USB-1616HS Series

USB 1 MHz, 16-Bit Multifunction Devices

Features

- 1 MS/s, 16-bit multifunction USB devices
- Synchronous analog I/O, digital I/O, and counter/timer I/O
- 8 differential (DIFF) or 16 single-ended (SE) analog inputs (software selectable per channel)
- Thermocouple inputs on any of the 8 DIFF inputs
- User-expandable up to 64 SE/32 DIFF analog inputs including thermocouple measurements
- Up to four 16-bit, 1 MS/s analog outputs
- 24 high-speed digital I/O lines
- Four 32-bit counter input channels with quadrature encoder capability
- Low-latency control output capability (as low as 2 µs latency)
- Requires TR-2U external power supply (included)

Software

- TracerDAQ® software included for acquiring and displaying data and generating signals
- Universal Library supports Visual Studio® and Visual Studio® .NET, including examples for Visual C++®, Visual C#®, Visual Basic®, and Visual Basic® .NET
- Comprehensive drivers for DASYLab® and NI LabVIEW™
- Supported by MATLAB® Data Acquisition Toolbox™
- InstaCal software utility for installing, calibrating, and testing
- Supported Operating Systems: Windows 7/Vista/XP SP2, 32- or 64-bit

Overview

The USB-1616HS Series offers high-speed, multifunction data acquisition in a low-cost, portable package. These devices offer synchronous and concurrent voltage input, temperature input, waveform output, counter input, quadrature encoder input, timer output, and digital I/O. For OEM or embedded applications, the same functionality is offered in a board-level product — see USB-2500 Series. Everything needed to begin acquiring, viewing, and storing data is included with the USB-1616HS Series, including comprehensive software support.

The USB-1616HS Series feature a 16-bit, 1 MS/s A/D converter, 16 analog input channels — user expandable to 64 — up to four 16-bit/1 MS/s analog outputs, 24 high-speed digital I/O, 2 timer outputs, and four 32-bit counters. All analog, digital, and counter/timer I/O can operate synchronously and simultaneously, ensuring deterministic I/O among all signal types.

The USB-1616HS Series provides 1 MHz sampling, synchronous multifunction I/O, analog input expansion capability, and extensive software support

USB-1616HS Series Selection Chart					
Product or System	**Analog Inputs**	**Input Ranges**	**Digital I/O**	**Analog Outputs**	**Counters/Timers**
USB-1616HS	16 SE/8 DIFF	7	24	0	4/2
USB-1616HS-2	16 SE/8 DIFF	7	24	2	4/2
USB-1616HS-4	16 SE/8 DIFF	7	24	4	4/2
USB-1616HS + AI-EXP48	64 SE/32 DIFF	7	24	0	4/2
USB-1616HS-2 + AI-EXP48	64 SE/32 DIFF	7	24	2	4/2
USB-1616HS-4 + AI-EXP48	64 SE/32 DIFF	7	24	4	4/2

The USB-1616HS Series includes a unique, low-latency, highly deterministic control output mode that operates independent of the computer. In this mode, digital, analog, and timer outputs respond to analog, digital, and counter inputs as fast as 2 µs; at least 1,000 times faster than other products that rely on the computer for decision making.

Other Hardware Features Include:

- Encoder measurements up to 20 MHz, including Z-channel zeroing
- Frequency and pulse-width measurements with 20.83 ns resolution
- Timing mode that measures the time between two counter inputs to 20.83 ns resolution
- Self-calibration

USB-1616HS-2 attached to a AI-EXP48 expansion device

USB-1616HS-2 attached to a AI-EXP48 expansion device by a CA-96A cable

USB-1616HS Series
General Information

Analog Input
The USB-1616HS Series has a 16-bit, 1 MHz A/D coupled with 16 SE, 8 DIFF analog inputs, or 8 DIFF thermocouple inputs. Seven software programmable ranges provide inputs from ±10 V to ±100 mV full scale. Each channel can be software configured for a different range, as well as for SE or DIFF bipolar input, or thermocouple input.

Every DIFF analog input on the USB-1616HS Series or on the AI-EXP48 expansion option can accept a thermocouple (TC) input. Built-in cold-junction sensors are provided for each of the removable screw terminal connectors, and any TC type can be attached to any channel. When measuring TCs the USB-1616HS Series operates in an oversample mode, where multiple readings are taken on each TC channel, digitally filtered, cold-junction compensated, and converted to temperature. As a result, channels with TCs attached are measured at a rate from 50 Hz to 10 kHz, depending on how much over sampling is selected. In-line cycle rejection mode, over sampling occurs during one cycle of either 50 Hz or 60 Hz, providing a high level of 50 Hz or 60 Hz rejection.

Analog Channel Expansion
Adding additional analog input channels for the USB-1616HS Series is easy using the optional AI-EXP48 expansion device. The AI-EXP48 connects to the USB-1616HS Series by either plugging directly into the expansion connector, or by a cable if distance is required between the two units. The AI-EXP48 provides an additional 48 SE/24 DIFF analog inputs, or 24 DIFF thermocouple inputs, software configured on a per channel basis. The total channel capacity with a AI-EXP48 attached is 64 SE or 32 DIFF inputs. The measurement speed of AI-EXP48 channels is the same 1 MS/s as with USB-1616HS Series channels. When configured to measure thermocouple channels the system sample rate is typically 50 Hz to 10 kHz per channel. This reduction in sample rate insures that temperature measurements are accurate, low noise, and stable.

Synchronous I/O
The USB-1616HS Series can make analog measurements and read digital and counter inputs, while synchronously generating up to four analog outputs as well as digital pattern outputs. Digital and counter inputs do not affect the overall A/D rate because they use no time slot in the scanning sequencer. For example, an analog input channel can be scanned at the full 1 MHz A/D rate along with digital and counter input channels. The 1 MHz A/D rate is unaffected by the additional digital and counter channels. Other data acquisition devices provide no capability to scan digital/counter channels concurrent with analog channels, in which case digital and counter channels must be read asynchronously, which leads to a non-deterministic collection of data.

Input Scanning
The USB-1616HS Series has several scanning modes to address a wide variety of applications. A 512-location scan buffer can be loaded by the user with any combination of analog input channels. All analog input channels in the scan buffer are measured sequentially at 1 µs per channel. The user can also specify that the sequence repeat immediately, or repeat after a programmable delay from 0 to 19 hours, with 20.83 ns resolution. For example, in the fastest mode, with a 0 delay, a single analog channel can be scanned continuously at 1 MS/s; two analog channels can be scanned at 500 KS/s each; 16 analog input channels can be scanned at 62.5 KS/s.

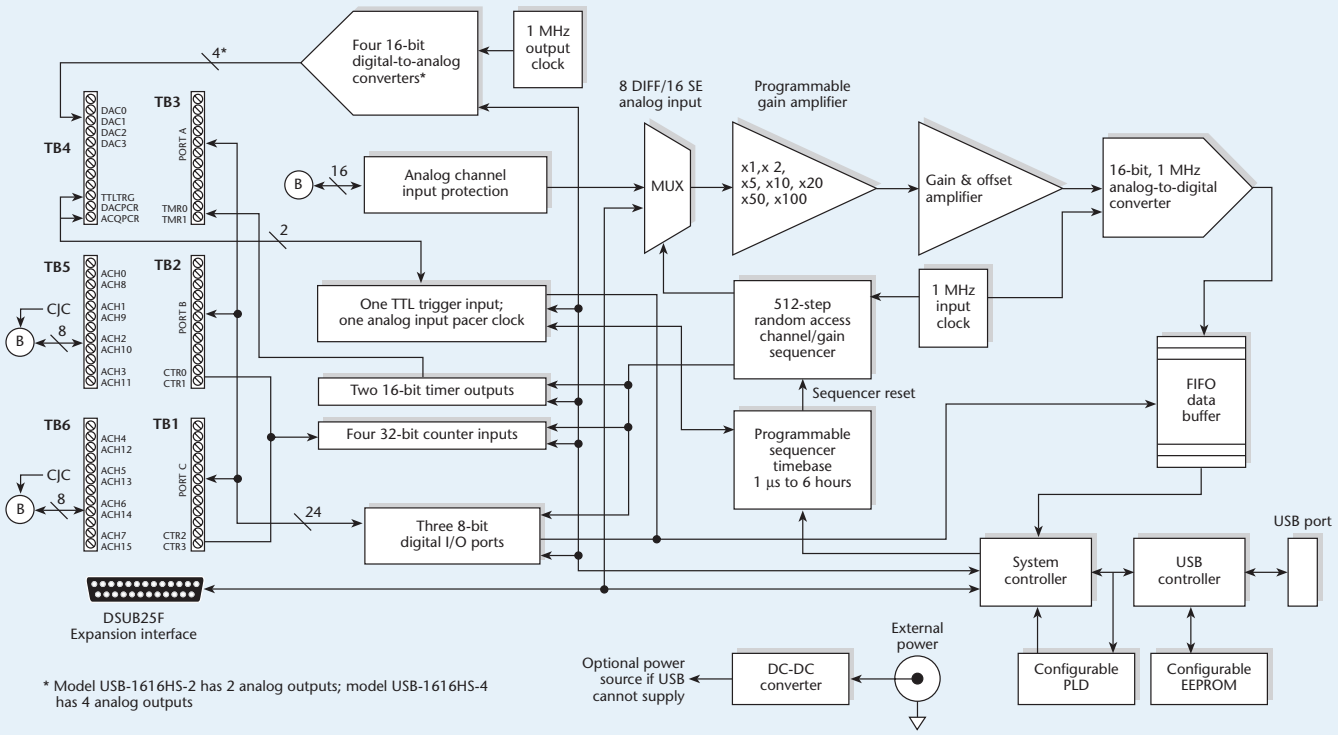
USB-1616HS Series digital inputs and counter inputs can be read in several modes. With software, the digital inputs or counter inputs can be read asynchronously at anytime before, during, or after an analog input scan sequence. This mode is not deterministic as to exactly when the digital or counter input is read relative to an analog input channel.

In either of the two synchronous modes, the digital inputs and/or counter inputs are read with deterministic time correlation to the analog inputs. In the once-per-scan mode, all of the enabled digital inputs and counter inputs are read during the first analog measurement of an analog input scan sequence. The advantage of this mode as compared to most other devices is the digital and counter inputs do not consume an analog input time slot, and therefore do not reduce the available bandwidth for analog input measurements. For example, presume all 24 bits of digital input are enabled, and all four 32-bit counters are enabled, and eight channels of analog inputs are in the scan sequence at the full 1 µs/channel rate. At the beginning of each analog input scan sequence, which would be 8 µs in total duration, all digital inputs and counter inputs will be measured and transferred to the PC during the first µs of the analog scan sequence.

Another synchronous mode is where digital inputs are scanned every time an analog input channel is scanned. For example, if eight analog inputs are scanned at 1 µs per channel continuously, and 24 bits of digital inputs are enabled, then the 24 bits of digital inputs will be scanned at 24 bits per 1 µs. If counters are enabled in this mode, they will be scanned at once per scan, in the same manner as in the prior example.

Output Timing
The digital and analog outputs on the USB-1616HS Series can be updated asynchronously or synchronously in several modes. In the asynchronous mode, digital and analog outputs can be updated at anytime before, during, or subsequent to an analog input sequence. The maximum update rate in this mode is non-deterministic and entirely dependent on the PC processor speed, the operating system, and programming environment.

USB-1616HS Series Block Diagram



In the synchronous output modes, the outputs can be updated continuously from the PC, or as the direct result of an input from either an analog channel, digital channel, or counter channel. When updated from the PC, the user can specify the rate by which the output is updated in 20.83 ns intervals, and outputs are updated synchronously at a maximum rate of 1 µs. For example, all four 16-bit analog outputs can be generating different waveforms from PC memory, while up to 16 bits of digital pattern could be generated from PC memory concurrently. The maximum rate of output is dependent on a number of factors, including the speed of the USB implementation on the PC. Typically, a total output bandwidth of 6 MS/s can be achieved.

Low-Latency Setpoint Control Mode

The other synchronous method of output is where either a digital, analog, or timer output is associated with any input — analog, digital or counter. The state or level of the output is determined by the level or state of an associated input. For example, a digital output can be programmed to be a logic 1 when an analog input exceeds a certain value, or when a frequency input exceeds a certain rate. In addition, hysteresis can be programmed for each limit to insure the output is stable near the transition point. Up to 8 digital outputs, 4 analog outputs, and 2 timer outputs can be programmed to respond to any analog, digital, or counter input. When analog or digital outputs are used in this mode, the user can specify two output values, determined by whether the input is above or below the limit.

The slowest rate by which an output can respond to an input is 2 µs plus the time period of a scan sequence. For example, if 4 channels of analog input are scanned continuously at 4 µs per scan, then the maximum latency between an analog input satisfying a limit, and the output responding, is 4 + 2 or 6 µs max. The worst-case response time can also be improved in several ways. For example, if a digital output is correlated to a digital input, then the worst-case latency can be reduced to 2 µs total if all digital inputs are scanned at the 1 µs rate without a delay period at the end of each scan.

In addition, an output status channel can be specified in the input scan sequence buffer so that users can correlate output state changes to their respective input channels within their data buffers and files. Adding the status channel takes no additional scan time and has no effect on the overall acquisition rate. The status channel can also be read asynchronously at any time during an acquisition for monitoring of the control outputs.

The advantage of this mode as compared to other boards is the response time can be in the range of 2 to 20 µs, vs. 1000 or more microseconds when using boards from other suppliers.

Analog Output
(USB-1616HS-2 and USB-1616HS-4 Only)

Two or four 16-bit, 1 MHz analog output channels are built into the USB-1616HS Series with an output range from –10 V to 10 V. The maximum rate at which analog outputs can be updated is dependent on several factors, including the speed of your USB port. Typically, with the A/D operating at full 1 MS/s rates, all 4 analog outputs can be updated continuously from PC memory at 1 MHz*. In addition, a program can asynchronously output a value to any of the D/As for non-waveform applications, presuming that the D/A is not already being used in the waveform output mode. Lastly, each of the analog outputs can be used in a control mode, where their output level is dependent on whether an associated analog, digital, or counter input is above or below a user-specified limit condition.

When used to generate waveforms, the D/As can be clocked in several different modes. Each D/A can be separately selected to be clocked from one of the sources described as follows.

Asynchronous Internal Clock. The onboard programmable clock can generate updates ranging from 1 MHz to once every 19 hours, independent of any acquisition rate.

Synchronous Internal Clock. The rate of analog output update can be synchronized to the acquisition rate derived from 1 MHz to once every 19 hours.

Asynchronous External Clock. A user-supplied external input clock can be used to pace the D/A, entirely independent of analog inputs.

Synchronous External Clock. A user-supplied external input clock can pace both the D/A and the analog input.

Digital I/O
Twenty four TTL-level digital I/O lines are included in the USB-1616HS Series. Digital I/O can be programmed in 8-bit groups as either inputs or outputs, and can be scanned in several modes (see Input Scanning). Ports programmed as inputs can be part of the scan group and scanned along with analog input channels, or can be asynchronously accessed through the PC at any time, including when a scanned acquisition is occurring. Two synchronous modes are supported when scanned along with analog inputs. One mode is where the digital inputs are scanned at the start of each scan sequence, which means the rate at which they are scanned is dependent on the number of analog input channels, and the delay period. For example, if eight analog inputs are enabled with 0 delay period, then the digital inputs in this mode would be scanned at once per 8 µs, which is 125 kHz.

In the other synchronous mode, the enabled digital inputs are scanned synchronously with every analog input channel. So in the example above, the digital inputs would be scanned at once per µs, or 1 MHz.

If no analog inputs are being scanned, the digital inputs can be scanned at up to 12 MS/s.

The low-latency digital output mode allows a digital output to be updated based on the level of an analog, digital, or counter input. In this mode, the user associates a digital output bit with a specific input, and specifies the level of the input where the digital output changes state. The response time in this mode is dependent on the number of input channels being scanned, and can typically be in the range of 2 to 6 µs.

Pattern Generation
Two of the 8-bit ports can be used to generate a 16-bit digital pattern at up to 1 MHz. The digital pattern can be read from PC RAM, or a file on the hard disk. Digital pattern generation is clocked in the same four modes as described with analog output.

Counter Inputs
Four 32-bit counters are built into the USB-1616HS Series. Each of the four counters will accept frequency inputs up to 20 MHz, and each counter channel can be configured in a variety of modes including counter, period, pulse width, time between edges, or multi-axis quadrature encoder. The counters can concurrently monitor time periods, frequencies, pulses, and other event-driven incremental occurrences from encoders, pulse generators, limit switches, proximity switches, and magnetic pick-ups. As with all other inputs to the USB-1616HS Series, the counter inputs can be read asynchronously under program control, or synchronously as part of an analog and digital scan group based either on an internal programmable timer, or an external clock source. The use of Z-channel encoders or usage of mapped channels requires that these channels need to be read synchronously.

The USB-1616HS Series supports quadrature encoders with up to 2 billion pulses per revolution, 20 MHz input frequencies, and x1, x2, x4 count modes. With only A phase and B phase signals, 2 channels are supported. With A phase, B phase, and Z index signals, 1 channel is supported. Each input can be debounced from 500 ns to 25.5 ms (total of 16 selections) to eliminate extraneous noise or switch induced transients. Encoder input signals must be within –5 V to 10 V and the switching threshold is TTL (1.3 V).

Timer Outputs
Two 16-bit timer outputs are built into the USB-1616HS Series, each capable of generating different square waves with a programmable frequency range from 16 Hz to 1 MHz.

* If waveform output throughput is critical to your application, contact factory for the most recent update on multi-channel DAC output rates

USB-1616HS Series

Specifications

Voltage Range*	Accuracy ±(% of reading + % Range) 23 °C ±10 °C, 1 year	Temperature Coefficient ±(ppm of reading + ppm Range)/°C -30 °C to 13 °C and 33 °C to 70 °C	Noise** (cts RMS)
-10 V to 10 V	0.031% + 0.008%	14 + 8	2.0
-5 V to 5 V	0.031% + 0.009%	14 + 9	3.0
-2 V to 2 V	0.031% + 0.010%	14 + 10	2.0
-1 V to 1 V	0.031% + 0.02%	14 + 12	3.5
-500 mV to 500 mV	0.031% + 0.04%	14 + 18	5.5
-200 mV to 200 mV	0.036% + 0.075%	14 + 12	8.0
-100 mV to 100 mV	0.042% + 0.15%	14 + 18	14.0

* Specifications assume differential input single channel scan, 1 MHz scan rate, unfiltered, CMV=0.0 V, 30 minute warm-up, exclusive of noise, range -FS to +FS

** Noise reflects 10,000 samples at 1 MHz, typical, differential short

Specifications

General

Power Consumption[1]	
Model	Power Consumption (Typical)[2]
USB-1616HS-2	3000 mW
USB-1616HS-4	3000 mW
USB-1616HS	3000 mW
USB-1616HS-2 + AI-EXP48	3400 mW
USB-1616HS-4 + AI-EXP48	3400 mW
USB-1616HS + AI-EXP48	3400 mW

1. The power consumption listed is for a single USB-1616HS Series device, or for a single device connected to a AI-EXP48 expansion device.
2. The included power adapter is required. By USB2 standards, USB2 ports are required to supply 2500 mW (nominal at 5 V, 500 mA).

Environment
Operating Temperature: –30 °C to 70 °C
Storage Temperature: –40 °C to 80 °C
Relative Humidity: 0% to 95% non-condensing
Communications: USB 2.0 high-speed mode (480 Mbps) if available, otherwise USB 1.1 full-speed mode (12 Mbps)
Acquisition Data Buffer: 1 MS
Vibration: MIL STD 810E Category 1 and 10
Signal I/O Connector: 6 banks of removable screw-terminal blocks
External Power
Connector: Switchcraft#RAPC-712
Power Range: 6 to 16 VDC (used when USB port supplies insufficient power, or when an independent power supply is desired)
Over-Voltage: 20 V for 10 seconds max
Expansion Connector: 25-pin D-SUB, female
Dimensions (L × W × H): 269 × 92 × 45 mm (10.6 × 3.6 × 1.6 in.)
Weight: 431 g (0.95 lb)

Analog Inputs

Channels: 16 SE or 8 DIFF, programmable on a per-channel basis as SE or DIFF
Expansion: An additional 48 analog inputs per device via optional AI-EXP48 device, expansion channel features are identical to those of the main channels
Expansion Connector: 25-pin D-SUB, female
Over-Voltage Protection: ±30 V without damage
Voltage Measurement Speed: 1 µs per channel
Ranges: Software or sequencer selectable on a per-channel basis, ±10 V, ±5 V, ±2 V, ±1 V, ±0.5 V, ±0.2 V, ±0.1 V
Input Impedance: 10 MΩ SE; 20 MΩ DIFF
Total Harmonic Distortion: –80 dB typ for ±10 V range, 1 kHz fundamental
Signal to Noise and Distortion: 72 dB typ for ±10 V range, 1 kHz fundamental
Bias Current: 40 pA typical (0 °C to 35 °C)
Crosstalk: –75 dB typ DC to 60 Hz; –65 dB typ @ 10 kHz
Common Mode Rejection: –70 dB typ DC to 1 kHz

Maximum Usable Input Voltage + Common Mode Voltage	
Ranges	Maximum (CMV + V_{IN})
±10 V, ±5 V, ±2 V, ±1 V, ±0.5 V	10.5 V
±0.1 V, ±0.2 V	2.1 V

TC Types and Accuracy†

TC Type	Temperature Range (°C)	Accuracy (±°C)	Noise, Typical (±°C)
J	-200 to 760	1.7	0.2
K	-200 to 1200	1.8	0.2
T	-200 to 400	1.8	0.2
E	-270 to 650	1.7	0.2
R	-50 to 1768	4.8	1.5
S	-50 to 1768	4.7	1.5
N	-270 to 1300	2.7	0.3
B	300 to 1400	3.0	1.0

† Assumes 16384 oversampling applied, CMV = 0.0 V, 60 minute warm-up, still environment, and 25 °C ambient temperature; excludes thermocouple error; TC_{IN} = 0 °C for all types except B (1000 °C), TR-2U power supply for external power

A/D Specifications

Type: Successive approximation
Resolution: 16 bit
Maximum Sample Rate: 1 MHz
Nonlinearity (Integral): ±2 LSB max
Nonlinearity (DIFF): ±1 LSB max

Input Sequencer

Analog, digital, and counter inputs can be scanned synchronously, based on either an internal programmable timer or an external clock source. Analog and digital outputs can be synchronized to either of these clocks.

Scan Clock Sources: 2
Note: The maximum scan clock rate is the inverse of the minimum scan period. The minimum scan period is equal to 1 µs times the number of analog channels. If a scan contains only digital channels then the minimum scan period is 250 ns.
1. Internal, programmable
Analog Channels from 1 µs to 19 hours in 20.83 ns steps
Digital Channels and Counters from 250 ns to 19 hours in 20.83 ns steps
2. External, TTL level input
Analog Channels down to 1 µs min
Digital Channels and counters down to 250 ns min
Programmable Parameters per Scan: Channel (random order), gain
Depth: 512 locations
Onboard Channel-to-Channel Scan Rate
Analog: 1 MHz max
Digital: 4 MHz if no analog channels are enabled, 1 MHz with analog channels enabled

External Acquisition Scan Clock Input

Maximum Rate: 1 MHz
Clock Signal Range: Logical zero 0 V to 0.8 V; logical one 2.4 V to 5.0 V
Minimum Pulse Width: 50 ns high, 50 ns low

Triggering

Trigger Modes: 7, individually selectable for starting and stopping an acquisition. Stop acquisition can occur on a different channel than start acquisition; stop acquisition can be triggered by modes 2, 4, 5, or 6 described below.
1. Single-Channel Analog Hardware Trigger
Any analog input channel can be software programmed as the analog trigger channel, including any of the analog expansion channels.
Input Signal Range: –10 V to 10 V max
Trigger Level: Programmable (12-bit resolution)
Hysteresis: Programmable (12-bit resolution)
Latency: 350 ns typ, 1.3 µs max
Accuracy: ±0.5% of reading, ±2 mV offset max
Noise: 2 mV RMS
2. Single-Channel Analog Software Trigger
Any analog input channel, including any of the analog expansion channels, can be selected as the software trigger channel. If the trigger channel involves a calculation, such as temperature, then the driver automatically compensates for the delay required to obtain the reading, resulting in a maximum latency of one scan period.
Input Signal Range: Anywhere within range of the selected trigger channel
Trigger Level: Programmable (16-bit resolution), including "window triggering"
Latency: One scan period max
3. Single-Channel Digital Trigger
A separate digital input is provided for digital triggering.
Input Signal Range: –15 V to 15 V
Trigger Level: TTL
Minimum Pulse Width: 50 ns high, 50 ns low
Latency: One scan period max
4. Digital Pattern Triggering
8- or 16-bit pattern triggering on any of the digital input ports. Programmable for trigger on equal, above, below, or within/outside of a window. Individual bits can be masked for "don't care" condition.
Latency: One scan period max

5. **Counter/Totalizer Triggering**
   Counter/totalizer inputs can trigger an acquisition. User can select to trigger on a frequency or on total counts that are equal, above, below, or within/outside of a window.
   Latency: One scan period max
6. **Software Triggering**
   Trigger can be initiated under program control.
7. **Multi-Channel Triggering**
   Up to 16 channels can be used to generate a trigger condition for any combination of analog, digital, or counter inputs. Multiple channels can either be combined in a logical "or" or "and" condition, with hysteresis programmable per channel. Maximum latency in this mode is one scan period.

Analog Outputs
(USB-1616HS-2 and USB-1616HS-4 only)

Analog output channels are updated synchronously relative to scanned inputs, and clocked from either an internal clock, or an external clock source. Analog outputs can also be updated asynchronously, independent of any other scanning in the system.
Channels
USB-1616HS-2: 2 DAC channels
USB-1616HS-4: 4 DAC channels
Resolution: 16 bits
Data Buffer: PC-based memory
Output Voltage Range: ±10 V
Output Current: ±1 mA
Offset Error: ±0.0045 V max
Digital Feedthrough: <10 mV when updated
DAC Analog Glitch: <12 mV typical at major carry
Gain Error: ±0.01%
Update Rate: 1 MHz max
Settling Time: 2 µs to rated accuracy
Clock Sources: 4, programmable
1. Internal D/A clock, independent of scanning input clock
2. Internal scanning input clock
3. External D/A input clock, independent of external scanning input clock
4. External scanning input clock

Digital I/O

Channels: 24
Ports: 3 x 8-bit, each port is programmable as input or output
Input Scanning Modes: 2 programmable
1. Asynchronous, under program control at any time relative to input scanning
2. Synchronous with input scanning

Input Characteristics: 220 Ω series resistor, 20 pF to common
Logic Keeper Circuit: Holds the logic value to 0 or 1 when there is no external driver.
Input Protection: ±15 kV ESD clamp diodes
Input Levels
Low: 0 V to 0.8 V
High: 2.0 V to 5.0 V
Output Levels
Low: <0.8 V
High: >2.0 V
Output Characteristics: Output 1.0 mA per pin
Sampling: 4 MHz max
Update Rate: 4 MHz max

Pattern Generation Output

Two of the 8-bit ports can be configured for 16-bit pattern generation. The pattern can also be updated synchronously with an acquisition at up to 4 MHz.

Counter

Each of the four high speed, 32-bit counter channels can be configured for counter, period, pulse width, time between edges, or multi-axis quadrature encoder modes. Counter inputs can be scanned synchronously along with analog and digital scanned inputs, based on an internal programmable timer, or an external clock source.
Channels: 4 x 32-bit
Input Frequency: 20 MHz max
Input Signal Range: –5 V to 10 V
Input Characteristics: 10 kΩ pull-up, 200 Ω series resistor, ±15 kV ESD protection
Trigger Level: TTL
Minimum Pulse Width: 25 ns high, 25 ns low
Debounce Times: 16 selections from 500 ns to 25.5 ms; positive or negative edge sensitive; glitch detect mode or debounce mode
Time Base Accuracy: 50 ppm (0 °C to 50 °C)
Five Programmable Modes: Counter, Period, Pulsewidth, Timing, Encoder
Counter Mode Options: Totalize, Clear on Read, Rollover, Stop at all Fs, 16- or 32-bit, any other channel can gate or decrement the counter
Period Mode Options: Measure x1, 10, 100, or 1000 periods, 16- or 32-bit, 4 different time bases to choose from: 20.83 ns, 208.3 ns, 2.083 µs, 20.83 µs, any other channel can gate the period measurement
Pulsewidth Mode Options: 16- or 32-bit values, 4 time bases to choose from: 20.83 ns, 208.3 ns, 2.083 µs, 20.83 µs, any other channel can gate the pulsewidth measurement
Timing Mode Options: 16- or 32-bit values, 4 time bases to choose from: 20.83 ns, 208.3 ns, 2.083 µs, 20.83 µs
Encoder Mode Options: x1, 2, 4 options, 16- or 32-bit values, Z-channel clearing of counter, any other channel can gate the counter
Multi-axis Quadrature Encoder Inputs:
- 1 channel with A (phase), B (phase), and Z (index)
- 2 channel with A (phase) and B (phase)
- x1, x2, and x4 count modes
- SE TTL

Frequency/Pulse Generators

Channels: 2 x 16-bit
Output Waveform: Square wave
Output Rate: 1 MHz base rate divided by 1 to 65,535 (programmable)
High-Level Output Voltage: 2.0 V min @ –1.0 mA; 2.9 V min @ –400 µA
Low-Level Output Voltage: 0.4 V max @ 400 µA

AI-EXP48

See the AI-EXP48 data sheet for complete specifications.

Calibration

2 years recommended.

USB-1616HS Series
Ordering Information

Ordering Information

Description	Part No.
USB-based 1 MS/s, 16-bit multifunction device with eight DIFF or 16 SE analog inputs, four counter inputs, two timer outputs, 24 digital I/O lines, USB cable, and TR-2U external power supply	USB-1616HS
USB-based 1 MS/s, 16-bit multifunction device with 8 DIFF or 16 SE analog inputs, two analog outputs, four counter inputs, two timer outputs, 24 digital I/O lines, USB cable, and TR-2U external power supply	USB-1616HS-2
USB-based 1 MS/s, 16-bit multifunction device with eight DIFF or 16 SE analog inputs, four analog outputs, four counter inputs, two timer outputs, 24 digital I/O lines, USB cable, and TR-2U external power supply	USB-1616HS-4
DIN-rail mounting adapter for USB-1616HS Series	DRM
Analog input expansion device, adds 48 SE/24 DIFF channels to USB-1616HS Series	AI-EXP48

Accessories & Cables

USB-1616HS Series to AI-EXP48 cable, 2 ft.	CA-96A
Terminal block	CN-153-12
E-type thermocouples wire, fiberglass (0 °C to 482 °C , 32 °F to 900 °F) 1 m	745690-E001
E-type thermocouples wire, fiberglass (0 °C to 482 °C , 32 °F to 900 °F), 2 m	745690-E002
J-type thermocouples wire, fiberglass (0 °C to 482 °C , 32 °F to 900 °F), 1 m	745690-J001
J-type thermocouples wire, fiberglass (0 °C to 482 °C , 32 °F to 900 °F), 2 m	745690-J002
K-type thermocouples wire, fiberglass (0 °C to 482 °C , 32 °F to 900 °F), 1 m	745690-K001
K-type thermocouples wire, fiberglass (0 °C to 482 °C , 32 °F to 900 °F), 2 m	745690-K002
T-type thermocouples wire, fiberglass (0 °C to 482 °C , 32 °F to 900 °F), 1 m	745690-T001
T-type thermocouples wire, fiberglass (0 °C to 482 °C , 32 °F to 900 °F), 2 m	745690-T002

Software

Icon-based data acquisition, graphics, control, and analysis software	DASYLab
Out-of-the-box virtual instrument suite with strip chart, oscilloscope, function generator, and rate generator – professional version	TracerDAQ Pro

Note: For OEM and embedded applications, see USB-2500 Series.

AI-EXP48, analog input expansion device

DRM, DIN-rail mounting adapter

USB-2500 Series, 16-bit/1 MHz USB data acquisition boards

CA-96A, USB-1616HS Series to AI-EXP48 cable

USB-1616HS-Series.indd
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