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# Full-Featured E Series Multifunction DAQ
# 12 or 16-Bit, up to 1.25 MS/s, up to 64 Analog Inputs





## E Series – Full-Featured

- 16 or 64 analog inputs at up to 1.25 MS/s, 12 or 16-bit resolution
- 2 analog outputs at up to 1 MS/s, 12 or 16-bit resolution
- 8 digital I/O lines (TTL/CMOS); two 24-bit counter/timers
- Analog and digital triggering
- 14 or 15 analog input signal ranges
- NI-DAQ driver simplifies configuration and measurements

### Families
- NI 6071E
- NI 6070E
- NI 6062E
- NI 6052E
- NI 6040E
- NI 6033E
- NI 6032E
- NI 6031E
- NI 6030E
- NI 6020E (only digital triggering)

### Operating Systems
- Windows 2000/NT/XP
- Real-time performance with LabVIEW (page 134)
- Others such as Linux and Mac OS X (page 187)

### Recommended Software
- LabVIEW
- LabWindows/CVI
- Measurement Studio
- VI Logger

### Other Compatible Software
- Visual Basic, C/C++, and C#

### Driver Software (included)
- NI-DAQ 7

### Calibration Certificate Included
See page 21.




| Family | Bus | Analog Inputs | Input Resolution | Max Sampling Rate | Input Range | Analog Outputs | Output Resolution | Output Rate | Output Range | Digital I/O | Counter/Timers | Triggers |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NI 6071E | PCI, PXI | 64 SE/32 DI | 12 bits | 1.25 MS/s | ±0.05 to ±10 V | 2 | 12 bits | 1 MS/s | ±10 V | 8 | 2, 24-bit | Analog, digital |
| NI 6070E | PCI, PXI, FireWire | 16 SE/8 DI | 12 bits | 1.25 MS/s | ±0.05 to ±10 V | 2 | 12 bits | 1 MS/s | ±10 V | 8 | 2, 24-bit | Analog, digital |
| NI 6062E | PCMCIA | 16 SE/8 DI | 12 bits | 500 kS/s | ±0.05 to ±10 V | 2 | 12 bits | 850 kS/s | ±10 V | 8 | 2, 24-bit | Analog, digital |
| NI 6052E | PCI, PXI, FireWire | 16 SE/8 DI | 16 bits | 333 kS/s | ±0.05 to ±10 V | 2 | 16 bits | 333 kS/s | ±10 V | 8 | 2, 24-bit | Analog, digital |
| NI 6040E | PCI, PXI | 16 SE/8 DI | 12 bits | 500 kS/s | ±0.05 to ±10 V | 2 | 12 bits | 1 MS/s | ±10 V | 8 | 2, 24-bit | Analog, digital |
| NI 6033E | PCI | 64 SE/32 DI | 16 bits | 100 kS/s | ±0.1 to ±10 V | 0 | - | - | - | 8 | 2, 24-bit | Analog, digital |
| NI 6032E | PCI | 16 SE/8 DI | 16 bits | 100 kS/s | ±0.1 to ±10 V | 0 | - | - | - | 8 | 2, 24-bit | Analog, digital |
| NI 6031E | PCI, PXI | 64 SE/32 DI | 16 bits | 100 kS/s | ±0.1 to ±10 V | 2 | 16 bits | 100 kS/s | ±10 V | 8 | 2, 24-bit | Analog, digital |
| NI 6030E | PCI, PXI | 16 SE/8 DI | 16 bits | 100 kS/s | ±0.1 to ±10 V | 2 | 16 bits | 100 kS/s | ±10 V | 8 | 2, 24-bit | Analog, digital |
| NI 6020E | NI USB | 16 SE/8 DI | 12 bits | 100 kS/s | ±0.05 to ±10 V | 2 | 12 bits | 20 S/s | ±10 V | 8 | 2, 24-bit | Digital |

*Table 1. NI Full-Featured E Series Model Guide (See page 228 for detailed specifications.)*

## Overview and Applications

NI Full-Featured E Series devices are the fastest and the most accurate multiplexed data acquisition devices available. They are ideal for applications ranging from continuous high-speed data logging to control applications to high voltage signal or sensor measurements when used with NI signal conditioning. Synchronize the operations of multiple devices using the RTSI bus or PXI trigger bus and easily integrate other hardware such as motion control and machine vision to create an entire measurement and control system.

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## Highly Accurate Hardware Design

NI Full-Featured E Series DAQ devices includethe following features and technologies:

**Temperature Drift Protection Circuitry** – Designed with components that minimize the effect of temperature changes on measurements to less than 0.0006% of reading per °C.

**Resolution-Improvement Technologies** – Carefully designed noise floor maximizes resolution.

**Onboard Self-Calibration** – Precise voltage reference included for calibration and measurement accuracy. Self-calibration is completely software controlled, with no potentiometers to adjust.

**NI DAQ-STC** – Timing and control ASIC designed to provide more flexibility, lower power consumption, and a higher immunity to noise and jitter than off-the-shelf counter/timer chips.

# Full-Featured E Series Multifunction DAQ 12 or 16-Bit, up to 1.25 MS/s, up to 64 Analog Inputs

**NI MITE** – ASIC designed to optimize data transfer for multiple simultaneous operations using bus mastering with three scatter-gather DMA channels for maximum performance of concurrent I/O operations.

**NI PGIA** – Measurement and instrument class amplifier that guarantees settling times at all gains. Typical commercial off-the-shelf amplifier components do not meet the settling time requirements for high-gain measurement applications.

**PFI Lines** – Eight programmable function input (PFI) lines that can be used for software-controlled routing of interboard and intraboard digital and timing signals.

**RTSI or PXI Trigger Bus** – Used to share timing and control signals between devices and synchronize operations.

**RSE Mode** – In addition to differential and nonreferenced single-ended modes, NI full-featured E Series devices offer referenced single-ended (RSE) mode for use with floating signal sources in applications with channel counts higher than eight.

**Onboard Temperature Sensor** – Included for monitoring the operating temperature of the device to ensure that it is operating within the specified range.

**Analog and Digital Triggering** – Only full-featured E Series devices provide the ability to set a trigger based on the level of an analog signal, in addition to the ability to trigger off an edge of a digital signal.

**More Input Ranges** – Up to 15 input ranges for optimal resolution, even for signals smaller than 50 mV.

## High-Performance, Easy-to-Use Driver Software

NI-DAQ is the robust driver software that makes it easy to access the functionality of your data acquisition hardware, whether you are a beginning or advanced user. Helpful features include:

**Automatic Code Generation** – DAQ Assistant is an interactive guide that steps you through configuring, testing, and programming measurement tasks, and generating the necessary code automatically for use in LabVIEW, LabWindows/CVI, or Measurement Studio.

**Cleaner Code Development** – Basic and advanced software functions have been combined into one easy-to-use yet powerful set to help you build cleaner code and move from basic to advanced applications without replacing functions.

**High-Performance Driver Engine** – Software-timed single-point input (typically used in control loops) with NI-DAQ achieves rates of up to 50 kHz. NI-DAQ also delivers maximum I/O system throughput with a multithreaded driver.

**Test Panels** – With NI-DAQ, you can test all of your device functionality before you begin development.

**Scaled Channels** – Easily scale your voltage data into the proper engineering units using the NI-DAQ Measurement Ready virtual channels by choosing from a list of common sensors and signals or creating your own custom scale.

**LabVIEW Integration** – All NI-DAQ functions use the waveform data type, which carries acquired data and timing information directly into more than 400 LabVIEW built-in analysis routines for display of results in engineering units on a graph.

## Worldwide Support and Services

NI provides you with a wealth of resources to help you get your application up and running more quickly, including:

**Technical Support** – Purchase of NI hardware or software gives you access to application engineers all over the world as well as Web resources with more than 3,000 measurement examples and more than 9,000 KnowledgeBase entries. – ***ni.com/support***

**NI Factory Installation Services (FIS)** – Software and hardware installed in PXI and PXI/SCXI systems, tested and ready to use – ***ni.com/advisor***

**Calibration** – Includes NIST-traceable basic calibration certificates, services for ANSI/NCSL-Z540 and periodic calibration – ***ni.com/calibration***

**Extended Warranty** – Meet project life-cycle requirements and maintain optimal performance in a cost-effective way – ***ni.com/services***

**Data Acquisition Training** – Instructor-led courses – ***ni.com/training***

**Professional Services** – Feasibility, consulting, and integration through our Alliance Partners – ***ni.com/alliance***

***For more information on NI services and support, please visit ni.com/services***

***For information on device support in NI-DAQ 7, visit ni.com/dataacquisition***

# Full-Featured E Series Multifunction DAQ
# 12 or 16-Bit, up to 1.25 MS/s, up to 64 Analog Inputs



| | | Full-Featured E Series | | | | Low-Cost E Series | | Basic |
|---|---|---|---|---|---|---|---|---|
| **Models** | | NI 6030E, NI 6031E, NI 6032E, NI 6033E | NI 6052E | NI 6070E, NI 6071E | NI 6040E | NI 6034E, NI 6036E | NI 6023E, NI 6024E, NI 6025E | PCI-6013, PCI-6014 |
| **Measurement Sensitivity* (mV)** | | 0.0023 | 0.0025 | 0.009 | 0.008 | 0.0036 | 0.008 | 0.004 |
| **Nominal Range (V)** | | | | | | | | |
| **Positive FS** | **Negative FS** | **Absolute Accuracy (mV)** | | | | | | |
| 10 | -10 | 1.147 | 4.747 | 14.369 | 15.373 | 7.56 | 16.504 | 8.984 |
| 5 | -5 | 2.077 | 0.876 | 5.193 | 5.697 | 1.79 | 5.263 | 2.003 |
| 2.5 | -2.5 | – | 1.190 | 3.605 | 3.859 | – | – | – |
| 2 | -2 | 0.836 | – | – | – | – | – | – |
| 1 | -1 | 0.422 | 0.479 | 1.452 | 1.556 | – | – | – |
| 0.5 | -0.5 | 0.215 | 0.243 | 0.735 | 0.789 | 0.399 | 0.846 | 0.471 |
| 0.25 | -0.25 | – | 0.137 | 0.379 | 0.405 | – | – | – |
| 0.2 | -0.2 | 0.102 | – | – | – | – | – | – |
| 0.1 | -0.1 | 0.061 | 0.064 | 0.163 | 0.176 | – | – | – |
| 0.05 | -0.05 | – | 0.035 | 0.091 | 0.100 | 0.0611 | 0.106 | 0.069 |
| 10 | 0 | 0.976 | 1.232 | 6.765 | 7.269 | – | – | – |
| 5 | 0 | 1.992 | 2.119 | 5.391 | 5.645 | – | – | – |
| 2 | 0 | 0.802 | 0.850 | 2.167 | 2.271 | – | – | – |
| 1 | 0 | 0.405 | 0.428 | 1.092 | 1.146 | – | – | – |
| 0.5 | 0 | 0.207 | 0.242 | 0.558 | 0.583 | – | – | – |
| 0.2 | 0 | 0.098 | 0.111 | 0.235 | 0.247 | – | – | – |
| 0.1 | 0 | 0.059 | 0.059 | 0.127 | 0.135 | – | – | – |

Note: Accuracies are valid for measurements following an internal calibration. Measurement accuracies are listed for operational temperatures within ±1 °C of internal calibration temperature and ±10 °C of external or factory-calibration temperature. One-year calibration interval recommended. The Absolute Accuracy at Full Scale calculations were performed for a maximum range input voltage (for example, 10 V for the ±10 V range) after one year, assuming 100 pt averaging of data.*Smallest detectable voltage change in the input signal at the smallest input range.

*Table 2. E Series Analog Input Absolute Accuracy Specifications*

| | | Full-Featured E Series | | | | Low-Cost E Series | | Basic |
|---|---|---|---|---|---|---|---|---|
| **Models** | | NI 6030E, NI 6031E, NI 6032E, NI 6033E | NI 6052E | NI 6070E, NI 6071E | NI 6040E | PCI-6036E | PCI-6024E, NI 6025E, | NI 6013, NI 6014 |
| **Nominal Range (V)** | | | | | | | | |
| **Positive FS** | **Negative FS** | **Absolute Accuracy (mV)** | | | | | | |
| 10 | -10 | 1.43 | 1.405 | 8.127 | 8.127 | 2.417 | 8.127 | 3.835 |
| 10 | 0 | 1.201 | 1.176 | 5.685 | 5.685 | – | – | – |

*Table 3. E Series Analog Output Absolute Accuracy Specifications*

## Recommended Accessories

Signal conditioning is required for sensor measurements or voltage inputs greater than 10 V. National Instruments SCXI is a versatile, high-performance signal conditioning platform, intended for high-channel-count applications. NI SCC products provide portable, flexible signal conditioning options on a per-channel basis. Both signal conditioning platforms are designed to increase the performance and reliability of your DAQ System, and are up to 10X more accurate than terminal blocks (please visit ***ni.com/sigcon*** for more details). Refer to the table below for more information:

**Sensor/Signals (>10 V)**

| System Description | DAQ Device | Signal Conditioning | Page |
|---|---|---|---|
| High performance | PCI-60xxE, PXI-60xxE, DAQPad-60xxE | SCXI | 270 |
| Low-cost, portable | PCI-60xxE, PXI-60xxE, DAQPad-60xxE | SCC | 251 |

**Signals (<10 V)[1]**

| System Description | DAQ Device | Terminal Block | Cable | Page |
|---|---|---|---|---|
| Shielded | PCI-60xxE/DAQPad-60xxE | SCB-68 | SH6868-EP | 214 |
| Shielded | PXI-60xxE | TB-2705 | SH6868-EP | 214 |
| Shielded | PCI-6071E/PCI-6033E/PCI-6031E | SCB-100 | SH100100 | 214 |
| Shielded | PXI-6071E/PXI-6031E | Two TBX-68s | SH1006868 | 214 |
| Shielded | DAQPad-60xxE | SCB-68 | SHC6868-EP | 214 |
| Low-Cost | PCI-60xxE/PXI-60xxE/DAQPad-60xxE | CB-68LP | R6868 | 214 |
| Low-Cost | DAQCard-60xxE | CB-68LP | RC6868 | 214 |

1Terminal Blocks do not provide signal conditioning (ie. filtering, amplification, isolation, etc.), which may be necessary to increase the accuracy of your measurements.

*Table 4. Recommended Accessories*

## Ordering Information

NI PXI-6071E .....777676-01
NI PCI-6071E .....777515-01
NI PXI-6070E .....777060-01
NI PCI-6070E .....777305-01
NI DAQPad-6070E for FireWire .....(See page 207)
NI DAQCard-6062E .....(See page 207)
NI PXI-6052E .....777962-01
NI PCI-6052E .....777745-01
NI DAQPad-6052E for FireWire .....(See page 207)
NI PXI-6040E .....777484-01
NI PCI-6040E .....777383-01
NI PCI-6033E .....777516-01
NI PCI-6032E .....777422-01
NI PXI-6031E .....777636-01
NI PCI-6031E .....777514-01
NI PXI-6030E .....777555-01
NI PCI-6030E .....777384-01
NI DAQPad-6020E for USB .....(See page 207)

Includes NI-DAQ driver software and calibration certificate.

For more information on warranty and value-added services, see page 20.

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# Multifunction DAQ Overview

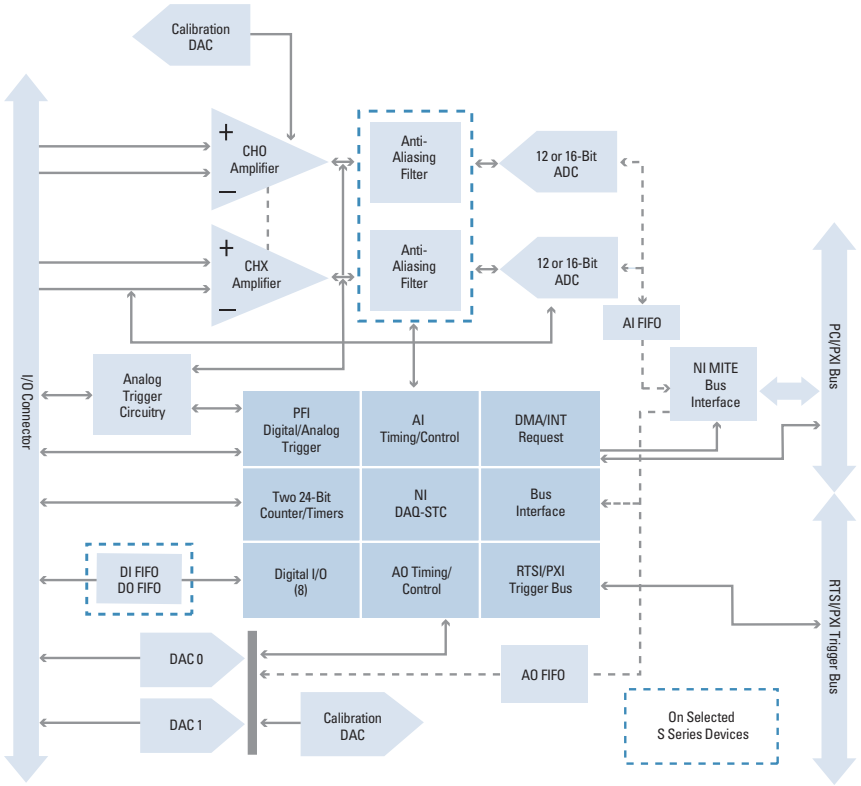



*Figure 1. S Series Hardware Block Diagram*

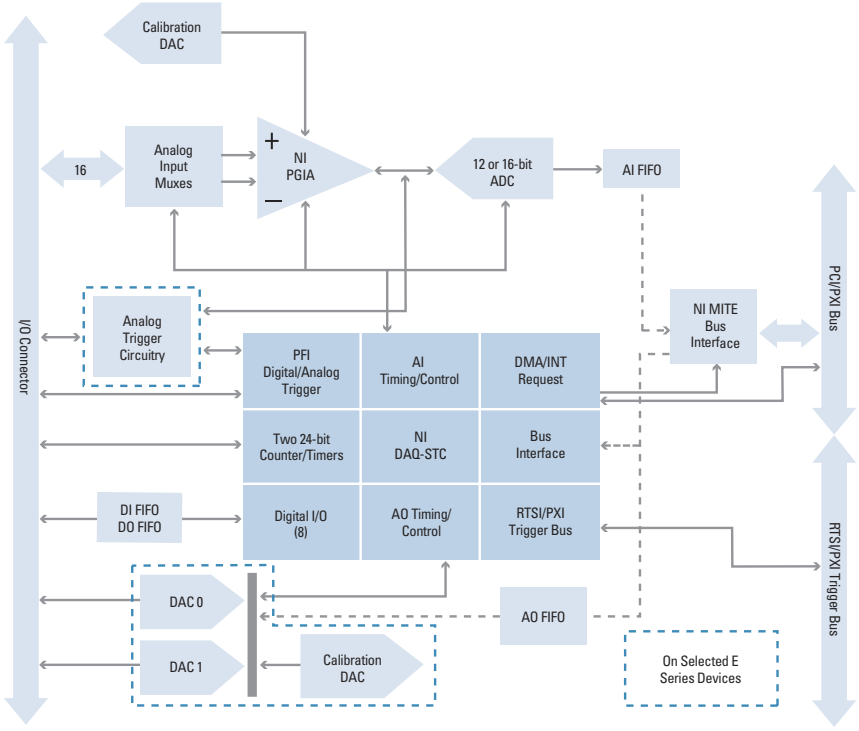



*Figure 2. E Series Hardware Block Diagram*

# 16-Bit E Series Multifunction DAQ Specifications

## Specifications – NI 6052E and NI 603xE

These specifications are typical for 25 °C unless otherwise noted.

### Analog Input

Accuracy specifications ..... See page 228.

#### Input Characteristics

| Number of Channels | |
|---|---|
| 6052E<br>6030E<br>6032E<br>6034E<br>6036E | 16 single-ended or 8 differential<br>(software selectable per channel) |
| 6031E<br>6033E | 64 single-ended or 32 differential<br>(software-selectable per channel) |

Resolution..... 16 bits, 1 in 65,536

| Maximum Sampling Rate | |
|---|---|
| 6052E<br>6034E<br>6036E | 333 kS/s<br>200 kS/s |
| 6030E<br>6031E<br>6032E<br>6033E | 100 kS/s |

Input signal ranges

| Device | Range Software Selectable | Bipolar Input Range | Unipolar Input Range |
|---|---|---|---|
| 6052E | 20 V | ±10 V | – |
| | 10 V | ±5 V | 0 to 10 V |
| | 5 V | ±2.5 V | 0 to 5 V |
| | 2 V | ±1 V | 0 to 2 V |
| | 1 V | ±500 mV | 0 to 1 V |
| | 500 mV | ±250 mV | 0 to 500 mV |
| | 200 mV | ±100 mV | 0 to 200 mV |
| | 100 mV | ±50 mV | 0 to 100 mV |
| 6030E | 20 V | ±10 V | – |
| 6031E | 10 V | ±5 V | 0 to 10 V |
| 6032E | 5 V | – | 0 to 5 V |
| 6033E | 4 V | ±2 V | – |
| | 2 V | ±1 V | 0 to 2 V |
| | 1 V | ±500 mV | 0 to 1 V |
| | 500 mV | – | 0 to 500 mV |
| | 400 mV | ±200 mV | – |
| | 200 mV | ±100 mV | 0 to 200 mV |
| | 100 mV | – | 0 to 100 mV |
| 6034E | 20 V | ±10 V | – |
| 6036E | 10 V | ±5 V | – |
| | 1 V | ±500 mV | – |
| | 100 mV | ±50 mV | – |

Input coupling..... DC
Maximum working voltage
(signal + common mode) ..... Each input should remain within ±11 V of ground
Overvoltage protection
Powered on..... ±25 V
Powered off ..... ±15 V

| Inputs Protected | |
|---|---|
| 6052E<br>6030E<br>6032E<br>6034E<br>6036E | AI<0..15>, AI SENSE |
| 6031E<br>6033E | AI<0..63>, AI SENSE,<br>AI SENSE2 |

FIFO buffer size ..... 512 samples, (1024 samples for DAQCard)
Data transfers
PCI, PXI ..... DMA, interrupts, programmed I/O
DAQCard ..... Interrupts, programmed I/O
DMA modes
PCI, PXI ..... Scatter-gather (single transfer, demand transfer)
Configuration memory size ..... 512 words

### Transfer Characteristics

Relative accuracy (dithered)

| Device | Typical | Maximum |
|---|---|---|
| 6052E<br>6034E<br>PCI-6036E | ±1.5 LSB | ±3 LSB |
| 6030E<br>6031E<br>6032E<br>6033E | ±0.75 LSB | ±1 LSB |
| DAQCard-6036E | ±3.0 LSB | ±6 LSB |

DNL

| Device | Typical | Maximum |
|---|---|---|
| 6052E<br>603xE<br>(except DAQCard-6036E) | ±0.5 LSB | ±1 LSB |
| DAQCard-6036E | ±1.0 LSB | +4, -2 LSB |

No missing codes
DAQCard 6036E..... 15 bits, guaranteed
Others ..... 16 bits, guaranteed

### Amplifier Characteristics

Input impedance

| Device | Normal Powered On | Powered Off | Overload |
|---|---|---|---|
| 6052E<br>603xE | 100 GΩ in parallel<br>with 100 pF | 820 Ω | 820 Ω |

Input bias and offset current

| Device | Bias Current | Offset Current |
|---|---|---|
| 6052E<br>6034E<br>PCI-6036E | ±200 pA | ±100 pA |
| 6030E<br>6031E<br>6032E<br>6033E | ±1 nA | ±2 nA |
| DAQCard-6036E | ±800 pA | ±100 pA |

# 16-Bit E Series Multifunction DAQ Specifications

## Specifications – NI 6052E and NI 603xE (continued)

CMRR, DC to 60 Hz

| | | CMRR | |
|---|---|---|---|
| **Device** | **Range** | **Bipolar (dB)** | **Unipolar (dB)** |
| 6052E | 20 V | 92 | – |
| | 10 V | 97 | 97 |
| | 5 V | 101 | 101 |
| | 2 V | 104 | 104 |
| | 100 mV to 1 V | 105 | 105 |
| 6030E | 20 V | 92 | – |
| 6031E | 10 V | 97 | 92 |
| 6032E | 5 V | – | 97 |
| 6033E | 4 V | 101 | – |
| | 2 V | 104 | 101 |
| | 1 V | 105 | 104 |
| | 100 mV to 500 mV | 105 | 105 |
| 6034E | 20 V | 85 | – |
| 6036E | 10 V | 85 | – |
| | 1 V | 96 | – |
| | 100 mV | 96 | – |

### Dynamic Characteristics

Bandwidth

| Device | Range | Small Signal (-3 dB) |
|---|---|---|
| 6052E | All ranges | 480 kHz |
| 6030E, 6031E, 6032E, 6033E | All ranges | 255 kHz |
| 6034E, 6036E | All ranges | 413 kHz |

System noise ($LSB_{rms}$, including quantization)

| Device | Range | Bipolar | Unipolar |
|---|---|---|---|
| 6052E | 2 to 20 V | 0.95 | 0.95 |
| | 1 V | 1.1 | 1.1 |
| | 500 mV | 1.3 | 1.3 |
| | 200 mV | 2.7 | 2.7 |
| | 100 mV | 5.0 | 5.0 |
| 6030E | 2 to 20 V | 0.6 | 0.8 |
| 6031E | 1 V | 0.7 | 0.8 |
| 6032E | 400 to 500 mV | 1.1 | 1.1 |
| 6033E | 200 mV | 2.0 | 2.0 |
| | 100 mV | – | 3.8 |
| 6034E | 10 to 20 V | 0.8 | – |
| PCI-6036E | 1 V | 1.0 | – |
| | 100 mV | 6.2 | – |
| DAQCard-6036E | 10 to 20 V | 1.5 | – |

Settling time to full-scale step

| | | Accuracy | | | | |
|---|---|---|---|---|---|---|
| **Device** | **Range** | **±0.00076% (±0.5 LSB)** | **±0.0015% (±1 LSB)** | **±0.0031% (±2 LSB)** | **±0.0061% (±4 LSB)** | **±0.024% (±16 LSB)** |
| 6052E | 2 to 20 V | – | 10 µs max | 5 µs max | 4 µs max | 3 µs max |
| | 1 V | – | 15 µs max | 5 µs max | 4 µs max | 3 µs max |
| | 200 to 500 mV | – | 15 µs max | 10 µs max | 4 µs max | 3 µs max |
| | 100 mV | – | 15 µs typical | 10 µs typical | 4 µs max | 3 µs max |
| 6030E 6032E | All | 40 µs max | 20 µs max | – | 10 µs max | – |
| 6031E 6033E | All | 50 µs max | 25 µs max | – | 10 µs max | – |
| 6034E | 1 to 20 V | – | – | 5 µs max | – | – |
| 6036E | 100 mV | – | – | – | 5 µs typical | – |
| DAQCard-6036E | 10 V | – | – | 5 µs max | – | – |

Crosstalk

| Device | Adjacent Channels | All Other Channels |
|---|---|---|
| 6052E 603xE | -75 dB | -90 dB |

### Analog Output

#### Output Characteristics

| Number of Channels | |
|---|---|
| 6052E 6030E 6031E 6036E | 2 voltage outputs |
| 6032E, 6033E, 6034E | None |

| Resolution | |
|---|---|
| 6052E 6036E 6030E 6031E | 16 bits, 1 in 65,536 |

| Maximum Update Rate | |
|---|---|
| 6052E | 333 kS/s |
| PCI-6036E | 10 kS/s, system dependent |
| 6030E 6031E | 100 kS/s |
| DAQCard-6036 | 1 kS/s, system dependent |

Type of DAC ..... Double buffered, multiplying

| FIFO Buffer Size | |
|---|---|
| 6052E, 6030E, 6031E | 2,048 samples |
| 6036E | None |

Data transfers
- PCI, PXI ..... DMA, interrupts, programmed I/O
- DAQCard ..... Interrupts, programmed I/O

DMA modes
- PCI, PXI ..... Scatter-gather (single transfer, demand transfer)

#### Transfer Characteristics

| Relative Accuracy | |
|---|---|
| 6052E | ±0.35 LSB typical, ±1 LSB maximum |
| 6030E 6031E | ±0.5 LSB typical, ±1 LSB maximum |
| 6036E | ±2 LSB maximum |

DNL ..... ±1.0 LSB maximum

| Monotonicity | |
|---|---|
| 6052E 6036E 6030E 6031E | 16 bits, guaranteed |

#### Voltage Output

| Ranges | |
|---|---|
| 6052E | ±10 V, 0 to 10 V, ±EXTREF, 0 to EXTREF; software selectable |
| 6030E 6031E | ±10 V, 0 to 10 V; software selectable |
| 6036E | ±10 V |

Output coupling ..... DC
Output impedance ..... 0.1 Ω maximum
Current drive ..... ±5 mA maximum
Protection ..... Short-circuit to ground

| Power-On State | |
|---|---|
| 6052E 6030E 6031E | 0 V (±20 mV) |
| PCI-6036E | 0 V (±44 mV) |
| DAQCard-6036E | 0 V (±60 mV) |

# 16-Bit E Series Multifunction DAQ Specifications

## Specifications – NI 6052E and NI 603xE (continued)

External reference input (6052E only)
- Range ..... ±11 V
- Overvoltage protection ..... ±25 V powered on, ±15 V powered off
- Input impedance ..... 10 kΩ
- Bandwidth (-3 dB) ..... 3 kHz
- Slew rate ..... 0.3 V/µs

### Dynamic Characteristics

Settling time and slew rate

| Device | Settling Time For Full-Scale Step | Slew Rate |
|---|---|---|
| 6052E | 3.5 µs to ±1 LSB accuracy | 15 V/µs |
| 6030E<br>6031E | 10 µs to ±1 LSB accuracy | 5 V/µs |
| PCI-6036E | 5 µs to ±1 LSB accuracy | 15 V/µs |
| DAQCard-6036E | 5 µs to ±4.5 LSB accuracy | 5 V/µs |

| | Noise |
|---|---|
| 6052E<br>6030E<br>6031E | 60 $\mu V_{rms}$, DC to 1 MHz |
| PCI-6036E | 110 $\mu V_{rms}$, DC to 400 kHz |
| DAQCard-6036E | 160 $\mu V_{rms}$, DC to 400 kHz |

Glitch energy (at mid-scale transition)

| Device | Magnitude | Duration |
|---|---|---|
| 6052E | ±10 mV | 1 µs |
| PCI-6036E | ±10 mV | 1 µs |

## Digital I/O

- Number of channels ..... 8 input/output
- Compatibility ..... 5 V/TTL/CMOS
- Power-on state ..... Input (high impedance)
- Data transfers ..... Programmed I/O

Digital logic levels

| Level | Minimum | Maximum |
|---|---|---|
| Input low voltage | 0.0 V | 0.8 V |
| Input high voltage | 2.0 V | 5.0 V |
| Output low voltage ($I_{out}$ = 5 mA) | – | 0.4 V |
| Output high voltage ($I_{out}$ = -3.5 mA) | 4.35 V | – |

## Timing I/O

### General-Purpose Up/Down Counter/Timers

Number of channels
- Up/down counter/timers ..... 2
- Frequency Scaler ..... 1

Resolution
- Up/down counter/timers ..... 24 bits
- Frequency Scaler ..... 4 bits

- Compatibility ..... 5 VTTL/CMOS

Digital logic levels

Base clocks available
- Up/down counter/timers ..... 20 MHz and 100 kHz
- Frequency Scaler ..... 10 MHz and 100 kHz

- Base clock accuracy ..... ±0.01%

Maximum external source frequency
- Up/down counter/timers ..... 20 MHz

- External source selections ..... PFI <0..9>, RTSI <0..6>, analog trigger; software selectable
- External gate selections ..... PFI <0..9>, RTSI <0..6>, analog trigger; software selectable
- Minimum source pulse duration ..... 10 ns, edge-detect mode
- Minimum gate pulse duration ..... 10 ns, edge-detect mode

Data transfers
- PCI/PXI Up/down counter/timer ..... DMA (scatter-gather), interrupts, programmed I/O
- DAQCard Up/down counter/timer ..... Interrupts, programmed I/O
- Frequency Scaler ..... Programmed I/O

## Triggers

### Analog Triggers

| | Number of Triggers |
|---|---|
| 6052E<br>6030E<br>6031E<br>6032E<br>6033E | 1 |
| 6034E<br>6036E | None |

Purpose
- Analog input ..... Start and stop trigger, gate, clock
- Analog output ..... Start trigger, gate, clock
- General-purpose counter/timers ..... Source, gate

| | Source |
|---|---|
| 6052E<br>6030E<br>6032E | AI<0..15>, PFI 0/AI START TRIG |
| 6031E<br>6033E | AI<0..63>, PFI 0/AI START TRIG |

Level
- Internal source, AI<0..15/63> ..... ±full-scale
- External source, PFI 0/AI START TRIG ..... ±10 V

- Slope ..... Positive or negative; software-selectable
- Resolution ..... 12 bits, 1 in 4,096
- Hysteresis ..... Programmable

Bandwidth (-3 dB)

| Device | Internal Source AI<0..15/63> | External Source PFI 0/AI START TRIG |
|---|---|---|
| 6052E | 700 kHz | 700 kHz |
| PCI-6030E, PCI-6031E, 6032E, 6033E | 255 kHz | 4 MHz |
| PXI-6030E, PXI-6031E | 255 kHz | 255 kHz |

- Accuracy ..... ±1% of full-scale range maximum

### Digital Triggers (all devices)

Purpose
- Analog input ..... Start and stop trigger, gate, clock
- Analog output ..... Start trigger, gate, clock
- General-purpose counter/timers ..... Source, gate

- Source ..... PFI <0..9>, RTSI <0..6>
- Compatibility ..... 5 VTTL
- Response ..... Rising or falling edge
- Pulse width ..... 10 ns minimum

# 16-Bit E Series Multifunction DAQ Specifications

## Specifications – NI 6052E and NI 603xE (continued)

### External Input for Digital or Analog Trigger (PFI 0/AI START TRIG)

(6052E, 6033E, 6032E, 6031E, 6030E only)

Impedance ..... 10 kΩ
Coupling ..... DC
Protection
  Digital trigger ..... -0.5 to Vcc + 0.5 V
  Analog trigger
    On/off/disabled ..... ±35 V

## Calibration

Recommended warm-up time ..... 15 minutes; 30 minutes for DAQCard
Calibration Interval ..... 1 year
Onboard calibration reference

| | DC Level | |
|---|---|---|
| 6052E, 6030E. 6031E, 6032E, 6033E | 5.000 V (±1.0 mV) | Over full operating temperature, actual value stored in EEPROM |
| 6034E, 6036E | 5.000 V (±3.5 mV) | |

| | Temperature Coefficient |
|---|---|
| 6052E, 6030E, 6031E, 6032E, 6033E | ±0.6 ppm/°C max |
| 6034E, 6036E | ±5.0 ppm/°C max |

| | Long-Term Stability |
|---|---|
| 6052E, 6030E 6031E, 6032E, 6033E | ±6.0 ppm/$\sqrt{1000\ h}$ |
| 6034E, 6036E | ±15.0 ppm/$\sqrt{1000\ h}$ |

## RTSI

Trigger lines
  PCI ..... 7
  DAQPad ..... 4

## PXI Trigger Bus (PXI only)

Trigger lines ..... 6
Star trigger ..... 1

## Bus Interface

PCI, PXI ..... Master, slave
DAQCard ..... Slave
DAQPad ..... Master, slave, asynchronous, 400 Mb/s

## Power Requirements[1]

| Device | +5 VDC (±5%) | Power Available at I/O Connector |
|---|---|---|
| PCI-6052E, PXI-6052E | 1.3 A | +4.65 to +5.25 VDC, 1 A |
| 6030E, 6031E, 6032E, 6033E | 1.5 A | +4.65 to +5.25 VDC, 1 A |
| 6034E PCI-6036E | 0.9 A | +4.65 to +5.25 VDC, 1 A |
| DAQCard-6036E | 300 mA | +4.65 to +5.25 VDC, 0.75 A |

DAQPad-6052E ..... 20W @ 9-24 VDC

## Physical[1]

### Dimensions (not including connectors)[1]

PCI ..... 17.5 by 10.6 cm (6.9 by 4.2 in.)
PXI ..... 16.0 by 10.0 cm (6.3 by 3.9 in.)
DAQCard ..... Type II PC Card
DAQPad ..... 30.7 by 25.4 by 4.3 cm (12.1 by 10 by 1.7 in.)

| | I/O Connectors |
|---|---|
| PCI-6052E 6030E 6032E 6034E PCI-6036E | 68-pin male SCSI-II type |
| 6031E 6033E | 100-pin female 0.050 D-type |
| DAQCard-6036E | 68-position VHDCI female |
| DAQPad-6052E | 68-pin male SCSI-II type, or 15 BNCs and 30 removeable screw terminals |

## Environment

Operating temperature
6052E, 6036E, 6034E ..... 0 to 55 °C
6030E, 6031E, 6032E, 6033E ..... 0 to 50 °C
Storage temperature ..... -20 to 70 °C
Relative humidity ..... 10 to 90%, noncondensing

## Certifications and Compliances

**CE Mark Compliance** CE

[1]See page 134 for RT Series device power requirements and physical parameters.

# Multifunction DAQ Cable and Accessory Selection Guides

## NI Cable Design Advantages

The SH68-68-EP cable is the most commonly used E Series and S Series cable. The cable is designed to work specifically with the NI Multifunction DAQ devices to preserve signal integrity through these technologies:

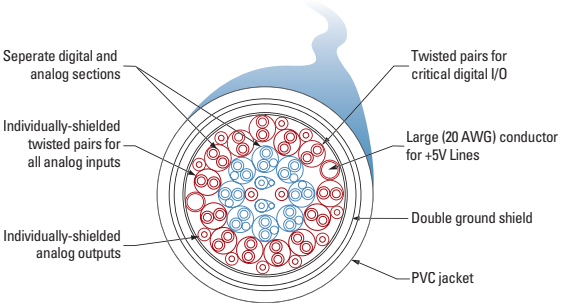



*Figure 1. SH68-68-EP Cable*



*Figure 2. NI offers a wide variety of cable and accessory options, such as the SH68-68-EP cable and the BNC-2110 terminal block.*

A variety of cabling and accessory options are available for your needs. Use the following tables to choose the most appropriate cables and accessories. To determine which Multifunction DAQ device best fits your needs, please see page 189.



| Platform | Shielding | Connect to ... | Cable | Adapter | Accessory |
|---|---|---|---|---|---|
| **PCI/PXI/USB/FireWire** | | | | | |
| | Shielded | SCC portable signal conditioning per channel | SH68-68-EP | – | SC-2345 and modules, page 251 |
| | Shielded | SCXI high-performance signal conditioning | SCXI-1349 | – | SCXI Chassis and Modules, page 270 |
| | Shielded | Screw terminals [1] | SH68-68-EP or SH68-68R1-EP | – | SCB-68 |
| | Shielded | BNC terminal block | SH68-68-EP | – | BNC-2110, BNC-2120, BNC-2090 |
| | Shielded | 50-pin connector | SH6850 | – | CB50, custom or 3rd party |
| | Shielded | Configurable connectivity box | SH68-68-EP | – | CA-1000, page 351 |
| | Unshielded | Screw terminals [1] | R6868 | – | TBX-68, CB-68LP, CB-68LPR, DAQ signal accessory |
| | Unshielded | 50-pin connector | R6850 | – | CB50, custom or 3rd party |
| **PXI only** | | | | | |
| | Shielded | Front-mounted screw terminals | N/A | – | TB-2705 |
| **PCMCIA** | | | | | |
| | Shielded | Screw terminals [1] | SHC68-68-EP or SHC68U-68-EP [2] | – | SCB-68, CA-1000 |
| | Shielded | 50-pin connector | SHC68-68-EP or SHC68U-68-EP [2] | 68M-50F MIO | CB50, custom or 3rd party |
| | Unshielded | Screw terminals [1] | RC68-68 | | TBX-68, CB-68LP, CB-68LPR, DAQ signal accessory |
| | Unshielded | 50-pin connector | RC68-68 | 68M-50F MIO | CB50, custom or 3rd party |

[1] Unshielded cables can connect to shielded accessories and vice-versa. [2] In adjacent PCMCIA slots, both cables types are required because the same cable would cause mechanical hindrance.

*Table 1. Cable Connection Specifications for 16-Channel E Series Devices and Basic Multifunction DAQ (except NI 6025E, which is on the next page)*

# Multifunction DAQ Cable and Accessory Selection Guides





| | | | |
|---|---|---|---|
| AI 0- | 34 | 68 | AI 0+ |
| AI 1+ | 33 | 67 | AI 0 GND |
| AI 1 GND | 32 | 66 | AI 1- |
| AI 2- | 31 | 65 | AI 2+ |
| AI 3+ | 30 | 64 | AI 2 GND |
| AI 3 GND | 29 | 63 | AI 3- |
| NC | 28 | 62 | NC |
| NC | 27 | 61 | NC |
| NC | 26 | 60 | NC |
| NC | 25 | 59 | NC |
| NC | 24 | 58 | NC |
| NC | 23 | 57 | NC |
| AO 0 | 22 | 56 | NC |
| AO 0 | 21 | 55 | AO GND |
| EXT REF | 20 | 54 | AO GND |
| P0.4 | 19 | 53 | D GND |
| D GND | 18 | 52 | P0.0 |
| P0.1 | 17 | 51 | P0.5 |
| P0.6 | 16 | 50 | D GND |
| D GND | 15 | 49 | P0.2 |
| +5 V | 14 | 48 | P0.7 |
| D GND | 13 | 47 | P0.3 |
| D GND | 12 | 46 | AI HOLD |
| PFI 0/AI START | 11 | 45 | EXT STROBE |
| PFI 1/REF TRIG | 10 | 44 | D GND |
| D GND | 9 | 43 | PFI 2/AI CONV |
| +5 V | 8 | 42 | PFI 3/CTR 1 SRC |
| D GND | 7 | 41 | PFI 4/CTR1 GATE |
| PFI 5/AO SAMP | 6 | 40 | CTR 1 OUT |
| PFI 6/AO START | 5 | 39 | D GND |
| D GND | 4 | 38 | PFI 7/AI SAMP |
| PFI 9/CTR 0 GATE | 3 | 37 | PFI 8/CTR 0 SRC |
| CTR 0 OUT | 2 | 36 | D GND |
| F OUT | 1 | 35 | D GND |

*Figure 2. S Series Devices Connector*

[1]No connects for boards that do not support AO or use an external reference with the SH1006868 cable.

| | | | |
|---|---|---|---|
| AI 8 | 34 | 68 | AI 0 |
| AI 1 | 33 | 67 | AI GND |
| AI GND | 32 | 66 | AI 9 |
| AI 10 | 31 | 65 | AI 2 |
| AI 3 | 30 | 64 | AI GND |
| AI GND | 29 | 63 | AI 11 |
| AI 4 | 28 | 62 | AI SENSE |
| AI GND | 27 | 61 | AI 12 |
| ACH13 | 26 | 60 | AI 5 |
| ACH6 | 25 | 59 | AI GND |
| AIGND | 24 | 58 | AI 14 |
| ACH15 | 23 | 57 | AI 7 |
| AO 0[1] | 22 | 56 | AI GND |
| AO 1[1] | 21 | 55 | AO GND |
| EXT REF[1] | 20 | 54 | AO GND |
| P0.4 | 19 | 53 | D GND |
| D GND | 18 | 52 | P0.0 |
| P0.1 | 17 | 51 | P0.5 |
| P0.6 | 16 | 50 | D GND |
| D GND | 15 | 49 | P0.2 |
| +5 V | 14 | 48 | P0.7 |
| D GND | 13 | 47 | P0.3 |
| D GND | 12 | 46 | AI HOLD |
| PFI 0/AI START | 11 | 45 | EXT STROBE |
| PFI 1/REF TRIG | 10 | 44 | D GND |
| D GND | 9 | 43 | PFI 2/AI CONV |
| +5 V | 8 | 42 | PFI 3/AI CTR 1 SRC |
| D GND | 7 | 41 | PFI 4/AI CTR 1 GATE |
| PFI 5/AO SAMP | 6 | 40 | CTR 1 OUT |
| PFI 6/AO START | 5 | 39 | D GND |
| DGND | 4 | 38 | PFI 7/AI SAMP |
| PFI 9/CTR 0 GATE | 3 | 37 | PFI 8/CTR 0 SRC |
| CTR 0 OUT | 2 | 36 | D GND |
| F OUT | 1 | 35 | D GND |

*Figure 3. I/O Connector for 16-Channel E Series and Basic Multifunction DAQ Devices, except NI 6025E*

| | | | |
|---|---|---|---|
| AI GND | 1 | 51 | AI 16 |
| AI GND | 2 | 52 | AI 24 |
| AI 0 | 3 | 53 | AI 17 |
| AI 8 | 4 | 54 | AI 25 |
| AI 1 | 5 | 55 | AI 18 |
| AI 9 | 6 | 56 | AI 26 |
| AI 2 | 7 | 57 | AI 19 |
| AI 10 | 8 | 58 | AI 27 |
| AI 3 | 9 | 59 | AI 20 |
| AI 11 | 10 | 60 | AI 28 |
| AI 4 | 11 | 61 | AI 21 |
| AI 12 | 12 | 62 | AI 29 |
| AI 5 | 13 | 63 | AI 22 |
| AI 13 | 14 | 64 | AI 30 |
| AI 6 | 15 | 65 | AI 23 |
| AI 14 | 16 | 66 | AI 31 |
| AI 7 | 17 | 67 | AI 32 |
| AI 15 | 18 | 68 | AI 40 |
| AI SENSE | 19 | 69 | AI 33 |
| AO 0 | 20 | 70 | AI 41 |
| AO 1 | 21 | 71 | AI 34 |
| EXT REF | 22 | 72 | AI 42 |
| AO GND | 23 | 73 | AI 35 |
| D GND | 24 | 74 | AI 43 |
| P0.0 | 25 | 75 | AI SENSE 2 |
| P0.4 | 26 | 76 | AI GND |
| P0.1 | 27 | 77 | AI 36 |
| P0.5 | 28 | 78 | AI 44 |
| P0.2 | 29 | 79 | AI 37 |
| P0.6 | 30 | 80 | AI 45 |
| P0.3 | 31 | 81 | AI 38 |
| P0.7 | 32 | 82 | AI 46 |
| D GND | 33 | 83 | AI 39 |
| +5 V | 34 | 84 | AI 47 |
| +5 V | 35 | 85 | AI 48 |
| AI HOLD | 36 | 86 | AI 56 |
| EXT STROBE | 37 | 87 | AI 49 |
| PFI 0/AI START | 38 | 88 | AI 57 |
| PFI 1/REF TRIG | 39 | 89 | AI 50 |
| PFI 2/AI CONV | 40 | 90 | AI 58 |
| PFI 3/CTR 1 SRC | 41 | 91 | AI 51 |
| PFI 4/CTR 1 GATE | 42 | 92 | AI 59 |
| CTR 1 OUT | 43 | 93 | AI 52 |
| PFI 5/AO SAMP | 44 | 94 | AI 60 |
| PFI 6/AO START | 45 | 95 | AI 53 |
| PFI 7/AI SAMP | 46 | 96 | AI 61 |
| PFI 8/CTR 0 SRC | 47 | 97 | AI 54 |
| PFI 9/CTR 0 GATE | 48 | 98 | AI 62 |
| CTR 0 OUT | 49 | 99 | AI 55 |
| F OUT | 50 | 100 | AI 63 |

*Figure 4. I/O Connector for 64-Channel E Series Devices*

| | | | |
|---|---|---|---|
| AI GND | 1 | 51 | P2.7 |
| AI GND | 2 | 52 | GND |
| AI 0 | 3 | 53 | P2.6 |
| AI 8 | 4 | 54 | GND |
| AI 1 | 5 | 55 | P2.5 |
| AI 9 | 6 | 56 | GND |
| AI 2 | 7 | 57 | P2.4 |
| AI 10 | 8 | 58 | GND |
| AI 3 | 9 | 59 | P2.3 |
| AI 11 | 10 | 60 | GND |
| AI 4 | 11 | 61 | P2.2 |
| AI 12 | 12 | 62 | GND |
| AI 5 | 13 | 63 | P2.1 |
| AI 13 | 14 | 64 | GND |
| AI 6 | 15 | 65 | P2.0 |
| AI 14 | 16 | 66 | GND |
| AI 7 | 17 | 67 | P1.7 |
| AI 15 | 18 | 68 | GND |
| AI SENSE | 19 | 69 | P1.6 |
| AO 0 | 20 | 70 | GND |
| AO 1 | 21 | 71 | P1.5 |
| NC | 22 | 72 | GND |
| AO GND | 23 | 73 | P1.4 |
| D GND | 24 | 74 | GND |
| P0.0 | 25 | 75 | P1.3 |
| P0.4 | 26 | 76 | GND |
| P0.1 | 27 | 77 | P1.2 |
| P0.5 | 28 | 78 | GND |
| P0.2 | 29 | 79 | P1.1 |
| P0.6 | 30 | 80 | GND |
| P0.3 | 31 | 81 | P1.0 |
| P0.7 | 32 | 82 | GND |
| D GND | 33 | 83 | P0.7 |
| +5 V | 34 | 84 | GND |
| +5 V | 35 | 85 | P0.6 |
| AI HOLD | 36 | 86 | GND |
| EXT STROBE | 37 | 87 | P0.5 |
| PFI 0/AI START | 38 | 88 | GND |
| PFI 1/REF TRIG | 39 | 89 | P0.4 |
| PFI 2/AI CONV | 40 | 90 | GND |
| PFI 3/CTR 1 SRC | 41 | 91 | P0.3 |
| PFI 4/CTR 1 GATE | 42 | 92 | GND |
| CTR 1 OUT | 43 | 93 | P0.2 |
| PFI 5/AO SAMP | 44 | 94 | GND |
| PFI 6/AO START | 45 | 95 | P0.1 |
| PFI 7/AI SAMP | 46 | 96 | GND |
| PFI 8/CTR 0 SRC | 47 | 97 | P0.0 |
| PFI 9/CTR 0 GATE | 48 | 98 | GND |
| CTR 0 OUT | 49 | 99 | +5 V |
| F OUT | 50 | 100 | GND |

*Figure 5. I/O Connector for the NI 6025E Device*

## E Series Devices (NI 6031E, NI 6033E, NI 6071E, NI 6025E)

| Platform | Shielding | Connect to ... | Cable | Cable Leg | Adapter | Accessory |
|---|---|---|---|---|---|---|
| **PCI, PXI** | | | | | | |
| | Shielded | Screw terminals | SH100100 | – | – | SCB-100 |
| | Shielded | Screw terminals | SH1006868 | MIO: | – | SCB-68 |
| | Shielded | | SH1006868 | Extended: | – | SCB-68 |
| | Shielded | Screw terminals[1] | SH1006868 | MIO: | – | TBX-68, CB-68LP, CB-68LPR, DAQ signal accessory |
| | Shielded | Screw terminals[1] | SH1006868 | Extended: | – | TBX-68, CB-68LP, CB-68LPR |
| | Shielded | BNC terminal block | SH1006868 | MIO: | – | BNC-2110, BNC-2120, BNC-2090 |
| | Shielded | | SH1006868 | Extended: | – | BNC-2115 |
| | Shielded | 50-pin connectors | SH1006868 | MIO: | 68M-50F MIO | Custom or 3rd party |
| | Shielded | | SH1006868 | Extended: | 68M-50F Extended | Custom or 3rd party |
| | Unshielded | 50-pin connector | R1005050 | MIO: | – | Custom or 3rd party |
| | Unshielded | | R1005050 | Extended: | – | Custom or 3rd party |

[1]Shielded cable with unshielded accessories

*Table 2. Cable Connection Specifications for 64-Channel E Series Devices and the NI 6025E*

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