

# High-Accuracy M Series Multifunction DAQ for USB 18-Bit, up to 625 kS/s, up to 32 Analog Inputs

## NI USB-6281, NI USB-6289

- 16 or 32 analog inputs at 18 bits, 625 kS/s (500 kS/s scanning)
- Up to 4 analog outputs at 16 bits, 2.8 MS/s (3  $\mu$ s full-scale settling)
- 7 programmable input ranges ( $\pm 100$  mV to  $\pm 10$  V) per channel
- Onboard lowpass filter available for higher accuracy
- Programmable analog output ranges and offsets per channel
- Up to 48 TTL/CMOS digital I/O lines (up to 32 hardware-timed at up to 1 MHz)
- Two 32-bit, 80 MHz counter/timers
- Analog and digital triggering
- NI-PGIA 2 and NI-MCal calibration technology for improved measurement accuracy
- NI signal streaming for 4 high-speed data streams over USB
- Power supply included
- 1-year warranty
- Additional warranty and calibration services available

### Operating Systems

- Windows Vista (32- and 64-bit)/XP/2000

### Recommended Software

- LabVIEW
- LabVIEW SignalExpress
- LabWindows™/CVI
- Measurement Studio

### Other Compatible Software

- C#, Visual Studio .NET
- ANSI C/C++

### Measurement Services Software (included)

- NI-DAQmx driver software
- Measurement & Automation Explorer configuration utility
- LabVIEW SignalExpress LE



Family	Bus	Analog Inputs	Resolution (bits)	Max Rate (S/s)	Analog Outputs	Analog Output Resolution (bits)	Max Rate (S/s)	Range (V)	Digital I/O	Clocked DIO <sup>1</sup>	Counter	Resolution (bits)
NI 6281	USB	16	18	625 k	2	16	2.8 M	$\pm 10$	24	8, up to 1 MHz	2	32
NI 6289	USB	32	18	625 k	4	16	2.8 M	$\pm 10$	48	32, up to 1 MHz	2	32

<sup>1</sup>Correlated DIO can be clocked at up to 1 MHz across USB and up to 10 MHz using onboard regeneration.

Table 1. Selection Guide for High-Accuracy M Series Multifunction DAQ for USB

## Overview

With recent bandwidth improvements and new innovations from National Instruments, USB has evolved into a core bus of choice for measurement and automation applications. NI M Series devices for USB deliver high-performance data acquisition in an easy-to-use and portable form factor through USB ports on laptop computers and other portable computing platforms. NI designed a new and innovative patent-pending NI signal streaming technology that enables sustained bidirectional high-speed data streams on USB. The new technology, combined with advanced external synchronization and isolation, helps engineers and scientists achieve high-performance applications on USB.

All high-accuracy devices have a minimum of 16 analog inputs, 24 digital I/O lines, seven programmable input ranges, analog and digital triggering, and two counter/timers.

## High Accuracy

NI M Series high-accuracy multifunction USB data acquisition (DAQ) devices are optimized for high accuracy at fast sampling rates. They incorporate the NI-PGIA 2 custom amplifier and NI-MCal self-calibration designed for low noise, fast settling to 18 bits, and maximum accuracy. An onboard lowpass filter rejects high-frequency noise and prevents aliasing, helping to deliver a resolution equivalent to more than 5½ digits for DC measurements, with an absolute accuracy of 980  $\mu$ V at the  $\pm 10$  V range and 28  $\mu$ V at  $\pm 10$  mV. High-accuracy NI USB-628x M Series devices also have an extended two-year calibration interval.

With the enhanced analog output on USB-628x devices, you can now define custom offset and range settings. This means you can maximize the 16 bits of output resolution around a fixed DC offset, increasing the accuracy of analog waveforms.

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### NI Signal Streaming

Unlike typical multifunction USB data acquisition devices, NI USB M Series DAQ devices incorporate NI signal streaming, a patent-pending technology that combines three innovative hardware- and software-level design elements to enable sustained high-speed and bidirectional data streams over USB. NI signal streaming, along with the error correction, noise rejection, power management, and power distribution inherent in the USB protocol, yields a robust, secure, and reliable bus. Without NI signal streaming, a multifunction data acquisition device can sustain only a single high-speed data stream, effectively making it a single-function device. For more information, visit [ni.com/usb](http://ni.com/usb).

### Applications

In addition to test, control, and design, the high accuracy offered by USB-628x devices opens new application areas for data acquisition in analytical instrumentation and medical devices. Applications that can benefit from 18-bit accuracy include:

- Semiconductor characterization
- Portable data logging – log environmental, structural, or voltage data quickly and easily
- Field-monitoring applications
- Embedded OEM applications in medical devices or analytical instrumentation
- In-vehicle data acquisition
- Academic lab use – academic discounts available

### USB M Series for Test

You can use the M Series high-accuracy analog inputs and 10 MHz digital lines with NI signal conditioning for applications including test, component characterization, and measurements requiring instrument-class accuracy. The 18-bit ADC and available filtering provide a four times increase in resolution and five times more measurement sensitivity. With fast sampling rates and a low noise floor, these devices can accurately acquire dynamic signals. Advanced analog clamping circuitry protects the hardware from overvoltage conditions and ensures accurate measurements on nonsaturated channels. High-accuracy USB-628x M Series devices are compatible with the NI SCC signal conditioning platform, providing amplification filtering and power for virtually every type of sensor. This platform is also compliant with IEEE 1451.4 smart transducer electronic data sheet (TEDS) sensors, which offer digital storage for sensor data sheet information.

USB M Series multifunction DAQ devices can also complement existing test systems with additional high-accuracy measurement channels. For higher-channel-count signal conditioning on USB, consider the NI CompactDAQ or SCXI platforms.

### USB M Series for Control

USB M Series digital lines can drive 24 mA for relay and actuator control. By clocking the digital lines as fast as 10 MHz (with onboard regeneration), you can use these lines for pulse-width modulation (PWM) to control valves, motors, fans, lamps, and pumps. With four waveform analog outputs, two 80 MHz counter/timers, and four high-speed data streams on USB, M Series devices can execute multiple control loops simultaneously. High-accuracy USB-628x M Series devices also offer direct support for encoder measurements, protected digital lines, and digital debounce filters. With up to 32 analog inputs, 32 clocked digital lines, and four analog outputs, you can execute multiple control loops with a single device.

You can also create a complete custom motion controller by combining USB M Series devices with the NI SoftMotion Development Module.

### USB M Series for Design

For design applications, you can use a wide range of I/O – from 32 analog inputs to 48 digital lines – to measure and verify prototype designs. USB M Series devices and NI LabVIEW SignalExpress interactive measurement software deliver benchtop measurements to the PC. With LabVIEW SignalExpress, you can quickly create design verification tests. The fast acquisition and generation rates of high-performance, high-speed USB M Series devices along with LabVIEW SignalExpress provide fast design analysis. You can convert your tested and verified LabVIEW SignalExpress projects to LabVIEW applications for immediate M Series DAQ use, and bridge the gap between test, control, and design applications.

### USB M Series for OEMs

Shorten your time to market by integrating world-class National Instruments OEM measurement products in your design. Board-only versions of high-accuracy USB M Series DAQ devices are available for OEM applications, with competitive quantity pricing and available software customization. The NI OEM Elite Program offers free 30-day trial kits for qualified customers. Visit [ni.com/oem](http://ni.com/oem) for more information.

### Recommended Training and Services

All M Series devices are available with additional warranty and calibration services. For new data acquisition programmers, NI recommends the “Data Acquisition: 7 Steps to Success” tutorial kit. This tutorial kit helps shorten development time for data acquisition applications by describing the various stages of getting started with DAQ including system definition, setup, test, and application programming.

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## Recommended Software

National Instruments measurement services software, built around NI-DAQmx driver software, includes intuitive application programming interfaces, configuration tools, I/O assistants, and other tools designed to reduce system setup, configuration, and development time. National Instruments recommends using the latest version of NI-DAQmx driver software for application development in NI LabVIEW, LabVIEW SignalExpress, LabWindows/CVI, and Measurement Studio software. To obtain the latest version of NI-DAQmx, visit [ni.com/support/daq/versions](http://ni.com/support/daq/versions). NI measurement services software speeds up your development with features including:

- A guide to create fast and accurate measurements with no programming using the DAQ Assistant
  - Automatic code generation to create your application in LabVIEW; LabWindows/CVI; LabVIEW SignalExpress; and Visual Studio .NET, ANSI C/C++, C#, or Visual Basic using Measurement Studio
  - Multithreaded streaming technology for 1,000 times performance improvements
  - Automatic timing, triggering, and synchronization routing to make advanced applications easy
  - More than 3,000 free software downloads available at [ni.com/zone](http://ni.com/zone) to jump-start your project
  - Software configuration of all digital I/O features without hardware switches/jumpers
  - Single programming interface for analog input, analog output, digital I/O, and counters on hundreds of multifunction DAQ hardware devices
- M Series devices are compatible with the following versions (or later) of NI application software – LabVIEW, LabWindows/CVI, or Measurement Studio versions 7.x; or LabVIEW SignalExpress 2.x.

## Recommended Accessories (Mass-Termination Versions)

Signal conditioning is required for sensor measurements or voltage inputs greater than 10 V. NI SCC products, which are designed to increase the performance and reliability of your data acquisition system, are up to 10 times more accurate than using terminal blocks alone. Refer to Table 2 for more information or visit [ni.com/sigcon](http://ni.com/sigcon).

Sensor/Signals (>10 V)		
System Description	Cable	Carrier
SCC Signal Conditioning	SH68-68-EP	SCC
Sensor/Signals (<10 V)		
System Description	Cable	Terminal Block
Screw Terminal (Shielded) <sup>2</sup>	SH68-68-EP	SCC-68 <sup>1</sup>
BNC Connectivity	SH68-68-EP	BNC-2110
Screw Terminal (Nonshielded) <sup>2</sup>	R68-68	SCC-68 <sup>1</sup>

Table 2. Recommended Accessories

## Ordering Information

NI USB-6281  
 Screw terminal ..... 780053-0P  
 Mass terminal ..... 780054-0P<sup>1</sup>

NI USB-6289  
 Screw terminal ..... 780055-0P  
 Mass terminal ..... 780056-0P<sup>1</sup>

Includes NI-DAQmx data acquisition driver software, 1 m USB cable, and AC adapter.  
<sup>1</sup>P is 1 (U.S. 120 VAC); 2 (Switzerland 220 VAC); 3 (Australian 240 VAC); 4 (Universal Euro 240 VAC); 6 (United Kingdom 240 VAC); 7 (Japanese 100 VAC)

### Board-Only Devices for OEM

NI USB-6281 OEM (qty 1) ..... 197596-03  
 NI USB-6289 OEM (qty 1) ..... 197596-01

### Data Acquisition Services

Data Acquisition: 7 Steps to Success..... 779489-01

## BUY NOW!

For complete product specifications, pricing, and accessory information, call 800 813 3693 (U.S.) or go to [ni.com/daq](http://ni.com/daq).

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## Specifications

For complete specifications, see the *NI 628x Specifications* manual at [ni.com/manuals](http://ni.com/manuals).

Specifications listed below are typical at 25 °C unless otherwise noted.

### Analog Input

Number of channels	
USB-6281 .....	8 differential or 16 single ended
USB-6289 .....	16 differential or 32 single ended
ADC resolution .....	18 bits
Maximum sampling rate .....	625 kS/s single channel, 500 kS/s multichannel (aggregate)
Input coupling .....	DC
Input range .....	±10, ±5, ±2, ±1, ±0.5, ±0.2, ±0.1 V
Maximum working voltage for analog inputs (signal + common mode) .....	±11 V of AI GND
Input impedance	
Device on	
AI+ to AI GND .....	>10 GΩ in parallel with 100 pF
AI- to AI GND .....	>10 GΩ in parallel with 100 pF
Device off	
AI+ to AI GND .....	820 Ω
AI- to AI GND .....	820 Ω
Input bias current .....	±100 pA
Crosstalk (at 100 kHz)	
Adjacent channels .....	-75 dB
Nonadjacent channels .....	-95 dB
Input FIFO size .....	2,047 samples
Scan list memory .....	4,095 entries
Data transfers .....	NI signal streaming, programmed I/O

### Analog Triggers

Functions .....	Start Trigger Reference Trigger Pause Trigger Sample Clock Convert Clock Sample Clock Timebase
Modes .....	Analog edge triggering, analog edge triggering with hysteresis, and analog window triggering
Resolution .....	10 bits

### Analog Output

Number of channels	
USB-6281 .....	2
USB-6289 .....	4
DAC resolution .....	16 bits
Maximum update rate	
1 channel .....	2.86 MS/s
2 channels .....	2.00 MS/s per channel
3 channels .....	1.54 MS/s per channel
4 channels .....	1.25 MS/s per channel

Timing accuracy .....	50 ppm of sample rate
Timing resolution .....	50 ns
Output range .....	offset ± reference, includes ±10, ±5, ±2, and ±1 V calibrated ranges
Output coupling .....	DC
Output impedance .....	0.2 Ω
Output current drive .....	±5 mA
Output FIFO size .....	8,191 samples shared among channels used
Data transfers .....	NI signal streaming, programmed I/O

### Calibration (AI and AO)

Recommended warm-up time .....	30 minutes
Calibration interval .....	2 years

### Digital I/O/PFI

#### Static Characteristics

Number of channels	
USB-6281 .....	24 total, 8 (P0.<0..7>), 16 (PFI <0..7>/P1, PFI <8..15>/P2)
USB-6289 .....	48 total, 32 (P0.<0..31>), 16 (PFI <0..7>/P1, PFI <8..15>/P2)
Ground reference .....	D GND
Direction control .....	Each terminal individually programmable as input or output
Pull-down resistor .....	50 kΩ typical, 20 kΩ minimum

#### Waveform Characteristics (Port 0 Only)

Terminals used	
USB-6281 .....	Port 0 (P0.<0..7>)
USB-6289 .....	Port 0 (P0.<0..31>)
Port/sample size	
USB-6281 .....	Up to 8 bits
USB-6289 .....	Up to 32 bits
Waveform generation (DO) FIFO .....	2,047 samples
Waveform acquisition (DI) FIFO .....	2,047 samples
DI sample clock frequency .....	0 to 1 MHz, system dependent
DO sample clock frequency	
Regenerate from FIFO .....	0 to 10 MHz
Streaming from memory .....	0 to 1 MHz, system dependent
Data transfers .....	NI signal streaming, programmed I/O

#### PFI/Port 1/Port 2 Functionality

Functionality .....	Static digital input, static digital output, timing input, timing output
Timing output sources .....	Many AI, AO, counter, DI, DO timing signals
Debounce filter settings .....	125 ns, 6.425 μs, 2.56 ms, disable; high and low transitions; selectable per input

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## General-Purpose Counter/Timers

Number of counter/timers .....	2
Resolution .....	32 bits
Counter measurements.....	Edge counting, pulse, semiperiod, period, two-edge separation
Position measurements .....	X1, X2, X4 quadrature encoding with Channel Z reloading; two-pulse encoding
Output applications.....	Pulse, pulse train with dynamic updates, frequency division, equivalent time sampling
Internal base clocks .....	80 MHz 20 MHz 100 kHz
Base clock accuracy.....	50 ppm
Inputs.....	Gate, Source, HW_Arm, Aux, A, B, Z, Up_Down
Data transfers .....	NI signal streaming, programmed I/O

## Frequency Generator

Number of channels.....	1
Base clocks .....	10 MHz, 100 kHz
Divisors.....	1 to 16
Base clock accuracy.....	50 ppm
Output can be available on any PFI terminal	

## External Digital Triggers

Source .....	Any PFI
Polarity .....	Software-selectable for most signals
Analog input function .....	Start Trigger Reference Trigger Pause Trigger Sample Clock Convert Clock Sample Clock Timebase
Analog output function .....	Start Trigger Pause Trigger Sample Clock Sample Clock Timebase
Counter/timer functions.....	Gate, Source, HW_Arm, Aux, A, B, Z, Up_Down
Digital waveform generation (DO) function.....	Sample Clock
Digital waveform acquisition (DI) function .....	Sample Clock

## Bus Interface

USB .....	Hi-Speed USB or full-speed USB
NI signal streaming.....	4 high-speed data streams; can be used for analog input, analog output, digital input, digital output, counter/timer 0, counter/timer 1

## Power Requirements

USB power supply requirements .....	11 to 30 VDC, 20 W
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## Power Limits

+5 V terminal.....	1 A max
P0/PFI/P1/P2 and +5 V terminals combined .....	2 A max
Power supply fuse.....	2 A, 250 V

## Physical Requirements

Enclosure dimensions (includes connectors)	
Screw termination .....	26.67 by 17.09 by 4.45 cm (10.5 by 6.73 by 1.75 in.)
Mass termination .....	18.8 by 17.09 by 4.45 cm (7.4 by 6.73 by 1.75 in.)

## Environmental

Operating temperature .....	0 to 45 °C
Storage temperature.....	-20 to 70 °C
Humidity .....	10 to 90% RH, noncondensing
Maximum altitude.....	2,000 m
Pollution degree (indoor use only).....	2

## Safety and Compliance

### Safety

This product is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA 61010-1

**Note:** For UL and other safety certifications, refer to the product label or visit [ni.com/certification](http://ni.com/certification), search by model number or product line, and click the appropriate link in the Certification column.

### Electromagnetic Compatibility

This product is designed to meet the requirements of the following standards of EMC for electrical equipment for measurement, control, and laboratory use:

- EN 61326 EMC requirements; Minimum Immunity
- EN 55011 Emissions; Group 1, Class A
- CE, C-Tick, ICES, and FCC Part 15 Emissions; Class A

**Note:** For EMC compliance, operate this device according to product documentation.

### CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EC; Electromagnetic Compatibility Directive (EMC)

**Note:** Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, visit [ni.com/certification](http://ni.com/certification), search by model number or product line, and click the appropriate link in the Certification column.

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## Environmental Management

NI is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial not only to the environment but also to NI customers.

For additional environmental information, refer to the NI and the Environment Web page at [ni.com/environment](http://ni.com/environment). This page contains the environmental regulations and directives with which NI complies, as well as any other environmental information not included in this document.

## Waste Electrical and Electronic Equipment (WEEE)

**EU Customers:** At the end of their life cycle, all products must be sent to a WEEE recycling center. For more information about WEEE recycling centers and National Instruments WEEE initiatives, visit [ni.com/environment/weee.htm](http://ni.com/environment/weee.htm).

## Management Methods for Controlling Pollution Caused by Electronic Information Products Regulation (China RoHS)

### 电子信息产品污染控制管理办法（中国 RoHS）



**中国客户** National Instruments 符合中国电子信息产品中限制使用某些有害物质指令 (RoHS)。关于 National Instruments 中国 RoHS 合规性信息，请登录 [ni.com/environment/rohs\\_china](http://ni.com/environment/rohs_china)。(For information about China RoHS compliance, go to [ni.com/environment/rohs\\_china](http://ni.com/environment/rohs_china).)

# NI Services and Support



NI has the services and support to meet your needs around the globe and through the application life cycle – from planning and development through deployment and ongoing maintenance. We offer services and service levels to meet customer requirements in research, design, validation, and manufacturing. Visit [ni.com/services](http://ni.com/services).

## Training and Certification

NI training is the fastest, most certain route to productivity with our products. NI training can shorten your learning curve, save development time, and reduce maintenance costs over the application life cycle. We schedule instructor-led courses in cities worldwide, or we can hold a course at your facility. We also offer a professional certification program that identifies individuals who have high levels of skill and knowledge on using NI products. Visit [ni.com/training](http://ni.com/training).

## Professional Services

Our NI Professional Services team is composed of NI applications and systems engineers and a worldwide National Instruments Alliance Partner program of more than 600 independent consultants and

integrators. Services range from start-up assistance to turnkey system integration. Visit [ni.com/alliance](http://ni.com/alliance).



## OEM Support

We offer design-in consulting and product integration assistance if you want to use our products for OEM applications. For information about special pricing and services for OEM customers, visit [ni.com/oem](http://ni.com/oem).

## Local Sales and Technical Support

In offices worldwide, our staff is local to the country, giving you access to engineers who speak your language. NI delivers industry-leading technical support through online knowledge bases, our applications engineers, and access to 14,000 measurement and automation professionals within NI Developer Exchange forums. Find immediate answers to your questions at [ni.com/support](http://ni.com/support).

We also offer service programs that provide automatic upgrades to your application development environment and higher levels of technical support. Visit [ni.com/ssp](http://ni.com/ssp).

## Hardware Services

### NI Factory Installation Services

NI Factory Installation Services (FIS) is the fastest and easiest way to use your PXI or PXI/SCXI combination systems right out of the box. Trained NI technicians install the software and hardware and configure the system to your specifications. NI extends the standard warranty by one year on hardware components (controllers, chassis, modules) purchased with FIS. To use FIS, simply configure your system online with [ni.com/pxiadvisor](http://ni.com/pxiadvisor).

### Calibration Services

NI recognizes the need to maintain properly calibrated devices for high-accuracy measurements. We provide manual calibration procedures, services to recalibrate your products, and automated calibration software specifically designed for use by metrology laboratories. Visit [ni.com/calibration](http://ni.com/calibration).

### Repair and Extended Warranty

NI provides complete repair services for our products. Express repair and advance replacement services are also available. We offer extended warranties to help you meet project life-cycle requirements. Visit [ni.com/services](http://ni.com/services).



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