



Create Flexible I/O Solutions for Intel Atom Processors

FPGA I/O Companion Chip Solutions

Altera® FPGAs provide the ideal platform to extend the functions and I/O features of industry-proven embedded processors. The addition of PCI Express® (PCIe®) interfaces to both FPGAs and embedded processors enables a low-cost, easy-to-use, high-performance interconnect between the devices, as shown in Figure 1.

Altera's transceiver FPGAs, including the Cyclone® IV GX and Arria® II GX FPGAs, can integrate application-specific peripherals, processor offload hardware engines, and Altera® Nios® II processors for local control and data processing as a companion chip. This approach simplifies the implementation and maintenance of time-critical or hardware-specific I/O functions as it will not be necessary to change the host processor or software when I/O requirements change.

Industrial and Automotive Applications

- Programmable logic controllers (PLCs)
- Human-machine interfaces (HMIs)
- Panel/industrial PCs (iPCs)
- Intelligent drives
- Infotainment head units
- Rear-seat entertainment
- Sensor integration and driver assistance

Key FPGA Companion Chip Advantages

- Create new companion chip solutions without changing your host processor, software, and development ecosystem.
- Lower total cost ownership (TCO) through a standard-based, open platform that offers system-level reconfigurability to meet market needs while preserving your existing hardware and software investments.
- Mitigate obsolescence risk through long-term FPGA product availability.
- Easily upgrade your products to future FPGAs or compatible processor architectures.
- Shorten time to market through design abstraction and reuse of hardware IP and firmware.

Figure 1: High-Performance PCIe Processor with FPGA as I/O Companion Chip

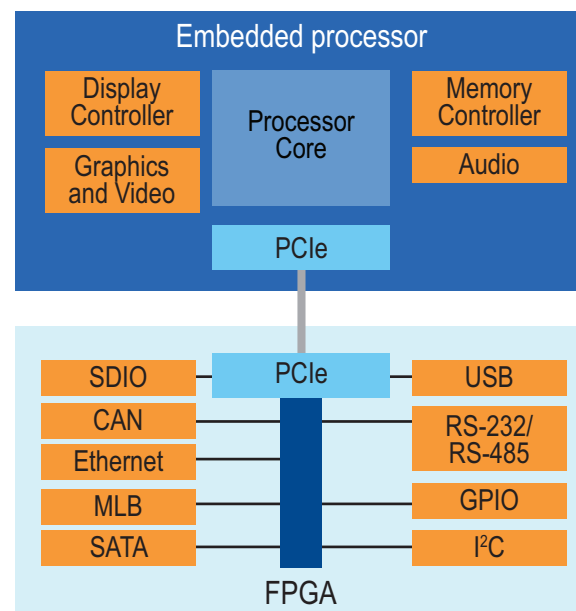


Table 1. Altera Transceiver Devices

Device	PCIe Hard IP Block Data Rate (Gbps)	PCIe Hard IP Block Functionality	Logic Elements	Transceivers	Max. Memory (Mb)
Cyclone IV GX	2.5	x1, x2, x4 endpoint and rootport	15K – 150K	2 – 8 up to 3.125 Gbps	0.4 – 6.5
Arria II GX	2.5	x1, x4, x8 endpoint and rootport	45K – 256K	4 – 16 up to 3.75 Gbps	0.7 – 8.5
Arria II GZ	6.375	x1, x2, x4, x8 endpoint and rootport	224k – 348k	24 up to 6.375 Gbps	11.1 – 16.4
Stratix® IV GT	2.5 – 5	x1, x4, x8 endpoint and rootport	230K – 530K	0 – 16 up to 6.5 Gbps, 8 – 32 up to 8.5 Gbps	6.3 – 20.3
Stratix IV GX	2.5 – 5	x1, x4, x8 endpoint and rootport	70K – 530K	12 – 24 up to 11.3 Gbps, 12 – 24 up to 6.5 Gbps	13.9 – 20.3
HardCopy® IV GX	2.5 – 5	x1, x4, x8 endpoint and rootport	2.8M – 11.5M usable ASIC gates	8 – 36 up to 6.5 Gbps	6.3 – 20.3

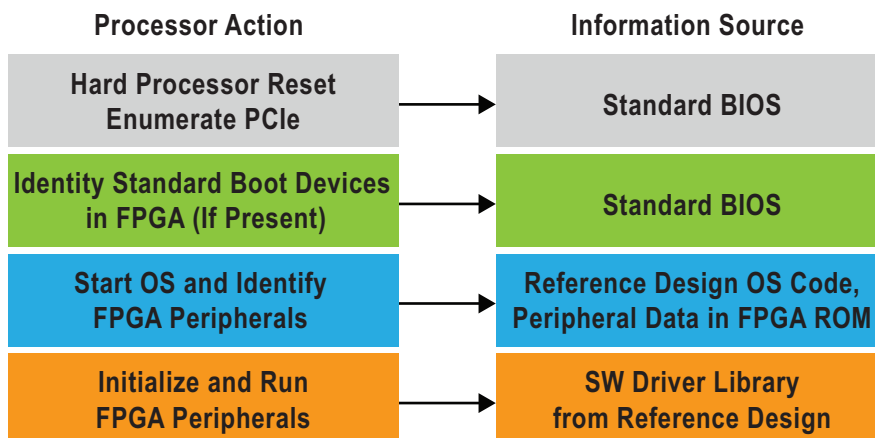
I/O Companion Framework

One of the biggest development challenges in developing an I/O companion system is the ability to integrate custom peripherals into an operating system (OS) environment. With the I/O companion framework, OS driver integration can be done even without a deep understanding of how the OS boots, initializes, and drives peripherals.

The FPGA I/O Companion Solution development framework contains everything you need to get the FPGA design working on your board – a verified Quartus® II reference design supporting a number of popular peripherals, documentation, I/O companion-specific tools, and x86 program code. The reference design, which comes complete with all the required design files, serves as a base to help you quickly get started on your own system. Easily add your own custom peripherals using the framework. The I/O companion framework also includes a development tool that generates a list of system peripheral IP functions that can be stored in an ROM and loaded into the FPGA at configuration time.

The SOPC Builder tool in Altera’s Quartus II development software makes it easy for you to integrate the peripheral IP functions. All you need to do is design your system and let the SOPC Builder generate the HDL code required to connect the peripherals in your design to the integrated PCIe hardware in the FPGA.

Figure 2: Processor Boot Procedure with I/O Companion FPGA



When the processor boots, it enumerates the PCIe bus and detects the boot devices instantiated in the FPGA. The processor recognizes the standard configuration boot peripherals built into the FPGA, such as SATA, SDIO, and SD card interfaces. The processor then uses the BIOS code to read data from the boot device and run the OS. Once the system is up, the OS initializes the drivers to enable the peripherals in the FPGA. When the OS reads the FPGA ROM, it knows which peripherals are present in the FPGA and loads the corresponding peripheral drivers from the supplied peripheral software driver library. Once the drivers load, the OS initializes and uses the FPGA peripherals as if they were implemented on the processor itself. The processor and FPGA now appear as an integrated process subsystem.

Support for Advanced Embedded Processors

The Intel® Atom™ Processor E6xx Series is one of the fastest growing families of low-power, high-performance embedded processors. It is ideal for next-generation embedded applications and is supported by a strong ecosystem of operating systems, software intellectual property (IP), and development tools. The Intel Atom Processor E6xx Series, coupled with an Altera transceiver FPGA, delivers a powerful and flexible development platform for custom applications requiring high performance, low power, and a compact footprint.

Kontron, a Premier member of the Intel Embedded Alliance, has developed a hardware platform showcasing the benefits of Altera FPGAs as an I/O companion solution to the Intel Atom Processor E6xx Series, as shown in Figures 3 and 4. An FPGA I/O companion solution reference design supports Linux on Kontron's Intel Atom-based COM Express™ FPGA Starter Kit that carries an integrated Cyclone® IV GX device. It also supports I/O companion solutions on any Altera transceiver FPGA development kit that has a PCIe edge connector plugged into the PCIe slot on the board. The peripheral drivers can also be easily ported to other boards. For more information on Kontron's COM Express Kit, visit www.kontron.com.

Figure 3: COM Express FPGA Baseboard from Kontron

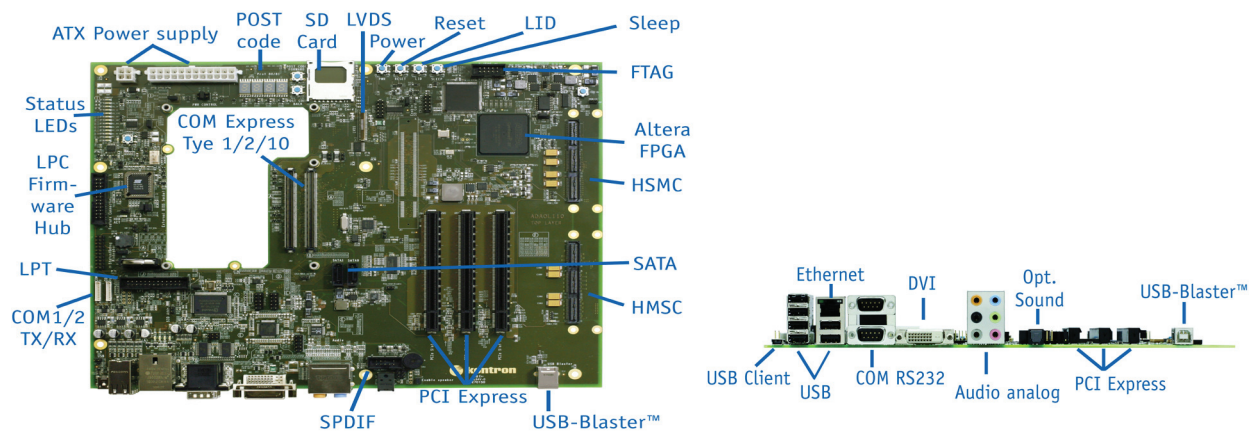
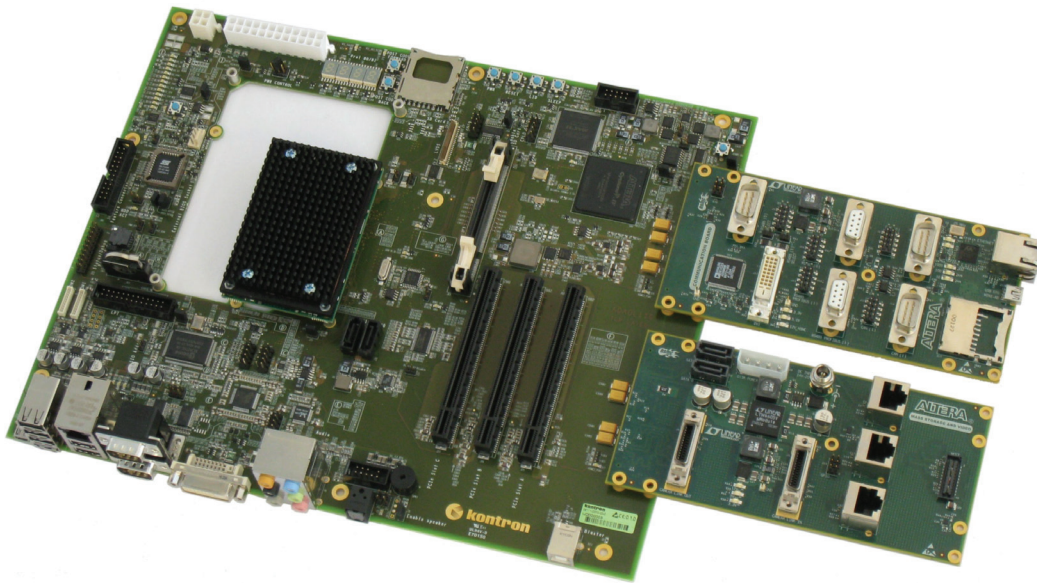


Figure 4: COM Express FPGA Starter Kit from Kontron



Reference Design Supported Peripherals

SATA, 10/100/1000 Ethernet with IEEE 1588 support, USB OTG, I²C, I²S, SPI, RS-485, RS-232, CAN, MOST, SD/SDIO/MMC, DVI, FPDLinkII, SGDMA, GPIO, DDR, PCIe

FPGA I/O Companion Solution

- Quartus II reference design
- Prebuilt SOPC Builder system
- Peripheral catalog ROM generator tool
- OS software
- Prebuilt configuration and software files (enabled for Kontron board)

Want to Dig Deeper?

For more information about Altera's companion chip solutions, visit the I/O Companion Chip page on www.altera.com/industrial.

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