X3-SD16

v1.1

Innovative Integration
... real time solutions!

PCI Express XMC Module with 16 channels of 24-bit A/D and D/A with 1.8M FPGA

FEATURES

- >100 dB analog dynamic range
- A/D: 16 simultaneously sampling channels of 144 ksps, 24-bit
- D/A: 16 simultaneously updated channels of 192 ksps, 24-bit
- -120 dB noise floor, 105 dB SFDR @ 1 kHz
- DC accurate with calibration
- Differential inputs with 2V, 10V, 20V ranges
- 4V output range; single ended outputs
- Xilinx Spartan3A DSP, 1.8M gate FPGA
- 4MB SRAM
- Sample clock is external or programmable, low jitter PLL
- Framed, software or external triggering
- Multi-card synchronization supports large channel count systems
- Log acquisition timing and events
- 44 bits digital IO on P16; 6 DIO on front panel
- 6.5W typical; standby mode 3.5W
- PCI Express XMC Module (75x150 mm)
- Use in any PCI Express desktop, compact PCI/PXI, or cabled PCI Express application

APPLICATIONS

- Vibration and acoustic measurement, recording and playback
- Sensor interfaces and real-time controls using FPGA-based signal processing

SOFTWARE

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

MATLAB®

XILINX®

DESCRIPTION

The X3-SD16 is a PCI Express XMC IO module featuring 16 simultaneously sampling 24-bit, 144 ksps A/D channels and 16 24-bit, 192 ksps D/A channels with an FPGA processing core. The analog inputs are fully differential with anti-alias filtering and programmable gain.

The module may be conduction cooled for embedded applications. Power consumption of <6.5W operating and 3.5W standby and conduction cooling features enable embedded applications with limited cooling capability.

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. Multi-card synchronization features allow large channel-count systems to digitize and playback simultaneously.

Data acquisition control, signal processing, buffering, and system interface functions are implemented in a Xilinx Spartan3A DSP FPGA, 1.8M gate device. Two 512Kx32 memory devices 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 transfer rates up to 180 MB/s to the host. A flexible data packet system implemented over the PCIe interface achieves high data transfer rates to the host that is readily expandable for custom applications.

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10/06/11

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X3-SD16

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-SD16	80255-0	XMC module with 16 channels of 24-bit A/Ds and DACs, 1.8M gate FPGA, 4MB SRAM
Logic		
X3-SD16 FrameWork Logic	55032	X3-SD16 FrameWork Logic board support package for RTL and MATLAB. Includes technical support for one year.
Software		
Linux	54042	Linux for SBC-Linux-ComEx, eInstrument-PC
Windows XP	54043	Windows XP Embedded for SBC-ComEx, eInstrument-PC
Windows XP	54044	Windows XP Pro for SBC-ComEx
Windows Vista	54046	Windows Vista Business for SBC-ComEx
Windows 7	54050	Windows 7 Pro 32-bit
Windows 7	54051	Windows 7 Embedded
Windows 7	54052	Windows 7 Pro 64-bit
Windows 7	54054	Windows 7 Pro 64-bit Embedded
Power		
Power Supply	80200-0	SBC-ComEx, eInstrument-PC Power Supply, DC (8-24V) input, 125W
Power Supply	80200-1	SBC-ComEx, eInstrument-PC Power Supply, AC (110-240) input, 125W, USA/Japan/Korea/Taiwan power cord
Power Supply	80200-2	SBC-ComEx, eInstrument-PC Power Supply, AC (110-240) input, 125W, UK/Australia/India power cord
Power Supply	80200-3	SBC-ComEx, eInstrument-PC Power Supply, AC (110-240) input, 125W, EU power cord
Cables		
MDR68 cable	65057	IO cable with MDR68 plug on each end, 3 feet length (0.92m)
PCIe cable	67057	67057: Single Lane PCI Express Cable - 5m
PCIe cable	67058	67057: Single Lane PCI Express Cable - 3m

PCIe cable	67059	67057: Single Lane PCI Express Cable - 1m
Coax Breakout Cable	67119	Front panel breakout cable with coax cables and BNC terminations for analog, clock and trigger inputs, ribbon cable for front panel digital IO. 1 meter length.
X3-SD16 breakout cable	67135-S	X3-SD16 breakout cable
Breakout	80112-1	MDR68-female to screw terminal block
Breakout	80116-0	MDR 68 BREAKOUT CABLE
MDR Cable	80116-1	MDR cable 68-pin and screw terminal block
Adapters		
XMC-PCIe x1 Adapter	80172-0	PCI Express Carrier card for XMC PCI Express modules, x1 lanes
PCIe X1 Cable Adapter	80181-0	Desktop PCI Express X1 Cable Adapter
PCIe X1 Cable Adapter	80186-0	Laptop PCI Express X1 Cable Adapter
XMC to CompactPCI Adapter	80207-0	CompactPCI to XMCe Adapter Board
cPCI-XMCe Adapter	80207-1-L4	cPCI-XMCe Adapter 3U Conduction Cooled
CPEX4	80246-0	X4 PCI Express Cable adapter card
XMC Adapter for 3U OpenVPX	80260-3	VPX-XMC 3U ADAPTER, conduction cooled, without REDI covers for X3 modules
XMC Adapter for 3U OpenVPX	80260-3RC	VPX-XMC 3U ADAPTER, conduction cooled, with REDI covers for X3 modules
XMC Adapter for 3U OpenVPX	80260-3RCA	VPX-XMC 3U ADAPTER, conduction cooled, with REDI covers for X3 modules & assembly
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.
eInstrument-DAQ Node	90181-0	XMC module carrier with 2.5 Gbps cabled PCI Express link to Host Computer housed in a rugged aluminum enclosure.
CPEX4 Hub	90241-0	Cabled PCI Express 4-port Hub including chassis
Framework		
Logic	55020	Framework Logic support for X3-25M module
XMC Modules		

X3-Timing	80234-0	MDR cable 68-pin and screw terminal block
X3-Timing	80234-1	XMC Module, 1 ppm crystal, no GPS
X3-Timing	80234-2	PCI Express XMC Module, 500 ppb crystal, with GPS
X3-Timing	80234-3	XMC Module, 1 ppm crystal, w/GPS
Embedded PC Host		
eInstrument PC	90199	Embedded PC XMC host with support for two XMC modules for standalone applications.
Custom Engineering and Consulting Services		
Engineering Services	56004	Software/hardware/firmware development
Technician Services	56005	Mechanical fabrication - Electronics prototyping
Premium Services	56006	Rapid turnaround premium, Engineering or Technician Services (add to base rate)
Visit	56009	Engineer Visit On Site for installation, application assistance, in-house training, custom SW
IP Blocks		
IP-TINY DDS	58003-0	1/3 size of Xilinx DDS with equal SFDR. Net version
IP-TINY DDS	58003-1	1/3 size of Xilinx DDS with equal SFDR, source version
IP-XLFFT	58011-0	Core for 64K to 1M points FFT for 1-D, 2-D signal Netlist undle with hardware
IP-XLFFT	58011-1	Core for 64K to 1M points FFT for 1-D, 2-D signal Netlist
IP-WINDOWING	58012-0	Run-time configurable Hann, Blackman, and Boxcar data windowing functions Netlist bundle with hardware
IP-WINDOWING	58012-1	Run-time configurable Hann, Blackman, and Boxcar data windowing functions Netlist
IP-WINDOWING	58525-0	Netlist version
IP-WINDOWING	58525-1	Source version
VPX		
VPX-COMEX	80271-0	3U VPX CPU Card, Spartan6 Forced Air Cooling, no REDI covers
VPX-COMEX	80271-0-L1	3U VPX CPU Card, Spartan6 Conduction Cooling, no REDI covers
VPX-COMEX	80271-0-L2	3U VPX CPU Card, Spartan6 Conduction Cooling, no REDI covers
VPX-COMEX	80271-0-L3	3U VPX CPU Card, Spartan6 Conduction Cooling, no REDI covers
VPX-COMEX	80271-0R-L0	Intel I7 @ 2.53 GHz, 128GB SSD Card with REDI covers
VPX-COMEX	80271-0R-L1	Intel I7 @ 2.53 GHz, 128GB SSD Card with REDI covers

VPX-COMEX	80271-0R-L3	Intel I7 @ 2.53 GHz, 128GB SSD Card with REDI covers
RTM-ComEx	80276-0	Rear terminal module for VPX-ComEx
RTM-ComEx	80276-0-L1	Rear terminal module for VPX-ComEx
RTM-ComEx	80276-0-L3	Rear terminal module for VPX-ComEx
VPXI-Extension	90277-0	VPXI-Extension
Media		
DVD	57001	Innovative Integration Installation DVD
Recorders		
Andale Turnkey Logging System	90036-1	2.4 TB RAID0 Array, 700 MB/s
Andale Turnkey Logging System	90036-11	Sustained rates limited to 1600 MB/s
Andale Turnkey Logging System	90036-12	14.4 TB RAID0 Array, 1600 MB/s
Andale Turnkey Logging System	90036-13	9.6 TB RAID0 Array, 1200 MB/s
Andale Turnkey Logging System	90036-14	48 TB RAID0 Array, 2400 MB/s
Andale Turnkey Logging System	90036-2	Sustained rates limited to 300 MB/s
Andale Turnkey Logging System	90036-4	4.8 TB RAID0 Array, 850 MB/s
Andale Turnkey Logging System	90036-5	Sustained rates limited to 850 MB/s
Andale Turnkey Logging System	90036-6	Sustained rates limited to 1000 MB/s
Andale Turnkey Logging System	90036-7	Sustained rates limited to 500 MB/s
Andale Turnkey Logging System	90036-8	14.4 TB RAID0 Array, 2400 MB/s
Andale Turnkey Logging System	90036-9	Sustained rates limited to 1600 MB/s
Systems		
Mezzanine Card	80208-1	Mezzanine card for SBC-ComEx

Mezzanine Card	80242-0	Mezzanine card for eInstrumentPC and SBC-ComEx exposing J16 signals from XMC sites 0 and 1, plus SBC-ComEx baseboard digital I/O signals, 1 ppb stability clock with GPS
Precision GPS Option	80247-0	Precision GPS Option for eInstrument PC and Atom. Includes Trimble Mini-T GPS receiver, Bullet III antenna and 10 M cable
eInstrument-PC	90199-1	Rackmount Adapter Kit
Low-Power eInstrument-PC	90200-0	90190-0+AC supply+chassis+boot SSD
Performance eInstrument-PC	90200-1	90190-1+AC supply+chassis+boot SSD
Performance ePC	90200-1A	90190-1+AC supply+chassis+boot SSD+VCO 350-460 MHz
Extreme eInstrument-PC	90200-2	90190-2+AC supply+chassis+boot SSD
Extreme eInstrument-PC	90200-3	90190-4+AC supply+chassis, 10-280 MHz SI570 VCO
Extreme eInstrument-PC	90200-5	90190-4+AC supply+chassis, 10-945 MHz SI570 VCO
Extreme eInstrument-PC	90200-6	Extreme eInstrument PC with SBC-ComEx carrier, DC supply, (10-945 MHz SI570 VCO range) I7 dual core at 2.5 Ghz, 4GB RAM and Enclosure for SBC-ComEx and SBC COMEX Power Supply, AC (110-240) input, 125W, USA/Japan/Korea/Taiwan power cord.
Low Power eInstrument ATOM PC	90201-0	90191-0+AC supply+chassis+Flash boot
Extreme eInstrument ATOM PC	90201-1	90191-2+AC supply+chassis+Flash boot
Low Power eInstrument ATOM PC	90201-3	Low-power eInstrument-PC ATOM PC with SBC-ComEx carrier, DC supply, ATOM CPU, 1GB RAM and Enclosure for SBC-ComEx and SBC COMEX Power Supply, DC (12V) input, 125W.
Extreme eInstrument ATOM PC	90201-4	90191-2+AC supply+chassis
Extreme eInstrument ATOM PC	90201-5	Extreme eInstrument ATOM PC with SBC-ComEx carrier, DC supply I7 dual core, 4GB RAM and enclosure for SBC-ComEx plus SBC COMEX power supply, DC (12V) input, 125W.
VPXI-ePC	90271-0	VPXI-ePC
VPXI-ePC	90271-0-L1	VPXI-ePC conduction cooled cooled 3U 1/2 rack OpenVPX 5 expansion slots Rugged Level 1
VPXI-ePC	90271-0-L2	VPXI-ePC conduction cooled cooled 3U 1/2 rack OpenVPX 5 expansion slots Rugged Level 2
VPXI-ePC	90271-0-L3	VPXI-ePC conduction cooled cooled 3U 1/2 rack OpenVPX 5 expansion slots Rugged Level 3

Storage		
Hitachi HTS722020K9A300	306019	200GB 7200 RPM SATA 3.0Gb/s Hard Drive
Disk Drive	36028	Solid state disk drive for SBC ComEx - 160 GB
Flash Drive	49016	4 Gigabytes memory USB Embedded
Western Digital Scorpio WD800BEVS	49017-0	80GB 5400 RPM SATA 1.5Gb/s Hard Drive
Flash Drive	49018	16 Gigabytes memory USB Embedded
Hard Disk	80212-0	Hard Disk Drive for SBC COMEX, eInstrument-PC; 200 GB
Hard Disk	80212-1	High Performance Hard Disk Drives for SBC COMEX, eInstrument-PC; two drives, 200 GB each
VelociRaptor WD6000HLHX	80212-3	600GB 10000 RPM 32MB Cache 2.5" Hard Drive
Disk Drive	80263	INTEL SOLID STATE DRIVE V SERIES SNV125-S2BD/30GB 2.5"
GPS		
Tyco A1029-D GPS antenna	68013G	Active, +25dB, 3.3V, SMA cable
GPS RECEIVER MODULE	68015G	Trimble Mini-T, high accuracy, 10 MHz output
GPS Antenna	68016G	Trimble Bullet III, 5V
NavSync CW25	80261	GPS Module for SBC-ComEx
GPS receiver and active antenna	90196-0	GPS receiver and active antenna (P/Ns 68013G + 80261)
GPS receiver and active antenna	90198-0	Trimble Mini-T GPS receiver and active antenna (P/Ns 68015G + 68013G

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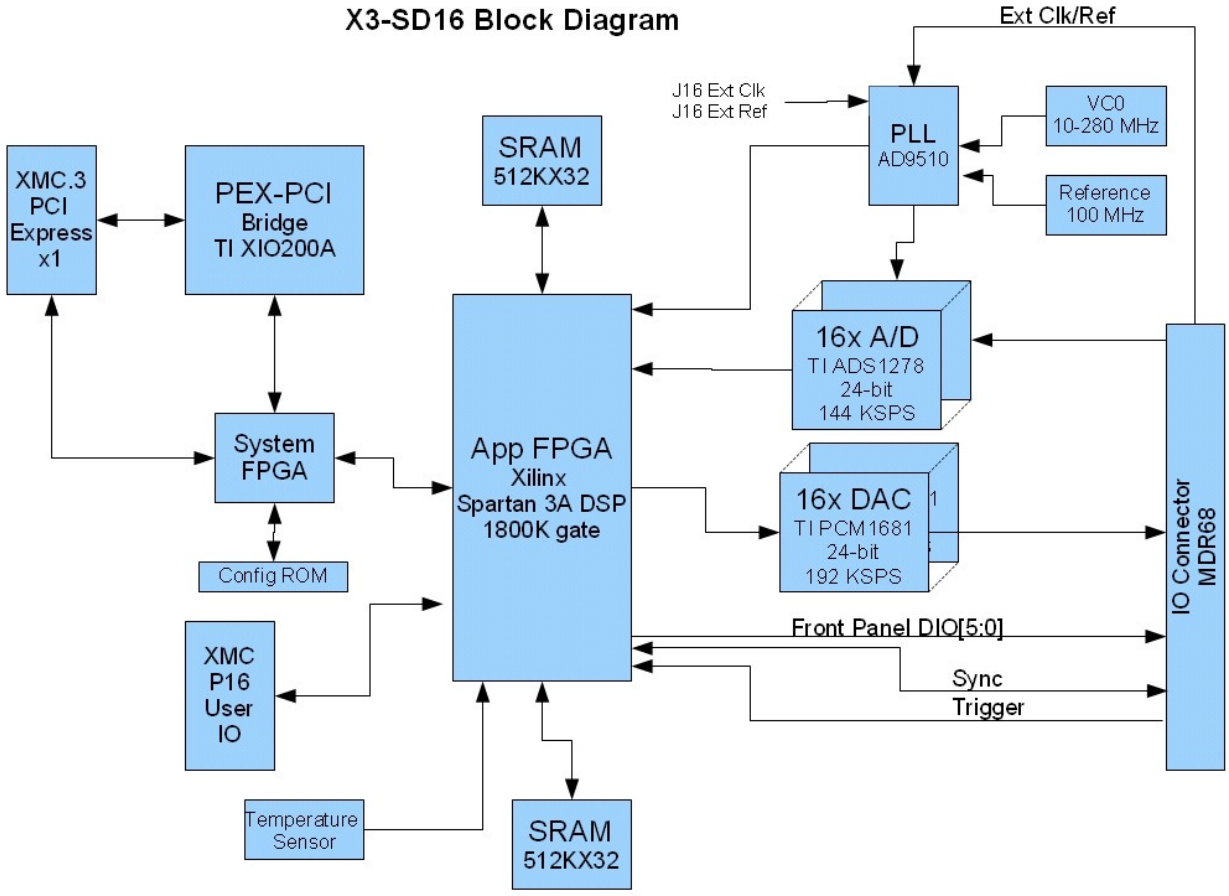

X3-SD16 Block Diagram
Ext Clk/Ref
J16 Ext Clk
J16 Ext Ref
PLL
AD9510
VCO
10-280 MHz
Reference
100 MHz
SRAM
512KX32
XMC.3
PCI
Express
x1
PEX-PCI
Bridge
TI XIO200A
16x A/D
TI ADS1278
24-bit
144 KSPS
System
FPGA
App FPGA
Xilinx
Spartan 3A DSP
1800K gate
16x DAC
TI PCM1681
24-bit
192 KSPS
IO Connector
MDR68
Config ROM
Front Panel DIO[5:0]
Sync
Trigger
XMC
P16
User
IO
Temperature
Sensor
SRAM
512KX32

X3-SD16

Standard Features

Analog Input	
Inputs	16
Input Range	Programmable 2, 10 and 20 V ranges
Input Type	Differential, DC coupled
Input Impedance	20K ohm
A/D Device	Texas Instruments ADS1278
A/D Type	24-bit, sigma-delta
A/D Sample Rate	Up to 144 ksps; On-board PLL clock range is 1.2ksps to 144 ksps * A/D and DAC must share the same clock rate
Analog Input Bandwidth	Pole at 250 kHz; Digital filter in A/D limits input range to Fs/2
Analog Output	
Output	16
Output Range	4V
Output Type	Single-ended, DC coupled
Output Drive Capability	Up to 10 mA/channel
Output Filter	Pole at 250 kHz
D/A Device	Texas Instruments PCM1681
D/A Type Resolution	24-bit, sigma delta
D/A Update Rate	Up to 192 ksps; On-board PLL clock range is 1.2ksps to 192 ksps* * A/D and DAC must share the same clock rate
Calibration	Factory calibrated. Gain and offset errors are digitally corrected in the FPGA. Non-volatile EEPROM coefficient memory.
Data Format	2's complement, 24-bit integer
Front Panel Connector	MDR68

FPGA	
Size	1.8M gate equivalent (standard device)
Flip-Flops	33,280
DSP48A Elements	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	132 MHz
Utilization	LUT 18%, FF 24%, BlockRAM 21%, DSP48A 9%

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

X3-SD16

Host Interface	
Type	PCI Express; 1 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	1.2kHz to 140 MHz
PLL Tuning Resolution	100 kHz
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 and clock are used for multiple card sync. One card is designated the master for synchronization.

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	LVTTL Configurable as LVDS 2.5V
Drive	+/-12 mA (LVTTL)
Connector	XMC P16

Front Panel Digital IO	
Total Number of Bits	6
Signal Standard	LVTTL
Drive	+/-12 mA (LVTTL)
Connector	Front Panel MDR68

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. (subset of VITA20)

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

X3-SD16

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 environment.
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

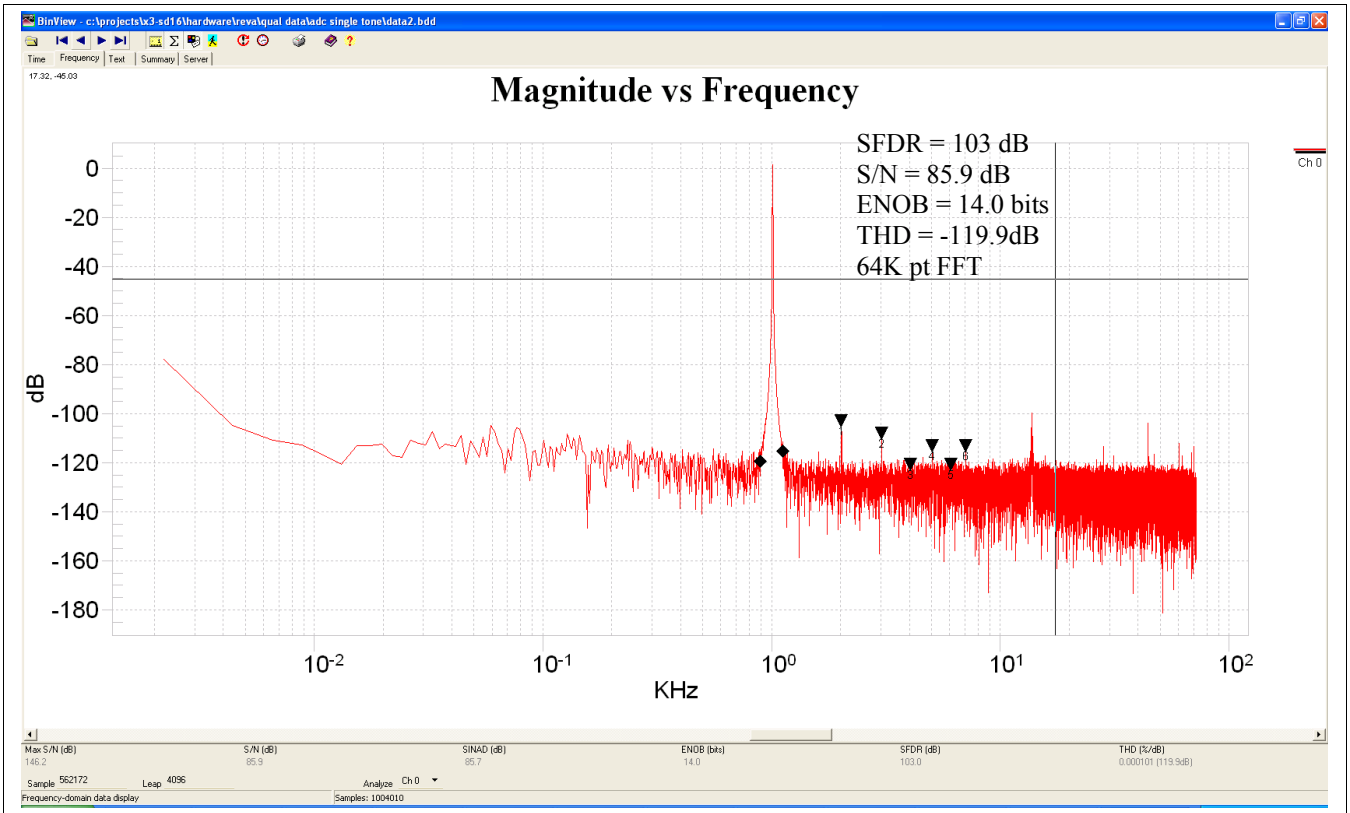
Parameter	Min	Typ	Max	Units
Supply Voltage	+3.15	+3.3	+3.45	V
Operating Temperature Range	0		70	C

PERFORMANCE CHARACTERISTICS

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

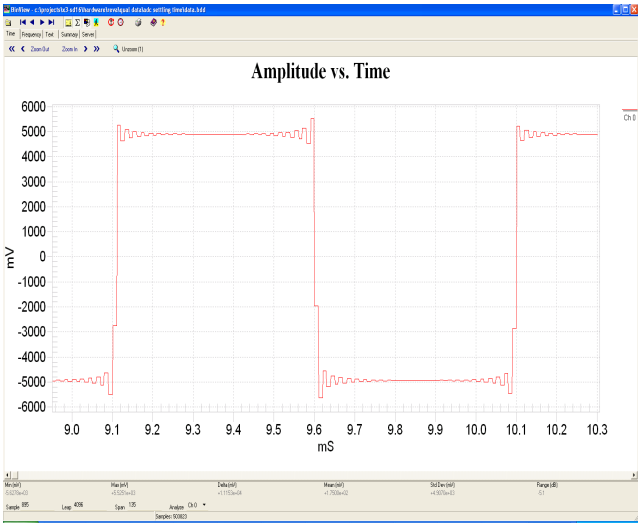
Parameter	**Typ**	**Units**	**Notes**
Analog Input			
Analog Input Flatness	+/-1	dB	0 to 70 kHz
Settling Time to 5%	1	ms	1.01 kHz, 10Vp-p square wave; digital filter in the A/D limits settling time. See graph.
SFDR	103	dB	1.01 kHz sine input, 1.9Vp-p , differential input, 64K point FFT
S/N	85.9	dB	1.01 kHz sine input, 1.9Vp-p , differential input, 64K point FFT
THD	-119.9	dB	1.01 kHz sine input, 1.9Vp-p , differential input, 64K point FFT
ENOB	14	bits	1.01 kHz sine input, 1.9Vp-p , differential input, 64K point FFT
Intermodulation Distortion	-116	dB	900 Hz and 1.01 kHz sine, 2Vp-p each, differential
Common Mode Rejection	-69	dB	1.01 kHz, 10Vp-p common mode input
Channel Crosstalk	-100	dB	1.01 kHz, 19.9Vp-p with MDR68 cable and screw terminal board

Noise	620	µV RMS	Grounded input.
Noise Floor	-120	dB	
Analog Input Calibration (after 5 min thermal stabilization)			
Gain Error	<0.02	% of FS	Calibrated
Offset Error	<500	µV	Calibrated
Calibration Interval	1	year	
Analog Output			
Output Bandwidth	+/-1	dB	0 to 90 kHz
SFDR	95.6	dB	1.01 kHz sine input, 2Vp-p , 128 ksps update rate, 64K point FFT
S/N	80.3	dB	1.01 kHz sine input, 2Vp-p , 128 ksps update rate, 64K point FFT
THD	-95.8	dB	1.01 kHz sine input, 2Vp-p , 128 ksps update rate, 64K point FFT
ENOB	12.8	bits	1.01 kHz sine input, 2Vp-p , 128 ksps update rate, 64K point FFT
Channel Crosstalk	-80	dB	1.01 kHz, 19.9Vp-p with MDR68 cable and screw terminal board (results limited by cable assembly)
Noise Floor	-110	dB	
Analog Output Calibration (after 5 min thermal stabilization)			
Gain Error	<0.02	% of FS	Calibrated
Offset Error	<500	µV	Calibrated
Calibration Interval	1	year	
Power			
Supply Current	1.99 (6.6W)	A	Full rate: 3.3V supply, all channels active at 144 ksps, 26C ambient
	1.26 (4.2W)	A	Standby: 3.3V supply, no channels active, 23C ambient
Operating Temperature	54	C	No forced air in 23C ambient, all channels active.

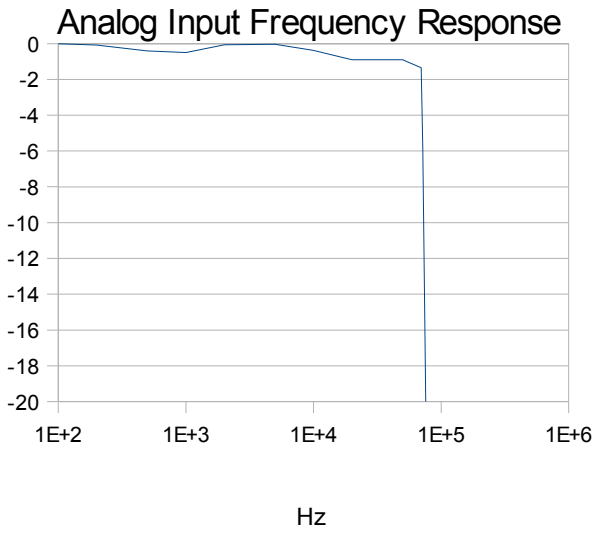


A/D Signal Quality, Fs=144 ksps, 1.01 kHz, 19.9Vp-p input

X3-SD16



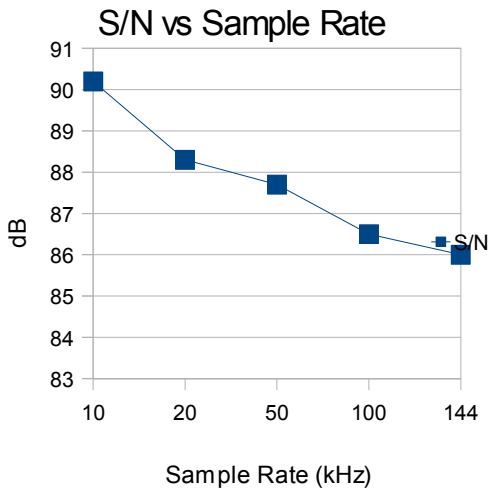
A/D Settling Time for a 1.01kHz, 10Vp-p square wave input

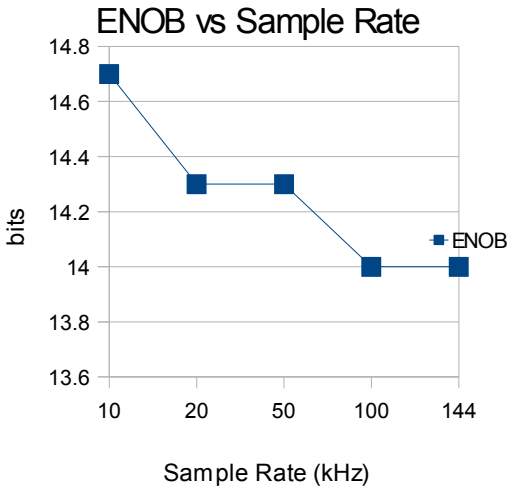


Analog Input Amplitude vs Frequency Response

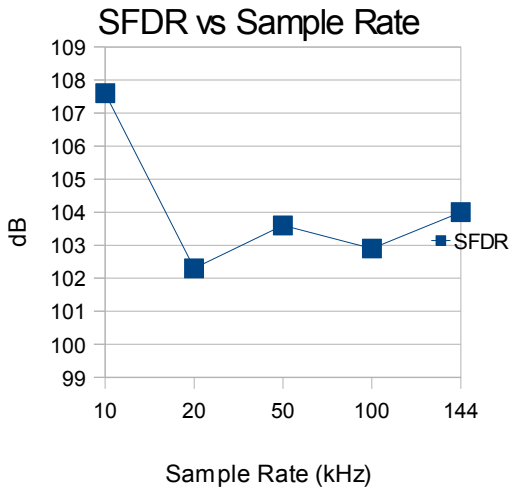
A/D Signal Quality vs. Sample Rate

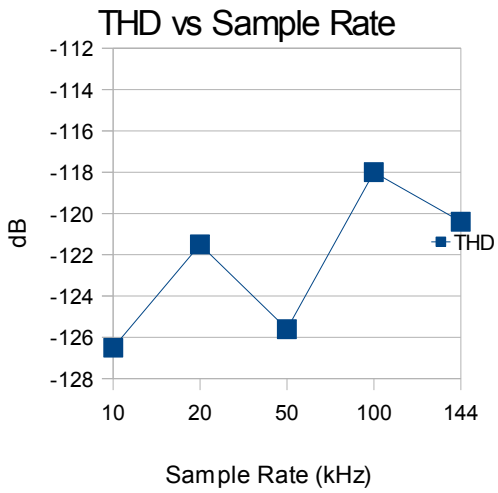
Note: All test results shown are 64K FFT



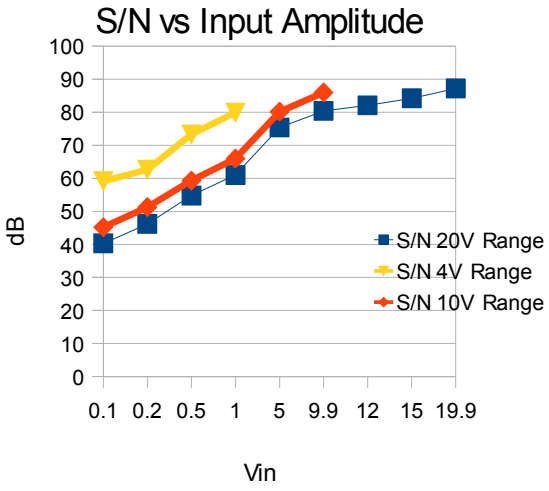


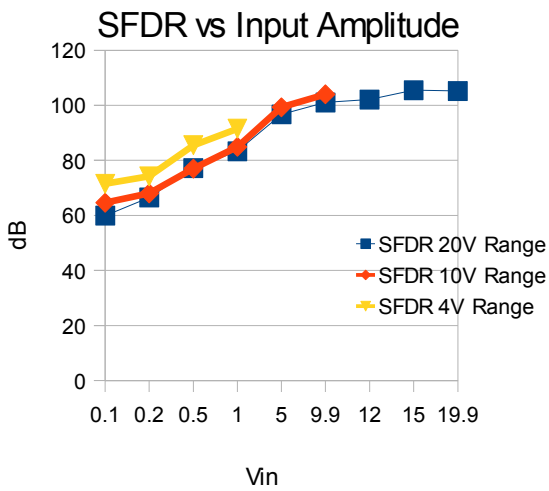
X3-SD16

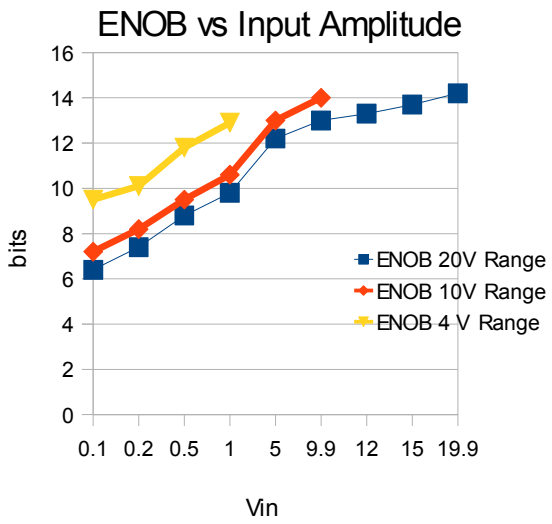


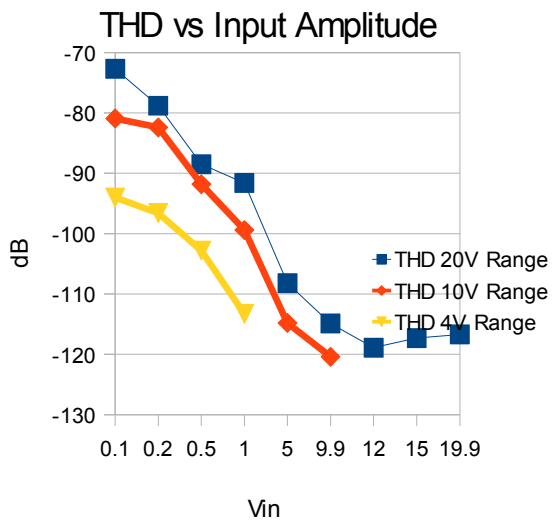


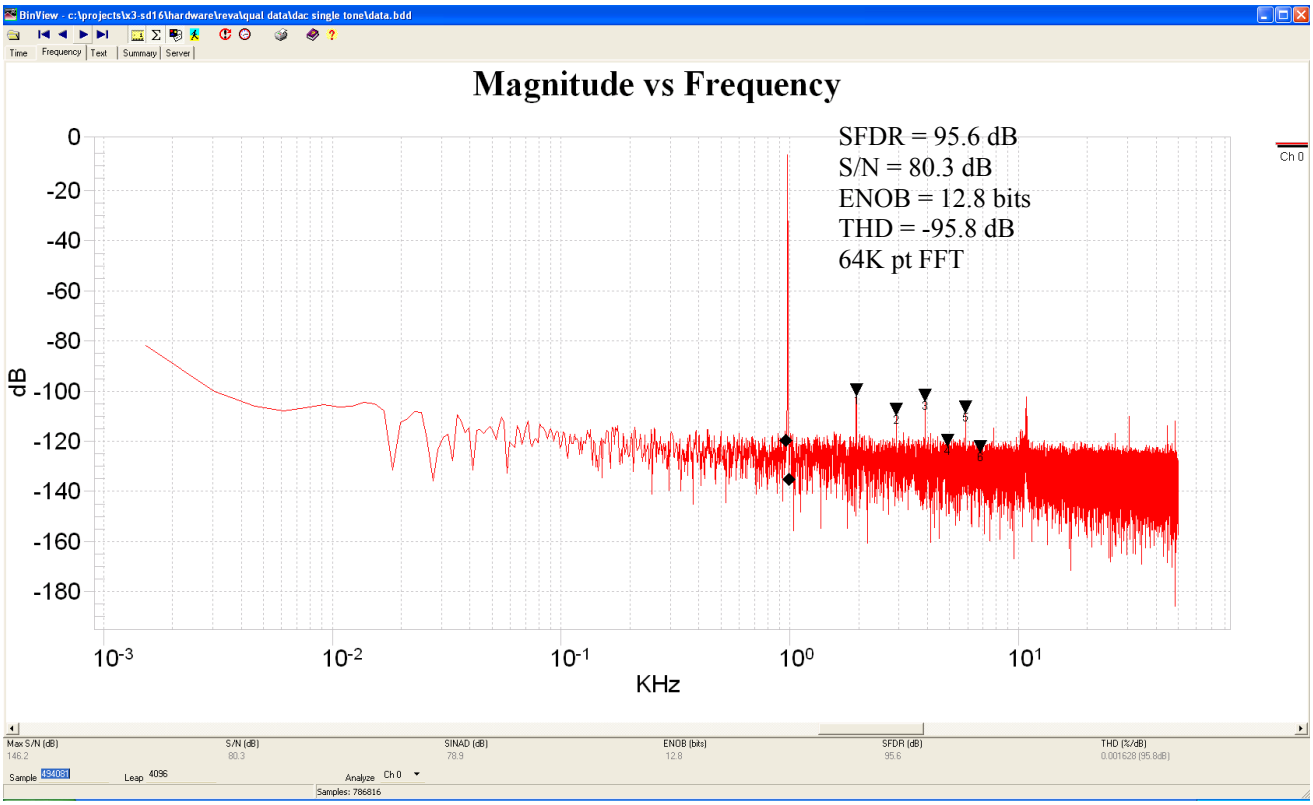
A/D Signal Quality vs. Input Amplitude



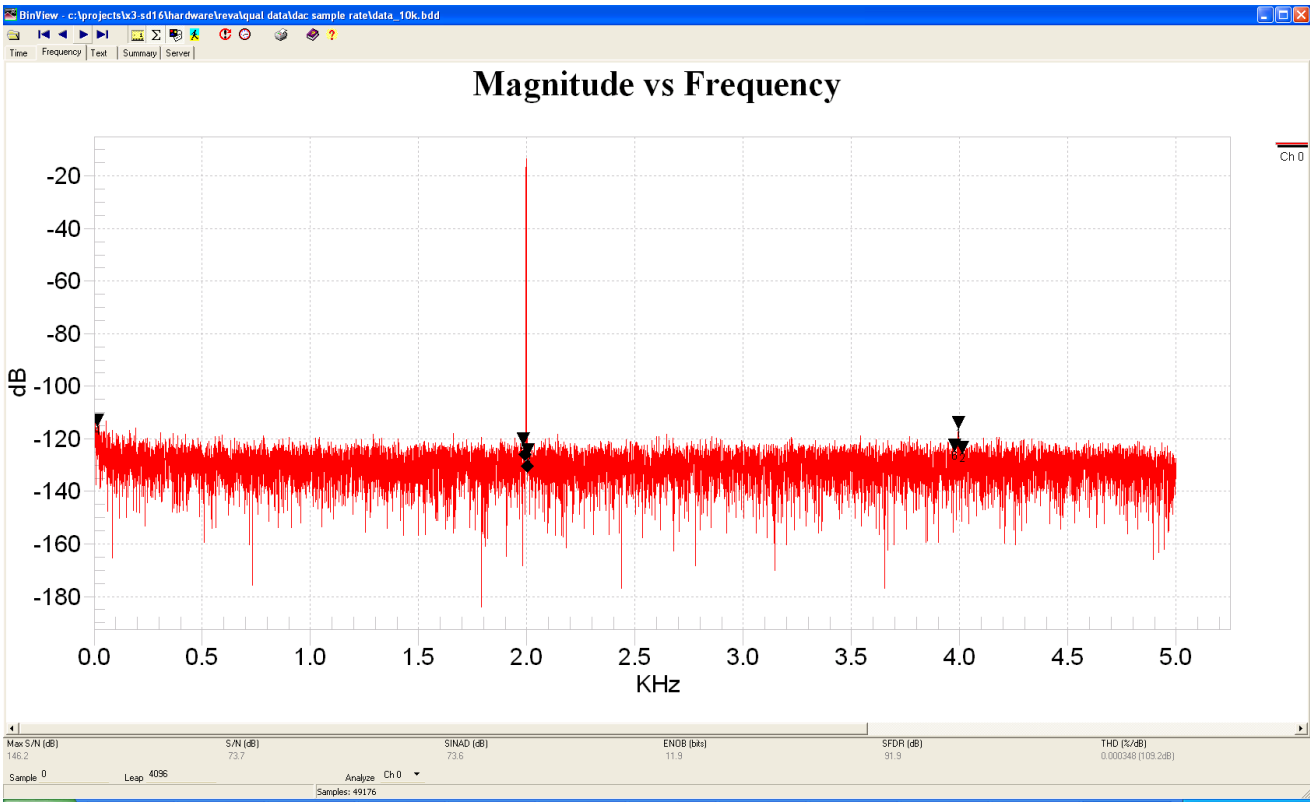








DAC Output for 1.01kHz sine, 2Vp-p, 128 ksps update rate (as measured by X3-SD16 A/D with single-ended input).



DAC Output for 2kHz sine, 2Vp-p, 10 ksps update rate (as measured by X3-SD16 A/D with single-ended input).

X3-SD16

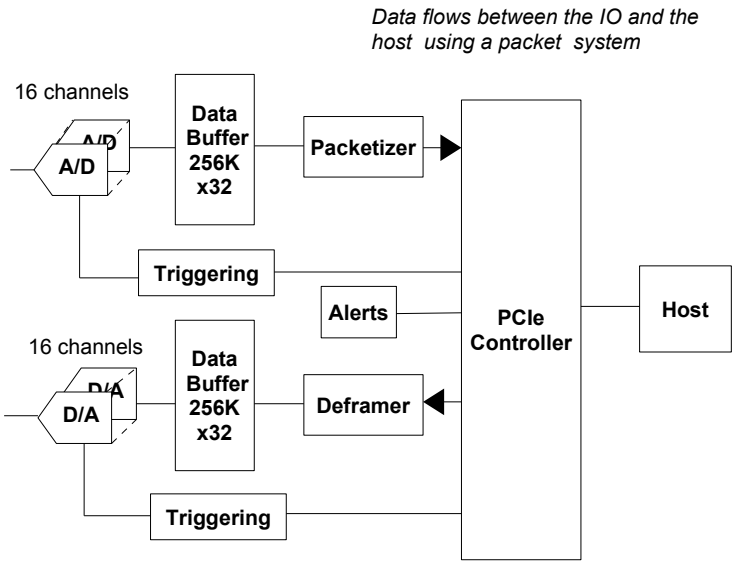
Architecture and Features

The analog front end of the X3-SD16 module has 16 simultaneously sampling channels of 24-bit, 144 ksps A/D input and 16 channels of 24-bit, 192 ksps D/A conversion. The dynamic range exceeds 100 dB, making this card ideal for applications such as vibration monitoring, SONAR and geophysical sensor interfaces.

Controls for triggering and clocks allow precise control over the collection of data and signal generation. Trigger modes include frames of programmable size, external and software. The A/D and D/A share a common trigger for simultaneous operation.

The sample clock may 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. With the external reference, multiple cards can be synchronized to a common time reference such as GPS.

Large channel-count systems are supported using multiple X3-SD16 with synchronization features for simultaneous sampling. Using a master/slave sync approach, all of the cards in the system can be synchronized, then can operate synchronous using a common trigger and clock. The clock is synchronized using either an external clock or from a common reference.



X3-SD-16Architecture

The X3 architecture has data buffering and a packet system to the host that provides an efficient and flexible host interface supporting full data rates to host memory to/from the card. The data buffer is a 2 MB SRAM that is split for use as the A/D and D/A data queues. Data to the buffer is transferred to the host memory using the PCIe controller interface as data packets, where the Malibu software drivers deliver the channelized data to the host program. 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 samples, 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 is monitored using the X3 alert mechanism. The alerts provide information on the timing of important events such as triggering, overranges and thermal overload. Packets containing data about the alert including an absolute system timestamp of the alert, and other information such as current temperature. This provides a precise overview of the card data acquisition process by recording the occurrence of these 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 at rates supported by the drive and controller. Triggering, sample rate controls, and data logging features allow you to use X3 modules in your application without ever writing code. Innovative software applications include *Binview* which provides data viewing, analysis and export data to MATLAB for large data files, as well as support applications for logic loading, firmware updates and system configuration.

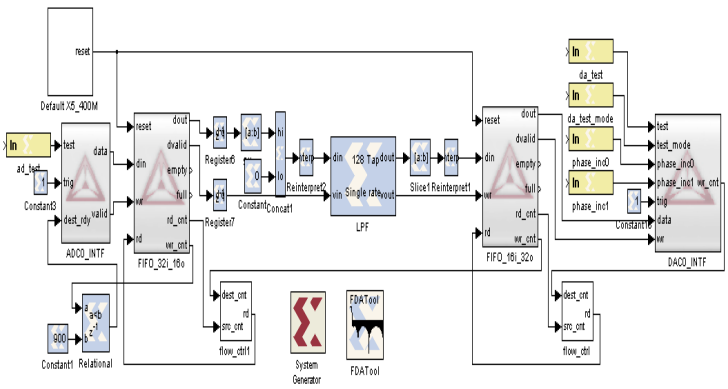
Software development tools for the X3 modules provide comprehensive support including device drivers, data buffering, card

controls, and utilities that allow developers to be productive from the start. At the most fundamental level, the software tools 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 in the Malibu software toolset. Supported OS include Windows and Linux, b0th 32 and 64-bit. For more information, the software tools and on-line help may be downloaded.

Logic Tools

High speed DSP, analysis, customized triggering and other unique features may be added to the X3 modules by modifying the logic. The FrameWork Logic tools support RTL and MATLAB developments. The standard logic provides a hardware interface layer that allows designers to concentrate on the application-specific portions of the design. Designer can build upon the Innovative components for packet handling, hardware interfaces and system functions, the Xilinx IP core library, and third party IP. RTL source for the FrameWork Logic is provided for customization. Each design is provided as a Xilinx ISE project, with a ModelSim testbench illustrating logic functionality.



The MATLAB Board Support Package (BSP) supports 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. The MATLAB tools are an extremely powerful design methodology that 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 Xilinx ISE tools.

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

Applications Information

Maximum Data Rates

Continuous data transfer to the host system memory may not support full data rate in all cases, depending on the system performance, software loading and hardware limitations. The PCI Express transfer rate may vary according to the host computer, operating system, and other system activity that may compete for bandwidth. The X3 modules support 250 MB/s full duplex during bursts, but actual sustained throughput is 180 MB/s in typical desktop PCs.

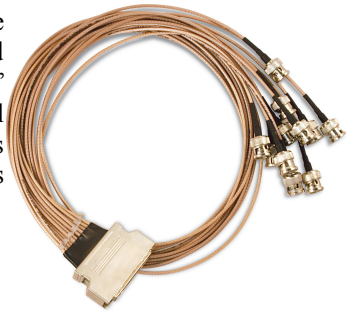
It is important to qualify systems for performance when data rates exceeding 120 MB/s are required.

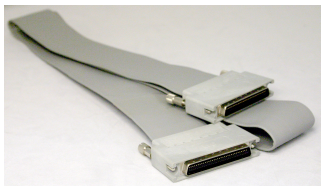
Cables

X3-SD16

X3 modules uses a shielded, jacketed 68-wire cable assembly for the front panel IO. This a pleated copper foil shield cable with "near coax" performance. This cable, plus the use of differential signals and use of ground signals as shields, results in good performance. A screw terminal assembly is available.

A cable with coax for each input is also offered.

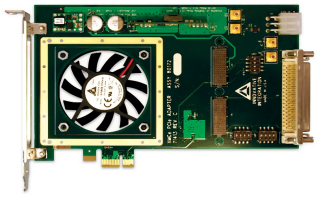
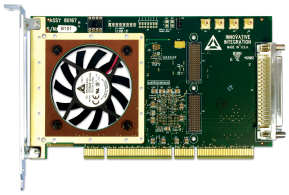




XMC Adapter Cards

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 modules use 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.

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

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

X3-SD16

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

Windows/Linux embedded PC
High performance (i7) or low power (Atom) models
Up to 8x USB, GbE, cable PCIe, VGA
Hosts 2x PCI Express XMC modules
GPS disciplined, programmable sample clocks and triggers to XMCs
Up to 400MB/s data logging using FLASH HDD
Up to 2 TB storage
9-18Vdc 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

X3-SD16

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