E-1608
16-Bit Multifunction Ethernet® DAQ Device

MC MEASUREMENT COMPUTING

Features
- **16-bit high-speed Ethernet device**
- **Sample rates up to 250 kS/s**
- **4 differential (DIFF) or 8 single-ended (SE) analog inputs**
- **Two 16-bit analog outputs**
- **Eight individually-configurable digital I/O lines**
- **One 32-bit counter input**
- **Includes a built-in 10/100 BASE-T auto-negotiation, high-speed communication port.**
- **Requires a TCP/IP and UDP connection to a network or computer**
- **Includes CAT-6 Ethernet cable and 5 V power supply adapter (required to provide external power)**
- **Available with enclosure and screw terminals, or as a board-only OEM version with header connectors (no case, CD, network cable, or power adapter included)**

Software

Supported Operating Systems
- **Windows 8/7/Vista® 32/64-bit**
  - **Universal library (UL), ULx for NI LabVIEW™**
- **Android™**
  - **UL for Android**

Ready-to-Run Applications
- **InstaCal™ (install, configure, and test)**
- **DAQami™ (acquire, view, and log) available for purchase**
- **TracerDAQ® (acquire, view, log, and generate)**

Supported Programming Environments
- **Visual Studio® and Visual Studio .NET, including examples for Visual C++®, Visual C#®, Visual Basic®, and Visual Basic .NET, and other IDEs**
- **Java® (Android only) including examples and demo apps**
- **LabVIEW (Windows only)**
- **DASYLab®**

The E-1608 offers four differential or eight single-ended analog inputs, two analog outputs, eight digital I/O, and one event counter input.

Overview
The Ethernet-based E-1608 is a low-cost, high-speed, multifunction I/O DAQ device that measures eight analog channels at 250 kS/s aggregate with 16-bit resolution.

This device also offers two analog outputs, eight digital I/O channels, and one counter input.

Ethernet Interface
The E-1608 has a built-in 10/100 BASE-T auto-negotiation, high-speed communication port. The networking protocols are TCP/IP and UDP.

Once connected to the network, the device can be remotely accessed and configured through software from anywhere on the network. Only one user at a time can access the E-1608.

Software is required to actively communicate with the E-1608 over Ethernet. The device does not operate as a stand-alone data logger.

Analog Input
The E-1608 provides 16-bit analog inputs that are software-selectable as four DIFF or eight SE inputs. The device supports input ranges of ±10 V, ±5 V, ±2 V, and ±1 V that are software-selectable per channel.

Analog Output
The E-1608 has two 16-bit, software-paced analog outputs that can be updated at a rate of 500 S/s. The output range is fixed at ±10 V.

Trigger Input
The E-1608 has an external digital trigger input. The trigger mode is software-selectable for edge- or level-sensitive mode. You can configure edge-sensitive mode for either rising or falling edge. In level-sensitive mode, you can configure for either high or low level. The default setting at power up is edge-sensitive, rising edge.

E-1608
General Information

E-1608 Block Diagram
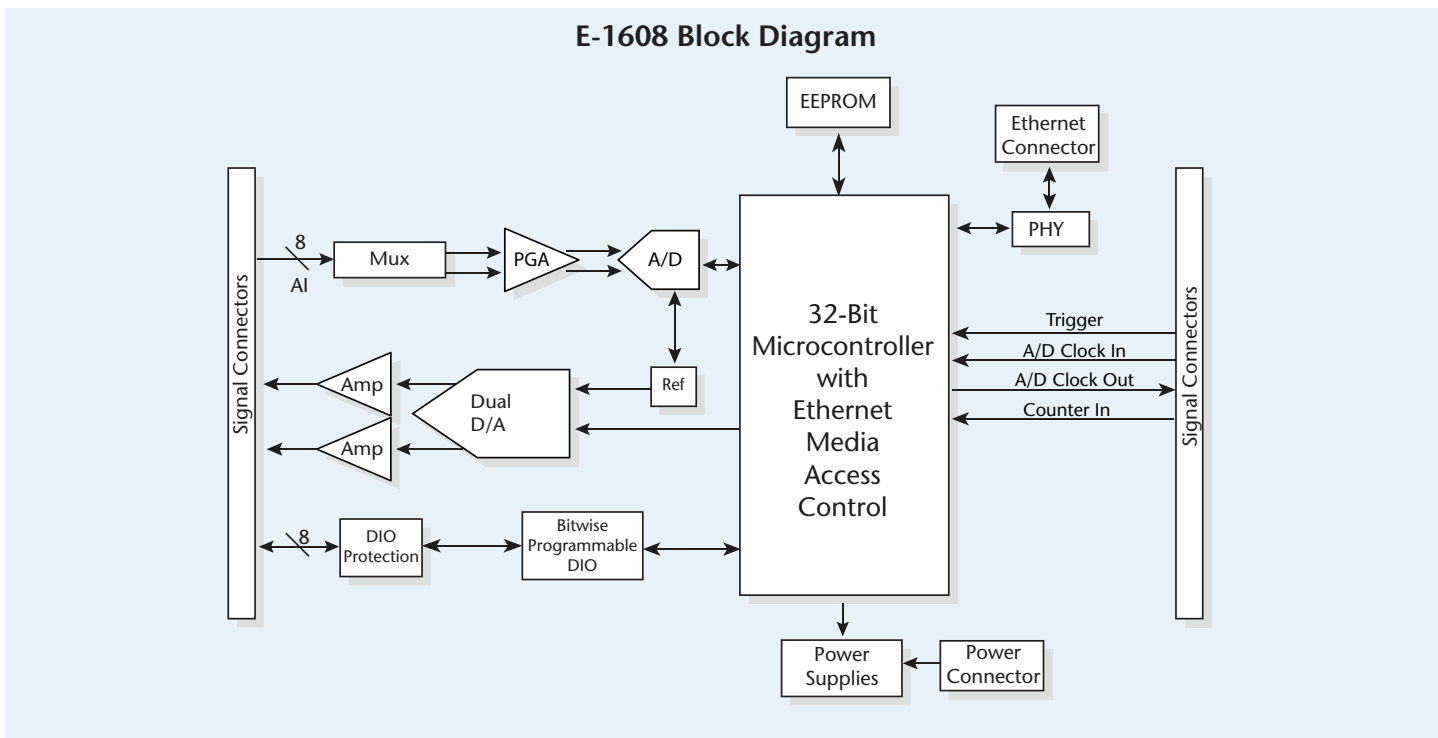
Digital I/O

Eight bidirectional digital I/O bits are individually-configurable for input or output. The digital I/O terminals can detect the state of any TTL-level input. You can configure for pull-up (+5 V) or pull-down (0 V) with an onboard jumper.

Counter Input

One 32-bit event counter can count TTL pulses. The counter accept inputs of up to 10 MHz.

Clock I/O

The E-1608 has one external clock input and one clock output for analog inputs.

Calibration

E-1608 devices are factory-calibrated. Specifications are guaranteed for one year. For calibration beyond one year, return the device to the factory for recalibration.

E-1608-OEM Version

The E-1608-OEM has a board-only form factor with header connectors for OEM and embedded applications (no case, CD, or network cable included). All devices can be further customized to meet customer needs.
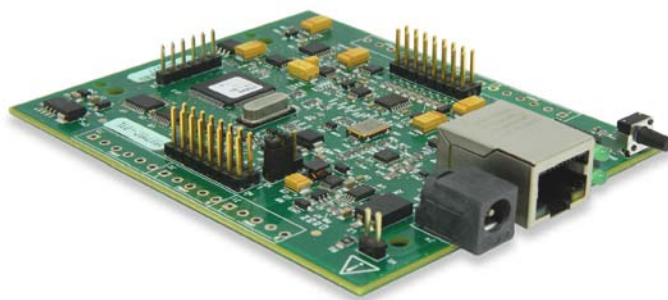
The E-1608-OEM has the same specifications as the standard device, but in a board-only form factor with header connectors instead of screw terminals.

Software Support

E-1608 devices are supported by the software in the table below.
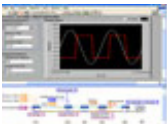
Ready-to-Run Applications		
InstaCal		An interactive utility that configures and tests MCC hardware. Windows® OS InstaCal is included with the free MCC DAQ Software bundle (CD/download).
DAQami		Advanced data logging application with drag-and-drop software interface that is used to acquire, view, and log data. DAQami can be configured to log analog channels and to view that data in real-time or post-acquisition on user-configurable displays. Windows OS DAQami is available as a purchased software download.
TracerDAQ and TracerDAQ Pro		A virtual strip chart, oscilloscope, function generator, and rate generator applications used to generate, acquire, analyze, display, and export data. The Pro version provides enhanced features. Windows OS TracerDAQ is included with the free MCC DAQ Software bundle (CD/download). TracerDAQ Pro is available as a purchased software download.
General-Purpose Programming Support		
Universal Library (UL)		Programming library of function calls for C, C++, VB, C# .Net, and VB .Net using Visual Studio and other IDEs. Windows OS The UL is included with the free MCC DAQ Software bundle (CD/download).
UL for Android		Programming library of function calls for Java programmers who develop apps for Android-based tablets and phones. UL for Android communicates with select MCC DAQ devices. Supports Android project development on Windows, Linux, Mac OS X UL for Android is included with the free MCC DAQ Software bundle (CD/download).
Application-Specific Programming Support		
ULx for NI LabVIEW		A comprehensive library of VIs and example programs for NI LabVIEW that is used to develop custom applications that interact with most MCC devices. Windows OS ULx is included with the free MCC DAQ Software bundle (CD/download).
DASYLab Driver		Icon-based data acquisition, graphics, control, and analysis software that allows users to create complex applications in minimal time without text-based programming. DASYLab is available as a purchased software download. Windows OS

E-1608
Specifications

Specifications

These specifications apply to both standard and OEM versions unless noted otherwise.

Analog Input

A/D Converter Type: Successive approximation
ADC Resolution: 16 bits
Number of Channels: 4 differential, 8 single-ended (software-selectable)
Input Voltage Range: ±10 V, ±5 V, ±2 V, ±1 V (software-selectable per channel)
Absolute Max Input Voltage (CHx relative to AGND): ±20 V max (power on), ±12 V max (power off)
Input Impedance: 1 GΩ (power on), 1200 Ω (power off)
Input Bias Current: ±10 nA
Input Bandwidth (All Input Ranges, Small Signal (–3 dB)): 700 kHz
Input Capacitance: 60 pf
Max Working Voltage (Signal + Common Mode)
  ±10 V Range: ±10.2 V max relative to AGND
  ±5 V Range: ±10.2 V max relative to AGND
  ±2 V Range: ±9.5 V max relative to AGND
  ±1 V Range: ±9.0 V max relative to AGND
Common Mode Rejection Ratio (f_{IN} = 60 Hz, All Input Ranges): 86 dB
Crosstalk (Adjacent Differential Mode Channels, DC to 10 kHz): –75 dB
Input Coupling: DC
Sample Rate: 0.019 Hz to 250 kHz, software-selectable
Trigger Source: TRIG (see External Trigger)
Sample Clock Source: Internal A/D clock or external A/D clock (AICKI pin)
Internal Sample Clock Stability: ±50 ppm
Internal Sample Clock Timebase: 80 MHz timer with 32-bit period (available frequencies are 80 MHz / integer period)
Throughput
This is the typical throughput when the device and host are both connected by Ethernet to the same local network. The throughput can vary significantly if a wireless connection is involved or data is sent over the internet and is not guaranteed
  Software Paced: 1000 to 5000 S/s typ, on local network
  Hardware Paced: 250 kS/s max
Channel Gain Queue (Up To 8 Elements): Software-selectable channel and range for each queue element
Warm-Up Time: 15 minutes min

Noise Performance

For the peak-to-peak noise distribution test, a differential input channel is connected to AGND at the input terminal block, and 16384 samples are acquired at the maximum rate available at each setting.

Range	Counts	LSBrms
±10 V	6	0.91
±5 V	6	0.91
±2 V	7	1.06
±1 V	9	1.36

Settling Time

Settling time is defined as the accuracy that can be expected after one conversion when switching from a channel with a DC input at one extreme of full scale to another channel with a DC input at the other extreme of full scale. Both input channels are configured for the same input range.

Range	4 µs Settling Accuracy (% FSR)	6 µs Settling Accuracy (% FSR)	10 µs Settling Accuracy (% FSR)
±10 V	0.0061	0.0031	0.0015
±5 V	0.0061	0.0031	0.0015
±2 V	0.0061	0.0031	0.0015
±1 V	0.0061	0.0031	0.0015

Analog Output

Number Of Channels: 2
Resolution: 16 bits
Output Ranges (Calibrated): ±10 V
Output Transient
  Powered On
    Duration: 5 ms
    Amplitude: 2 V p-p
  Powered Off
    Duration: 400 ms
    Amplitude: 10 V p-p
Differential Non-Linearity (16-bit Monotonic): ±0.35 LSB typ, ±1 LSB max
Output Current (AOUTx Pins): ±3.5 mA max
  Leave unused AOUTx output channels disconnected
Output Coupling: DC
Power On and Reset State: DACs cleared to uncalibrated zero-scale: 0 V, ±50 mV unless the alarm function is enabled for the output.
  AOUTx defaults to 0 V whenever the device is powered on or a reset command is issued to the device, unless the alarm functionality is enabled for the output.
  Alarm Functionality
    Either or both outputs may be configured to go to defined values when an Ethernet connection with a host is established or lost.

Slew Rate: 5 V/µs
Throughput (Software Paced): 1000 to 5000 S/s typ, on local network
  This is the typical throughput when the device and host are both connected by Ethernet to the same local network. The throughput can vary significantly, and typical throughput is not guaranteed if a wireless connection is involved or data is sent over the internet.

Calibrated Absolute Accuracy (Analog Output)

Range: ±10 V
Absolute Accuracy: (± 18.7 LSB)

Calibrated Absolute Accuracy Components (Analog Output)

Range: ±10 V
% of Reading: ± 0.024
Offset: ±2.2 mV)
Offset Tempco: 30.1 µV/°C
Gain Tempco: 13.2 ppm of range/°C

Relative Accuracy (Analog Output)

Range: ±10 V
Relative Accuracy (INL): ±4.0 LSB typ

Accuracy

Analog Input DC Voltage Measurement Accuracy (All Values are (±))						
Range	Gain Error (% of Reading)	Offset Error	INL Error (% of Range)	Absolute Accuracy at Full Scale	Gain Temperature Coefficient (% Reading/°C)	Offset Temperature Coefficient
±10 V	0.024	915 µV	0.0076	4075 µV	0.0014	47 µV/°C
±5 V	0.024	686 µV	0.0076	2266 µV	0.0014	24 µV/°C
±2 V	0.024	336 µV	0.0076	968 µV	0.0014	10 µV/°C
±1 V	0.024	245 µV	0.0076	561 µV	0.0014	5 µV/°C

E-1608
Specifications

MEASUREMENT COMPUTING

Analog Input/Output Calibration

Recommended Warm-Up Time: 15 minutes min
Calibration Method: Factory
Calibration Interval: 1 year (factory calibration)

Digital Input/Output

Digital Type: 5 V TTL input/advanced BiCMOS output
Number of I/O: 8
Configuration: Independently-configured for input or output
Pull-Up Configuration: All pins pulled up to 5 V using 47 K resistors (default). Can be changed to pull-down using an internal jumper.
Digital I/O Transfer Rate (System-Paced): 100 to 5000 port reads/writes or single bit reads/writes per second typ, on local network
This is the typical throughput when the device and host are both connected by Ethernet to the same local network. The throughput can vary significantly, and typical throughput is not guaranteed if a wireless connection is involved or data is sent over the internet.
Alarm Functionality: Any combination of DIO bits may be configured to become outputs and go to defined values when an Ethernet connection with a host is established or lost.
Power On and Reset State: All bits are input unless the alarm functionality is enabled for them.
Input High Voltage Threshold: 2.0 V min
Input High Voltage Limit: 5.5 V absolute max
Input Low Voltage Threshold: 0.8 V max
Input Low Voltage Limit: –0.5 V absolute min, 0 V recommended min
Output High Voltage: 3.8 V typ at no load, 3.0 V min (IOH = –3 mA), 2.0 V min (IOH = –32 mA)
Output Low Voltage 0.15 V typ at no load, 0.55 V max (IOL = 64 mA)
Power On and Reset State: Input

External Trigger

Trigger Source (External Digital): TRIG
Trigger Mode: Software-selectable edge or level sensitive; user configurable for CMOS-compatible rising or falling edge, high or low level
Trigger Latency: 2 µs + 1 pacer clock cycle max
Trigger Pulse Width: 1 µs min
Input Type: Schmitt trigger, 47 kΩ pull-down to ground
Schmitt Trigger Hysteresis: 1.01 V typ, 0.6 V min, 1.5 V max
Input High Voltage Threshold: 2.43 V typ, 1.9 V min, 3.1 V max
Input High Voltage Limit: 5.5 V absolute max
Input Low Voltage Threshold: 1.42 V typ, 1.0 V min, 2.0 V max
Input Low Voltage Limit: –0.5 V absolute min, 0 V recommended min

External Clock Input/Output

Terminal Names: AICKI, AICKO
Terminal Types
    AICKI: Input (receives A/D pacer clock from external source)
    AICKO: Output (outputs internal A/D pacer clock)
Input Clock Rate: 250 kHz max
Clock Pulse Width
    AICKI: 1 µs min
    AICKO: 1.8 µs min
Clock Mode: Edge-sensitive, rising

Input Type: Schmitt trigger, 47 kΩ pull-down to ground
Schmitt Trigger Hysteresis: 1.01 V typ, 0.6 V min, 1.5 V max
Input High Voltage Threshold: 2.43 V typ, 1.9 V min, 3.1 V max
Input High Voltage Limit: 5.5 V absolute max
Input Low Voltage Threshold: 1.42 V typ, 1.0 V min, 2.0 V max
Input Low Voltage Limit: –0.5 V absolute min, 0 V recommended min
Output High Voltage: 4.4 V min (IOH = –50 µA), 3.80 V min (IOH = –8 mA)
Output Low Voltage 0.1 V max (IOL = 50 µA), 0.44 V max (IOL = 8 mA)

Counter

Pin Name: CTR
Counter Type: Event counter
Number of Channels: 1
Input Type: Schmitt trigger, 47 kΩ pull-down to ground
Input Source: CTR screw terminal
Resolution: 32 bits
Schmitt Trigger Hysteresis: 1.01 V typ, 0.6 V min, 1.5 V max
Input High Voltage Threshold: 2.43 V typ, 1.9 V min, 3.1 V max
Input High Voltage Limit: 5.5 V absolute max
Input Low Voltage Threshold: 1.42 V typ, 1.0 V min, 2.0 V max
Input Low Voltage Limit: –0.5 V absolute min, 0 V recommended min
Input Frequency: 10 MHz max
High Pulse Width: 50 ns min
Low Pulse Width: 50 ns min

Memory

Data FIFO (Analog Input): 49,152 samples
Non-Volatile Memory: 2,048 bytes (768 bytes for calibration, 256 bytes for user, 1,024 bytes for network settings)

Power

External Power Supply: 5V, 1A
Supply Current (Quiescent Current): 330 mA typ*, 710 mA max including all external loading
User Output Voltage Range (Available at +VO Terminal): 4.40 V min to 5.25 V max, assumes supplied AC adapter is used
User Output Current (Available at +VO Terminal): 10 mA max

Network

Ethernet Connection

Ethernet Type: 100 Base-TX, 10 Base-T
Communication Rates: 10/100 Mbps, auto-negotiated
Connector: RJ-45, 8 position
Cable Length: 100 meters max
Additional Parameters: HP Auto-MDIX support

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* This is the total quiescent current requirement for the device that includes the LEDs. This does not include any potential loading of the digital I/O bits, +VO terminal, or the AOUTx outputs.

Network Interface

Protocols Used: TCP/IP (IPv4 only), UDP
Network Ports Used: UDP:54211 (discovery), UDP:6234 (bootloader only), TCP:54211 (commands), TCP:54212 (scan data)
Network IP Configuration: DHCP + link-local, DHCP, static, link-local
Network Name: E-1608-xxxxxx, where xxxxxx are the lower 6 digits of the device MAC address
Network Name Publication: By NBNS (responds to b-node broadcasts, therefore only available on the local subnet)

Network Factory Default Settings

Factory Default IP Address: 192.168.0.101
Factory Default Subnet Mask: 255.255.255.0
Factory Default Gateway: 192.168.0.1
Factory Default DHCP Setting: DHCP + link-local enabled

Network Security

Security Implementation: TCP sockets are not opened unless application sends the correct PIN code (stored in non-volatile memory, may be changed by user, default value 0000)
Number of Concurrent Sessions: 1
Vulnerabilities: TCP Sequence Number Approximation Vulnerability

LED Displays and the Factory Reset Button

Power LED (Top)
    3.3 V < V_{ext} < 5.9 V: On
    V_{ext} < 3.3 V, V_{ext} > 5.9 V: Off (power fault)
Activity LED (Bottom): On when there is a valid host connection and blinks when a command is received or an AInScan is running.
Ethernet Connector LEDs
    Left, Green: Link/activity indicator; on when there is a valid Ethernet link and blinks when network activity is detected.
    Right, Yellow: Speed indicator; on for 100 Mbps, off for 10 Mbps or no link.
Factory Reset Button: Used to reset the network configuration settings to the factory default values.

Environmental

Operating Temperature Range: 0 °C to 55 °C max
Storage Temperature Range: –40 °C to 85 °C max
Humidity: 0% to 90% non-condensing max

Mechanical

Dimensions (L × W × H)
    Standard Version: 117.9 × 82.8 × 29.0 mm (4.64 × 3.26 × 1.14 in.)
    OEM Version: 98.30 × 76.71 × 14.61 mm (3.87 × 3.02 × 0.575 in.)

Screw Terminal Connectors (E-1608 Standard)

Connector Type: Screw terminal
Wire Gauge Range: 16 AWG to 30 AWG

Header Connectors (E-1608-OEM)

I/O Connector Type: Two 2 × 8 pin 0.1 in. pitch headers labeled W2 and W4
Power Connector Type: DC barrel input jack labeled 4 (mates with 5.5 mm OD / 2.1 mm ID plug) and 1 x 2 pin 0.1 in. pitch header labeled W1

Ordering Information

Part No.	Description
E-1608	Ethernet-based DAQ device with eight analog inputs, 250 kS/s sample rate, two analog outputs, one 32-bit counter input, and eight DIO lines. Includes network cable, power adapter, and MCC DAQ software CD.
E-1608-OEM	Board-only Ethernet-based DAQ device with eight analog inputs, 250 kS/s sample rate, two analog outputs, one 32-bit counter input, and eight DIO lines.

Software also Available from MCC

DAQami	Easy-to-use advanced data logging application to acquire, view, and log data
TracerDAQ Pro	Out-of-the-box virtual instrument suite with strip chart, oscilloscope, function generator, and rate generator – professional version
DASYLab	Icon-based data acquisition, graphics, control, and analysis software