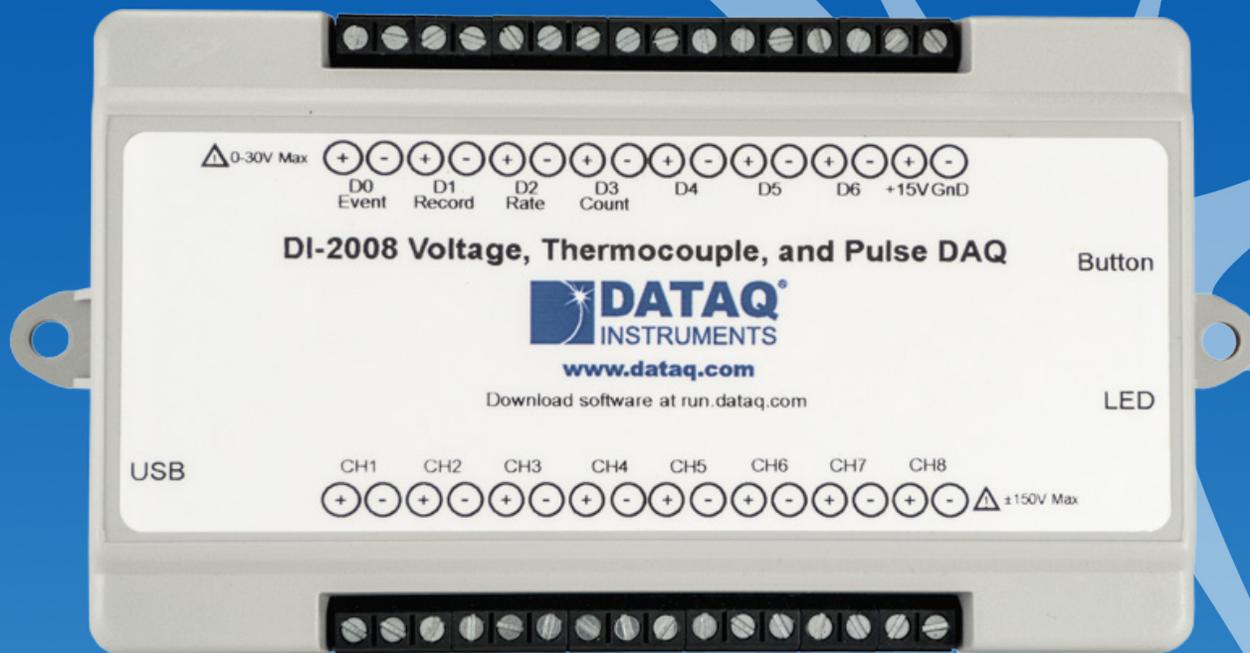# DI-2008 Thermocouple and Voltage Data Acquisition System

- ✓ **Includes DI-2008 instrument, WinDaq software, calibration certificate, terminal screwdriver, and USB cable (6-feet)**
- ✓ **Eight differential and isolated analog input channels**
- ✓ **Seven bi-directional digital input ports, including:**
  - ✓ **Counter input for totalizing applications**
  - ✓ **Rate input for frequency/flow/rpm applications**
- ✓ **ChannelStretch™ channel expansion to 128 analog and 112 digital channels**
- ✓ **Programmable voltage and thermocouple measurements per channel**
- ✓ **10 mV to 50 V programmable range per channel in 12 steps**
- ✓ **Programmable support for type J, K, T, B, R, S, E, N thermocouples per channel**
- ✓ **High resolution (16-bit) measurements**
- ✓ **2000 Hz max sample throughput for a single channel and 200 Hz for two or more**
- ✓ **Minimum sample throughput rates as low as 1 sample per day**
- ✓ **USB interface**
- ✓ **Included WinDaq software for ready-to-run measurements**
- ✓ **Included .NET class for Visual Studio program development**
- ✓ **Fully documented device protocol supports other operating systems**

DATAQ INSTRUMENTS®

DI-2008 Description

One PC-based product offers affordable and expandable measurement flexibility with analog isolation that's so critical for successful measurements in any situation: Model DI-2008. Read on and let us show you why this low-cost data acquisition system supplies the performance of products many times its price.

Analog Subsystem

Eight analog input channels adapt to a wide range of measurement types and applications. Each channel can be independently programmed for a thermocouple or voltage measurement. Programmed as a voltage channel you can select one of twelve measurement ranges from ±10 mV to ±50 V. A range of ±5 V supports 4-20 mA measurements using typically a 250 Ω shunt resistor (model R250 sold separately). Programmed as a thermocouple channel you can select from eight thermocouple types: J, K, T, B, R, S, E, or N. Linearization and junction compensation are automatically applied by the DI-2008 for the selected TC type to deliver values scaled in either °C or °F. Rounding out the DI-2008, a built-in 15 V sensor excitation power supply simplifies external wiring and further reduces overall system cost. Finally, all analog measurements benefit from a 16-bit ADC resolution to reveal even the smallest signal variations.

Virtually any measurement will experience a difference in ground potential between the instrument, the signal source, and even between signal sources. Known as common mode voltages, they cause noisy measurements in the best case or damage to the instrument in the worst case unless it's specifically designed to tolerate them like the DI-2008. Each DI-2008 analog input is electrically isolated from other channels and from ground for safe and accurate measurements in the presence of common mode voltages. Channel isolation means that each analog input is free to float to an independent common mode voltage imposed upon it by the signal source up to 120 V rms, and still provide an accurate and noise-free measurement.
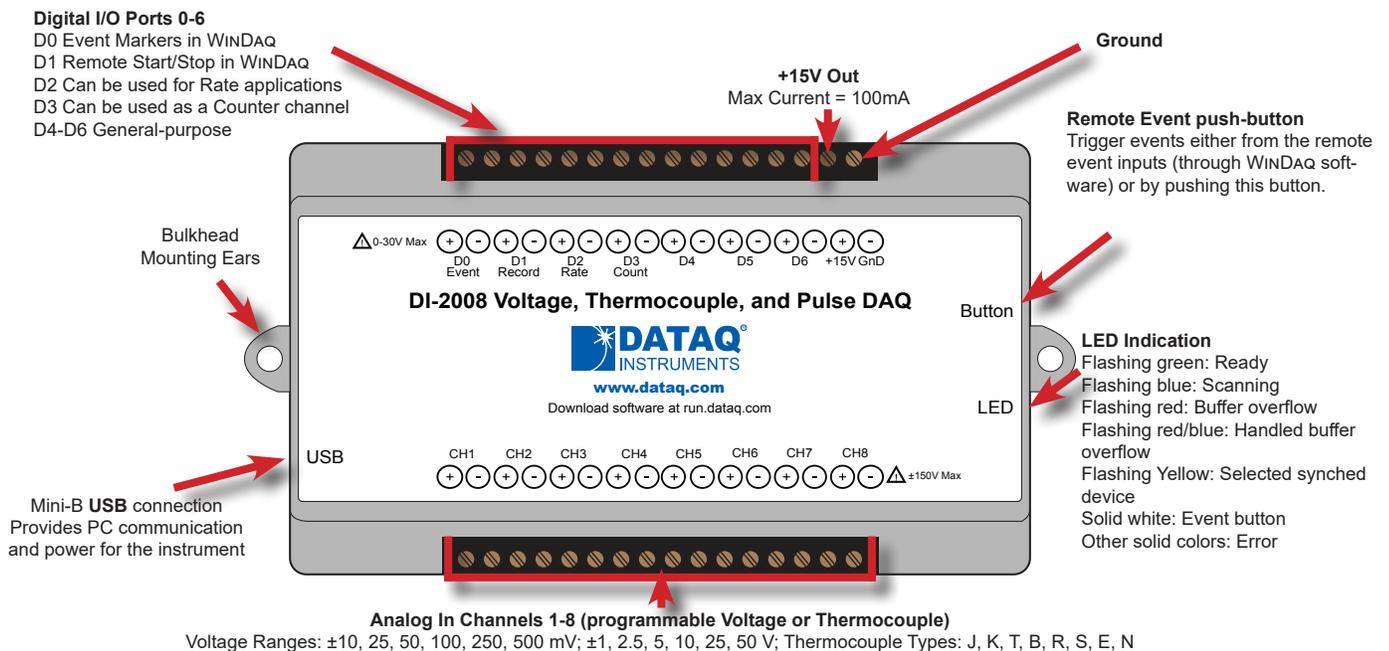
Digital Port Subsystem

The DI-2008 provides 7 digital ports, each configurable as an input or a switch. Input protection is provided to 30 V. Configured as a switch a digital port can be used to control external loads up to 30 V @ 100 mA, and the switch can be controlled asynchronously without interrupting the scanning process. When activated as inputs two ports allow dual functionality to be used as discrete inputs, or one as a counter and the other a rate input. The rate input features a 50 kHz maximum measurement allocated over twelve programmable measurement ranges (10 Hz to 50 kHz full scale). The counter input provides 16-bit resolution and a terminal count value of 65,535. The discrete, counter, and rate inputs are members of the same internal scan list used by the analog input channels. This means that all enabled elements are acquired synchronously, which allows meaningful comparisons between analog and digital channels. For example, the rate input measuring engine speed allows rpm data to be acquired synchronously with analog data.

Supports ChannelStretch™ Channel Expansion

Simply add more DI-2008s to achieve synchronous channel expansion up to 128 analog channels and 112 digital ports (details inside).

DI-2008 Close-up

Digital I/O Ports 0-6
D0 Event Markers in WinDaq
D1 Remote Start/Stop in WinDaq
D2 Can be used for Rate applications
D3 Can be used as a Counter channel
D4-D6 General-purpose

+15V Out
Max Current = 100mA

Ground

Remote Event push-button
Trigger events either from the remote event inputs (through WinDaq software) or by pushing this button.

Bulkhead Mounting Ears

⚠ 0-30V Max
+ − + − + − + − + − + − + − + −
D0   D1   D2   D3   D4   D5   D6 +15V GnD
Event Record Rate Count

DI-2008 Voltage, Thermocouple, and Pulse DAQ

DATAQ INSTRUMENTS
www.dataq.com
Download software at run.dataq.com

Button

LED

LED Indication
Flashing green: Ready
Flashing blue: Scanning
Flashing red: Buffer overflow
Flashing red/blue: Handled buffer overflow
Flashing Yellow: Selected synched device
Solid white: Event button
Other solid colors: Error

USB

CH1 CH2 CH3 CH4 CH5 CH6 CH7 CH8
+ − + − + − + − + − + − + − + − ⚠ ±150V Max

Mini-B USB connection
Provides PC communication and power for the instrument

Analog In Channels 1-8 (programmable Voltage or Thermocouple)
Voltage Ranges: ±10, 25, 50, 100, 250, 500 mV; ±1, 2.5, 5, 10, 25, 50 V; Thermocouple Types: J, K, T, B, R, S, E, N

DI-2008 Major Features and Benefits

Eight Analog Input Channels
Measure as many as eight analog system variables at once with a single instrument.

Supports ChannelStretch™ Channel Expansion
Add more DI-2008s to provide synchronous channel expansion to 128 analog channels and 112 digital ports.

Differential Input configuration
Noise-cancelling measurements in virtually any application setting.

Programmable Voltage Ranges per Channel
Each DI-2008 channel may be programmed for one of the following ranges: ±10, 25, 50, 100, 200, 500 mV; ±1, 2.5, 5, 10, 25, 50 V

Programmable Thermocouple Types per Channel
The DI-2008 supports direct-connected J, K, T, B, R, S, E, and/or N thermocouples without external signal conditioning.

Wide Sampling Rate Range
Sample from minute to millisecond intervals using the supplied software. A single enabled channel can be sampled as fast as 2 kHz or as low as 1 sample every 2.5 hours.

Excitation Power Supply Output
Forget additional power supplies. Use the DI-2008's 15 V/60 mA excitation output to power external sensors, like voltage and 4-20 mA output sensors.

Rate Measurement Channel
Measure pulse rates from sensors for rpm or flow, for example. Twelve programmable ranges from 10 Hz to 50 kHz.

Counter Channel
Totalize the number of pulses applied. Useful for integrating rate information, like flow rate to volume, or simply the number of events.

16-bit Measurement Resolution
Resolve even the smallest changes in applied voltage and temperature (see specifications for details).

Isolated Analog Inputs
Allows no-consequence, off-ground measurements in demanding industrial settings.

Seven Digital Ports
Folds discrete I/O into the measurements process. Each bit is programmable as an input or as a switch.

Protected Inputs
Analog and digital inputs are protected to prevent mishap-causing damage to the instrument. Analog inputs to 120 V rms and digital to +30 V.

Built-in CJC
Cold junction compensation is automatically enabled for any channel programmed as a thermocouple input.

Included Ready-to-run Software
Our WinDaq data acquisition software offers real time display and disk streaming for the Windows environment up to the full sample rate of the DI-2008. The real time display can operate in a smooth scroll or triggered sweep mode of operation, and can be scaled into any unit of measure. Event markers with comments allow you to annotate your data acquisition session with descriptive information as you record to disk. Raise your productivity to new heights with WinDaq's unique multitasking feature. Record waveform data to disk in the background while running any combination of programs in the foreground — even WinDaq Playback software to review and analyze waveform data as it's being stored! Playback supports waveform analysis (Statistics, X-Y plots, frequency analysis) and the ability to export data to Microsoft Excel. WinDaq recording and playback software is provided free with every DI-2008 purchase. See the WinDaq Multimedia Tutorial for more information.

DI-2008 Dimensional Drawing

Top View

6.71
6.31
5.71
3.26
2.13
5.45
Ø0.20

Side View

1.15
1.67
3.35
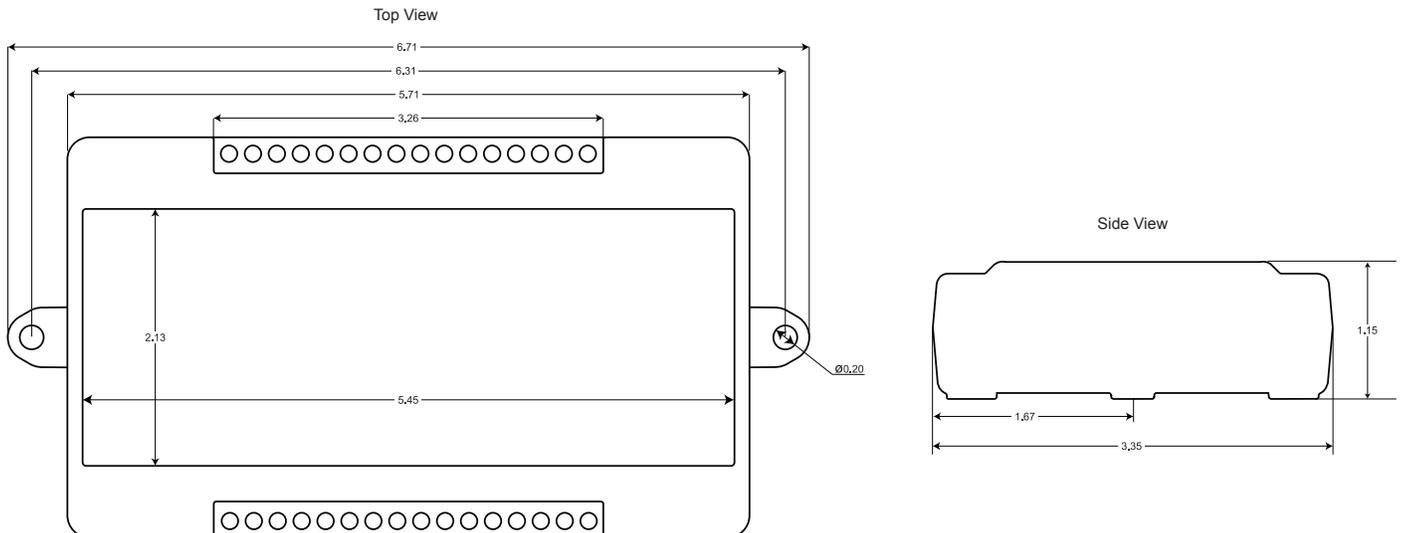
All dimensions in inches

Channel Expansion Using ChannelStretch™ Technology

Need more than eight analog channels or seven digital ports? Just add another DI-2008. In fact you can add as many as 15 additional units for a total of 128 analog channels and 112 digital ports. Multiple DI-2008s connected to the same USB hub automatically synchronize to within 10 µS between units, and the maximum sample rate throughput of each instrument is preserved. For example, twelve chained DI-2008 each with a single enabled channel supports 24 kHz throughput (12 × 2 kHz.) If you need more USB ports to accommodate more DI-2008 units, simply cascade multiple hubs to expand USB port count. Best of all, when using WinDaq software the enabled channels of all synced units flow into the same WinDaq application. They're displayed and recorded together as though they were all acquired from a single instrument. See Detailed Specifications for supported channels and sample rate combinations. The WinDaq/Unlock option is required for a DI-2008 to use ChannelStretch™ when using our WinDaq software, but the ChannelStretch™ feature supports the instrument protocol and .Net class so you can fold this powerful feature into your own applications.

ChannelStretch™ Technology

16 units max
Max throughput ≥ 480 kHz

to PC

USB hub*

to Power as required
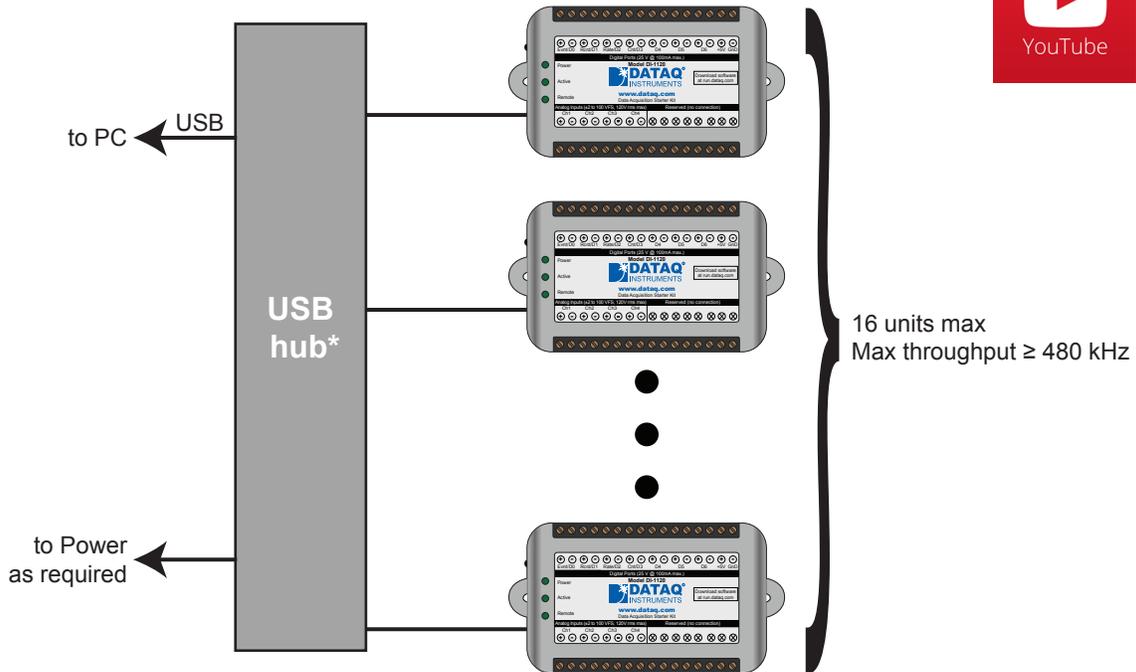
*DATAQ Instruments 7-port USB hub (part number 2000310). Cascade for a higher port count.

DI-2008 I/O Equivalent Circuits

Analog Input
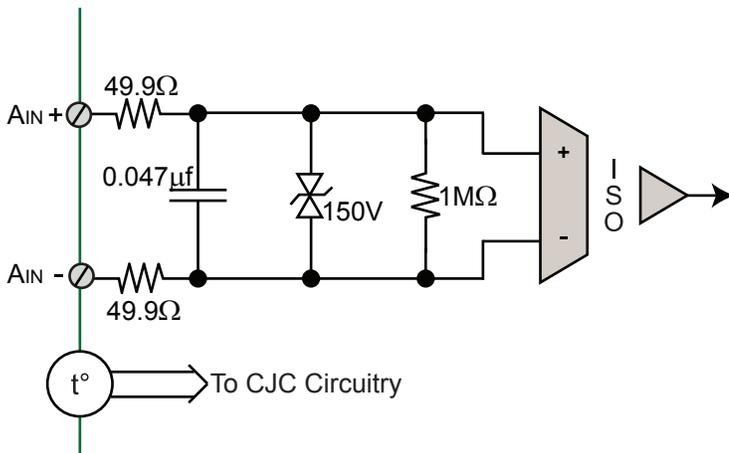
Digital Port
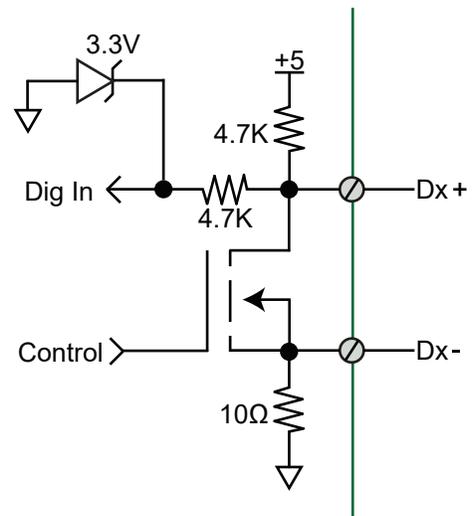
The DI-2008 can adapt to almost any industrial measurement. Typical uses are:

- Off-ground current shunts
- 4-20 mA process current (including self-powered
- Totalizing applications (volume from flow, energy, etc.)

- Large source voltages
- Thermocouple-based temperatures
- Rate (rpm, flow, etc.)

The DI-2008's isolated analog inputs allow the instrument to tolerate measurement conditions that products many times it price range will not. This is important for measurement applications with inherent common mode voltages, like high-side current shunts in both 4-20 mA and general current measurements. Isolation also reduces ground loop and common mode voltage errors associated with long wiring runs, grounded thermocouples and other grounded measurement sources. In short, no other product in its price range provides more measurement flexibility and adaptability than the DI-2008.
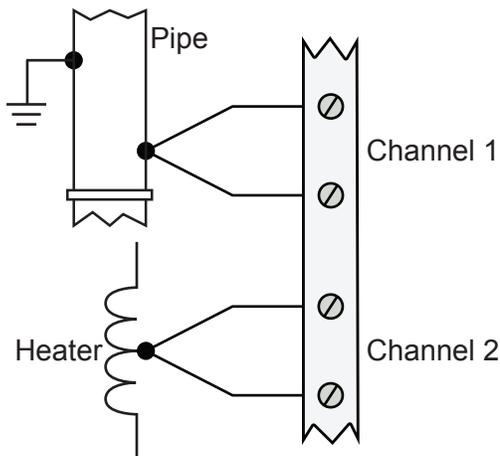
General configuration
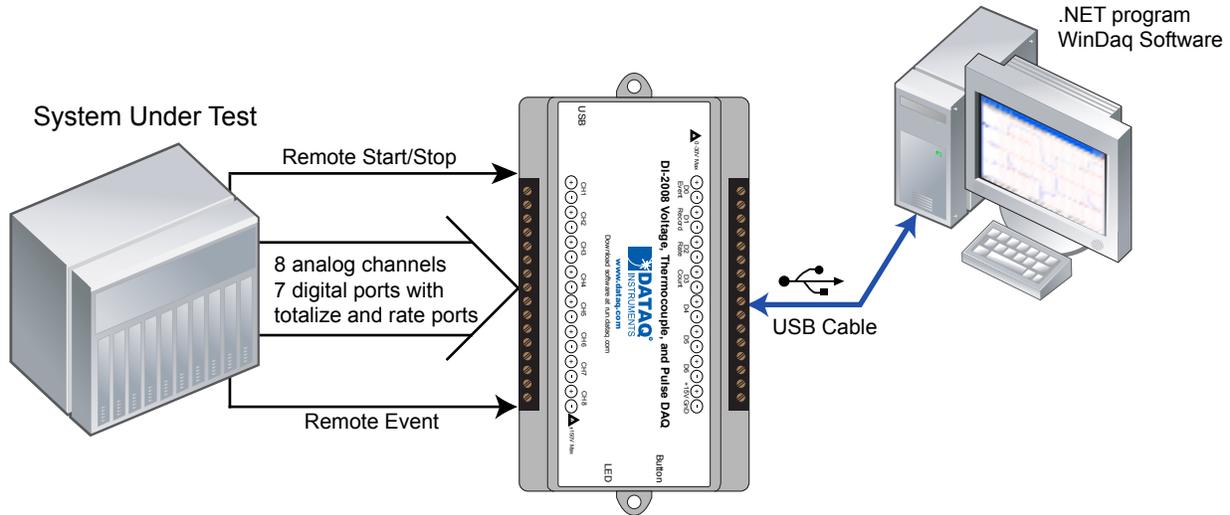
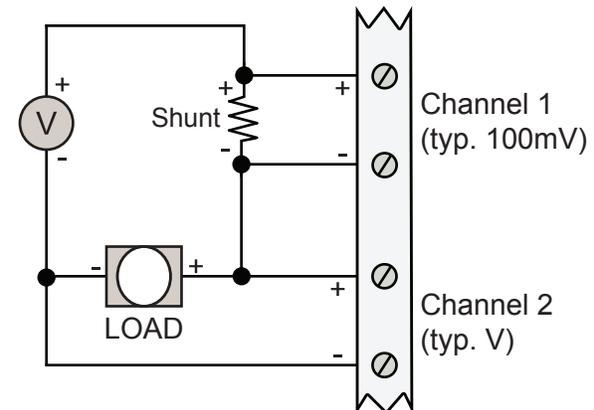### 4-20 mA current (low-side shunt)
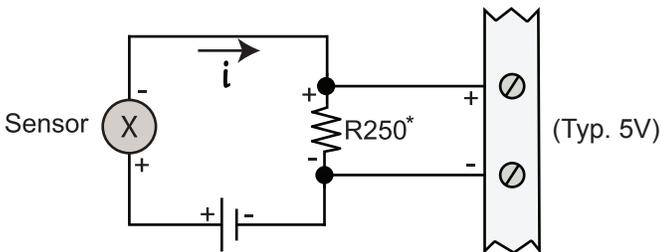
4-20 mA current (high-side shunt)
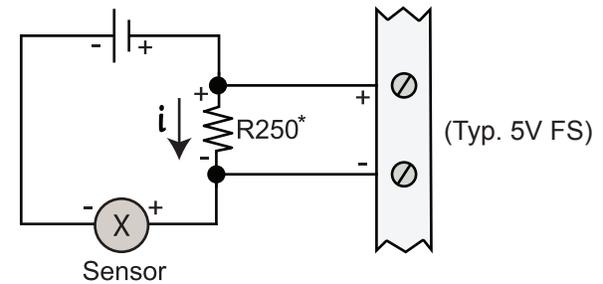
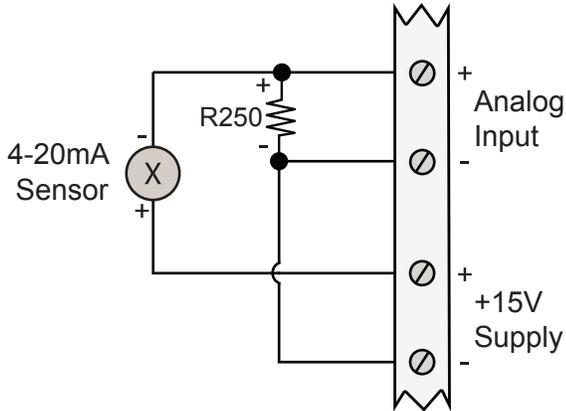### Grounded and Powered Thermocouple

Simultaneous voltage and current
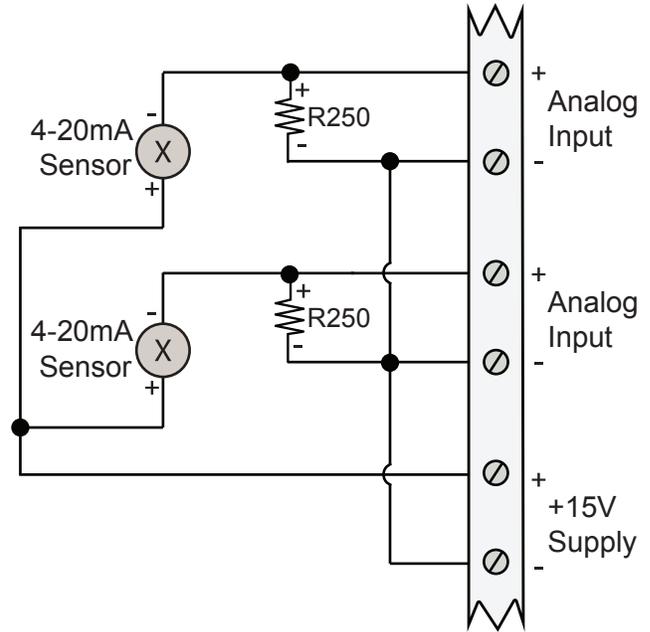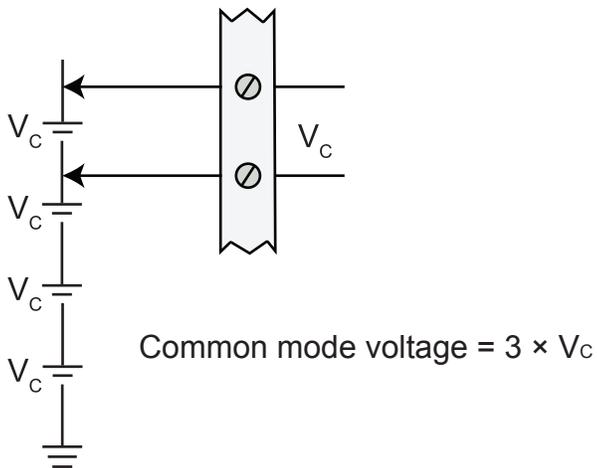

*Model R250, 250 shunt resistor, see Ordering Guide

Self-powered 4-20 mA sensor

4-20mA Sensor — X

R250

Analog Input

+15V Supply

Two Self-powered 4-20 mA sensors

4-20mA Sensor — X

R250

Analog Input

4-20mA Sensor — X

R250

Analog Input

+15V Supply

Stacked cells

V_C

V_C

V_C

V_C

V_C

Common mode voltage = $3 \times V_C$

Heat flux sensor

T_1

T_2

1mV = 1BTU/ft^2/sec

(Typ. 10mV)
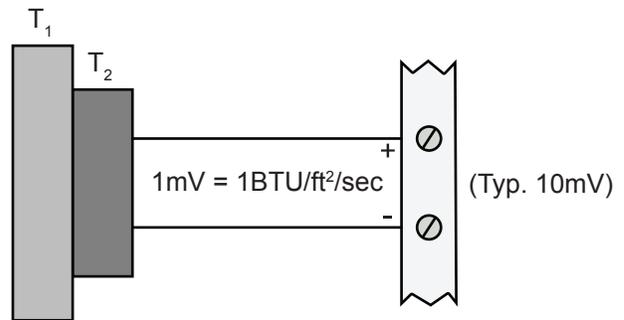
Totalizing (ex. volume from flow)

Rate measurement

Proximity sensor

Shaft

12 pulses per revolution
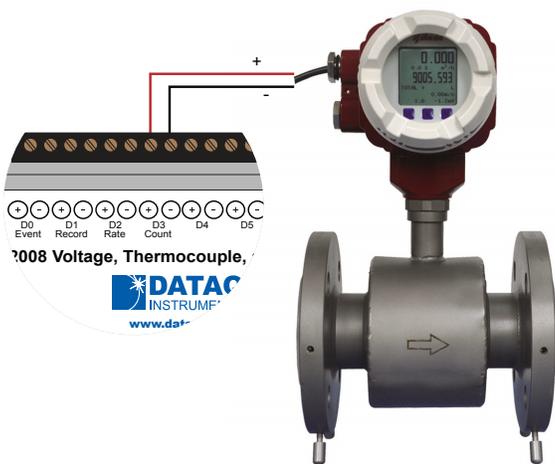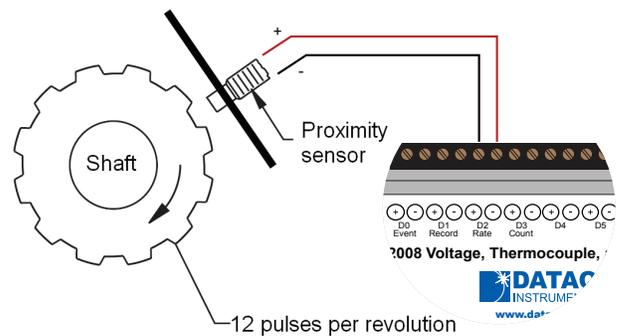
Photovoltaic Measurements
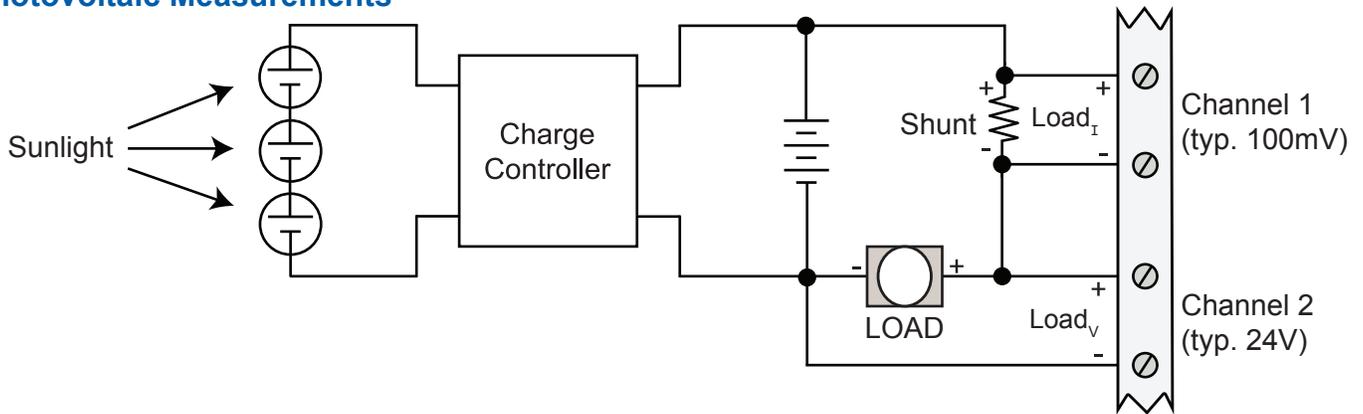
Operating Digital Ports as Switches

Each DI-2008 digital port can be configured as a digital input or used as a switch to control an external load. Ports are configured by a MOSFET that defines the port's function, where the MOSFET is either on or off. When the MOSFET is off the port is available as a discrete input. Turning the MOSFET on allows the port to function like a switch for loads up to 30 V and 100 mA with the following typical correct and incorrect connections:
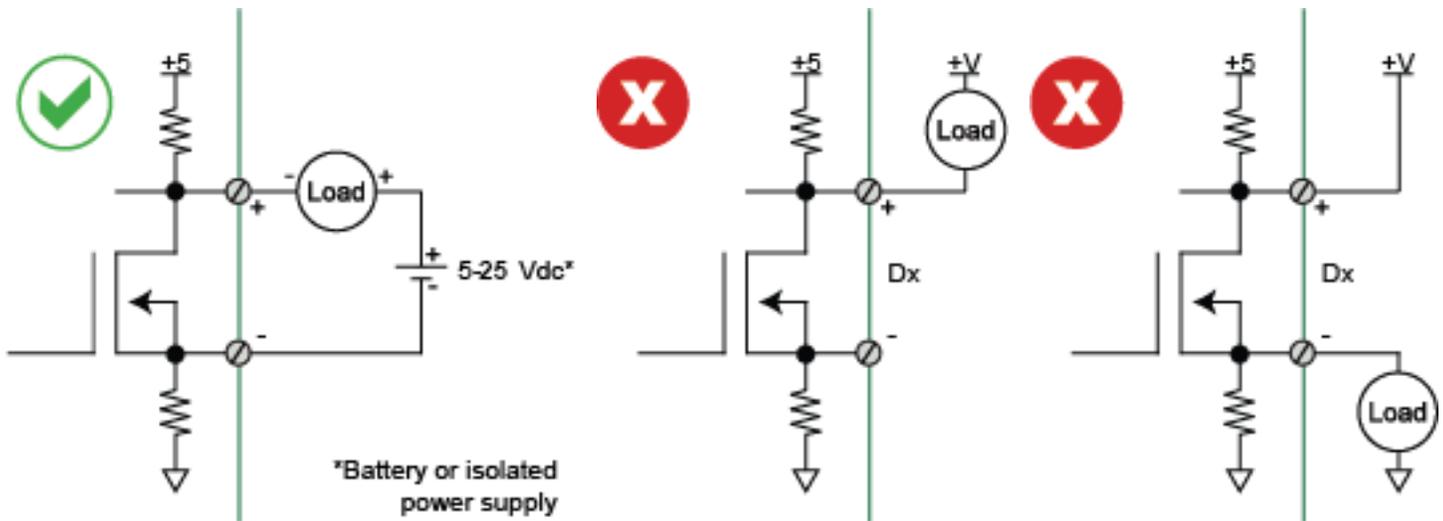
Setup

Double-click and enter the channels you want to acquire into the WinDaq scan list. These can be channels from a single or multiple units using ChannelStretch™. Click to select a voltage, TC, rate, or count channel. Click to define a single to 32-channel display - either triggered sweep (oscilloscope-like) or scrolling (chart recorder-like). Click again to define a sample rate ranging from about 10 samples per day to 2,000 samples per second.
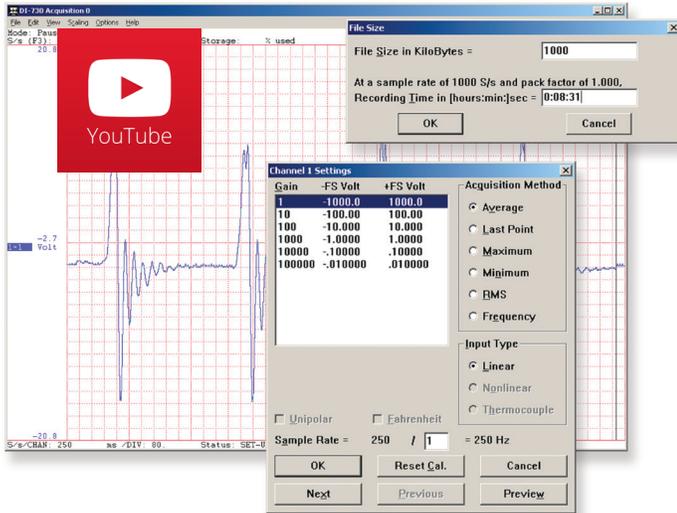
Scale

Define engineering units per channel to display waveform values in meaningful units such as psi, °F or °C, amps, rpm, watts, Horse-power— any unit of measure you need.
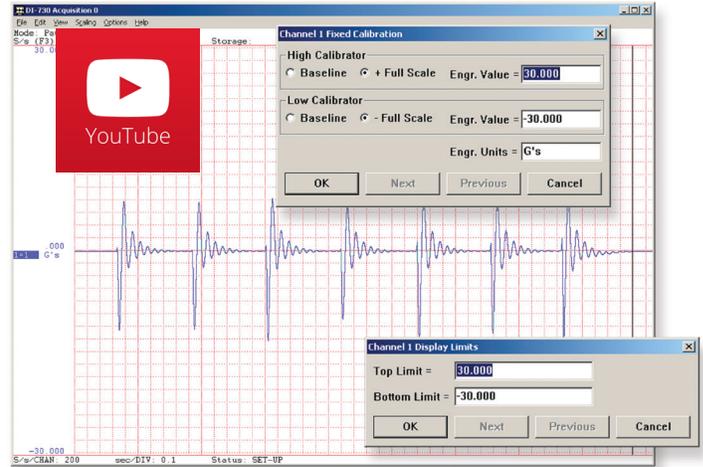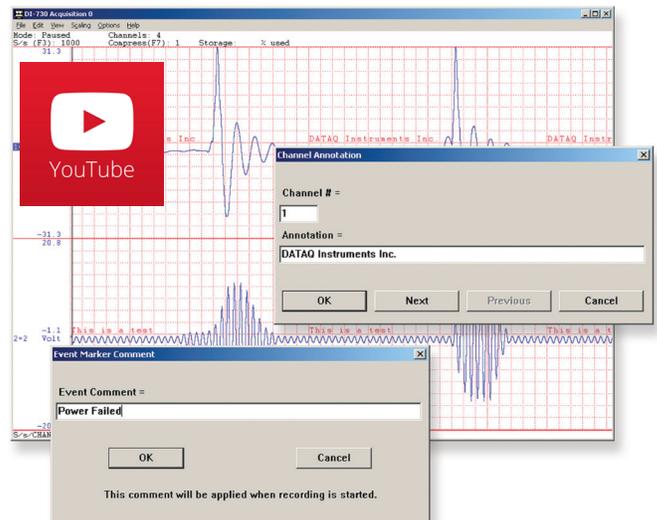
Record

Choose a continuous waveform recording mode or the triggered mode with selectable trigger level, slope, and post-trigger times. WINDAQ automatically time- and date-stamps, then streams acquired data to disk — record as much data as you need. At the same time, WINDAQ supplies a real-time graphical display of any or all channels so you always know where you are and where you're going.
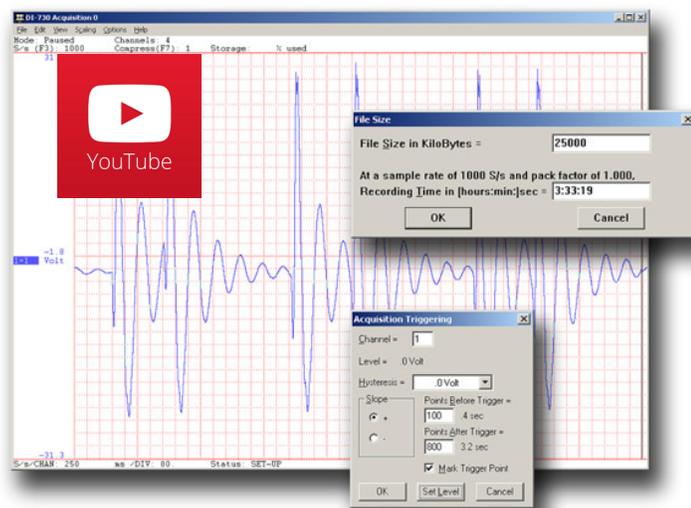
## Annotate

Of course, you can label any channel with text that describes it — "Motor 1," "Engine speed," "Vertical position," etc. But WINDAQ also allows you to supply commented event markers while you record — "Beginning test phase 1," "Small vibrations noticed," "Starting cool-down cycle," etc. Your comments and our acquired data combine to form a complete diary of your data acquisition session.

Playback

Recording is only half the solution. WᴵɴDᴀϙ's Waveform Browser playback software allows you to graphically manipulate waveforms in ways you've never seen on a PC. Compress an entire recording to one screen-width for a bird's eye view, then expand around an area of interest for a closer look. Use the cursor to measure amplitudes and timing with precision. Move to any event marker with the click of a mouse button.
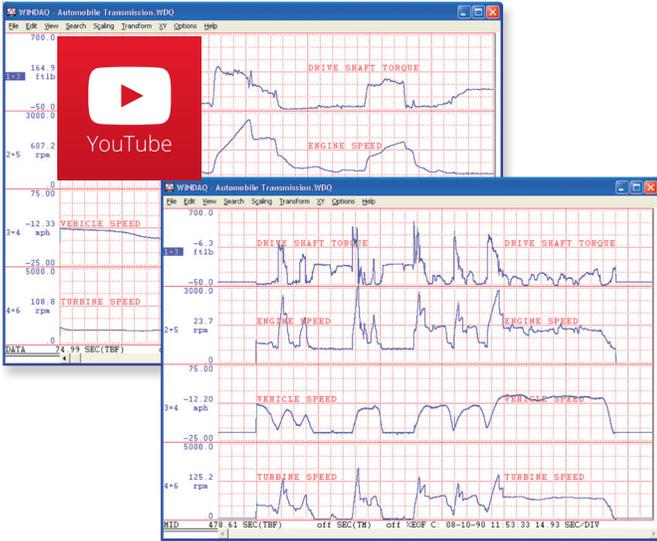
Multitask

Double your productivity and let WᴵɴDᴀϙ record while you review last week's results from your spreadsheet, or compose a memo with your word processor. You can even play back data already stored to disk while you're still recording.
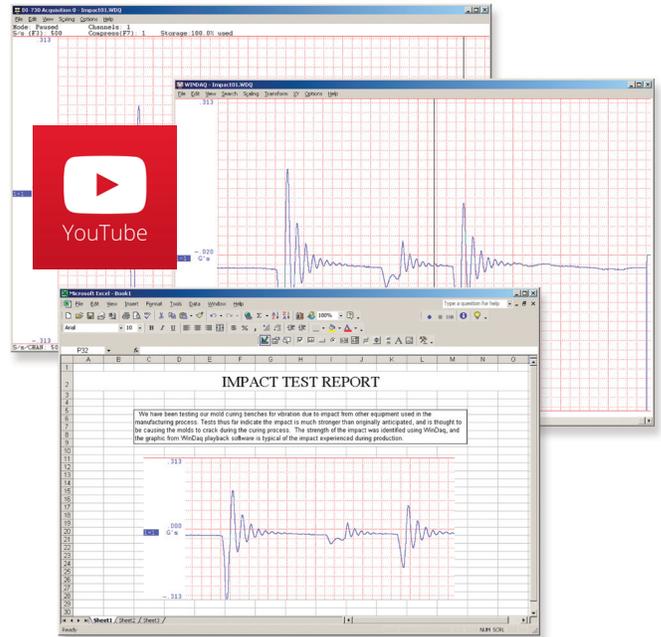
Analyze

Waveform interpretation is easy with our built-in analysis functions. Apply frequency and filtering analysis with the WᴵɴDᴀϙ Waveform Browser FFT and DFT functions. Analyze any range of waveform data with the statistics function. Use X-Y plotting to examine the relationship of one channel to another. Optional Advanced CODAS analysis functions allow waveform peak detection, integration, differentiation, arithmetic operations, and more.
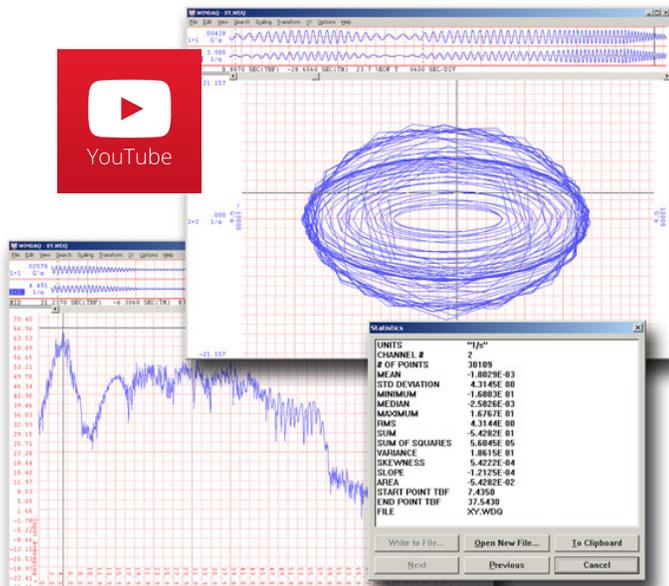
Export

The WᴵɴDᴀϙ Waveform Browser can export any range of data to your spreadsheet, or any other analysis or presentation package you use. You can even copy a graphical image displayed by the WᴵɴDᴀϙ Waveform Browser and paste it directly into a word processing document. Finally, export any range of waveform graphics to your printer for a hard copy record.
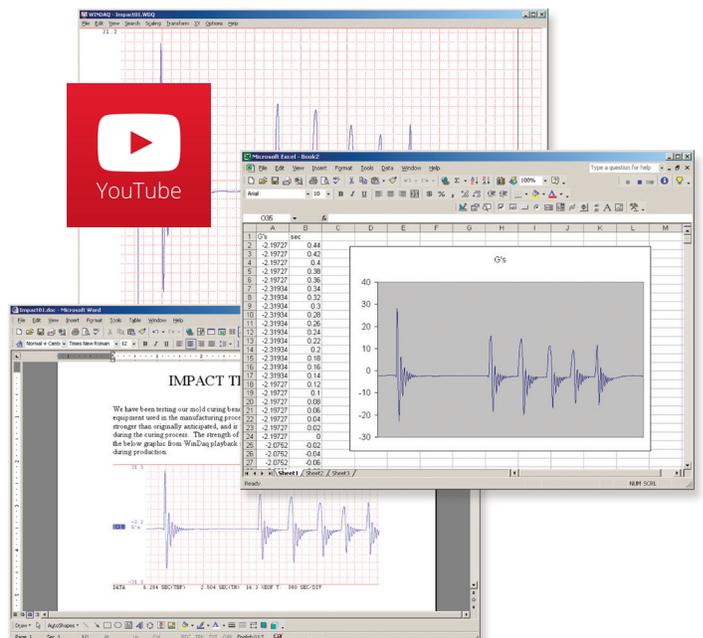
For programmers, the DI-2008 is supported outside of the supplied ready-to-run WinDaq application by a published protocol and a .NET class. The protocol defines the nuts-and-bolts communication syntax to and from the instrument necessary to configure the DI-2008, allow it to take measurements, and to retrieve those measurements through a connected PC. You'd use the DI-2008 at its protocol level if you wanted to program the instrument outside the Windows environment and/or use a programming language that is not supported by .NET. For example, operating systems such as OSX and Linux, and programing languages such as Java and Python are candidate situations to use the DI-2008 Protocol. Otherwise, programming efforts using a .NET language such as Visual BASIC and C# under Windows take advantage of the .NET class provided with the instrument. Both the protocol and the .Net class support the DI-2008's ChannelStretch™ channel expansion feature to a maximum 128 analog and 112 analog ports.
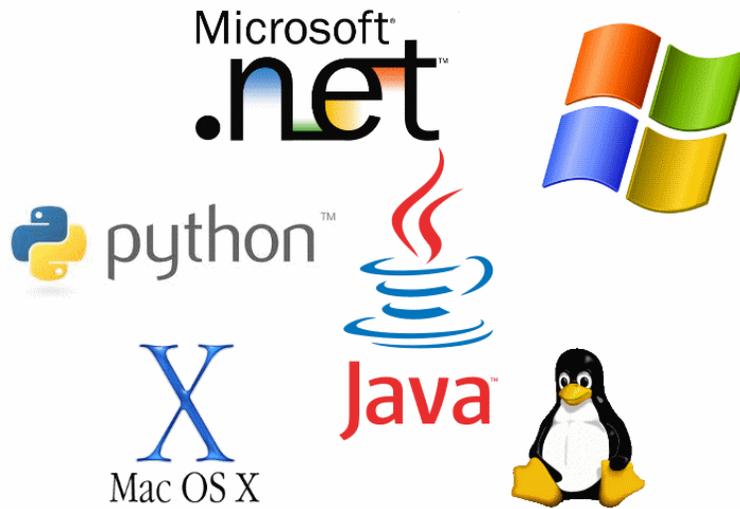
DI-2008 Specifications

Signal Inputs

Analog Inputs

Number of Channels:	8
Configuration:	Differential, Isolated
Programmable measurements per channel:	Voltage, thermocouple

Programmable thermocouple types and measurement range per channel:

Over 25 ±5 °C ambient temperature range.
Stable ambient temperature.
Following 30 minutes warm-up.
Excluding common mode error.
Excluding thermocouple error.

TC type	Temperature Measurement range (°C)	Accuracy (°C)
J	-190 to 1200	±(0.1% of span + 2)
K	-180 to 1360	
T	-190 to 400	±(0.1% of span + 1)
B	600 to 1000	±(0.2% of span + 4)
	1001 to 1810	±(0.1% of span + 3)
R	-40 to 300	±(0.2% of span + 6)
	301 to 1760	±(0.1% of span + 3)
S	-40 to 400	±(0.2% of span + 6)
	401 to 1750	±(0.1% of span +3)
E	-160 to 990	±(0.1% of span + 1)
N	-170 to 50	±(0.1% of span + 3)
	51 to 1290	±(0.1% of span + 1)

Programmable voltage measurements ranges per channel:

At 25 °C ambient temperature.
Following 30 minutes warm-up.
Excluding common mode error.

Range (±)	Accuracy
10 mV	
25 mV	
50 mV	
100 mV	
250 mV	
500 mV	±(0.05% of range + 10 µV)
1 V	
2.5 V	
5 V	
10 V	
25 V	
50 V	

Input impedance:	1 MΩ, all ranges
Isolation:	Input-to-output, Channel-to-channel
Absolute max input without damage:	120 Vrms
Maximum common mode voltage:	120 Vrms
Min common mode rejection (330Ω unbalance):	>100 dB (DC to 60 Hz)
Channel-to-channel crosstalk rejection: ($R_{source} \le 330\ \Omega$; $Freq_{source} \le 60$ Hz)	> 100 dB at any throughput

Digital Ports

Number of ports:	7
Type:	MOSFET switch
Configuration:	Programmable as an input or switch
Pull-up value:	4.7 KΩ
Isolation:	None
Input high voltage threshold:	2.4 V minimum
Input low voltage threshold:	0.8 V maximum
Absolute max input without damage:	$0 \le V \le 30$ V

Count/Rate

Digital port assignment:	Count: Port 2 configured as input Rate: Port 3 configured as input
Internal pull-up value:	4.7 kΩ
Input high voltage threshold:	2.4V
Input low voltage threshold:	0.8V
Terminal count:	65,535
Maximum rate frequency:	50 kHz
Minimum rate frequency:	0.5 Hz
Maximum count frequency:	50 kHz

Power

Excitation output:	+15 V dc (-7.5% to +2.5%) at 70% load (47 mA), 67 mA at full load
Power consumption:	0.75 Watts (from USB port)

ADC Characteristics

Voltage measurement resolution:

Range (±)	Resolution	Units
10 mV	0.305	
25 mV	0.763	
50 mV	1.53	
100 mV	3.05	
250 mV	7.63	
500 mV	15.26	µV
1 V	30.5	
2.5 V	76.3	
5 V	152.6	
10 V	305	
25 V	763	
50 V	1.53	mV

Temperature measurement resolution:

TC type	Resolution	Units
J	0.086	
K	0.096	
T	0.037	
B	0.096	°C
R/S	0.111	
E	0.073	
N	0.092	

4-20 mA current loop resolution:	13,100 ADC counts over the 4-20 mA range (5 VFS range with 250-Ω shunt resistor)
Maximum sample throughput rate:	Single enabled channel: 2 kHz Two or more enabled channels: 200 Hz
Minimum sample throughput rate: (Hardware)	1 enabled analog channel: 0.000109 Hz 2 or more enabled analog channels: 0.000011 Hz
Min sample throughput rate:	.0001969 Hz (with WinDaq software)
Sample rate timing accuracy:	50 ppm

Indicators, Connections, Controls

Interface:	USB 2.0 (mini-B style connector)
Indicators (LED):	Power, Active, Event
Input connections:	Two 16-position terminal strips
Pushbutton:	Manual event when used with WinDaq software

ChannelStretch

WinDaq software:	If any synced device has two or more enabled analog channels, all synced devices must enable the same number of analog and digital channels and the same sample throughput rate. If all synced devices have one or zero enabled analog channels, sample rate per channel must be the same across all devices.
Programmed (.Net- or protocol-based):	Sample rate per channel must be the same across all synced devices.

*One or more digital ports configured as a discrete input counts as one digital channel. Rate and count inputs count as one digital channel each.

Environmental

Operating temperature:	0 to 70 °C (voltage and TC measurements)
Storage temperature:	-20 to 70 °C
Storage humidity:	0 to 90 %RH, non-condensing

Physical Characteristics

Enclosure:	Hardened Plastic
Mounting:	Desktop; bulkhead
Dimensions:	6.68W × 3.28D × 1.13H in 169.67W × 83.31D × 28.7H mm
Weight:	5.7 oz. (162 grams)

Software Support

WinDaq Software:	OS support: Visit http://www.dataq.com/products/windaq/window-compatability.
Programming:	DATAQ Instruments Dot Net SDK, Instrument protocol, DLL, and ActiveX Control

Description	Order No.
DI-2008 Millivolt, Volt, Thermocouple, Pulse Data Acquisition System Includes DI-2008 data acquisition hardware, USB cable (6-ft.), screwdriver for screw terminal, WinDaq data acquisition and Playback software, .NET Class and protocol document.	DI-2008
R250 250Ω shunt resistor for 4-20 mA process current loop measurements.	R250
7-port USB Hub Powered USB hub supports channel expansion applications using ChannelStretch™	2000310
16-ft USB Extension Cable USB 2.0 Type A Extension USB Cable, 16ft. Daisy chain up to 5 cables for extended length.	CBL-100641-16
WinDaq/Unlock Unlocks the DI-2008 to allow ChannelStretch™ support when using WinDaq software.	WinDaq/Un-lock-2008

DATAQ® INSTRUMENTS

241 Springside Drive
Akron, Ohio 44333
Phone: 330-668-1444
Fax: 330-666-5434

Data Acquisition Product Links
(click on text to jump to page)
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