# VPX-COMEX

V 1.1 9/2/11

Innovative Integration
... real time solutions!

## Rugged 3U OpenVPX System CPU Featuring Intel I7 CPU, Integrated PCI EXpress Switch and System Timing

## FEATURES

- 3U OpenVPX Intel i7 CPU card
  - MOD3-SWH-4F-16.4.5-2 (PCIe Gen2)
- Runs Windows, Linux, VxWorks
- COM Express Type 2 or 6 CPU module
  - Intel I7 dual or quad core processor
  - Up 16GB 1333MHz DDR3 ECC memory
- GbE, USB 2.0, 3x SATA, DisplayPort (L0 only)
- PCI Express Data Plane Switch
  - x16 PCI Express Gen2 root complex to VPX
  - Configurable as x16, x8, x4,x2, or x1
  - Cable PCI Express x8 port supports system expansion and redundancy
- Integrated 1.8 in SATA SSD up to 256 GB
- Precision timing/triggering support
  - VPX P2: 4 clocks and 4 triggers (LVDS)
  - Front Panel : 4 clock and 4 trigger SMAs
  - PLL with 125KHz to 1GHz tuning range with -110 dB phase noise @ 10kHz
  - 10MHz, 0.5 PPM clock reference
  - Clock and Reference inputs
  - Support for GPS integration
- Xilinx Spartan6 LX45T to LX120T FPGA core
  - PCIe interface
  - Up to 128MB memory
- < 50W typical; conduction or forced-air cooling
- Operating Environments L0 to L4
  - Up to -40 to 85C, 0 to 100% RH
  - 30g shock, 0.1 g2/Hz random vibe

## APPLICATIONS

- VPX System CPU
- System controller for DSP, data acquisition and control system applications
- High Speed Data Recording and Playback
- Embedded Instrumentation and Control

## SOFTWARE

- Windows/Linux/VxWorks
- C++ Host Tools

XILINX


OpenVPX™

VPXComEx

## DESCRIPTION

The VPX-COMEX is a 3U OpenVPX CPU card that integrates a COM Express CPU module with PCI Express switch, system timing features, and a Spartan6 FPGA core. This powerful combination of features on an embedded PC running Windows Linux or VxWorks makes the VPX-COMEX an ideal embedded system CPU for communications. instrumentation, and data acquisition applications.

The VPX-COMEX CPU core is a COM Express module, a PICMG industry standard, that is an Intel-architecture I7 or I5 CPU. The COM Express IO includes USB, Ethernet, DisplayPort and other IO, making it easy to use and well supported. The COM Express module runs Windows, Linux, or VxWorks. Real-time applications are supported using VxWorks and RT Linux,.

The VPX-COMEX has support for x16 PCIe Gen2 lanes on the VPX backplane plus a x8 front panel cabled PCIe port. The endpoints are configurable as x16 down to x1 lanes, providing up to 16 VPX peripheral cards. This flexibility allows system designers to allocate bandwidth to get the right mix of performance to each expansion card. The cable PCIe port is used for system expansion, or as a non-transparent bridge to another CPU system.

Timing and triggering features support system-wide synchronized data acquisition by distributing clocks and triggers over the backplane and front panel. The VPX-COMEX timing sub-system generates multiple, low noise, matched sample clock and triggers operating at up to 1 GHz are distributed to the VPX peripheral cards.

A Xilinx Spartan6 FPGA core connects the CPU core with the on-card peripherals through PCI Express. Framework Logic tools support development on the FPGA for custom DSP and system interfaces. The FPGA provides a powerful way to customize the VPX-COMEX for unique requirements for triggering features, add custom interfaces, or provide co-processing functions to the CPU.

Options for wide temperature (-40 to 85C) and vibration/shock are available for both conduction-cooled and air-cooled applications IPMI functions for system management includes temperature and power consumption monitoring. The card requires a a double-wide (8HP) slot. REDI covers are available.

Software tools for host development include C++ libraries, drivers and boot images for VxWorks, Windows and Linux. Application examples demonstrating features are provided.

# VPX-COMEX

This electronics assembly can be damaged by ESD. Innovative Integration recommends that all electronic assemblies and components circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

## ORDERING INFORMATION

| Product | Part Number | Description |
|---|---|---|
| VPX-COMEX | 80271-0-<ER> | 3U OpenVPX CPU card; I7-610e dual core processor, 2.53 GHz, 4MB DDR3, GbE, USB2.0, 3 SATA300, PCI Express Gen2 switch, 128GB SSD, cabled PCIe port, timing/triggering., Xilinx Spartan6 LX45T FPGA with 64MB memory.<br>Forced air cooling, no REDI covers.<br>DisplayPort video is only available on -L0, no video port on other environment ratings.<br>Note: COM Express module is Type 2 for all environmental ratings above L0. |
| VPX-COMEX | 80271-1-<ER> | 3U OpenVPX CPU card; I7-610e dual core processor, 2.53 GHz, 4MB DDR3, GbE, USB2.0, 3 SATA300, PCI Express Gen2 switch, 128GB SSD, cabled PCIe port, timing/triggering., Xilinx Spartan6 LX45T FPGA with 64MB memory.<br>Conduction cooling, no REDI covers.<br>DisplayPort video is only available on -L0, no video port on other environment ratings.<br>Note: COM Express module is Type 2 for all environmental ratings above L0. |
| VPX-COMEX REDI Covers | 61208 | VITA48 REDI covers for VPX-COMEX assembly. |
| | | |
| VPX-COMEX FrameWork Logic | 55034 | VPX-COMEX FrameWork Logic board support package for RTL. Includes technical support for one year. |
| | | |
| Software | 57001 | Malibu software installation DVD including drivers for Windows and Linux. |
| | | |
| RTM-COMEX | 80276 | 3U OpenVPX Rear Terminal Module for VPX-COMEX; 4 USB 2.0 ports (2 internal and two rear panel), 10/100/1000 Ethernet RJ-45, rear panel clock and trigger expansion port, GPS support, battery, DisplayPort connector. |
| | | |
| VPXI-5 Backplane | 80275 | 3U OpenVPX backplane; 5 slots total: CPU/Switch plus 4 peripheral slots. Supports VPX-COMEX timing and triggering features. ATX power supply connection. |
| | | |

# VPX-COMEX

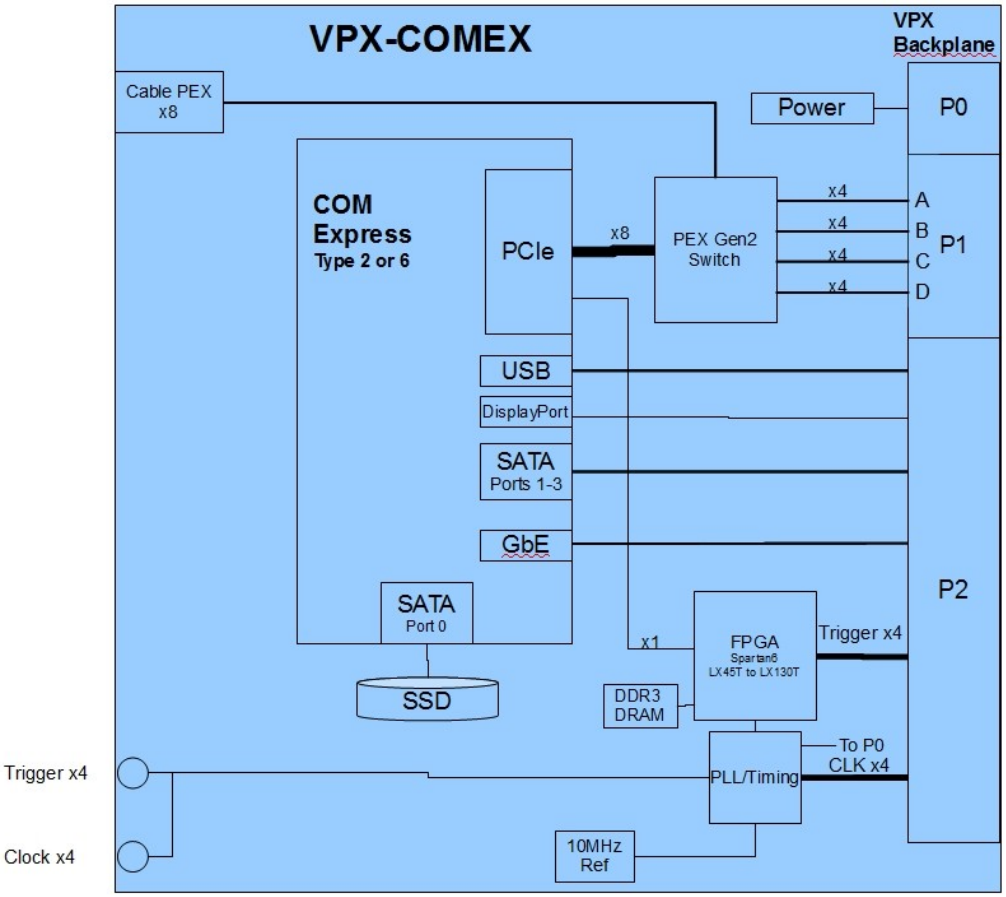
## Operating Environment Ratings

The VPX-COMEX is qualified for wide temperature, vibration and shock to suit a variety of applications in each of the environmental ratings L0 through L4 and 100% tested for compliance.

| **Environment Rating <ER>** | | **L0** | **L1** | **L2** | **L3** | **L4** |
|---|---|---|---|---|---|---|
| Environment | | Office, controlled lab | Outdoor, stationary | Industrial | Vehicles | Military and heavy industry |
| Applications | | Lab instruments, research | Outdoor monitoring and controls | Industrial applications with moderate vibration | Manned vehicles | Unmanned vehicles, missiles, oil and gas exploration |
| Cooling | | Forced Air | Forced Air | Conduction | Conduction | Conduction |
| Operating Temperature | | 0 to +50C | -40 to +85C | -20 to +65C | -40 to +70C | -40 to +85C |
| Storage Temperature | | -20 to +90C | -40 to +100C | -40 to +100C | -40 to +100C | -50 to +100C |
| Vibration | Sine | - | - | 2g<br>20-500 Hz | 5g<br>20-2000 Hz | 10g<br>20-2000 Hz |
| | Random | - | - | 0.04 $g^2$/Hz<br>20-2000 Hz | 0.1 $g^2$/Hz<br>20-2000 Hz | 0.1 $g^2$/Hz<br>20-2000 Hz |
| Shock | | - | - | 20g, 11 ms | 30g, 11 ms | 40g, 11 ms |
| Humidity | | 0 to 95%,<br>non-condensing | 0 to 100% | 0 to 100% | 0 to 100% | 0 to 100% |
| Conformal coating | | | Conformal coating<br>extended temperature range devices | Conformal coating,<br>extended temperature range devices | Conformal coating,<br>extended temperature range devices,<br>Thermal conduction assembly | Conformal coating,<br>extended temperature range devices,<br>Thermal conduction assembly,<br>Epoxy bonding for devices |
| Testing | | Functional,<br>Temperature cycling | Functional,<br>Temperature cycling,<br>Wide temperature testing | Functional,<br>Temperature cycling,<br>Wide temperature testing<br>Vibration, Shock | Functional,<br>Temperature cycling,<br>Wide temperature testing<br>Vibration, Shock | Functional,<br>Testing per MIL-STD-810G for vibration, shock, temperature, humidity |

Minimum lot sizes and NRE charges may apply. Contact sales support for pricing and availability.

# VPX-COMEX


VPX-COMEX
VPX Backplane
Cable PEX x8
Power
P0
COM Express Type 2 or 6
PCIe
x8
PEX Gen2 Switch
x4
x4
x4
x4
A
B
C
D
P1
USB
DisplayPort
SATA Ports 1-3
GbE
P2
SATA Port 0
SSD
x1
FPGA Spartan6 LX45T to LX130T
Trigger x4
DDR3 DRAM
To P0 CLK x4
PLL/Timing
Trigger x4
Clock x4
10MHz Ref

# VPX-COMEX

## Standard Features

| VPX | |
|---|---|
| Size | 3U, 160 x 100 mm<br>8HP width (44mm) |
| Cooling | Conduction or forced-air |
| Standards | ANSI/VITA 65 OpenVPX compatible<br>ANSI/VITA 46 VPX<br>ANSI/VITA 48.1 Air Cooled VPX<br>ANSI/VITA 48.2 Conduction Cooled VPX |
| OpenVPX Module Profiles | MOD3-SWH-4F-16.4.5-2 (PCIe Gen2)<br>MOD3-SWH-4F-16.4.5-1 (PCIe Gen1)<br>MOD3-SWH-2F8U-16.4.6-1 (PCIe Gen2)<br>MOD3-SWH-2F8U-16.4.6-1 (PCIe Gen1) |
| Compatible OpenVPX Slot Profiles | SLT3-SWH-4F-14.4.4<br>SLT3-SWH-2F8U-14.4.5 |

| COM Express Site | |
|---|---|
| Standards | PCIMG COM.0 COM Express Base Specification 2.0 Compliant |
| Type | 2 or 6 |
| Size | Supports 95 x 125 mm modules |
| Verified Modules | L0 : Portwell PCOM-B216VG-VI<br>Adlink Express-HR-i5-2515E<br>L1-L4 : Adlink Express-CBR-R-20 |
| CPU Types | L0: Low Power:i7-620UE ULV, dual cores, 1.06 GH, 4 MB cache<br>L0: High Performance:<br>i7-610e SV, dual core, 2.53 GHz, 4 MB cache<br>i7-2715QE SV, quad core, 2.1GHz, 6MB cache<br>L1-4: Rugged: i7-620LE, dual core, 2.0 GHz, 4 MB cache |
| COM Express Memory | PCOM-B216VG-VI:<br>Up to 8GB (dual channel), DDR3, 1066 MHz<br>Adlink Express-HR-i5-2515E:<br>Up to 16GB (dual channel), DDR3, 1333 MHz<br>See approved memory list |
| BIOS | Secondary BIOS memory off-module |

| IO | |
|---|---|
| USB | 1 port USB 2.0 on VPX J2<br>1 port on internal debug connector |
| Ethernet | 10/100/1000 port on VPX J2 |
| SATA | 3 SATA ports to VPX J2<br>1 SATA port to integrated SSD |
| Video | L0: DisplayPort<br>Integrated graphics engine on i7<br>L1-L4 : no video |
| Cabled PCI Express | Front Panel<br>x8 lane Gen 2 (5Gbps full duplex)<br>PCIMG PCI Express Cable Specification 1.0 |
| FPGA IO | 4 differential signal pairs (8 wires total)<br>Direct connect to FPGA<br>LVDS_33, LVCMOS_33 IO standards |
| **PCI Express Ports** | |
| PCIE Switch | IDT PES32NT24AG2 |
| Topology | Upstream Port : x8 PCIe (Gen1)<br>Downstream Ports: x16 Gen2 lanes configurable as any combination of x16, x8, x4, x2, or x1 endpoints |
| Partitions | Supports up to 4 partitions |
| Configuration | Configures from FLASH ROM or from CPU |
| Expansion | Cable PCIe: x8 lane, Gen2<br>Supports downstream x8, x4, x2, x1 endpoints<br>Galvanic isolation from expansion endpoints |
| Bridging | Non-transparent bridge support for connection to another PCIe complex<br>Common or non-common clock operation |

# VPX-COMEX

| Integrated Storage Options | |
|---|---|
| Drives | 1.8 in SSD drive |
| Size | 128 GB standard |
| Interface | SATA 300 |

| Timing and Triggering Support Features | |
|---|---|
| Sample Clock Sources | PLL, external |
| PLL Range | 0.125 to 945 MHz,<br>970 to 1134 MHz,<br>1213 to 1417 MHz |
| PLL Reference | Internal: 10 MHz, 0.5 pom reference<br>or<br>External: LVDS input from VPX J2 |
| Trigger Modes | Software or external input<br>N point frames or unframed |
| Trigger Outputs | 4 LVDS pairs to VPX J2<br>4 Front panel SMA (50 ohm) |
| Clock input | LVDS pair on VPX J2 |
| Clock Outputs | 4 LVDS pairs to VPX J2<br>4 Front panel SMA (50 ohm) |
| Module Synchronization | Simultaneously trigger both modules<br>Matched clocks |
| System Synchronization | Output clocks and triggers for system functions |

| FPGA Core | |
|---|---|
| FPGA | Xilinx Spartan6 LX45T to LX130T<br>Configures form FLASH |
| Memory | Up to 128 MB DDR3 DRAM<br>64Mx16<br>64MB standard |
| Functions | Controls triggering and sample clock generation<br>4 signal pairs to VPX J2 (8 wires)<br>PCIe x1 to COM Express CPU<br>PCIe Swtich configuration control<br>UART interface for GPS<br>Temperature monitoring<br>Peripheral card resets<br>SMB interface |
| Development Tools | FrameWork Logic available for FPGA in VHDL<br>Xilinx ISE Development Tools<br>JTAG interface for debug/test |

| Power Management | |
|---|---|
| Power States | Standby and Hibernate modes<br>Wake from LAN, PCIe |
| 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 |
| Controls | ATX power controls : power good, power enable, power button on VPX J2 |

| Power Requirements | |
|---|---|
| Input | 3.3V @ 3A<br>12V @ 3A<br>5V @ 0.5A<br>5V Auxiliary @ 0.2A |
| Consumption<br>** Power is highly dependent on CPU and peripheral use. The stated power is typical use. | *Varies according COM Express module requirements*<br>25W: VPX-COMEX with i7-620UE SLV 1.06 GHz COM Express module, 2GB memory<br>50W: VPX-COMEX with i7-610E SV 2.53 GHz COM Express module, 4GB memory |
| Hazardous Materials | Lead-free and RoHS compliant |

# VPX-COMEX

## Architecture and Features

The VPX-COMEX is a 3U OpenVPX CPU module that combines an embedded PC with sample clock and triggering features to create a customizable instrument for a variety of applications. An integrated PCI Express switch provides data and expansion plane connectivity to the VPX system.

### Embedded PC

The VPX-COMEX integrates a COM Express CPU on a 3U VPX card. The COM Express module is a PC on a module and provides the computing engine, available with the advanced Intel i7 processors. This industry-standard CPU module runs same applications as a desktop computer, and is completely PC compatible.

***COM Express Advantages***

- Intel compatible PC runs Windows, Linux, VxWorks
- Scalable performance
- PCI Express Gen2, Gb Ethernet, SATA, USB
- Upgradeable as requirements change and evolve
- Compact 95 x 125 mm form-factor
- Industry-standard, multi-vendor

The modularity of the COM Express module allows the VPX-COMEX to be configured for the performance and power that is right for the application. When newer processors are available or system requirements change, the COM Express module can be changed without changing the system architecture or software. Leveraging this industry standard also means that there are many vendors and varieties to choose from.

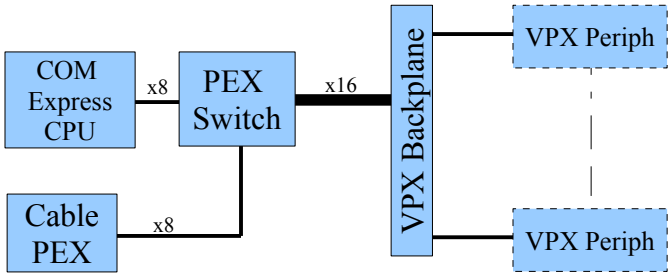
The VPX-COMEX provides familiar PC interfaces for expansion and connectivity: Gigabit Ethernet, USB ports, and SATA HDD. An integrated 1.8 inch Solid State Drive (SSD) provides rugged, low power storage for boot image and data storage. The VPX-COMEX may also be booted from USB or Ethernet. The USB, GbE and SATA (3 total) ports are connected to VPX J2 backplane connector for system use or Rear Terminal Module connection. The RTM-COMEX provides rear terminal access to these ports, plus other supporting functions using standard PC connectors.

Applications for lab and office environments (rating L0) use a Type6 COM Express module, while rugged applications (ratings L1 to L4) use a Type2 COM Express. The Type 6 module has DisplayPort Graphics, a high performance digital video standard. The Type2 module has no video port. Developers using Type2 modules must either use remote terminal access into the system or use a USB monitor.

### PCI Express Architecture

The COM Express module is the root of the PCIe complex. An x8 lane interface links the CPU to the system PCIe switch, providing 2GB/s connectivity to the PCIe system switch. The switch connects to the VPX backplane with x16 downstream lanes configurable as any combination of x16, x8, x4,x2 or x1 endpoints.

***PCI Express Architecture***




*Integrated PCIe switch supports x16 lanes to the VPX backplane and x8 cable PEX expansion*

A front panel cabled PCI Express port provides expansion to the PCIe plane and is used for adding an expansion chassis or second system. A non-transparent bridge in the PCIe switch supports extension to other CPUs and root complexes by providing an translation between the two PCIe planes. This is useful for linking two systems for high speed data transfers or redundancy.

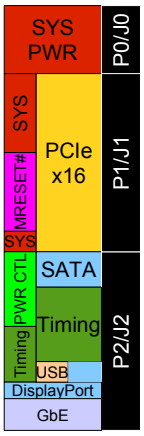
### OpenVPX

# VPX-COMEX

The VPX-COMEX is compatible with all OpenVPX slot profiles that use PCI Express exclusively on VPX connector J1. There are currently two such profiles defined in the OpenVPX specification, both of which dedicate VPX backplane connector J1 to PCIe (see spec table). The switch supports many port widths from x16 to x1, and operates Gen1 (2.5 Gbps) or Gen2 (5 Gbps) on all ports. This allows the VPX-COMEX to be used in OpenVPX systems with 1 to 16 cards. The system designer can allocate the bandwidth for each card by choosing the backplane topology for the application.

***VPX Connectivity***

**- ANSI/VITA 65 OpenVPX Compatible**
**- P0: System Power and Controls**
**- P1: PCI Express + System Controls**
**- P2: SATA, Timing Controls, DisplayPort, USB, GbE, ATX Power Controls**




Because the VPX-COMEX integrates the PCIe switch, it performs the function of both the CPU and switch card in the OpenVPX system. All VPX peripheral cards connect directly to the PCIe switch, creating a powerful data plane architecture centered around the PCIe fabric. This connectivity gives the CPU high bandwidth to the peripherals, but also enables the peripherals to communicate directly to one another concurrently.

The User IO specified by OpenVPX is used for the system peripherals, such as USB and GbE, for use with a rear terminal module or routed on the backplane to a slot.

### Triggering and Sample Clocks

System timing features on the VPX-COMEX deliver low-noise sample clocks and synchronized triggering to the backplane and front panel. Sample clocks for the are generated using an on-card PLL or from an external clock input. In conjunctions with the triggering functions, system-level timing supports synchronous sampling by the peripheral cards and coordinated signal sampling crucial to DSP, data acquisition and control systems.

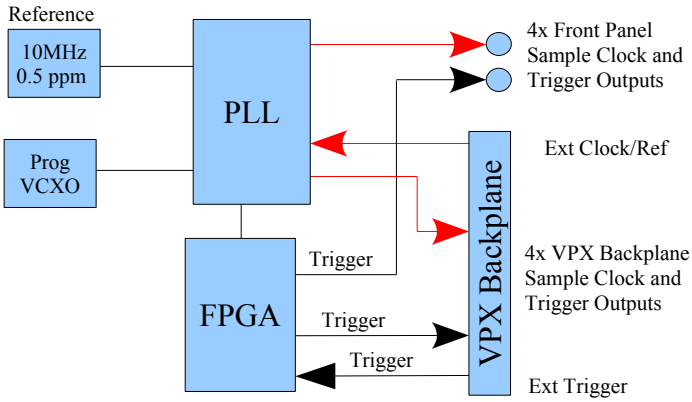
### Remote Operation

VPX-COMEX can be operated using Ethernet as a remote computer or embedded instrument. For pure embedded operation, the VPX-COMEX can operate "headless" without monitor, keyboard or mouse. The system boots from a SATA SSD or HDD.

### Application FPGA

The Application FPGA allows the VPX-COMEX to be customized for many IO functions, such as triggering and control features. The FPGA is a PCIe peripheral to the COM Express CPU. New functions can added to the system as PCI devices by adding them to the FPGA design. FPGA logic

***Sample Controls and Clocking***




| Timing Signal | Purpose | Front Panel | VPX P2 | Signal Type |
|---|---|---|---|---|
| FS_CLK | Sample clock | 4; 50 ohms | 4, LVDS | Up to 1GHz |
| TRIGGER | Sample Trigger | 4; 50 ohms | 4, LVDS | Up to 1GHz |
| MD | Trigger | - | 2; mult-drop LVDS | Up to 50 MHz |
| TF | Sync flag | - | 2 | Open drain SE |
| FD | FPGA IO pairs | | 4 | LVDS |

is provided in the FrameWork Logic tools, which includes the standard functionality that can be modified or used as an example.

The FPGA device is a Xilinx Spartan6 device. The logic is loaded from an on-card ROM that is field reprogrammable. Development uses a Xilinx USB JTAG cable and Xilinx ISE development tools (free download at www. xilinx.com ).

**Rear Terminal Module**

The RTM-COMEX provides standard PC connections for the DisplayPort and Ethernet. A 4-port hub expands the USB to 4 ports, two on the rear panel and two for internal cabling.

The RTM-COMEX also provides SMA inputs for external clock and trigger signals on the rear panel. A GPS interface is also provided which includes a UART port and timing reference input and PPS input from the GPS.

Innovative supports customer RTM design by providing mechanical drawings, models and schematics for the RTM-COMEX.

## Software Tools

Software development tools for the VPX-COMEX 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.

Support software for integration with Innovative FPGA and data acquisition cards is provided for every Innovative card. The programs demonstrate VPX-COMEX use for data acquisition and logging using Innovative products. 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 VPX-COMEX 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 testbench illustrating logic functionality.

# VPX-COMEX

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