VPXI ePC

V1.1
10/21/11

Air Cooled 4U 1/2 Rack OpenVPX Windows/Linux/VxWorks Computer with Four Expansion Slots

FEATURES

- VPX for Instrumentation
  - 3U OpenVPX embedded computer system
  - Integrated timing and triggering
  - Advanced PCI Express connectivity
  - Rugged with wide-temperature options
- Embedded PC
  - Runs Windows, Linux or VxWorks
  - COM Express module with Intel i5/i7 CPU with up to 8 GB memory
  - Gb Ethernet, 4x USB, Displayport video
  - 256GB SSD + up to 3 removable drives
- ½ rack, 4U system
  - Five slots total : CPU slot + 4 Peripheral Slots
  - Up to 3 HDD/SSD storage slots
  - Supports Innovative X3/X5/X6 and VPX6-COP
  - Supports most PCI Express modules
- Integrated timing and triggering features
  - Synchronized, multi-card sampling
  - Internal or external clock/references
  - Generate low phase noise sample clocks from 0.125 to 1 GHz
  - 10MHz, 0.5 ppm stable clock reference
  - Optional GPS timing reference
- Advance bus architecture
  - PCI Express plane with x4 lanes to each slot
  - Supports multiple endpoints to each slot
  - Mesh interconnects all IO cards
  - x8 cabled PCIe system expansion port
- Rear Terminal Modules for I/O and CPU slots
- Forced air cooling with upper and lower fans
- Integrated 350W power supply
- Expands to additional VPXI chassis using cable PCI Express option

APPLICATIONS

- Embedded instrumentation
- Remote, autonomous IO
- Mobile instrumentation
- Distributed data acquisition
- Signal Processing Clusters

VPXI System Chassis (Front View)

DESCRIPTION

The VPXI-ePC is a OpenVPX embedded computer system that is a performance architecture for instrumentation, signal processing and embedded computing applications. The system has a CPU slot with four expansion slots in a ½ rack, 4U enclosure. The VPX-COMEX CPU combines an Intel-architecture COM Express CPU module with timing and communications features.

VPXI integrates timing features into the VPX architecture providing synchronized high performance clock and trigger features to each slot. Peripheral slots receive a dedicated clock and trigger input, as well as several shared coordination signals. These signals are used by VPX6-COP, X6 and X3 IO card families and support simultaneous and coordinated sampling. An optional high-precision GPS can be used with the VPX-COMEX as a timing reference.

The PCI Express system bus is fast and flexible, supporting real-time, data-intensive applications with advanced features for bandwidth allocation and partitioning. Each peripheral slot sustains data rates over 1GB/s over the PCIe bus. The system can be expanded to to another system or expansion chassis using the cabled PCIe port.

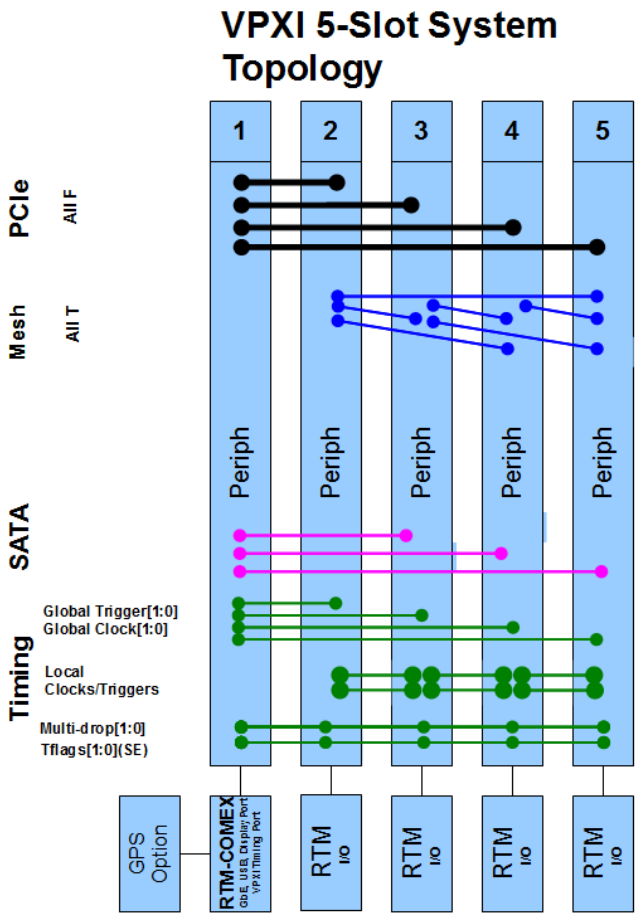
The VPXI may host one VPX-COMEX CPU card to create a Windows/Linux/VxWorks compatible PC. The VPXI-ePC can run the same applications as desktop system. Performance OS such as Linux Xeonmai and VxWorks are used for real-time applications.

Special features for applications include rear terminal IO support, an integrated FPGA with 128MB DRAM, and LCD panel support. Design support for custom features includes example RTM module designs, FPGA application code and CAD for mechanical integration.

VPXI ePC

ORDERING INFORMATION

Product	Part Number	Description
VPXI-ePC	90271-0	VPXI System - VPX chassis including VPX-COMEX CPU module(80271) with Intel i7 dual core, 2.53GHz, 4GB, GbE, 4 USB, SATA, DisplayPort video), RTM-COMEX rear terminal IO module, 4 additional peripheral slots, IO slot, backplane, 350W power supply (specify locale for power cord), fan assemblies, no GPS; no VPX IO cards included.
GPS Options		
Precision GPS + antenna	90197-1	GPS receiver module, Trimble Mini-T. Mounts in VPXI Chassis (90271-0). Includes Trimble 53110-15, 5V Bullet III antenna and interface cable.



Features

VPX VITA 65 5-slot system
Controller with 5Payload + HDD/IO
Control Plane: PCIe; Central, 16 lanes
Data Plane:
- Mesh, x2 connects all peripherals

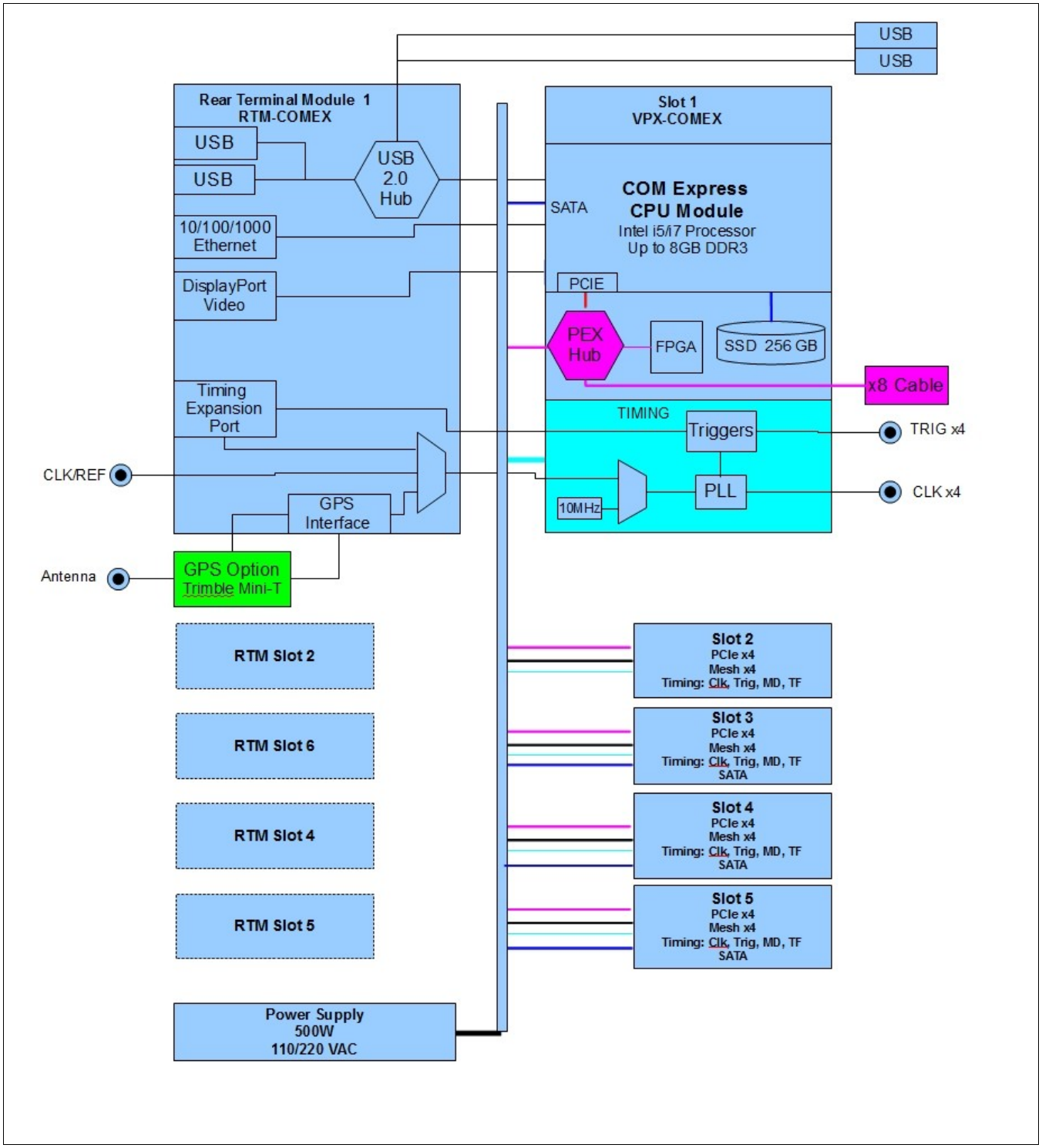
Timing and Triggers
- Global Triggers – 1 per slot LVDS
- Global Clocks – 1 per slot LVDS
- Local Clock and Trigger per slot LVDS
- Multi-drop – 2 MLVDS pairs to all slots
- Flags – 2 single-ended daisy chain

Individual slot resets
System Reference
- 10MHz Stratum3
- GPS input option

Slot	PCIe	IO	Timing	OpenVPX Profile
1	Root 4F, 8T or 16UT	3 SATA GbE, USB, DisplayPort	Global Clk[3:0] Global Trig[3:0] Local Trig Local Clock	SLT3-SWH-4F-14.4.4
2	F	SATA	Global Clk Global Trig Local Trig Local Clock	SLT3-PER-1F14.3.2
3	F	SATA 3 x2 Mesh	Global Clk Global Trig Local Trig Local Clock	SLT3-PER-1F14.3.2 *and* SLT3-STO-2U-14.5.1
4	F	SATA 3 x2 Mesh	Global Clk Global Trig Local Trig Local Clock	SLT3-PER-1F14.3.2 *and* SLT3-STO-2U-14.5.1
5	F	SATA 3 x2 Mesh	Global Clk Global Trig Local Trig Local Clock	SLT3-PER-1F14.3.2 *and* SLT3-STO-2U-14.5.1

UT = x1 lane
T = x2 lanes
F = x4 lanes

VPXI ePC


USB
USB
Rear Terminal Module 1
RTM-COMEX
USB
USB
USB 2.0 Hub
10/100/1000 Ethernet
DisplayPort Video
Timing Expansion Port
CLK/REF
GPS Interface
Antenna
GPS Option
Trimble Mini-T
RTM Slot 2
RTM Slot 6
RTM Slot 4
RTM Slot 5
Power Supply
500W
110/220 VAC
Slot 1
VPX-COMEX
SATA
COM Express
CPU Module
Intel i5/i7 Processor
Up to 8GB DDR3
PCIE
PEX Hub
FPGA
SSD 256 GB
x8 Cable
TIMING
Triggers
TRIG x4
10MHz
PLL
CLK x4
Slot 2
PCIe x4
Mesh x4
Timing: Clk, Trig, MD, TF
Slot 3
PCIe x4
Mesh x4
Timing: Clk, Trig, MD, TF
SATA
Slot 4
PCIe x4
Mesh x4
Timing: Clk, Trig, MD, TF
SATA
Slot 5
PCIe x4
Mesh x4
Timing: Clk, Trig, MD, TF
SATA

VPXI ePC

Standard Features

CPU Card	
CPU Types	Low Power:i7-620UE ULV, dual core, 1.06 GHz, 4 MB cache High Performance: i7-610e SV, dual core, 2.53 GHz, 4 MB cache
Memory	Up to 8GB DDR3, 1066
SSD	256GB May be used as boot drive or removed
Ports	Integrated PCIe switch x16 lanes configured as 4 x4, Gen2 Front panel x8 PCIe cable
OpenVPX Module Profile	MOD3-SWH-4F-16.4.5-2
Integrated Storage	
Solid-State Disk (SSD)	1.8 in, 256GB, SATA300
IO Ports	
USB	USB 2.0 to quad port USB hub on RTM 2 Type A rear panel ports 2 type A front panel ports
Ethernet	10/100/1000 port on rear panel
SATA	3 SATA 300 ports Mapped to slots 3,4,5
Video	DisplayPort Integrated graphics engine on i7
VPX Slots	
Standards	OpenVPX VITA 65 Slots
Number	5
Card Size	3U VPX
Slot Pitch	Slot 1: 8HP Slots 2-5: 4HP
Power	50W per slot maximum
OpenVPX slot profiles (VITA 65)	Slot1 : SLT3-SWH-4F-14.4.4 Slots 2-5 : SLT3-PER-1F-14.3.2 Slots 3-5 **also** have SATA for storage: Slots 3-5 : SLT3-STO-2U-14.5.1

Backplane Connectivity	
PCI Express	Root complex: Slot 1 Gen2 capable 16 lanes x4, x2, or x1 lanes to slots 2-5 Bridge support partitions Integrated DMA controllers Front panel x8 Cable Expansion Supports expansion chassis or second CPU system
Mesh	Slots 2-5 have x2 link connections Private links are protocol agnostic Aurora or custom protocols
Timing and Triggering Support Features	
Sample Clock Sources	PLL, external
PLL Range	0.125-1000 MHz
PLL Reference	10 MHz 1 PPM stable reference *or* external input *or* optional GPS-disciplined clock
Trigger Modes	Software, GPS-synchronized, GPS Time, external input
Trigger Outputs	One per VPX peripheral slot, LVDS
Clock input	Use as sample clock or PLL Reference SMA on RTM
Clock Outputs	One per peripheral slot, LVDS One SMA output on RTM
Peripheral Synchronization	Simultaneously trigger all slots Matched clock and trigger lengths
System Synchronization	Output clock and trigger
Sample Clock Sources	PLL, external

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Customization Features	
FPGA	Xilinx Spartan6 LX75T FPGA Controls triggering, PLL and system functions 8 differential pairs to VPX P2 PCIe Interface to COM Express CPU FrameWork Logic available for FPGA in VHDL
Rear Terminal IO	VPX Rear Terminal Modules for slots 2-5

GPS Option	
Type	12 satellite, parallel tracking
Outputs	PPS, 10 MHz
Phase Noise	-120 dBc @ 10 Hz -135 dBc @ 100 Hz -145 dBc for 1kHz and higher
Accuracy	1.16×10^{-12} (one day average)
Maker	Trimble Electronics, model MINI-T
Interface	Serial interface to FPGA (PCIe device peripheral to CPU)

Power Management	
Standard	VITA48.1 REDI air cooling
Power States	Low power states supported including wake features from PCI Express and LAN
Temperature Monitors	2 total : COM Express module and VPX-COMEX assembly each have a temperature sensor
Alarms	Programmable warning and failure levels
Over-temp Monitor	Disables power supplies
Fans	Upper and lower fan assemblies Adjustable speed settings Off-Low-High

Physicals	
Dimensions (LxWxH)	4U, ½ rack 9.8 x 8.3 x 6.0 in [250 x 210 x 152 mm]
Weight	TBD
Hazardous Materials	Lead-free and RoHS compliant

Power Supply	
Input	110 to 220V VAC 12V and 28 V options available
Total Power	350W

Reliability	
MTBF	>50000 Hours for base configuration.

VPXI ePC

Architecture and Features

The VPXI-ePC is a 4U, 5-slot, VPX embedded PC that runs Windows, Linux, or VxWorks. The system integrates 3U VPX IO and processing modules with supporting peripherals for timing controls, data storage and system communications that is customizable for a wide range of signal processing, data acquisition and control applications requiring high performance.

VPXI

VPXI moves OpenVPX into signal processing and data acquisition applications by combining the advanced architecture and ruggedness of VPX with system timing and synchronization features. This enables VPXI systems to tightly integrate data acquisition cards with CPU and signal processing cards for demanding real-time applications such as wireless communications, RADAR, and medical imaging.

VPXI ePC Advantages

- Intel i7 architecture PC runs Windows, Linux or VxWorks

- PCI Express Control and Data plane supports 2 GB/s per slot

Multiple, high performance connections to every card

- Integrated timing and synchronization for sampling

- OpenVPX (VITA 65) industry standard system

- Compact size ½ rack, 4U system accepts 3U cards

- Supports Innovative X3, X5, X6 module families, VPX-COP

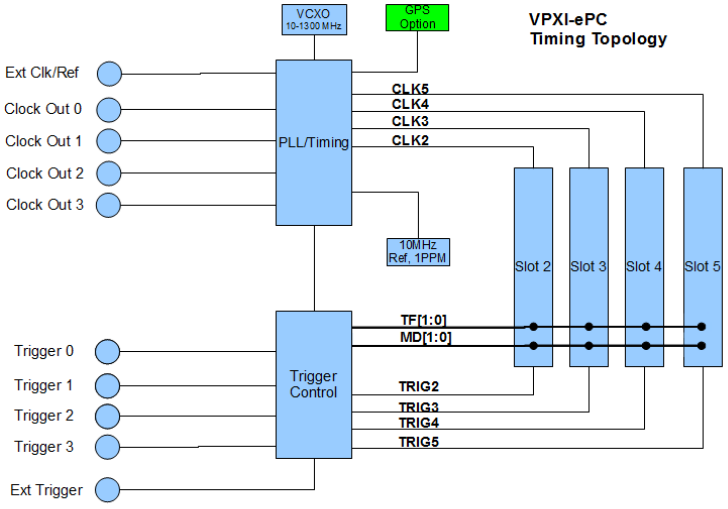
- Rugged, wide temperature operation supported

VPXI System Architecture

VPXI leverages the OpenVPX standard (VITA 65) support multiple high speed (>500MB/s) data planes for inter-card communications. The primary plane is PCI Express with its root complex supported by the COM Express CPU. The PCI Express plane is very fast and flexible: it supports up to 2GB/s transfer rates to each slot. Sustained rates of >1GB/s are achieved in streaming designs. Peripheral cards communicate directly with the CPU, simplifying software and system configuration.

Integrated Timing and Synchronization

VPXI integrates timing and synchronization features into the system for data acquisition and signal processing applications. Low phase noise sample clocks are distributed from the CPU slot to each IO card (slots 2-5) as well as synchronous triggers. These can be used by the IO cards for simultaneous sampling or as reference clocks for local timing signals. Additional lower speed multi-drop signals are used for timing coordination amongst cards.



Sample clocks are either generated using an in-system PLL or from an external input. The PLL is programmable for ranges from 125KHz up to 1 GHz. The PLL uses an internal high stability reference, an external input, or an optional GPS-disciplined reference. The GPS-disciplined clock allows multiple, remote instruments to sample simultaneously and act cooperatively. Position and time data is also available from the GPS when installed. The GPS option uses a Trimble Mini-T GPS that has exceptionally low phase noise and and high stability.

Embedded PC

VPXI ePC

The VPXI-ePC is Windows/Linux/VxWorks compatible – it runs the same applications as a desktop computer. The system is powered by a COM Express CPU module that is a PC on a module and provides the computing engine, available with the advanced Intel i5/i7 processors.

The COM Express module provides the PCI Express bus root complex that links the VPX peripheral cards to the CPU. All IO slots are connected by PCI Express to the CPU.

The DisplayPort video and USB keyboard/mouse make operating the VPXI-ePC just like any PC. DisplayPort supports high resolution displays and HD audio. "Headless" operation is also supported for truly embedded applications without keyboard/monitor/mouse attached. In the headless mode, the VPXI-ePC can be remotely controlled and accessed over Ethernet.

VPX ComEx

- Intel compatible PC runs Windows, Linux, VxWorks
- Scalable performance: Intel Celeron up to quad-core i7
- PCI Express, Gb Ethernet, USB 2.0, SATA

VPXI Connectivity

- PCI Express Control/Data Plane and mesh connnections
- PCIe Gen2 supports 1 GB/s sustained rates
- Advanced features for multiple endpoints and DMA
- Cable PCIe port for expansion and redundant systems
- Private interconnects between all slots with x2 lanes
- Low latency, deterministic performance

Data Plane Connections to IO Slots

The VPXI-ePC has two independent planes of connectivity to all IO (slots 2-5) : PCI Express and private interconnects. Each of these planes is implemented on the VPXI backplane.

The primary connection to the CPU is the PCI Express plane. Each slot 2-5 be a PCI Express peripheral to the CPU. This plane is extensible to another chassis using cabled PCI Express to add additional peripheral slots to the system.

More advanced architectures can use the PCI Express switch to create multiple connections to each peripheral card. This allows peripherals to exchange data over dedicated virtual channels, providing high bandwidth and determinacy. Redundant systems, or dual CPU systems, can use the switch to create a non-transparent bridge between the PCI Express bus of each system.

A private mesh of interconnects links all slots 2-5 to one another. These links use Aurora or custom protocols between slots as private connections. Each slot can communicate with the others at rates up to 1 GB/s, supporting real-time data transfers for tight integration of the system in signal processing applications.

Remote Operation

VPXI-ePC can be operated using Ethernet as a remote computer or embedded instrument. For pure embedded operation, the VPXI-ePC operates "headless" without monitor, keyboard or mouse. The system boots from a SATA SSD or HDD, USB or Ethernet. Applications such remote desktop are used during development and are later deployed using remote terminals over Ethernet to control the system.

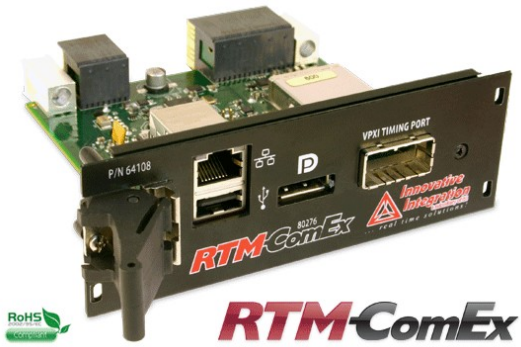
Application FPGA

The Application FPGA allows the VPXI-ePC to be customized for many IO functions, such as triggering and control

features. The FPGA device is a Xilinx Spartan6, 450K gate device. New functions are added to the system as PCI Express devices by adding them to the FPGA design. FPGA logic is provided in the FrameWork Logic tools, which includes the standard functionality that can be modified or used as an example. Development is via a Xilinx USB JTAG cable and Xilinx ISE development tools.

Rear Terminal IO

The VPXI-ePC can be customized for each IO card using the Rear Terminal Module (RTM). The RTM provides access to each IO slot through connections to J0-J2. The RTM is used to provide application-specific rear connectors and is large enough to integrate IO buffers and other logic.



Innovative offers an RTM example design that connects to VPX6-COP or X3/X5/X6 modules for connection to the FPGA on the IO card. Mechanicals and schematics for the IO Mezzanine are available for design support.

Software Tools

Software development tools for the VPXI-ePC provide comprehensive support application development including device drivers, peripheral configuration and control, and utilities that allow developers to be productive from the start. Software classes provide C++ developers a powerful, high-level interface to the system devices that makes system integration and achieving real-time, high speed data acquisition easier.

Software for data logging and analysis are provided with every Innovative X3/X5/X6 module. Data can be logged to system memory at full rate or to disk drives at rates supported by the drive and controller. Triggering and sample rate controls are provided to support data acquisition applications without writing code. Innovative software applets include *Binview* which provides data viewing, analysis and import to MATLAB for large data files.

Support for MS Visual C++ is provided. Supported OS include Windows, Linux and VxWorks. For more information, the software tools User Guide and on-line help may be downloaded.

Logic Tools

Customized IO interfaces, triggering and other unique features may be added to the VPXI-ePC by modifying the FPGA logic. The FrameWork Logic tools provide support for VHDL/Verilog developments. Application logic can be modified by building upon the Innovative components for hardware interfaces and system functions. Each design is provided as a Xilinx ISE project with VHDL source for top level logic with a ModelSim testbench illustrating logic functionality.

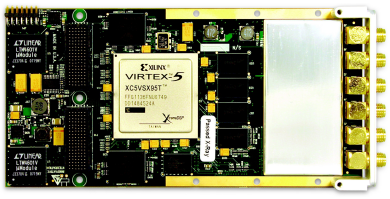
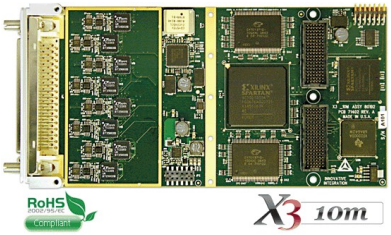
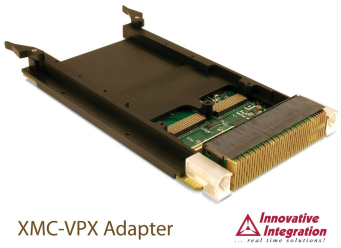
Adding VPX Cards

Plug VPX cards into the VPXI-ePC to build your custom, turnkey embedded instrument. Compatibility with OpenVPX standard makes system configuration easier with COTS or custom card designs. Many cards are compatible with the slot profile used in VPXI because of the ubiquity of PCIe for embedded real-time applications.

The VPX6-COP is a native 3U VPX card from Innovative that features a powerful FPGA computing core and configurable IO front-end using FMC modules. The VPX6-COP can be configured with many FMC module front ends for a variety of applications.

XMCs can be used in VPXI systems with an adapter card. Innovative X3, X5, and X6 XMC module can be used in VPXI systems and integrate with both PCIe and private connections. These X-module families feature analog and digital IO with FPGA computing cores on high performance PCI Express modules. FrameWork Logic development tools from Innovative allow you to design in MATLAB and VHDL and rapidly implement high speed signal processing on the XMC.

VPXI ePC

X6 Module Family **Xilinx Virtex6** **LX240T/SX315T/SX475T** **2GB/s PCIe** **4GB DRAM** 	**X5 Module Family** **Xilinx Virtex5 SX95T** **1GB/s PCIe** **512MB DRAM** **8MB QDR SRAM** 
X3 Module Family – Multi-channel IO with FPGA **Analog/Digital IO** **Xilinx Spartan3A DSP 1.4 Mgate** **PCI Express** **4 MB SRAM** 	**XMC adapter for 3U VPX** **X8 lanes on Ports A-B or C-D** **J16 mapped to backplane** **IPMI support** **Conduction or Air-cooled** 
VPX6-COP – 3U FPGA coprocessor with FMC IO site FPGA **Xilinx Virtex6 LX240T/SX315T/SX475T** **Conduction or Air-cooled** 	

See the selection of VPX, XMC IO and FPGA modules at http://www.innovative-dsp.com/by.php?cat=FormFactor&type=5&sort=Type

VPXI ePC

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