



PI-3105 Multi-Channel Data Acquisition System

Features:

- Low-noise architecture
- Scalable from 1 to 32 data channels
- 14-bit/10 MHz ADCs available now
- 14-bit/50 MHz ADCs shipping 5/08
- 16-bit/2 MHz ADCs shipping soon
- Correlated Double Sampling (CDS) option
- Aggregate data rate up to 2.5 GB/sec
- Up to 4 GB total on-board memory
- Prog. gain, offset, filter, & convert strobes
- Array size up to 64K per side
- Real-time correction and imaging
- Real-time or automated operation

Applications:

- Visible or infrared devices
- CCD, FPA or CMOS imagers
- R&D/Device characterization
- Production test
- Incoming device inspection
- Camera development
- Sensor visualization

Introduction:

The PI-3105 is a scalable, high-performance data acquisition subsystem designed for acquiring analog or digital video outputs from CCDs, IR FPAs, and CMOS image sensors.

This highly flexible system is suitable for testing a wide variety of imaging devices, from astronomy and medical devices with micro-volt outputs, to military and machine-vision devices with GB/sec data rates. The system can be reconfigured easily by swapping out low-cost pre-amp and A/D modules.

The included software controls gain, offset, filtering, and strobe timing, while video monitor outputs and real-time display provide immediate feedback

on your sensor's performance. When integrated with our popular electronic stimulus products, the PI 3105 completes Pulse Instruments' 3rd-generation of fully-integrated imaging test stations. The PI 3105 can also be integrated with 3rd-party products and software.

High-Performance Architecture:

The PI-3105 is electrically separated into analog and digital sections. Fig. 1 shows the analog electronics—Preamplifiers, Acquisition Interface Module (“AIM”), Analog Power Supply and DUT Interface—enclosed by the dashed line. All control and signal lines passing between the analog and digital sections are optically or galvanically isolated at the AIM.

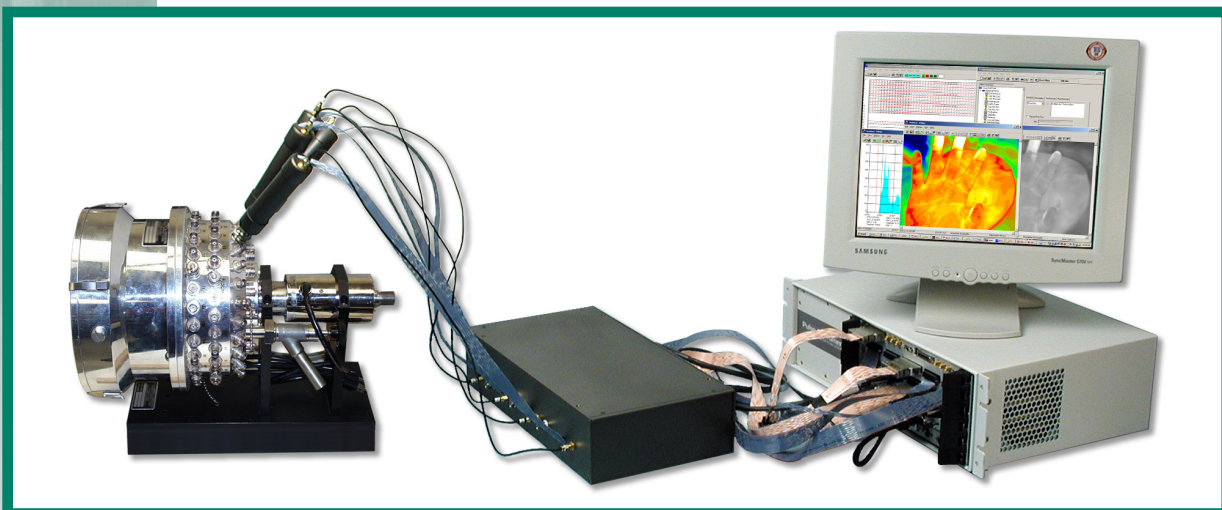
The digital components (Timing/Control Card, Multiplexer Card, Digital Acquisition Card, and CPU) are housed in a CompactPCI mainframe.

Analog Electronics

A low-noise, variable-gain preamplifier is followed by a high-bandwidth, variable-gain stage. The signals from this gain stage are passed through a programmable filter to the A/D converters to be digitized with or without optional CDS. The digitized data is then passed through isolators to the digital electronics.

Preamplifiers:

Preamplifiers are designed for placement adjacent to the DUT, both to minimize cable capacitance presented to the DUT and to minimize noise. The inputs have BNC or SMA input connectors, designed for connection to a DUT interface or Dewar via a short length of coaxial cable. The preamplifier outputs can drive several feet of coaxial cable, allowing them to be positioned as close as possible to the DUT while allowing other components of the system to be kept in the rack or on the optical bench.



Pulse Instruments

1234 Francisco Street Torrance CA 90502
Tel: (310) 515-5330 Fax: (310) 515-0068
sales@pulseinstruments.com
www.pulseinstruments.com

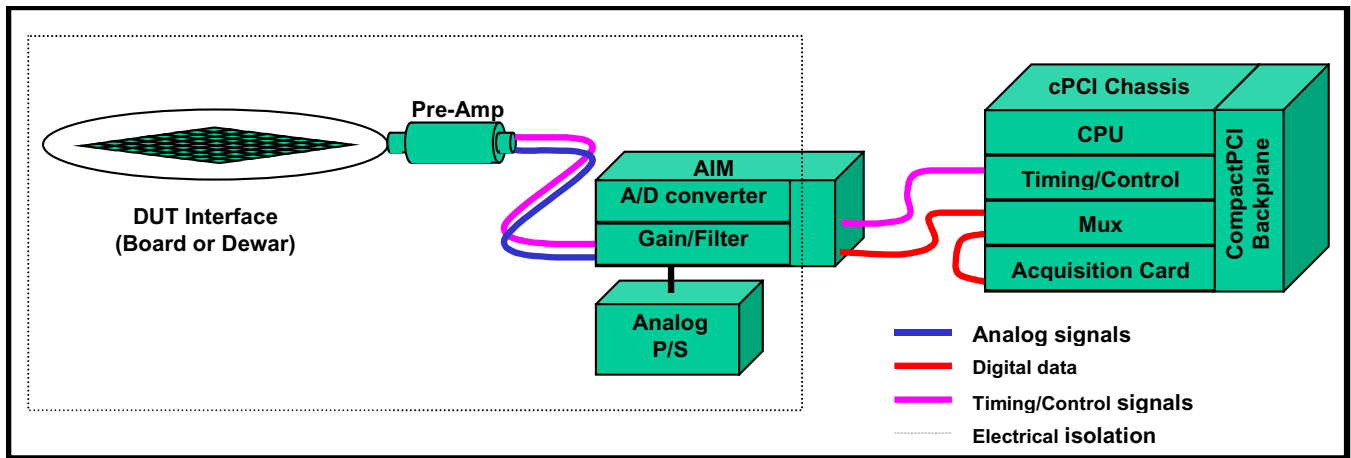


Fig. 1: Simplified View of One Data Acquisition Channel

Two preamplifier models are available. Model PI-3150 has DC to 30 MHz bandwidth, programmable gain from 1x-28x, and ± 10 V DC global offset compensation with 16-bit resolution. Model PI-3170 has 1 MHz to 200 MHz bandwidth, gain of 0.5x-18x, and ± 5 V DC global offset with 15-bit resolution. The maximum input signal swing is $4 V_{pp}$ for all models.

Acquisition Interface Module (AIM):

The Acquisition Interface Module (PI-3100) houses the signal conditioning (Gain/Filter) stages and the A/D converters for up to 4 acquisition channels. The AIM also provides the electrical isolation for data and control lines for these channels.

The AIM is powered by an analog power supply and distributes power to the preamplifiers and the A/D channels. The video, measure and CDS strobe monitoring signals are available at three BNC connectors. The four channels' monitor signals are multiplexed into these connectors and are selectable in software.

The size of the Acquisition Interface Module package is approximately 2.75" H x 10" W x 14" D. The unit can be located several feet from the outputs of the preamplifiers. Each analog power supply will power up to two AIMs and their associated acquisition channels.

Gain/Filter Stage:

The video output from the preamp drives a 50 Ω input load on the Gain/Filter board. Additional gain of 1x to 15x is available on some models. Combined with the preamp gain, the total gain can be up to 420x.

Following the gain stages are selectable filter stages for anti-aliasing. One stage provides maximum bandwidth without any filtering. The remaining settings are set at intervals (e.g. 50 MHz, 10 MHz, 1 MHz, 100 kHz and 10 kHz) at -3 dB frequencies.

A/D Converters:

The A/D converters are plug-in modules in the AIM. The digitizers are built around monolithic A/Ds in small, swappable modules with various resolution and sample-rate options. A/D modules with the optional CDS feature have two A/D converters, and modules without CDS have one.

A/D conversion is timed by one or two independent strobes per video channel, supplied by the Timing/Control card. One strobe triggers the video A/D and the other triggers the optional CDS A/D. These pulses can be set at any position within the pixel period with a resolution of 50 ps. In CDS mode the digital output from the second A/D converter is digitally subtracted from the output of the primary video A/D converter. By using a digital CDS method, the PI-3105

system permits CDS operation over the entire range of sampling frequencies supported by the A/D modules.

The analog video signals are also connected to separate buffer stages for monitoring purposes. There are three monitor signals from each A/D channel—video, measure strobe, and CDS strobe—with their relative time positions preserved from the A/D to the monitor outputs. By monitoring these signals on an oscilloscope the user can set the strobe position at the desired point relative to the video signal.

Digital Electronics:

The digital section of the acquisition subsystem consists of the CompactPCI mainframe, Timing/Control card, optional Multiplexer card, Digital Acquisition card, and CPU card. As described above, all data and control lines from/to the digital electronics are isolated within the AIM.

Timing/Control Card:

The Timing/Control card (PI-41100-x) generates timing signals and controls for up to 16 acquisition channels (or 8 channels with CDS). The card takes three TTL clock inputs (pixel clock, line sync and frame sync) and outputs up to 16 measure/CDS strobes, 4 line sync pulses, and 4 frame sync pulses. The clock inputs must be generated externally by a pattern generator, such as the PI-2005.

The A/D strobes are passed through programmable delays to set their time positions with respect to the video signal. Each of the 16 measure/CDS strobes' delays is independently programmable. There is a separate line sync and frame sync output for each 4-channel AIM. The line and frame sync signals follow the same timing path as the A/D strobes through the AIM, mux, and acquisition card to ensure data alignment.

The Timing/Control card also outputs control signals for setting the gain, offset, and filter parameters on each of the preamplifiers and the A/D channels in up to 4 AIMs.

Multiplexer Card:

Digitized data from the AIM can be passed through an optional 4:1 multiplexer card (PI-41110) before entering the digital acquisition card. The mux can be configured in software as a 2:1, 3:1 or 4:1 mux and will operate up to a 80 MHz total data rate. The card can also be configured in 1:1 mode as a scanner or switch.

Digital Acquisition Card:

The Digital Acquisition Card (PI-41000-x) has two 16-bit wide inputs with 256 MB or 512 MB of total memory depth. The maximum data rate at each input is 80 MHz, meaning that data can be collected at up to 320 MB per second per card until the on board buffers are full. Once data acquisition is complete, data are transferred to the CPU via DMA.

Large memories onboard the acquisition cards decouple the data acquisition from the PCI bus, allowing for data acquisition at rates far higher than the bandwidth of PCI. Data acquisition is continuous and un-interrupted, regardless of the loading on the PCI bus or operating system. The PI-41000 Digital Acquisition Card also requires no horizontal or vertical blanking intervals, allowing collection of every pixel from your device, including reference rows and columns and from devices that integrate during readout.

With the use of multiplexer cards in 4:1 mode, each PI-41000 can handle up to 8 data channels. Up to 8 cards can be deployed in parallel to handle up to 32 channels at a total data rate of up to 2.5 GB per second into 4 GB of RAM.

CPU Card:

The CPU card controls the acquisition subsystem and displays and processes the acquired data. The CPU runs Pulse Instruments or custom applications under Windows 2000/XP.

A variety of CPU cards is available to meet your acquisition and computing requirements, with x86 processors running at currently available speeds, and up to 2 GB of RAM. All CPU cards have on-board video, USB, and Gigabit Ethernet connectors, and the CompactPCI mainframe supports a variety of fixed and removable storage devices. An optional GPIB interface permits the entire subsystem to be slaved to an external PC running Pulse Instruments or custom applications.

Subsystem Configuration:

The Acquisition Subsystem can be configured with 1 to 32 A/D converter channels. All pre-amps and A/Ds installed in an AIM must be identical, but pre-amps and A/Ds can be swapped out by the user for different resolution/bandwidth requirements. Different AIMS may be populated differently.

The quantity of supporting components (e.g. AIMS, Timing/Control, Mux, and Acquisition cards) is determined by the number and operating frequency of your device's outputs and whether or not CDS mode is needed. The following is a sample configuration of an 8-ch. system with CDS:

- 1 x PI-11008-D2, CompactPCI Instrument Mainframe with CPU
- 8 x PI-3150, Pre-amplifier Module (BNC mount)
- 2 x PI-3100, Acquisition Interface Module (AIM)
- 8 x PI-41010, Gain/Filter board, 1x-15x, 10 MHz-10 kHz
- 8 x PI-41040-1, 14-bit, 10 MHz A/D Converter Module with CDS
- 1 x PI-3103A, Analog Power Supply
- 2 x PI-41110, 4:1 Digital Multiplexer Card
- 1 x PI-41000-512, Digital Acquisition Card with 512 MB SDRAM
- 1 x PI-41100-16, Timing/Control Card with 16 timing channels

Compatibility:

The PI-3105 can be used stand-alone, or in conjunction with other FPA test equipment, including a wide variety of products from Pulse Instruments, including pattern generators, clock drivers, and low-noise DC bias supplies.

CompactPCI- and PXI-based test instrumentation can be integrated via PI-31002 CPCI bridge cards, and Pulse Instruments 4000 Series instru-

mentation can be integrated via the PI-31001 PI-Bus Interface Card. 3rd-party instrumentation, such as DVMS, oscilloscopes, temperature controllers, etc., may be integrated via a PI-31000 GPIB Interface option.

With an embedded Windows PC as the system controller and Gigabit Ethernet ports on-board, the PI-3105 can also be integrated into a corporate data network for distributed analysis, archiving, and management.

Software:

The hardware is supplied with PI-Controller or PI-DATS graphical test software. The software controls all acquisition parameters such as gain, filter selection, offset correction and time positioning of the measurement strobes. The software also allows the user to specify imaging parameters, such as the Area of Interest (AOI) to be captured, the number of frames of data to be taken, and the partitioning of multiple-output devices for image re-assembly.

Real-time Control and Imaging:

Under PI-Controller, all hardware control is real-time, with simple graphical controls for all hardware settings.

For setup, diagnostics, and visualization, video can be displayed on-screen in real-time. Maximum video frame rate is determined by the array size, readout speed, CPU speed, and graphics hardware.

Automated Test:

PI-DATS automated test system software permits automated testing of imaging devices by scripting the behavior of PI-Controller and by automating data reduction and analysis routines. Menu controls permit operator input at run-time, and built-in variables, looping, and branching controls enhance testing flexibility.

Display, Reduction, and Analysis:

The PI-PLOT module provides false color, grayscale, histogram, and skyline plots, while a de-mosaicing routine is built in for displaying Bayer-filtered data in color. Corrected or uncorrected data may be viewed in real-time (256 x 256 at up to 80 Hz), or data may be saved to disk for offline analysis, display, and archiving.

Analysis routines built into PI-DATS include statistics and transformations, plus an open-ended interface and hooks to 3rd-party software (e.g. Excel and MATLAB) for user-defined analysis and plotting. Color-averaging routines are available for handling Bayer-filtered data from color image sensors.

PI-DATS also contains several image-correction routines commonly used in infrared detector testing, including two-point non-uniformity correction (NUC), bad pixel mapping with cluster analysis, and bad-pixel replacement.

The control DLL has an entry point for function calls to an external DLL, so customers can write custom processing or transformation routines while retaining PI-DATS user interface and automation features. DLL examples with complete source code are provided as MSVC++ projects.



Fig. 2: Uncorrected and Fully-Corrected Images Acquired by PI-3105

Image data may be played back on-screen, processed further within PI-DATS, or sent to another application for analysis.

Compatibility:

The PI 3105 may also be controlled by custom applications and integrated into an existing test system. The hardware control DLL and binary data format are fully documented to facilitate integration with 3rd-party software, and Pulse Instruments customers have successfully controlled the PI-3105 via C++, LabVIEW, MATLAB, IDL, HTBasic, and VisualBasic/VBA. Application examples with complete source code are provided as MSVC++ projects.

With the optional GPIB interface, the PI-3105 can also be run in "instrument mode" and slaved to an existing GPIB-equipped PC. The PC may run PI-Controller or PI-DATS under Windows, or it may run a custom application under any operating system that supports GPIB. The command set for remote or local operation is the same, so a custom application can be written to run either on the internal CPU board or on an external PC

with the same codebase.

Configuration & Delivery:

The PI-3105 Data Acquisition System is shipping now with 14-bit/10 MHz ADCs. Typical delivery is 6-8 weeks ARO. A 14-bit/50 MHz A/D module will ship in May, 2008, and a 16 bit/2 MHz A/D module is in final development. To obtain a quotation send a description of your testing application including:

- Logical (pixel) size of your imaging device
- Number of analog output channels from your device
- Sample rate and digitizing resolution required (MHz, bits)
- Output partitioning scheme (contiguous, interleaved, etc)
- Whether or not CDS is required
- Typical number of contiguous frames to be acquired
- Configuration of the test fixture (Dewar, personality card, etc.)

SPECIFICATIONS:

Pre-Amplifiers:	PI-3150	PI-3170*
Video Input Load:		
Resistive	10 K Ω	>1 K Ω
Capacitive:	<20 pf	<20 pf
Video Signal BW (Min, -3 dB):	DC-30 MHz	1 MHz - 200 MHz*
Power Bandwidth (Min, -3 dB):	DC-30 MHz	1 MHz - 200 MHz*
Video Input Signal:		
Signal Type:	Single-ended	Single or Differential, specify at time of order
Signal Amplitude:	4.0 V _{pp}	4.0 V _{pp}
Global Offset:	±10 Volts	±5 Volts
Connector:	BNC	BNC or SMA, specify at time of order
Video Output Signal:		
Output:	Single-ended	Single-ended
Signal Output:	4.0 V _{pp} /50 Ω	2.0 V _{pp} /50 Ω
Connector:	SMA	SMA
Gain:	1x - 28x	0.5x - 18x
Gain Accuracy:	±0.2 dB, DC to 5 MHz	±0.2 dB, 1 MHz to 25 MHz
Open filter; Global Offset= 0 V; 0.5, 1, 2, 4, 8, and 16 tested, others by design	±0.3 dB for Gain = 260 - 420.	for Gain = 0.5 to 18

System Specification:

Video Signal Processing:			
Filter Type:	Low-pass, single pole		
Filter settings: (-3 dB, ±0.5 dB)	PI-41010	PI-41060	PI-41070
	Open	Open	Open
	10 MHz	50 MHz	50 MHz
	1 MHz	10 MHz	10 MHz
	100 kHz	1 MHz	1 MHz
	10 kHz		
SNR:	PI-41040	PI-41060	PI-41070
	14 bit/10 MHz BW w/PI-3150	16 bit/2 MHz BW w/PI-3150	14 bit/50 MHz BW w/PI-3170
	<u>Min</u>	<u>Typ</u>	<u>Typ</u>
Gain = 1:	72.0 dB	74.0 dB	84.0 dB
Gain = 2:	71.0 dB	73.0 dB	82.5 dB
Gain = 4:	72.0 dB	74.0 dB	83.0 dB
Gain = 8:	71.0 dB	73.0 dB	81.5 dB
A/D Conversion:	PI-41040	PI-41060	PI-41070
Resolution:	14 bit	16 bit	14 bit
Max. Sample Rate:	10 MHz	2 MHz	50 MHz*
Bandwidth:	40 MHz	10 MHz	200 MHz*
CDS Option:	Y	Y	N

* Preliminary

PI-3100 Acquisition Interface Module (AIM)

Number of ADCs/AIM:	1 - 4
Number of AIMS/system:	up to 8
Analog inputs:	SMA connectors. See below for electrical characteristics
Digital Control & Data Lines	Isolated for both signal and ground
Digital Outputs	16 data bits plus frame, line and pixel clock, LVDS-compatible. 40-pin header connector, AMP #104069-6.
Power	PI-3103A Linear Power Supply
AIM Size	14" x 10" x 2.75" Approximate
Monitor Signals	Video, Measure Strobe and CDS Strobe via front-panel BNC connectors.

PI-41000-xxx Digital Acquisition Card:

Memory Size:	256 MB, or 512 MB (specify at time of order)
Data Inputs:	Two input ports, configurable as: <ul style="list-style-type: none"> • One 16-bit wide input • Two 16-bit wide inputs • One 32-bit wide input
Maximum Acquisition Rate:	80 MHz (320 MB/sec)
Timing Signals Required:	Frame & Line Sync, Pixel Clock, either via SMA connector or via header connector
Input Signals:	LVDS
Input Connectors:	40-pin header connector, AMP #104069-6

PI-41100-x A/D Timing and Control Card:

Control Signals:	Gain settings, Filter selection, CDS mode, and global offset for up to 4 AIMS
Input Timing Signals:	Frame Sync, Line Sync and Pixel Clock
Output Timing Signals:	16 signals for Measure or CDS strobes. Frame and Line Sync fanned out 4x
Timing Signal Connectors:	9 pin Micro-D, Molex #83611-9006
Time Positioning:	Independent control for each signal.
Range/Resolution:	0 to 1 μ s in 50 ps steps for 10 MHz model 0 to 128 ns in 50 ps steps for 50 MHz model

PI-41110 4:1 High Speed Digital Multiplexer Card:

Number of Muxed Channels:	Programmable, 1:1, 2:1, 3:1, 4:1
Bit width/channel:	16-bits, plus frame, line and pixel clks
Maximum Output Rate:	80 MHz total (up to 4 channels @ 20 MHz each, or one 80 MHz channel in 1:1 mode).
I/O Signals:	LVDS
I/O Connectors:	40-pin header connector, AMP #104069-6