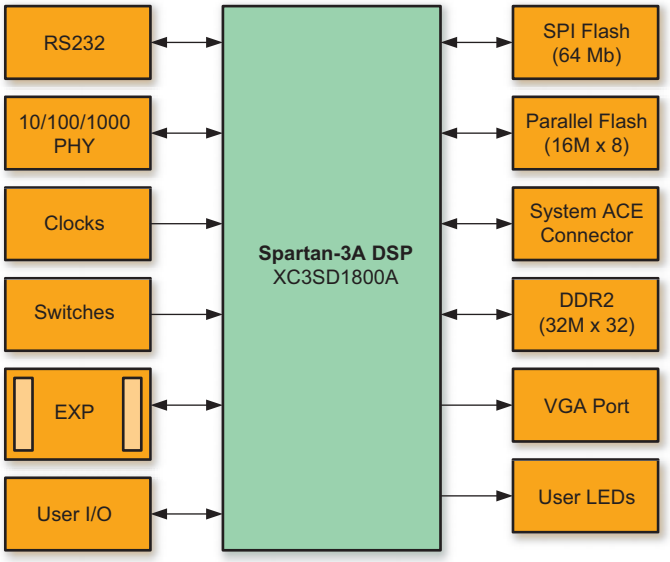

Figure 1 – Spartan-3A DSP Starter Platform block diagram

Signal Category	Pins Per Connector	Pins Per Dual EXP Slot
Single-Ended I/O	34	68
Single-Ended Clocks	2	4
Differential I/O Pairs (22)	44	88
Differential Clock Input Pair (1)	2	4
Differential Clock Output Pair (1)	2	4
2.5V pins (333 mA per pin)	12	24
3.3V pins (333 mA per pin)	12	24
Grounds	12	24
Total	120	240

Table 1 – EXP connector I/O assignments

ported. Each EXP connector can support up to 84 single-ended I/O signals or a mix of single-ended and differential pairs. Providing as many as 24 differential pairs per EXP connector, 48 pairs total, is essential for certain high-bandwidth LVDS interfaces used in video and communications applications. The Spartan-3A DSP Starter Platform board provides a user-selectable I/O voltage jumper for each EXP connector. This allows each EXP connector to be configured for either 2.5V or 3.3V signaling.

As you can see, the EXP slot included on the Spartan-3A DSP Starter Platform opens the door to a wide range of add-on application modules and custom user interfaces. Avnet has created a set of off-the-shelf EXP modules that are interchangeable between any EXP-enabled baseboard, including the Spartan-3A DSP Starter Platform. Let's explore some of these modules to see how they customize the starter platform and create powerful prototype systems that leverage Spartan-3A DSP features.

Video Applications

The Spartan-3A DSP FPGA is ideal for cost-sensitive DSP algorithmic and co-processing applications. Video and image processing, especially the video surveillance and video security markets, are good fits for this FPGA family. To help jump-start applications in this area, Avnet has created the Video EXP module. The Video EXP offers a full compliment of professional/consumer (or "prosumer")-level front-end video functions. With support for DVI, component, composite, S-video, image sensor, and VGA inputs, plus DVI, VGA, and LCD panel video outputs, the Video EXP addresses a broad range of video processing applications.

Figure 2 shows an example video over Ethernet application that can be built from the combined Video EXP and Spartan-3A DSP baseboard. The Spartan-3A DSP SelectIO interface can handle the LVDS interfaces to the image sensors and LCD flat panel. The 250 MHz DSP48A slices and larger enhanced block RAM enable the DSP-intensive image processing pipe. Functions such as the Bayer filter, color-space conversion, chroma sub-sampling, and MPEG-4 video compression can all be implemented and run in real time inside the FPGA. A 32-bit MicroBlaze™ processor helps manage the processing pipe as well as the Ethernet interface.

Wireless Communications Systems

The increasing demand for Internet access has lead to the explosive growth of wireless communication systems that provide a continuous Internet connection. WiMAX is one wireless access technology that is gaining in popularity and has significant market potential. Based on the IEEE 802.16e-2005 standard, WiMAX supports high-speed Internet

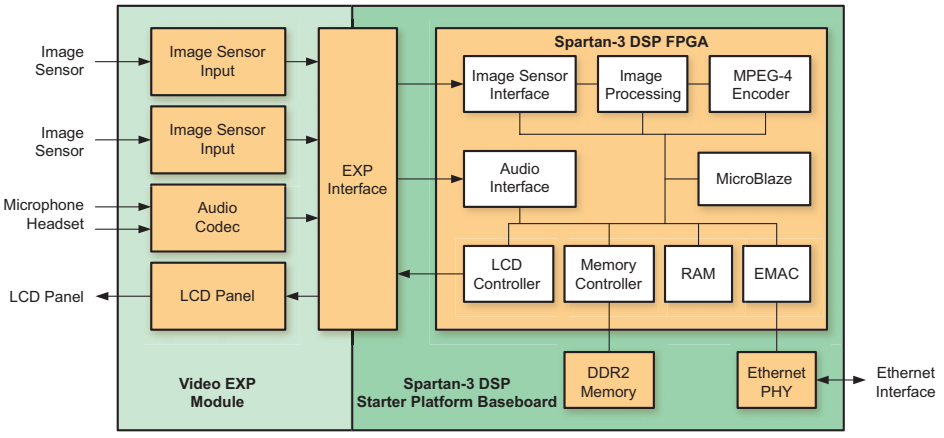

Figure 2 – Video over Ethernet application example

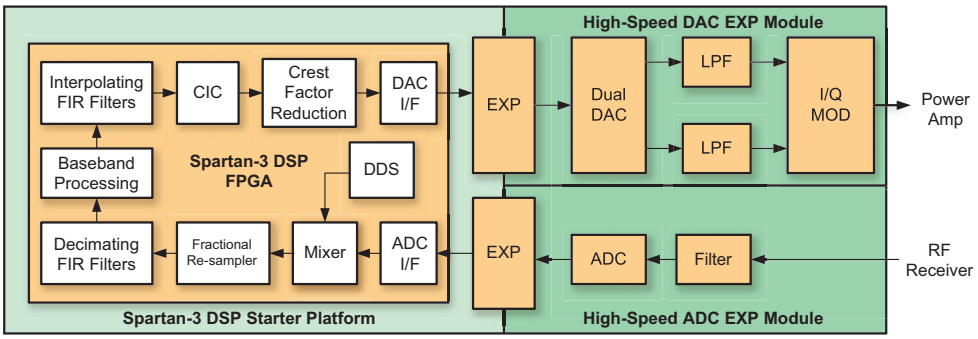

Figure 3 – Example wireless communication system

access using advanced signal processing schemes such as orthogonal frequency-division multiple access (OFDMA) and multiple input multiple output (MIMO) technology. The Spartan-3A DSP is a perfect solution for supporting these high-bandwidth, processing-intensive applications that require flexibility and fast time to market.

To support wireless communications prototyping, Avnet and Texas Instruments have developed two EXP modules that complement the digital IF processing capabilities of the Spartan-3A DSP Starter Platform. A High Speed ADC EXP module and a High Speed DAC EXP module support 12-bit, 500 MSPS analog-to-digital conversion and 16-bit, 1 GSPS digital-to-analog conversion. As half modules, each EXP requires just one EXP connector; thus any combination of two half EXP modules is supported by the starter platform baseboard.

Figure 3 is an example direct conversion wireless communications system that you can prototype with the Spartan-3A DSP Starter Platform, the High-Speed DAC EXP and the High-Speed ADC EXP. The enhanced DSP48A slices inside the Spartan-3A DSP make it ideal for implementing digital front-end processing. Digital up conversion (DUC), comprising two polyphase interpolating FIR filters, a CIC filter, and a crest factor reduction block, can be implemented inside the Spartan-3A DSP FPGA. The output drives the high-speed interpolating DACs on the EXP module, which in turn drives the RF power amplifier for transmission. On the receive side, the IF signal can be directly sampled with the 500 MSPS ADC and passed to the FPGA for digital down conversion (DDC).

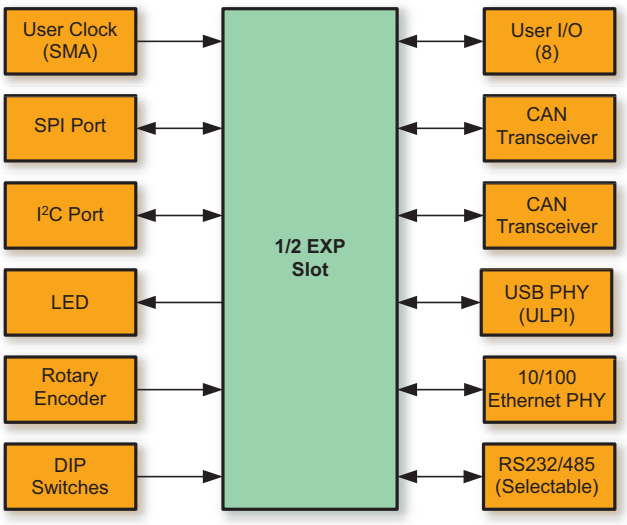

Figure 4 – Interface EXP module block diagram

Embedded Processing Platforms

Although the Spartan-3A DSP FPGA family has features that make it well suited for high-performance DSP applications, it is also a capable choice for embedded processing solutions. The enhanced on-chip block RAM makes the Spartan-3A DSP an especially good fit for the soft-core MicroBlaze embedded processor. To better address MicroBlaze processor-based embedded applications, you can add the Interface EXP half module as defined in Figure 4. The Interface EXP supports many of the common embedded processing interfaces found in processor-based systems. Because the Interface EXP is a half-module format, you still have the option of adding a second half EXP module. When combined with soft cores inside the Spartan-3A DSP FPGA, you have ultimate flexibility and control over your design. Xilinx provides IP cores for all of the interfaces, including USB, CAN, Ethernet, SPI, I²C, and UART.

Conclusion

The Xilinx Spartan-3A DSP Starter Platform is a great way to explore applications around the Spartan-3A DSP FPGA family. The EXP slot included on the board sets this kit apart, enabling customization that addresses video processing, communications, embedded systems, and a wide range of other applications. The available EXP add-on modules allow you to quickly build up real-world prototypes and turn your concepts into reality.

Should a specific function not exist in an off-the-shelf form, you can easily create your own with a custom-designed EXP card. Avnet also provides a prototype EXP module that is great for accessing all of the I/O signals on standard .1" headers.

Avnet will continue to introduce new EXP modules that will further the reach and capability of this starter platform as well as other EXP-enabled baseboards. For a complete listing of EXP modules and the EXP specification (available for downloading), visit *www.em.avnet.com/exp.*