

## ITC-18 Technical Specification

### ◆ Analog Input:

Number of channels	8, differential, optically isolated
Type of ADC	successive approximation
Input connector	BNC
Resolution	18 bit converter, 16 bit data (1 in 65536)
Acquisition rate	200 kHz aggregate
Input range	-10.24 to +10.239 Volts
Aperture delay	10 ns
Aperture jitter	50 ps rms
Conversion speed	software selectable, 5 μs to 82 ms
Differential nonlinearity	±0.002% of FSR
Drift	±50 ppm/ °C
Input impedance	1MΩ
Signal-to-noise ratio	+90dB
Crosstalk	<1 LSB

### ◆ Programmable Gain:

Gain	software selectable, 1, 2, 5, or 10V/V
Settling time	3.5 μs to 0.01% all gains
Nonlinearity	±0.0003% of FSR
Max. input voltage	±40 Volts
Input CMRR	100dB

### ◆ Digital Inputs:

Digital inputs	16, logic level, optically isolated
Input type	CMOS logic compatible
Operational mode	software selectable, level sense / latching
	active high / active low
Minimum pulse width	150 ns
Input connectors	bits (0 to3) on front panel BNC, 16 bits on rear panel multi-pin connector
Max. input voltage	±40 Volts

### ◆ Trigger Input:

Number	1, selectable isolated / non-isolated
Input type	CMOS logic compatible
Operational mode	software selectable, edge mode
	software selectable, invert sense
Minimum pulse width	150 ns
Input connector	BNC on front panel
Max. input voltage	±40 Volts

### ◆ Analog Output:

Number of channels	4, pseudo-differential, optically isolated
Type of DAC	double buffered, multiplying
Output connector	BNC
Resolution	18 bit converter, 16 bit data (1 in 65536)
Output Range	-10.24 to +10.239 volts
Conversion speed	software selectable, 5 μs to 82 ms
Gain error	0.2% of FSR
Gain linearity	<2dB
Gain drift	±25 ppm of FSR/ °C
Signal-to-noise ratio	116dB
Output impedance	200Ω (for output overload protection)
Short circuit to ground	indefinite
Output load current	±8mA typical

### ◆ Digital Outputs:

#### Standard

Number	32, optically isolated
Output driver	AC, HCT, ACT, HCT, VCT, or 8 TTL loads
Output connectors	bits (0 to 3) on front panel BNC 32 bits on dual 50 pin connector

#### High current drive

Number	14, optically isolated
Output driver	AC, HCT, ACT, HCT, VCT, or 8 TTL loads
Output connector	14 bits on DB-25 pin connector
Output sink current	350mA maximum

#### Asynchronous outputs

Number	16, non-isolated
Output driver	HC logic compatible
Output connectors	34 pin connector

#### Sequencer outputs

Number	7, optically isolated
Output driver	AC, HCT, ACT, HCT, VCT logic compatible, or 8 TTL loads
Output connectors	7 bits on dual 50 pin connector

### ◆ Trigger Output:

Number	1, selectable isolated / non-isolated
Output driver	AC, HCT, ACT, HCT, VCT, or 8 TTL loads
Output connector	BNC on front panel
Max. output current	6 mA

### ◆ Software and Drivers:

MacOS	C/C++ Metrowerks libraries Carbon Driver and Framework library Wavemetrics IGOR Pro XOP's Heka PatchMaster, Pulse, X-Chart Molecular Devices AxoGraph Bruxon Acquire PulseControl XOP's
MacOS X	Carbon Driver and Framework library Wavemetrics IGOR Pro Carbon XOP's Heka PatchMaster Molecular Devices AxoGraph
Windows 9x, ME, NT, 2000, XP	32 bit C/C++ library, DLL and driver Wavemetrics IGOR Pro XOP's National Instruments LabView vi's Heka PatchMaster, Pulse, X-Chart, TIDA Bruxon Acquire Strathclyde WinWCP Driver and C/C++ library
Linux	Driver and C/C++ library

All drivers are available for download at <http://www.instrutech.com>

### ◆ FIFO Memory:

Standard:	1024 kilosample FIFO
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### ◆ Host Interfaces:

PCI-18:	Interface to 5 Volt PCI bus
PCI-18V3:	Interface to 3.3 Volt PCI bus
USB-18:	Interface to USB 2.0 high-speed bus

### ◆ Model Numbers:

ITC-18/PCI:	ITC-18 with 5 Volt PCI bus host interface
ITC-18/PCIV3:	ITC-18 with 3.3 Volt PCI bus host interface
ITC-18/USB:	ITC-18 with USB 2.0 host interface

### ◆ Power Requirements:

85-264VAC, 47-440 Hz, 15 Watts

### ◆ Dimensions:

Width: 19", Height: 1.75", Depth: 10.5", Weight: 8 pounds

### ◆ Warranty:

Two years parts and labor

## Host Interface Specification

### PCI-18



The PCI-18 host interface card is a short form factor, 32-bit, 33 MHz 5Volt PCI bus plug in card. The PCI-18 is compatible with Apple, PC, and other computer systems that feature a 5Volt PCI Bus. Please note that the PCI-18 can only be physically connected to a 5Volt or Universal PCI bus connector.

### PCI-18V3



The PCI-18V3 host interface card is a short form factor, 32-bit, 33 MHz 3.3Volt PCI bus plug in card. The PCI-18V3 is compatible with Apple G5, PC, and other computer systems that feature a 3.3Volt PCI Bus. Please note that the PCI-18V3 can only be physically connected to a 3.3Volt or Universal PCI bus connector.

### USB-18



The USB-18 host interface is a USB v2.0 high-speed (480Mbps) interface for Apple, PC, and other computer systems that feature USB v2.0 high-speed ports.

An extra feature of the USB-18 is the addition of sixteen asynchronous digital input and output lines.

Specifications are typical at 25°C unless otherwise noted. Specifications subject to change without prior notice. ©1998-2005 InstruTECH Corporation

**InstruTECH**  
Precision Instrumentation for Biological Research

20 Vanderventer Avenue, Suite 101E  
Port Washington, New York 11050-3752 U.S.A.  
Phone: 516 883-1300 Fax: 516 883-1558  
Email: [sales@instrutech.com](mailto:sales@instrutech.com)  
<http://www.instrutech.com>

# ITC-18: 16-bit data acquisition interface



The ITC-18 is the second generation low-noise 16-bit data acquisition interface from InstruTECH Corporation. The ITC-18 offers unsurpassed capability while retaining all of the exceptional features of its predecessor, the ITC-16. The ITC-18 provides a major improvement in the quality of acquired data, making measurements that would otherwise not be possible.

**InstruTECH**

## Hardware Configuration

The ITC-18 is an external rack-mountable data acquisition unit that is attached to the computer using a dedicated host interface. This configuration offers major advantages over traditional data acquisition designs. One advantage is noise performance. Most data acquisition devices are printed circuit boards installed directly into the computer. The interior of a computer is an electrically noisy environment that will dramatically affect the noise performance of high speed D/A and A/D converters. Mounting all of the analog electronic components in an external box provides the most effective means of shielding the analog signal from this noise.

Another advantage is the capability to use the analog front end (ITC-18 rack unit) with a variety of host interfaces. Moving the ITC-18 from one computer platform to another is a simple matter of using the appropriate host interface, and installing compatible software. Utilizing the same hardware when changing computer platforms provides a cost effective upgrade path to newer computer technologies without sacrificing your initial investment. Since the ITC-18's initial inception we have designed host adapters to interface to various computer bus architectures (i.e. ISA, NUBUS, PCI, and USB 2.0).

## Optical Isolation

The analog electronics of the ITC-18 are optically isolated from the digital circuitry of the computer. This provides complete electrical isolation between the computer and the measuring equipment. Computers contain digital electronics that switch at high speed, producing large electrical transients. The computer ground functions as the return path for these transients, resulting in substantial high-frequency ground noise. The ITC-18 has a completely separate analog ground that is isolated from the computer ground. With the ITC-18 computer ground noise is not coupled into the measurement.

Optical Isolation is essential if low-noise analog outputs are desired.

The optical isolation of the ITC-18 brings with it another benefit that simplifies complex measurement systems. Since the analog inputs and outputs of the ITC-18 float with respect to power ground, the ITC-18 and the computer are not a source of ground loop problems.

## FIFO Memory

The ITC-18 is supplied with a large 1024 kilosample FIFO memory for input and output data. The ITC-18 allows data acquisition to be performed independent of the activity of the host computer. A large FIFO memory allows uninterrupted continuous high speed acquisition with today's multitasking operating systems.

## Specialized Applications

The ITC-18 uses programmable gate arrays that allow the internal hardware to be altered for specialized applications. One available application is the *Artificial Synapse Dynamic Clamp*. The clamped cell is connected to an A/D input via a Voltage Clamp amplifier. The stimulus is computed, based on voltage measured from the cell, lookup tables for excitation, inhibition and conductance values and other parameters. This stimulus is applied to the cell via the current input of the Voltage Clamp amplifier.

## Analog I/O

A unique design characteristic of the ITC-18 is the synchronization of all analog and digital signals. All inputs and outputs are updated simultaneously. Most data acquisition devices on the market do not do this. They sample multiple channels by using a multiplexer. This means that there is a time delay between the samples from each channel. This makes timing correlation measurements difficult.

The ITC-18 provides eight analog input channels. Each input channel uses an 18-bit A/D converter preceded by a programmable gain stage. Each A/D input can be programmed with a full scale range of  $\pm 1$ ,  $\pm 2$ ,  $\pm 5$ , or  $\pm 10$  Volts. This gain stage reduces the need for external signal amplifiers before the ITC-18. Using separate A/D converters for each analog input channel also has other advantages. One benefit gained by using separate A/D converters is reduced crosstalk between channels. The same multiplexer mentioned in the previous paragraph, is the source of another disadvantage. It is a single point where all of the analog input signals connect. This point, where the analog signals come together, can introduce cross coupling between the signals. The amount of crosstalk will vary based on frequency and amplitude. High-frequency signals show the greatest coupling into other channels while large amplitude signals will also couple into smaller signals. The ITC-18 has no measurable cross talk between channels.

The ITC-18 provides four 18-bit instrumentation grade D/A converters featuring high accuracy with less than 1 bit ( $\sim 300 \mu\text{V}$ ) of noise. This extremely low noise allows for the observation of least significant bit transitions. The D/A circuitry used in the ITC-18 is temperature stabilized and "De-glitched" for ideal performance. A typical D/A circuit will have a large glitch energy around zero and major bit transitions, the ITC-18's D/A converters are free from this artifact.

The ITC-18 uses a "sequence RAM" to control the sampling order of both the analog and digital channels. This provides the ability to update individual channels at different rates. This arrangement optimizes the acquisition of signals with dissimilar bandwidth.

This architecture makes the ITC-18 particularly important when making measurements using high-frequency signal sources, multiple signal sources with large differences in amplitude between them or when analyzing multiple signals for timing correlation.

## Digital I/O

The ITC-18 provides sixteen digital inputs, thirty-two digital outputs, seven sequence RAM trigger outputs and fourteen asynchronous non-isolated digital outputs. The digital input channels feature level sensitive or latched modes. For maximum versatility the inputs can be inverted, allowing rising or falling edge triggering. Thirty-two digital output channels in two banks of sixteen, with fourteen channels paralleled with current sink circuitry for driving perfusion valves or other devices directly. Seven programmable trigger outputs for triggering from any location in the scanning sequence RAM and fourteen asynchronous auxiliary digital outputs that can be updated at any time regardless of the ITC-18's acquisition state. ITC-18's that use a USB-18 host interface have an additional sixteen asynchronous non-isolated digital inputs and outputs.