

X3-DIO

PCI Express XMC Module with 100 MHz Streaming Digital IO, 1.8M FPGA and 4MB Memory

FEATURES

- Stream digital data to/from memory or disk
- 400 MB/s LVDS capture/playback to SRAM
- 100 MB/s capture to system memory/disk**
- 50 MB/s streaming from system memory
- 64 single-end/32 differential digital IO
- Optional on-card termination
- Xilinx Spartan3A DSP, 1.8M gate FPGA
- 4MB SRAM
- Programmable or external timebase
- Framed, software or external triggering
- Log acquisition timing and events
- 44 bits digital IO on P16
- Power Management features
- PCI Express XMC Module (75x150 mm)
- Use in any PCI Express desktop, compact PCI/PXI, or cabled PCI Express application

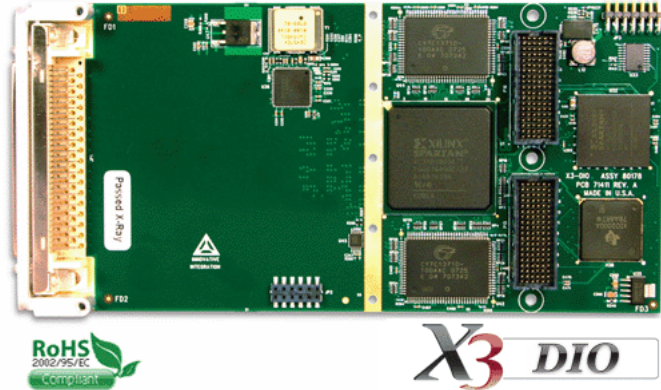
APPLICATIONS

- Digital Pattern Generation
- Capture and record digital data
- Custom Digital Interfaces for Remote IO
- Digital Controls

SOFTWARE

- Data Acquisition, Logging and Analysis applications provided
- Windows/Linux Drivers
- C++ Host Tools
- VHDL/MATLAB Logic Tools

** Andale datalogger required for disk storage



DESCRIPTION

The X3-DIO is a PCI Express XMC IO module for high speed digital IO data interfaces featuring 64bits of front-panel digital IO. The digital IO is either single-ended LVCMOS or LVDS differential pairs that is directly connected to the FPGA, for applications such as high speed pattern generation, digital recording, custom IO interfaces and controls.

Flexible trigger methods include counted frames, software triggering and external triggering. The sample rate clock is either an external clock or on-board programmable PLL clock source.

Data acquisition control, signal processing, buffering, and system interface functions are implemented in a Xilinx Spartan3A DSP FPGA, 1.8M gate device. Two 512Kx32 memories are used for data buffering and FPGA computing memory.

The logic can be fully customized using VHDL and MATLAB using the FrameWork Logic toolset. The MATLAB BSP supports real-time hardware-in-the-loop development using the graphical, block diagram Simulink environment with Xilinx System Generator.

The PCI Express interface supports continuous data rates up to 180 MB/s between the module and the host. A flexible data packet system implemented over the PCIe interface provides both high data rates to the host that is readily expandable for custom applications.

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Innovative Integration products and disclaimers thereto appears at the end of this data sheet. All trademarks are the property of their respective owners.



11/29/08

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Innovative Integration standard warranty. Production processing does not necessarily include testing of all parameters.

X3-DIO



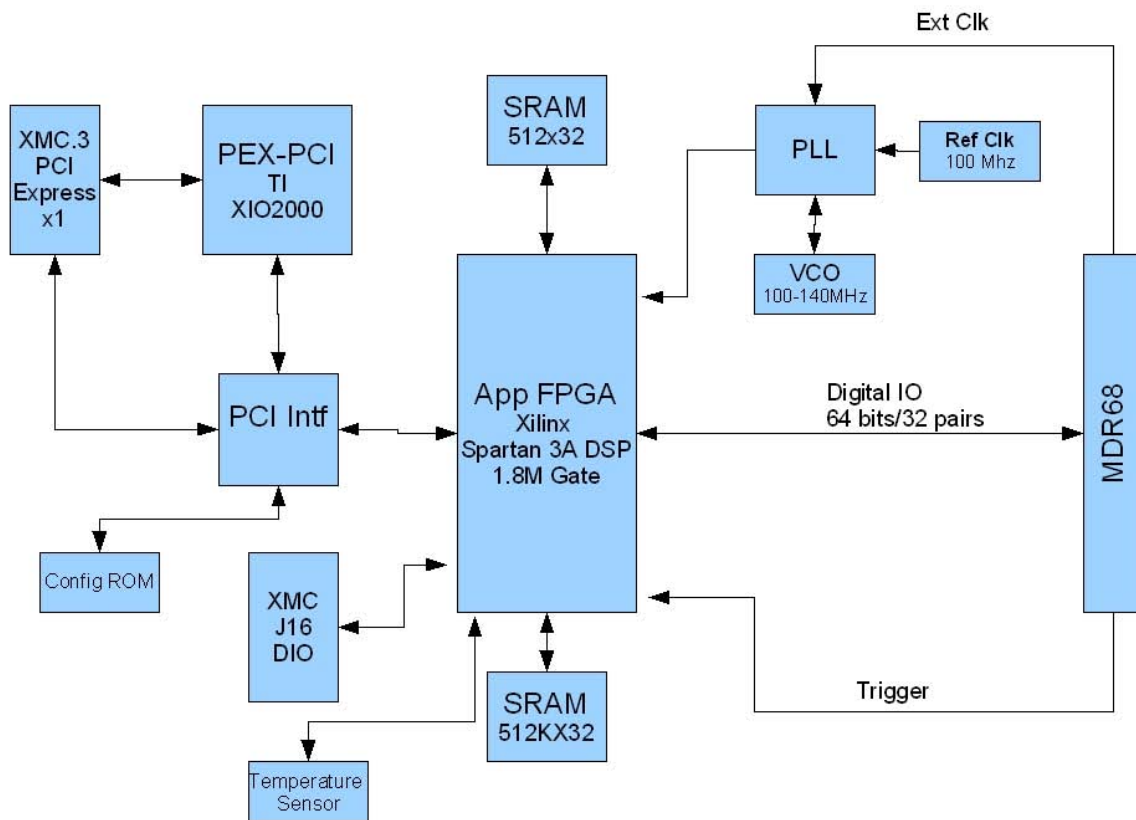
This electronics assembly can be damaged by ESD. Innovative Integration recommends that all electronic assemblies and components circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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-DIO	80178-0	PCI Express XMC module with 64 bits digital IO, 1.8M gate FPGA, 4MB SRAM
Logic		
X3-DIO FrameWork Logic	55022	X3-DIO FrameWork Logic board support package for RTL and MATLAB. Includes technical support for one year.
Cables		
MDR68 cable	65057	IO cable with MDR68 plug on each end, 3 feet length (0.92m). Use for single-ended IO.
MDR	67067	IO cable with MDR68 plug on each end, 3 feet length (0.92m). Use for differential IO.
MDR68 breakout	80116-0	Breakout module with MDR68 Connector and screw terminal connection
Adapters		
XMC-PCIe x1 Adapter	80172-0	PCI Express Carrier card for XMC PCI Express modules, x1 lanes
XMC-PCI Adapter	80167	PCI Carrier card for XMC PCI Express modules, 64-bit PCI-X
XMC-cPCI Adapter	80207	3U Compact PCI/PXI 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
Embedded PC Host		
eInstrument PC	90199	Embedded PC XMC host with support for two XMC modules for standalone applications.

X3-DIO

X3-DIO Block Diagram



X3-DIO

Standard Features

Front Panel Digital IO	
Total Number of Bits	64
Balanced Pairs	32
Signal Standard	LVTTL or LVDS
LVTTL Max Signal Rate	50 MHz
LVDS Max Signal Rate	100 MHz
Current Capability	+/-12 mA (LVTTL)
Termination	LVDS : 100 ohms across pairs LVCMOS : 33 ohms series option
Source	Direct connect to FPGA
Connector	MDR68

FPGA	
Size	1.8M gate equivalent
Flip-Flops	33,280
Multipliers	84
CLB	4160
Block RAMs	84 (1512K bits)
FPGA Device	Xilinx Spartan3A DSP XC3SD1800A-4FGG676C
Configuration	SelectMAP from PCIe interface JTAG during development
Clock Rate	107 MHz system clock
Size	1.8M gate equivalent

Memory	
Size	4 MB total 2 devices @ 512Kx32 each
Type	Synchronous ZBT SRAM
SRAMs	Cypress CY7C1371D-133AXC
Uses	FPGA Buffer Memory FPGA computation memory
Clock Rate	107 MHz

X3-DIO

Host Interface	
Type	PCI Express; single lane
Sustained Data Rate	180 MB/s
Protocol	Packet data
Connector	XMC P15
Interface Standard	PCIe 1.0a; VITA 42.3
Logic Update	In-system reconfiguration

Clocks and Triggering	
Clock Sources	PLL or External
PLL Output	4 MHz to 140 MHz
PLL Resolution	1530 Hz
PLL Jitter	<1 ps RMS
PLL Programming	Host programmed via PCIe
PLL Reference	Internal: 100 MHz clock External reference : J16 input
Triggering	External, software, acquire N frame
Decimation	1:1 to 1:4095 in FPGA
Channel Clocking	All channels are synchronous
Multi-card Synchronization	External triggering, clock, and PLL reference are supported.

Acquisition Monitoring	
Alerts	Trigger, Queue Overflow, Channel Over-range, Timestamp Rollover, Temperature Warning, Temperature Failure, PLL Unlocked
Alert Timestamping	15 ns resolution, 32-bit counter

P16 Digital IO	
Total Number of Bits	44
Balanced Pairs	22
Signal Standard	LVTTTL/LVDS
Drive	+/-12 mA (LVTTTL)
Connector	XMC P16

Power Management	
Temperature Monitor	May be read by the host software
Alarms	Software programmable warning and failure levels
Over-temp Monitor	Disables analog IO power supplies
Power Control	Channel enables and power up enables
Heat Sinking	Conduction Cooling supported. (VITA20 subset)

Physicals	
Form Factor	Single width IEEE 1386 Mezzanine Card
Size	75 x 150 mm
Weight	100g
Hazardous Materials	Lead-free and RoHS compliant

X3-DIO

ABSOLUTE MAXIMUM RATINGS

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	
Analog Input Voltage, Vin+ or Vin- to GND	-0.3	+6	V	
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)

RECOMMENDED OPERATING CONDITIONS

Parameter	Min	Typ	Max	Units
Supply Voltages	+3.15	+3.3	+3.45	V
	+11	+12	+13	V
Operating Temperature	0		60	C

X3-DIO

ELECTRICAL CHARACTERISTICS						
Over recommended operating free-air temperature range at 0°C to +60°C, unless otherwise noted.						
Parameter	Min	Max	Typ	Units	Notes	
Single-ended LVCMOS 3.3V (P16 DIO, trigger inputs, front panel DIO using single-ended IO)						
Digital Input Low Threshold	0	0.8	0.5	V	LVCMOS33 IO standard	
Digital Input High Threshold	2.0	3.3	2.7	V	LVCMOS33 IO standard	
Digital Output High	2.9	3.3	3.2	V	LVCMOS33 IO standard	
Digital Input Input Low	0	0.4	0.1	V	LVCMOS33 IO standard	
Digital Output Current	+/-10	+/-14	+/-12	mA	LVCMOS33 IO standard, 12 mA standard	
Differential LVDS 2.5V (front panel IO using differential, clock input)						
Digital Input Differential	100	600	350	mV	LVDS 25 IO standard, 100 ohm termination	
Digital Input Common Mode Range	0.3	2.20	1.20	V	LVDS 25 IO standard, 100 ohm termination	
Digital Output Differential	100	600	-	mV	LVDS 25 IO standard, 100 ohm termination	
Digital Output Common Mode Range	0.8	1.6	-	V	LVDS 25 IO standard, 100 ohm termination	
Power						
Power Consumption	Total			3.5	W	For standard logic, 107 MHz system clock, 100 MHz sample clock, streaming to system, ambient temperature = 24C
	+3.3V Supply			100	mA	
	+12V Supply			16	mA	

X3-DIO

Architecture and Features

The X3-DIO module supports high rate data capture and playback for digital interface, communications, pattern generation and controls applications. The front-panel digital IO supports data capture or playback at 200 MB/s single-ended or 400 MB/s as differential pairs to memory on the module. The digital IO can be used as 64 single-ended as LVCMOS 3.3V signals with programmable direction or 32 differential pairs as LVDS by programming the application logic to select the IO standard. Standard logic images are provided for 64 LVCMOS bidirectional IO, 32 LVDS inputs, or 32 LVDS outputs. Additional digital IO control bits from the FPGA are mapped to P16 for application control and signaling.

The standard logic can playback and record data for any combination of front panel digital IO bytes. All digital IO is simultaneously sampled/updated using a programmable or external sample clock.

Controls for triggering and clocks allow precise control over the collection of data. Trigger modes include frames of programmable size, external and software. Multiple X3-DIO cards can sample simultaneously using external trigger inputs with synchronized sample clocks. The sample clock can be external or generated from the on-card PLL. The PLL can either use the on-card 100 MHz reference, or can use an external reference. When an external reference is used, the sample clock is synchronous to the reference.

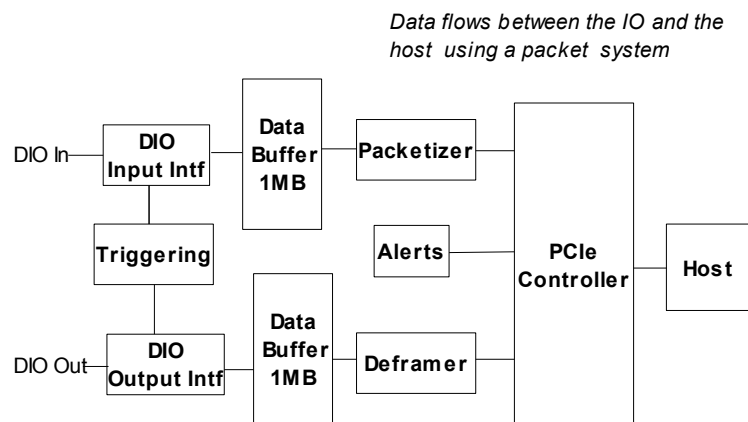
The X3 architecture has data buffering and a packet system to the host that provides an efficient and flexible host interface. The data buffer is a 2MB SRAM that is used as a dual-queue FIFO, one queue for incoming DIO data and one for outgoing DIO data. Data to the buffer is transferred to the host using the PCIe controller interface as data packets. The packet data system controls the flow of packets to the host, or other recipient, using a credit-based system managed in cooperation with the host software. The packets may be transmitted continuously for streams of data from the DIO, or as occasional packets for status, controls and analysis results. The data buffering and flow control system delivers high throughput with low latency and complete flexibility for data types and packet sizes to match the application requirements for all types of applications.

The data acquisition process can be monitored using the X3 alert mechanism. The alerts provide information on the timing of important events such as triggering, buffer overrun and thermal overload. Packets containing data about the alert including a system timestamp of the alert, and other information such as current temperature. This provides a precise overview of the data acquisition process by recording real-time events making the X3 modules easier to integrate into larger systems.

Software Tools

Software for data logging and analysis are provided with every X3 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 allow you to use the X3 performance in your applications without ever writing code. Innovative software applets include *Binview* which provides data viewing, analysis and import to MATLAB for large data files.

Software development tools for the X3 modules provide comprehensive support including device drivers, data buffering, card controls, and utilities that allow developers to be productive from the start. At the most fundamental level, the software tools



X3-DIO Architecture

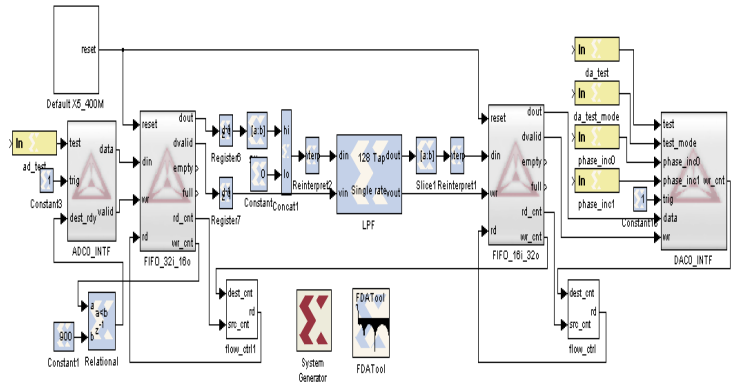
X3-DIO

deliver data buffers to your application without the burden of low-level real-time control of the cards. Software classes provide C++ developers a powerful, high-level interface to the card that makes real-time, high speed data acquisition 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.

Logic Tools

The X3 module logic in the FPGA may be modified to add high speed DSP, analysis, customized triggering and other unique features. The FrameWork Logic tools provide support for development using RTL and MATLAB. The standard logic provides a hardware interface layer that allows designers to concentrate on adding the application-specific portions of their design. This allows the designer to build upon the Innovative components for packet handling, hardware interfaces and system functions, the Xilinx IP core library, and third party IP. Each design is provided with RTL source for the FrameWork Logic ready for customization, a Xilinx ISE project, and a ModelSim testbench illustrating logic functionality.



The MATLAB Board Support Package (BSP) allows logic development using Simulink and Xilinx System Generator. These tools provide a graphical design environment that integrates the logic into MATLAB Simulink for complete hardware-in-the-loop testing and development. This is an extremely power design methodology, since MATLAB can be used to generate, analyze and display the signals in the logic real-time in the system. Once the development is complete, the logic can be embedded in the FrameWork logic using the RTL tools.

The FrameWork Logic User sales brochure and User Guide more fully detail the development tools.

Applications Information

Maximum Data Rates

The maximum data rates supported by the module are limited by the PCI Express transfer rate when the total data rate exceeds 150 MB/s. The PCI Express transfer rate may vary according to the host computer, operating system, and other software that may compete for bandwidth. The X3 modules support 250MB/s full duplex during bursts, but actual sustained throughput is 180 MB/s in typical desktop PCs.

It is important to qualify systems for performance when data rates exceeding 150 MB/s are required.

This rate limitation does not apply to data generated in the FPGA.

Cables

The X3 module family uses a shielded, jacketed 68-wire cable assembly for the front panel IO that provides a high number of connections while preserving signal quality. The pleated copper foil shield is “near coax” in its performance. This cable, plus the use of differential signals and use of ground signals as shields, produce the best results. A screw terminal assembly is available.






XMC Adapter Cards



X3-DIO

XMC modules can be used in standard desktop system or compact PCI/PXI using an adapter card. The adapter cards are software transparent.

The X3 module family uses the auxiliary P16 connector for digital IO and additional clock inputs. A total of 44 bits of digital IO, directly connected to the application FPGA, are routed to the rear edge MDR connector as 22 balanced differential pairs supporting LVDS or lower speed single-ended LVCMOS signals. The X3 modules also have a sample clock input and PLL reference input to J16. The cPCI/PXI adapter uses these to connect to system clocks, while the PCIe desktop adapter provides SMB input connectors for system clock inputs.

<p>PCIe-XMC Adapter (80172) x1 PCIe to XMC SMB Clock and trigger inputs</p> 	<p>PCI-XMC Adapter (80167) 64-bit, 133 MHz PCI-X host x4 PCIe to XMC</p> 	<p>Compact PCI-XMC Adapter (80207) 64-bit, 133 MHz PCI-X host x4 PCIe to XMC PXI triggers and clock support</p> 
--	---	---

Applications that need remote or portable IO can use either the eInstrument PC or eInstrument Node with X3 modules.

<p>eInstrument PC with Dual PCI Express XMC Modules (90199) Windows/Linux embedded PC 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</p> 	<p>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</p> 
---	---

X3-DIO

IMPORTANT NOTICES

Innovative Integration Incorporated reserves the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to Innovative Integration's terms and conditions of sale supplied at the time of order acknowledgment.

Innovative Integration warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with Innovative Integration's standard warranty. Testing and other quality control techniques are used to the extent Innovative Integration deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

Innovative Integration assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using Innovative Integration products. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

Innovative Integration does not warrant or represent that any license, either express or implied, is granted under any Innovative Integration patent right, copyright, mask work right, or other Innovative Integration intellectual property right relating to any combination, machine, or process in which Innovative Integration products or services are used. Information published by Innovative Integration regarding third-party products or services does not constitute a license from Innovative Integration to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from Innovative Integration under the patents or other intellectual property of Innovative Integration.

Reproduction of information in Innovative Integration data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice.

Innovative Integration is not responsible or liable for such altered documentation. Resale of Innovative Integration products or services with statements different from or beyond the parameters stated by Innovative Integration for that product or service voids all express and any implied warranties for the associated Innovative Integration product or service and is an unfair and deceptive business practice. Innovative Integration is not responsible or liable for any such statements.

For further information on Innovative Integration products and support see our web site:

www.innovative-dsp.com

Mailing Address: Innovative Integration, Inc.

2390A Ward Avenue, Simi Valley, California 93065

Copyright ©2007, Innovative Integration, Incorporated



Kane Computing Ltd
7 Theatre Court, London Road,
Northwich, Cheshire, CW9 5HB, UK.
Tel: +44(0)1606 351006
Fax: +44(0)1606 351007/8
Email: sales@kanecomputing.com
Web: www.kanecomputing.co.uk