## SPECIFICATIONS:

| Pre-Amplifiers: | PI-3150-1 | PI-3170 | PI-3180-1 |
|---|---|---|---|
| Video Input Load: | | | |
| Resistive | 10 KΩ | 1 KΩ | 10 KΩ |
| Capacitive: | <20 pf | <20 pf | <20 pf |
| Video Signal BW (Min, -3 dB): | DC - 30 MHz | DC - 200 MHz (0.5, 1, 2, 4x)<br>DC - 150 MHz (8, 16x) | DC - 40 MHz |
| Video Input Signal: | | | |
| Signal Type: | Single-ended or Differential, jumper select | Single or Differential, jumper select | Single or Differential, switchable |
| Signal Amplitude: | 4.0 $V_{PP}$ | 4.0 $V_{PP}$ | 8.0 $V_{PP}$ |
| Global Offset: | ±10 Volts<br>16 bit resolution | ±5 Volt<br>15 bit resolution | ±8 Volts<br>16 bit resolution |
| Input Connector: | BNC | BNC | BNC |
| Video Output Signal: | | | |
| Output: | Single-ended | Single-ended | Single-ended |
| Signal Output: | 4.0 $V_{PP}$/50 Ω | 2.0 $V_{PP}$/50 Ω | 8.0 $V_{PP}$/50 Ω |
| Connector: | SMA | SMA | SMA |
| Gain: | 1x - 28x | 0.5x - 18x | 1x - 64x |
| Gain Accuracy:<br>Open filter,<br>Global Offset= 0 V,<br>Gains 0.5 - 16 tested,<br>others by design | ±0.2 dB, DC to 5 MHz<br>for Gain = 1 - 252 and<br>±0.3 dB for Gain =<br>260 – 420. | ±0.2 dB,<br>1 MHz to 25 MHz<br>for Gain = 0.5 to 18x | ±0.2 dB,<br>DC to 5 MHz<br>for Gain = 1 - 16x |

**System Specification:**

Video Signal Processing:

| | PI-41010 | PI-41070 | PI-41080-1 |
|---|---|---|---|
| Filter settings:<br>(-3 dB, ±0.5 dB) | Open<br>10 MHz<br>1 MHz<br>100 kHz<br>10 kHz | 200 MHz<br>50 MHz<br>10 MHz<br>1 MHz | Open<br>10 MHz<br>5 MHz<br>1 MHz |
| Filter Type (Low-pass): | Single pole | Two-pole diff. (200 MHz)<br>One-pole diff. (all others) | Low-pass, single pole |

SNR:

| Gain | PI-41040<br>14 bit/10 MHz<br>w/PI-3150/PI-41010<br>Typ | PI-41060<br>16 bit/2 MHz<br>w/PI-3150/PI-41010<br>Typ |
|---|---|---|
| 1 | 73.0 dB | 84.0 dB |
| 2 | 72.0 dB | 82.5 dB |
| 4 | 73.0 dB | 83.0 dB |
| 8 | 72.0 dB | 81.5 dB |

| PI-41070<br>14 bit/50 MHz BW<br>w/PI-3170<br>Gain | Typ |
|---|---|
| 0.5 | 67 dB |
| 1 | 67 dB |
| 2 | 67 dB |
| 4 | 66 dB |

| PI-41080-1<br>16-bit/10 MHz BW<br>w/PI-3180<br>Gain | Typ |
|---|---|
| 1 | 85 dB |
| 2 | 85 dB |
| 4 | 84 dB |
| 8 | 81 dB |

| A/D Conversion: | PI-41040 | PI-41040 | PI-41070 | PI-41080-1 |
|---|---|---|---|---|
| Resolution: | 14 bit | 16 bit | 14 bit | 16 bit |
| Max. Sample Rate: | 10 MSamples/sec | 2 MSamples/sec | 50 MSamples/sec | 10 MSamples/sec, w/ or w/o CDS<br>20 MSamples/sec, dual-chip mode |
| Min. Sample Rate: | >DC | >DC | 1 MHz | 1 MHz |
| CDS Option: | Y | Y | N | Y |

**PI-3100-USB Acquisition Interface Module (AIM)**

| | |
|---|---|
| Number of AIMs/system: | 1 - 8 |
| ADC channels/AIM: | 1 - 4 |
| Analog inputs: | SMA connectors, 50 Ω |
| Timing Signal Connectors: | 9 pin Micro-D, Molex #83611-9006 |
| Input Timing Signals: | Frame Sync, Line Sync, Pixel Clock, and CDS clock, TTL levels |
| Time Positioning: | Independent control for each signal. |
| Range/Resolution: | 0 - 1 $\mu$s in 50 ps steps for ≤10 MSamples/sec<br>0 - 128 ns in 50 ps steps for ≥10 MSamples/sec |
| Digital Control & Data Lines | Isolated for both signal and ground |
| Number of Muxed Channels: | Programmable, 1:1, 2:1, 3:1, 4:1 |
| Maximum Output Rate: | 80 MHz total (up to 4 channels @ 20 MHz each, or one 80 MHz channel in 1:1 mode). |
| Digital Outputs | 16 data bits plus frame, line and pixel clock, LVDS-compatible. 40-pin header connector, AMP #104069-6. |
| Power | PI-3103D Linear Power Supply |
| AIM Size | 17" x 10.5" x 3.5" Approximate |
| Monitor Signals | Video, Convert Strobe and CDS Strobe, rear-panel BNC connectors |

**PI-41000-4G Digital Acquisition Card:**

| | |
|---|---|
| Memory Size: | 4 GB |
| Data Inputs: | Two input ports, configurable as:<br>• One 16-bit wide input<br>• Two 16-bit wide inputs<br>• One 32-bit wide input |
| Maximum Acquisition Rate: | 80 MHz (320 MB/sec), two channels<br>120 MHz (240 MB/sec), one channel |
| Timing Signals Required: | Frame & Line Sync, Pixel Clock, either via SMA connector (Micro-D) or via header connector (LVDS) |
| Data Input Signals: | LVDS |
| Data Input Connectors: | 40-pin header connector, AMP #104069-6 |
| Exernal Clock Input: | TTL/50 Ohms |
| External Clock Connector: | 9 pin Micro-D, Molex #83611-9006 |
| Arm I/O: | TTL/50 Ohms |
| Arm Connector: | SMA |

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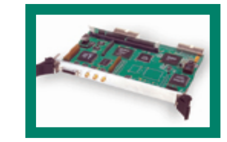


# PI-3105 Multi-Channel Data Acquisition System

**Features**:
- Low-noise architecture
- Scalable from 1 to 32 data channels
- 14-bit, 10 MHz ADCs
- 14-bit, 50 MHz ADCs
- 16-bit, 10/20 MHz ADCs
- Correlated Double Sampling (CDS) option
- Aggregate data rate up to 2.5 GB/sec
- Up to 32 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 (Digital Acquisition Card, and CPU) are housed in a CompactPCI mainframe.

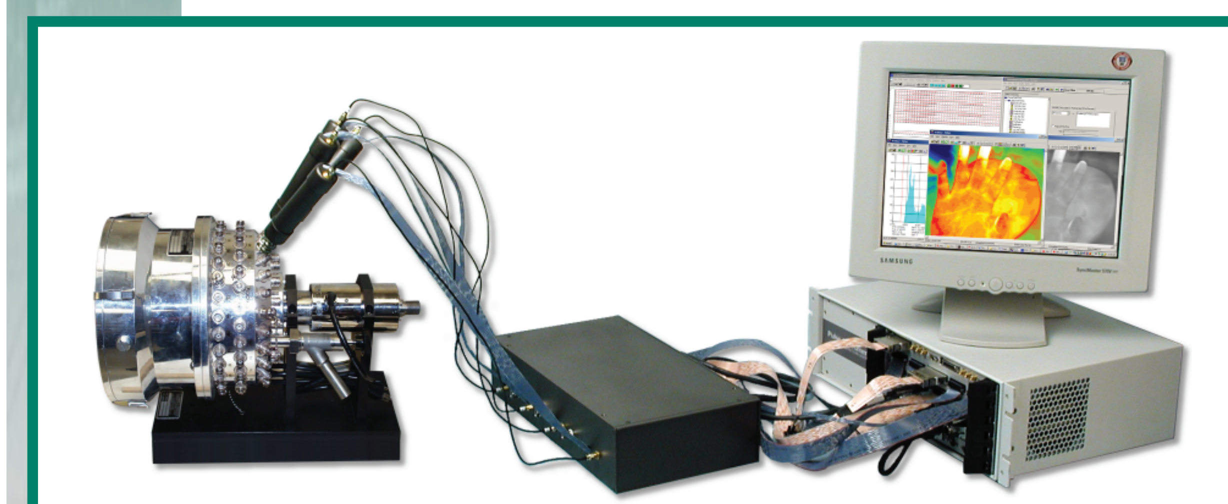
**Analog Electronics**

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 and to minimize noise. The inputs have BNC 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.

Three preamplifier models are available, with bandwidth up to 200 MHz and gain up to 64x, depending on model.

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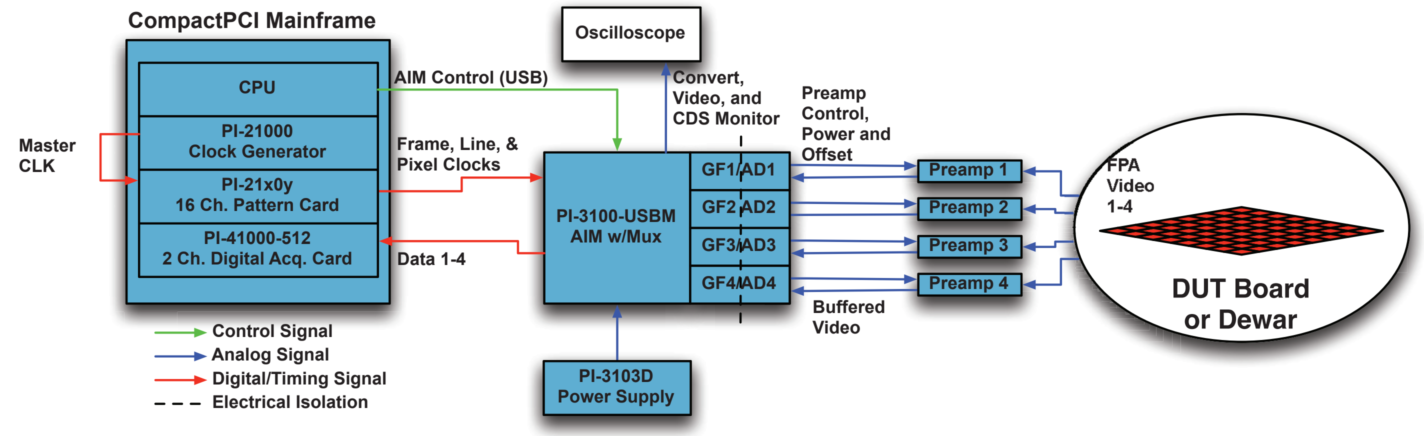


**Fig. 1: Acquisition System Block Diagram**

**Acquisition Interface Module (AIM):**
The Acquisition Interface Module (PI-3100-USB) 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 signal, convert strobe, CDS strobe, and reference clock signals are available at four 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 3.5" H x 10.5" W x 11" 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 stage. Additional gain of 1x to 15x is available on selected 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 –3 dB cutoffs at frequency intervals (e.g. 50 MHz, 10 MHz, 1 MHz, 100 kHz and 10 kHz, depending on model).

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

A/D conversion is timed by one or two independent strobes per video channel, supplied by the pattern generator. One strobe triggers the video ADC and the other triggers the optional CDS ADC. These pulses can be set at any position within the pixel period (1 $\mu$s maximum delay) with a resolution of 100 ps. In CDS mode the digital output from the second ADC is digitally subtracted from the output of the primary video ADC. By using a digital CDS method, the PI-3105 system permits CDS operation over the entire range of sampling frequencies supported by the ADC modules.

The analog video signals are also connected to separate buffer stages for monitoring purposes. The monitor signals from each ADC channel—video, convert strobe, and CDS strobe—have their relative time positions preserved from the ADC 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 Pattern Generator, Digital Acquisition card, and CPU card. As described above, all data and control lines from/to the digital electronics are isolated within the AIM.

**Pattern Generator and AIM:**
Each AIM receives TTL timing signals (pixel clock, line sync and frame sync) and fans them out to each of the 4 acquisition channel. The clock inputs must be generated externally by a pattern generator, such as the PI-2005.

The ADC strobes are passed through programmable delays to set their time positions with respect to the video signal. Each of the 16 video/CDS strobes' delays is independently programmable. The line and frame sync signals follow the same timing path as the A/D strobes through the AIM and acquisition card to ensure data alignment.

USB controls set the gain, offset, and filter parameters on each of the preamplifiers and the A/D channels in up to 8 AIMs.

**Multiplexer Card:**
Digitized data inside the AIM can be passed through an optional 4:1 multiplexer card before being output to 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. AIMs with the multiplexer feature have model number PI-3100-USBM.

**Digital Acquisition Card:**
The Digital Acquisition Card (PI-41000) has two 16-bit wide inputs with 4 GB 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. 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 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 AIMs in 4:1 mux 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 32 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 7.

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 32 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.

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

CompactPCI- and PXI-based test instrumentation can be integrated via PI-31002 CPCI bridge cards, and PI-4000 Series instrumentation can be integrated via USB. 3rd-party instrumentation, such as DVMs, oscilloscopes, temperature controllers, etc., may be integrated via GPIB.

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.

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 typically ships 6-8 weeks ARO. 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.)

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