The ITC-18 is the second generation low-noise 16 bit computer 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.

Hardware Configuration

The ITC-18 is an external rack-mountable data acquisition unit that is attached to the computer using a dedicated host interface card. This configuration offers major advantages over traditional data acquisition designs. 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.

The PCI-18, the ITC-18 PCI host interface card is compatible with all PCI 2.0 compliant computers. Moving the ITC-18 from one PCI computer platform to another is a simple matter of relocating the host interface card, and installing compatible software. For non-PCI compliant computers we offer the AT-18 for ISA bus, and the MAC-18 for the NUBUS. All three computer plug-in cards, the PCI-18, AT-18 and MAC-18, connect to the same ITC-18 interface. Utilizing the same hardware when changing computer platforms provides a cost effective upgrade path to newer computer technologies without sacrificing your initial investment.

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 equipment making your measurements. 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 now 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.

The ITC-18 implements Dynamic Clamp in hardware rather than in software. In this Dynamic Clamp configuration the ITC-18 samples four co-phase A/D channels at 50 kHz (20 µs), performs the necessary calculations and drives the outputs. All calculations are done within one sample clock, resulting in an input to output delay of only 20 µs.

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 corrolation measurements difficult. The ITC-18 does not stop with this capability. An external clock option allows for precise synchronization of multiple ITC-18 interfaces or our DVP-32 Digital Video Processor. This feature allows for the simultaneous sampling of more than 8 channels (using multiple ITC-18 interfaces) or the synchronization of video images with your analog data (using the DVP-32 Digital Video Processor).

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 ±1, ±2, ±5, or ±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 (~300 µV) of noise. This extremely low noise allows for the observation of least significant bit transistions. 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 transistions, 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 dissimiliar 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, solenoids, 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 are available.

Software Support

The ITC-18 has extensive software support. Software drivers are available for Windows 3.x, Windows 95/98, Windows NT, Windows 2000, Windows XP, MacOS classic, MacOS X, Linux, National Instruments LabView, and for Wavemetrics IGOR Pro (XOP's). Software packages that support the ITC-18 are ECELL from Instrutech; Patchmaster, Pulse, X-Chart and TIDA from Heka Elektronik; Acquire and Device Access from Bruxton Corporation; AxoGraph from Axon Instruments; PulseControl XOP's from Dr. Bookman and Strathclyde WinWCP. Many custom applications have also been written for the ITC-18. Please contact us to discuss any specialized applications that you may have.

Technical Specification

♦ Analog Input:

Number of channels	8, differential, optically isolated
Type of ADC	successive approximation
Input connector	BNC on front panel
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, instrumentation grade 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 or latching Active high or active low
Minimum pulse width	150 ns
Input connectors	bits (0 to3) on front panle BNC, 16 bits on rear panel multi-pin connector
Max. input voltage	±40 Volts

♦ Triggers:

Input

Number	1, hardware 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

Output

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

♦ Host interfaces:

PCI-18:	Interface to PCI bus, MacOS and Windows

♦ 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

♦ Analog Output:

Number of channels	4,pseduo-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 impediance	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 logic compatible, or 8 TTL loads
Output connectors	bits (0 to 3) on front panel BNC 32 bits on rear panel muli-pin connector

High current drive

Number	14, optically isolated
Output driver	AC, HCT, ACT, HCT, VCT logic compatible, or 8 TTL loads max
Ouput connector	14 bits on rear panle DB-25 multi-pin connector
Output sink current	350mA maximum

Asynchronous outputs

Number	16, non-isolated
Output driver	HC logic compatible
Output connectors	34 pin multi-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 rear panel muli-pin connector

♦ FIFO memory:

Standard:	1024 kilosample FIFO

♦ External clock:

Optional 12.8 megahertz external clock will synchronize multiple ITC-18 interfaces or with DVP-32 Digital Video Processor.

♦ Drivers:

MacOS	68k and PPC C/C++ Metrowerks libraries Wavemetrics IGOR Pro XOP's Carbon Driver and Framework library
MacOS X	Carbon Driver and Framework library Wavemetrics IGOR Pro Carbon XOP's
Windows 3.x	32 bit C/C++ library
Windows 9x, ME	32 bit C/C++ library and VxD driver Wavemetrics IGOR Pro XOP's National Instruments LabView drivers
Windows NT, 2000, XP	32 bit C/C++ library and kernel driver Wavemetrics IGOR PRO XOP's National Instruments LabView
Linux	Driver and C/C++ library

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ITC-18/PCI Computer Interface

- All synchronous analog and digital channels are optically isolated
- Eight simultaneously sampling differential analog input channels
- Eight 18 bit 200kHz A/D converters
- 200kHz to 12Hz sampling in 1.25 µS steps (200 kHz aggregate)
- Programmable input gain: ±1, ±2, ±5, ±10 volts
- Analog input range: ± 10.24 volts
- Four psedu-differential analog output channels
- Four 18 bit instrumentation grade D/A converters
- Analog output range: ± 10.24 volts
- Sixteen synchronous digital input channels
- Thirty-two synchronous digital output channels, fourteen with current sink capability
- Sixteen asynchronous digital output channels
- Large 1megasample FIFO
- PCI host interface
- Easy installation, no IRQ or DMA channel settings
- Compatible with Windows9x, ME, Windows NT, 2000, XP, MacOS, MacOS X, LabView and Linux

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