# A Programmable ExpressCard Solution

## Philips Semiconductors and Xilinx offer a two-chip, low-cost, low-power, programmable PCI Express solution.

by Ho Wai Wong-Lam
Marketing Manager
Philips Semiconductors
*ho.wai.wong-lam@philips.com*

Abhijit Athavale
Sr. Marketing Manager
Xilinx, Inc.
*abhijit.athavale@xilinx.com*

ExpressCard modules are thinner, faster, and lighter slide-in cards introduced by PCMCIA to replace existing PC card and CardBus modules, which are primarily used for functionality upgrades and expansion in the notebook computer aftermarket. Likewise, the ExpressCard module is initially intended to serve the notebook computer aftermarket (Figure 1a).

In the desktop computer market (Figure 1b), both PC manufacturers and end users have a strong desire to shift towards the sealed-box model and to embrace easy and foolproof upgrades using the expansion slide-in cards that notebook computers have already deployed for a decade. This trend in desktop computers offers ease-of-use for end users and less service costs for PC manufacturers, as end users will not need to open their desktop computers and potentially damage the machine. ExpressCard technology will probably expand into PC-based appliances such as media boxes and IP set-top boxes.

### ExpressCard Technology

The ExpressCard standard specifies that all ExpressCard modules can support either USB 2.0 or PCI Express (or both) and that all ExpressCard slots must accommodate modules designed to use either the 480 Mbps USB 2.0 interface or the single lane ("x1") 2.5 Gbps PCI Express interface. The ExpressCard standard also supports hot-plug and has stringent requirements on form factor, power-management modes, and thermal limits.

ExpressCard modules come in two sizes:

- ExpressCard/34:
  34 mm (W) x 75 mm (L) x 5 mm (H)
- ExpressCard/54:
  54 mm (W) x 75 mm (L) x 5 mm (H)

Host systems can provide any combination of slots for the 34- or 54-module widths. The 34-mm module will work in a slot designed for 54-mm-wide modules, but not vice versa.

Thermal limits are defined as "inside the slot" dissipation. The thermal limit is 1.3W for ExpressCard/34 modules and 2.1W for ExpressCard/54 modules.

ExpressCard technology makes active-state L0s and active-state L1 power management mandatory for PCI Express. Active state power management (ASPM) allows very aggressive hardware-initiated power management functionality that goes beyond what is achievable by using PCI-PM and ACPI (advanced configuration and power interface) software power-management techniques.

Hotplug functionality is a well-established part of CardBus and USB specifications, and is also supported by the PCI Express specification. ExpressCard module users can install and remove modules at any time without powering down the host computers. Furthermore, auto-detection and configuration of PCI Express and USB 2.0 allows a host system to support ExpressCard technology without using an external slot controller. A small ExpressCard power switch is required to control power to the slot.

Windows XP and 2000 do not provide native discovery support for PCI and PCI Express devices. But with Windows Longhorn, graceful removal and discovery of PCI Express devices will be as seamless as USB devices today.

*Figure 1 – ExpressCard modules in (a) notebook and desktop (b) computers (Photo reproduction permission granted by PCMCIA)*

### PX1011A PCI Express PHY and Spartan-3E FPGAs

Together, Philips Semiconductor and Xilinx offer a low-cost programmable PCI Express solution for the emerging ExpressCard market. Our solution provides fully compliant x1 PCI Express endpoints using a Philips PX1011A PCI Express PHY, a Xilinx® Spartan™-3E FPGA, and a Xilinx LogiCORE™ PCI Express IP core. The solution meets the requirements of the ExpressCard specification with its low power, advanced packaging, signal integrity, and full compliance with the PCI Express specification. In addition, the programmable, reconfigurable fabric of the solution enables you to build innovative ExpressCard applications such as multi-function cards or intelligent peripherals and also reduces costs associated with part inventory and qualification.

Many emerging ExpressCard applications may not be able to utilize existing semiconductor devices because of package, power, signal integrity, or other technical requirements. Instead of waiting for chips that meet the requirements to be manufactured, our two-chip proven programmable solution offers you a low-risk, cost-effective alternative with a short time to market and a longer time in market. The final product can be designed, tested, and shipped in a manner of weeks – and you always have the chance to upgrade or repair the hardware in case of unforeseen problems.

#### Philips PX1011A

The Philips PX1011A is an x1 2.5 Gbps PCI Express PHY device optimized for use with low-cost FPGAs. It is available in a very small package, delivers superior transmit-and-receive performance, and is compliant to PCI Express specifications v1.0a and v1.1. PX1011A is designed to serve both ExpressCard/34 and ExpressCard/54 applications. PX1011A has the following key features to support ExpressCard applications:

- Low power dissipation in normal L0 mode (<300 mW), including I/O
- Small and thin 81-pin package (9 x 9 x 1.05 mm), occupying only a small fraction of the real estate available on the ExpressCard/34 module
- Supports active-state L0s and L1 modes
- In the optional L2 mode, you can use a sideband WAKE# signal as a wake-up mechanism for the L2 power mode

#### Xilinx Spartan-3E FPGA and PCI Express IP Core

The Xilinx PCI Express IP core is designed for the Spartan-3E FPGA and has a small resource footprint. It implements complete logical and transaction layers as defined by the PCI Express specification, leaving approximately 50% of resources for designing in a Spartan-3E500, for example.

The Spartan-3E FPGA communicates with the PX1011A PHY using the source-synchronous 250 MHz PXPIPE standard – based on SSTL_2 I/O – and provides abundant block RAM resources that you can use to implement transmit-and-receive side buffers to store transaction layer packets. The Spartan-3E500 FPGA is available in very small ball-grid-array packages that meet the mechanical requirements of the ExpressCard specification. The PCI Express IP core has the following features required by ExpressCard applications:

- Fully compliant to the PCI Express base specification v1.1
- 2.5 Gbps bandwidth in each direction
- Resource usage
- 5,408-5,708 LUTs
- Six block RAMs
- 3,920-4,017 flip-flops
- PCI/PCI Express power-management functions
- Active-state power management (ASPM)
- Programmed power management (PPM)
- Compatible with current PCI software model

The combined Philips/Xilinx PCI Express solution is low in power dissipation (700-800 mW), making it suitable for both ExpressCard/34 and ExpressCard/54 applications.

Furthermore, the joint solution has successfully completed PCI Express compliance tests administered at PCI-SIG Compliance Workshop #45 in June 2005, and is listed on PCI-SIG Integrators List.

Using the Philips/Xilinx solution, applications can fully benefit from the high 2.5 Gbps throughput offered by PCI Express, while enjoying the flexibility of a programmable solution.

## DVB-T ExpressCard/34 Demonstrator

At the Consumer Electronics Show (CES) in January 2006, we demonstrated the world's first programmable ExpressCard application, comprising the Philips PX1011A PCI Express PHY and PDD 2016 DVB-T module (Figure 2), as well as a Xilinx Spartan-3E FPGA with the optimized Xilinx PCI Express IP core (Figure 3).

*Figure 2 – The Philips/Xilinx CES 2006 DVB-T ExpressCard/34 module demonstrates live digital TV reception on a notebook computer.*


*Figure 3 – Xilinx Spartan-3E FPGA and Philips PX1011A on a DVB-T ExpressCard/34 demonstrator*

The Philips DVB-T ExpressCard/34 demonstrator resides in a notebook computer ExpressCard slot and receives DVB-T signals from a live TV transmitter. Streaming TV reception is displayed on a notebook computer.

Philips RF Solutions chose the joint Philips/Xilinx solution to convert the MPEG transport stream to PCI Express packets (required for communication with the host processor) based on the following benefits:

- Lower total cost than competitive solutions
- Ability to future-proof for further product enhancements and keep up with ExpressCard standard modifications
- Increased reusability across customer products

## Conclusion

As ExpressCard technology becomes ubiquitous initially in notebook computers, it will then make headway into desktop computers and other PC-based appliances such as media boxes and IP set-top boxes. Our joint Philips/Xilinx ExpressCard solution provides a low-cost, low-power programmable solution to enable many emerging applications in the coming years.

For more information, please visit:

- *www.standardics.philips.com/products/pcie/phys/*
- *www.xilinx.com/pciexpress*
- *www.xilinx.com/spartan3e*
- *www.xilinx.com/prs_rls/silicon_spart/0603philips.htm.*