

# X3-Timing

V 0.1 3/1/09



## Precision Timing for Sample Rate Generation and Triggering Controls with GPS-disciplined and 1 PPM Reference Clocks

### FEATURES

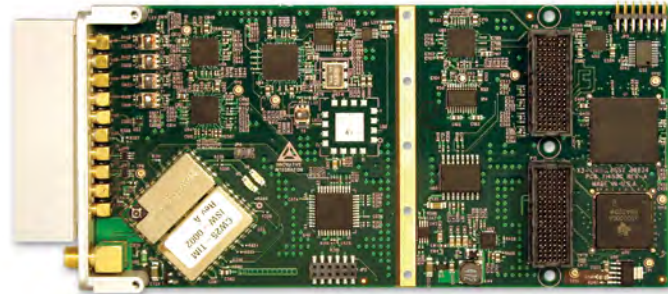
- Clock generation and distribution
- Four single-ended clock outputs
- External clock/reference input
- Low jitter: 0.2 ps jitter RMS
- Programmable 1.5 kHz to 1 GHz range
- 10 MHz, 1 ppm frequency reference
- Optional GPS-disciplined reference
- Indoor GPS reception under most conditions
- Four programmable trigger outputs
- Supports PXI DSTAR, DCLKA, DCLKB, triggers and local bus
- External trigger input
- Instant-on configuration
- XMC Module (75x150 mm)
- PCI Express (VITA 42.3)

### APPLICATIONS

- Sample clock generation for high speed data acquisition applications
- Sample clock generation for multi-channel systems
- Synchronization for distributed systems
- GPS-coordinated systems
- Timing Generation

### SOFTWARE

- Windows/Linux Drivers
- C++ Host Tools



### DESCRIPTION

The X3-Timing is an XMC I/O module with precision, low-noise clock generation and distribution for data acquisition and communications timing applications. The module has four output clocks and four output triggers as well as a clock/reference input and a trigger input. The X3-Timing can also act as a system timing card in PXI systems, providing the reference clock, sample clocks and triggering.

In the sample clock generation mode, the X3-Timing can generate clocks from 1560 kHz to 1 GHz. The clocks are referenced to GPS, an on-card 1 ppm oscillator, or an external input. The PLL circuit is fully programmable, providing extremely low noise clocks with 0.2 ps RMS jitter typically. The output clocks are phase aligned to within 100 ps. Each output clock is a 1 to 80 subdivision of the PLL or external clock.

The optional GPS receiver outputs a 10 MHz reference signal locked to the GPS that is very stable and low noise. This GPS receiver has been specially optimized for optimum time stability and receiver sensitivity. The receiver requires only one satellite for time tracking and -186 dBw power, making it able to receive indoors in most conditions.

A Windows and Linux application are provided that are used to configure and control the X3-Timing features. Configurations can be stored for instant-on use in the on-card memory.

Software tools for host development include C++ libraries and drivers for Windows and Linux.

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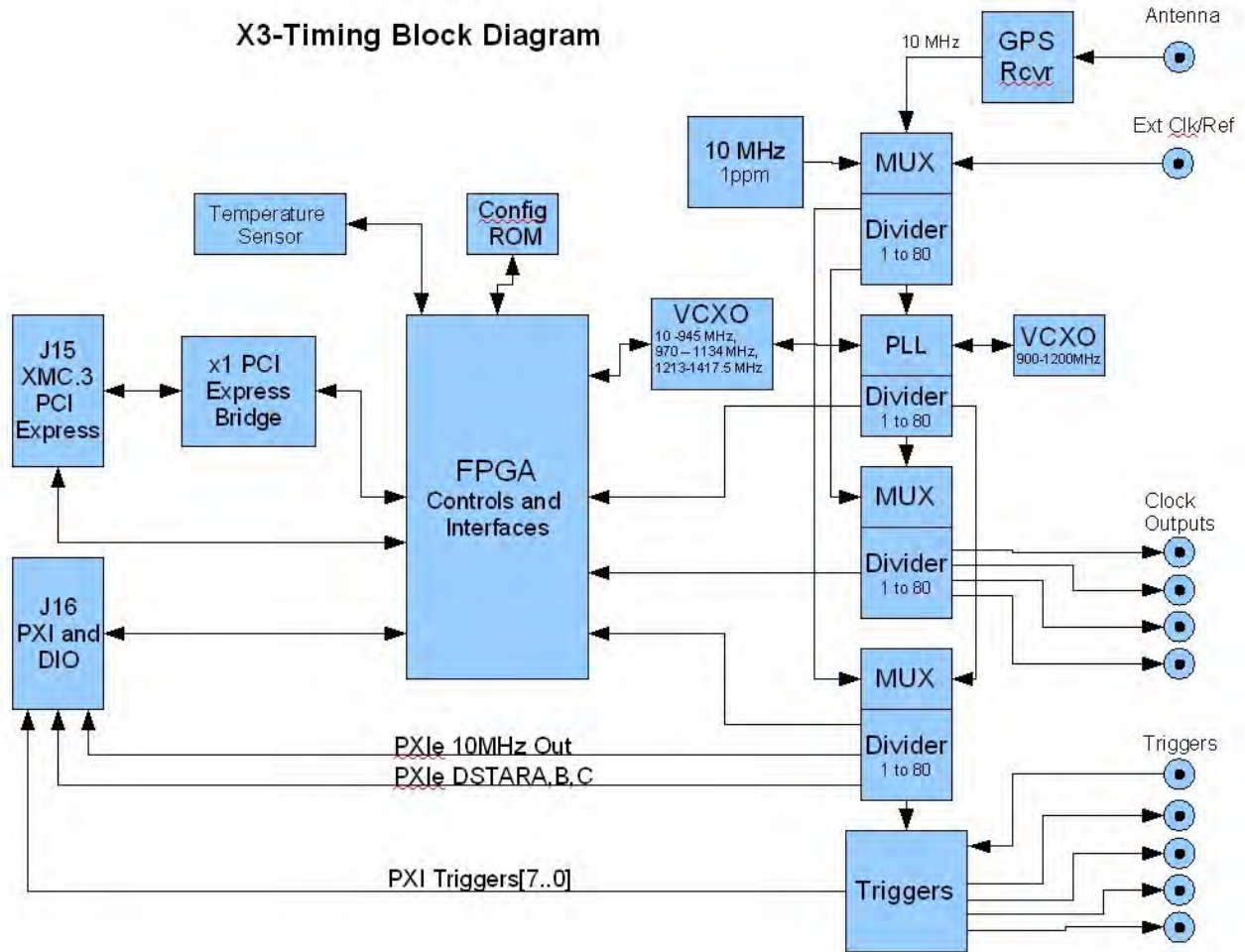
This electronics assembly can be damaged by ESD. Innovative Integration recommends that all electronic assemblies and components circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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
X3-Timing	80234-0	PCI Express XMC module with four clock outputs, four trigger outputs, external trigger and clock inputs, PXI clock support and 280 ppm reference. No GPS.
X3-Timing	80234-3	PCI Express XMC module with four clock outputs, four trigger outputs, external trigger and clock inputs, PXI clock support, GPS and 1 ppm reference.
<b>Cables</b>		
MMCX to BNC cable	67069	MMCX to BNC male coax cable, 1m
<b>Adapters</b>		
XMC-PCIe x1 Adapter	80172-0	PCI Express Carrier card for XMC PCI Express modules, x1 lanes
XMC- PCIe x8 Adapter	80173-0	PCI Express Carrier card for XMC PCI Express modules, x8 lanes
XMC-PCI Adapter	80167	PCI Carrier card for XMC PCI Express modules, 64-bit PCI-X
XMC-cPCI Adapter	80207	3U Compact PCI Carrier card for XMC PCI Express modules, 64-bit PCI-X
XMC-Cabled PCIe Adapter	90181	Cabled PCI Express Carrier card for XMC PCI Express modules, single-lane.
<b>Embedded PC Host</b>		
<i>eInstrumentPC</i> embedded PC XMC host	90200	Embedded PC with support for two XMC modules; Celeron, Core2Duo or Penryn CPU; Windows or Linux
<i>eInstrumentPC-Atom</i> low-power embedded PC XMC host	90201	Embedded PC with support for two XMC modules; Intel Atom or Penryn CPU; Windows or Linux

# X3-Timing

X3-Timing Block Diagram



# X3-Timing

## Standard Features

Clock Generation	
Clock Sources	Programmable PLL: TI CDCE72010
	External: Sine/square input
PLL References	Programmable to select either 10 MHz oscillator (see specs below), 10 MHz GPS-disciplined clock, or external input
PLL Frequency Range	1.56kHz to 1 GHz
PLL Tuning Resolution	<1 kHz
PLL Jitter	< 0.2 ps RMS (using on-card reference)

Reference	
Frequency	10 MHz
Stability	1 ppm
Accuracy	Calibrated to 1 ppm
Noise	-120 dBc/Hz @ 10 MHz offset

Clock/Reference Input	
Inputs	1
Input Range	0.5-3.3Vp-p (-2 to +14.3 dBm), Vcm=1.2 to 3.0VDC, sine or square wave
Input Type	Single ended, AC coupled
Input Impedance	50 ohm
Input Frequency Range	1kHz to 500 MHz
Routing	Clock or PLL Reference
Connector	MMCX female

Clock Outputs	
Outputs	4
Output Range	850 mVp-p, min for 50 ohm load
Output Type	Single ended, DC coupled
Output Impedance	50 ohm
Connectors	MMCX female

Triggers	
Outputs	4
Modes	Continuous or N-point frame
Sources	Software, external, GPS
Output trigger rate	250 MHz max
Frame Sizes	4 to 16M points

GPS	
Outputs	10 MHz disciplined by GPS
Reference Accuracy	25 ns RMS to UTC
Antenna	Active antenna required, SMA input
Acquisition Time	2 minutes from cold start

PXI Features	
PXI Clocks	PXI STAR A,B,C PXI Clock
PXI Reference Output	10MHz – GPS or 1 ppm reference
PXI Triggers	8
PXI	LVTTL (3.3V)
Drive	+/-12 mA
Connector	XMC P16

# X3-Timing

<b>Power Management</b>	
Temperature Monitor	May be read by the host software

<b>Host Interface</b>	
Type	PCI Express; 1lanes
Connector	XMC P15
Interface Standard	PCIe 1.0a; VITA 42.3
Logic Update	In-system reconfiguration

<b>Physicals and Calibration</b>	
Form Factor	Single width IEEE 1386 Mezzanine Card
Size	75 x 150 mm
Weight	100g
Hazardous Materials	Lead-free and RoHS compliant
Calibration	Factory calibrated for frequency accuracy. Non-volatile EEPROM coefficient memory.
Calibration Interval	1 year

# X3-Timing

<b>ABSOLUTE MAXIMUM RATINGS</b>				
Exposure to conditions exceeding these ratings may cause damage!				
Parameter	Min	Max	Units	Conditions
Supply Voltage, 3.3V to GND	+3.0	+3.6	V	
Clkin/Trigger Input Voltage	-5.7	+5.7	V	DC Coupled
Operating Temperature	0	70	C	Non-condensing, forced air cooling required
Storage Temperature	-65	+150	C	
ESD Rating	-	1k	V	Human Body Model
Vibration	-	5	g	9-200 Hz, Class 3.3 per ETSI EN 300 019-1-3 V2.1.2 (2003-04)
Shock	-	40	g peak	Class 3.3 per ETSI EN 300 019-1-3 V2.1.2 (2003-04)
<b>RECOMMENDED OPERATING CONDITIONS</b>				
Parameter	Min	Typ	Max	Units
Supply Voltage	+3.15	+3.3	+3.45	V
Operating Temperature	0		60	C

# X3-Timing

## RECOMMENDED OPERATING CONDITIONS

### ELECTRICAL CHARACTERISTICS

Over recommended operating free-air temperature range at 0°C to +60°C, unless otherwise noted.

Parameter	Typ	Units	Notes
Output Frequency Range	0.1 to 1000	MHz	
Clock Jitter	100**	fs	Target specification with output filter
Accuracy	1	PPM	After calibration
Stability	1**	PPM	
Relative Time Delay, Output to Output	TBD	fs	
GPS Acquisition Time	120	Sec	Cold start, outdoors
Power Consumption	TBD	W	

\*\* target specification

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## Architecture and Features

The X3-Timing module is a PCI Express XMC module designed to support high speed digitizing systems with multiple channels. The card provides extremely low noise clock signals that are required for accurate digitizing of high speed analog signals in systems such as RF/IF front ends, RADAR systems and high speed pulse digitizing.

Distributed systems are supported using GPS, allowing systems to be tightly locked to GPS time without physically sharing any signals.

### Clock Generation

The X3-Timing features a flexible sample rate generation architecture built around a PLL with tunable VCXO. The PLL and VCXO are fully programmable with an output range from 100 kHz to 1 GHz.

The PLL reference inputs are also software programmable and provide selection between a 10 MHz 1PPM on-card oscillator, GPS-disciplined clock and an external input. Both the GPS and on-card oscillator are very stable and low noise. The references may be divided before the PLL by values from 1 to 80 (not all numbers inclusive) so that high frequency external inputs can be used.

### Clock Outputs

There are four clock outputs on the front panel and four PXI clocks. All clock outputs may be synchronous or individually subdivided from the PLL or external clock, or the reference clock.

### Triggering

The X3-Timing has four trigger outputs to the front panel and an additional 8 triggers for PXI. The triggers are programmable for framed mode, used for data snapshots, or continuous mode. The trigger can be fired from software, external input, or GPS time. All trigger outputs are synchronous.

<b>Trigger Mode</b>	Continuous	<i>Trigger is true on next rising edge of the sample clock until source is deasserted</i>
	Framed	<i>Once fired, the trigger is true for N data points</i>

### Distributed Data Acquisition

The GPS reference is used for distributed applications so that sample clocks can be synchronous without physical connection. Anywhere GPS is available, this reference will provide synchronization to UTC time.

### PXI Support

The X3-Timing can act as a PXI system timing card when used with the PXI adapter (80207). PXI clock outputs for the system STAR clocks are sourced from the PLL or external clock input through a separate clock divider/buffer device. These clocks may be the PLL, external clock, or subdivisions of these.

The PXI 10 MHz system reference may also be driven by the on-card reference to provide higher stability or GPS synchronization. (Requires 80207 Rev B or higher). PXI signals use J16 to connect with the PXI adapter card.

The triggering controls also provide eight PXI triggers synchronized to the sample clocks.

### Configuration Storage

The X3-Timing configuration can be saved to on-card FLASH memory for instant-on configuration. After programming, the X3-Timing can be used in a “stand-alone” mode without the computer as an instrument with the eInstrument Node DAQ. The configuration can always be updated using the software by reconnecting to the computer.

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## Software Tools

The X3-Timing can be easily configured using the configuration program. The application provides a control panel interface for configuring the PLL and clock distribution features including reference source, output frequency, GPS functions, triggering modes, and PXI timing. No programming is necessary for most applications. Configurations may be saved for instant recall, or stored and recalled later.

Software development tools for the X3-Timing provides comprehensive support including device drivers, card controls, GPS interface and utilities that allow developers to be productive from the start. Software classes provide C++ developers a powerful, high-level interface to the card making the X3-Timing easier to integrate into applications.

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

## Applications Information





### Cables

The X3-Timing module uses coaxial cable assemblies for the IO. The mating cables have an MMCX male connector and 50 ohm characteristic impedance for best signal quality.

### XMC Adapter Cards

XMC modules can be used in standard desktop system or compact PCI/PXI using a XMC adapter card. An auxiliary power connector to the PCI Express adapters provides additional power capability for XMC modules when the slot is unable to provide sufficient power. The adapter cards allow the XMC modules to be used in any PCIe or PCI system.

The X3-Timing uses the auxiliary P16 connector to interface to provide additional triggers and clocks for PXI. When the X3-Timing card is used with the cPCI/PXI adapter (80208), the card may act as a system timing controller. The 10MHz system reference clock is replaced by the X3-Timing reference, either GPS or 1ppm oscillator.

<p><b>PCIe-XMC Adapter (80172)</b> x1 PCIe to XMC Clock and trigger inputs</p> 	<p><b>PCIe-XMC Adapter x8 lane (80173)</b> x8 PCIe to XMC x8 RIO ports supported on P16</p> 	<p><b>PCI-XMC Adapter (80167)</b> 64-bit, 133 MHz PCI-X host x4 PCIe to XMC</p> 	<p><b>Compact PCI-XMC Adapter (80207)</b> 64-bit, 133 MHz PCI-X host x4 PCIe to XMC PXI triggers and clock support</p> 
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Applications that need remote or portable IO can use either the eInstrument PC or eInstrument Node with X3 modules.

# X3-Timing

## eInstrument PC with Dual PCI Express XMC Modules (90199 or 90201)

Windows/Linux embedded PC  
Low power Intel Atom available  
8x USB, GbE, cable PCIe, VGA  
High speed x8 interconnect between modules  
GPS disciplined, programmable sample clocks and triggers to XMCs  
100 MB/s, 400 GB datalogger  
12V operation



## eInstrument DAQ Node – Remote IO using cabled PCI Express (90181)

PCI Express system expansion  
Up to 7 meter cable  
electrically isolated from host computer  
software transparent



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