DI-2108 USB Data Acquisition (DAQ) System

- Eight armored analog differential inputs
  - Up to ±100 V without damage
  - 80 dB common mode rejection
  - Fixed measurement range of ±10 V full scale
- Adaptable anti-alias filter per channel
  - Corner frequency set as a function of sampling rate
- Up to 16-bit analog-to-digital resolution
- Up to 220 kHz sample throughput rate
- Seven digital ports
  - Programmable per port as input or switch
  - Support for rate measurements to 50 kHz
  - Support for 16-bit counter
  - External trigger input
- Software support includes:
  - Ready-to-run WinDaq software
  - Published protocol for software development in all operating systems
DI-2108 Description

Analog Subsystem
Model DI-2108 delivers premium analog performance at a surprisingly affordable price. Eight analog input channels provide differential measurement flexibility and a ±10 V full scale range. The differential input configuration provides noise rejection, easily adapts to single-ended signal sources, and is protected up to ±100 V dc or peak ac so that inevitable measurement mishaps will not harm the instrument. The front-end feeds a flexible resolution analog-to-digital converter that ranges from 12 to 16 bits as a function of sampling rate. Lower sampling rates deliver higher resolution readings. The maximum sampling throughput rate of the DI-2108 is 220 kHz, providing 12 bits of resolution. Rounding off the analog subsystem are anti-alias filters per channel with automatic selection of corner frequency at approximately one tenth of the sampling frequency. Finally, an external trigger input allows A-D conversion to be synchronized to external events.

Digital Port Subsystem
The DI-2108 provides 7 digital ports, each configurable as an input or a switch. Input protection is provided to 25 V. When activated as inputs two ports allow dual functionality as discrete inputs, or programmed as a counter or 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 in lock-step with analog data. Configured as a switch a digital port can be used to control external loads up to 25 V @ 100 mA, and the switch can be controlled asynchronously without interfering with the scanning process.

Packaging and Controls
We’ve released the DI-2108 in a new, sleek, low-profile package to allow it to fit in almost any location. Rubber feet on the bottom of the case prevent it from sliding around in your workspace. A multi-color LED conveys device status at a glance, and a side-mounted pushbutton provides manual event marking capability when used with WinDaq software.
**Eight Analog Input Channels**
Measure as many as eight system variables at once with a fixed ±10 V full scale range.

**Differential Analog Input Configuration**
Enhanced noise immunity.

**Anti-alias Filter per Analog Channel**
Reduces the risk of acquiring meaningless, aliased data. Corner frequency automatically selected at one-tenth of the sampling rate.

**Armored Inputs Absorb Mistakes**
Analog inputs are protected to ±100 V and digital inputs up to 25 V.

**Fast, 220 kHz Sample Throughput Rate**
Observe fast phenomena that other products in the DI-2108 price range would miss.

**12- to 16-bit ADC Resolution**
One product potentially addresses your measurement needs, from low to high resolution, as a function of sampling rate.

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

**Rate Measurement Channel**
Measures pulse rate as may be acquired from a pickup for rpm measurement, or sensor to measure flow.

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

**Software Support**
Offered with ready-to-run WinDaq software and documented command protocol for OS-independent use.

**External Trigger Input**
Allows the DI-2108 to synchronize conversions to external events.

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**DI-2108 Dimensional Drawing**

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All dimensions in inches
DI-2108 I/O Equivalent Circuits

**Analog Input**

![Analog Input Circuit]

**Digital Port**

![Digital Port Circuit]

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**Anti-alias Filter Architecture**

The DI-2108 employs an anti-alias filter per analog channel with automatic corner frequency selection. The filter is a CIC (cascaded integrator comb) type that uses as many as 512 samples per channel to calculate in real time as data is acquired. Filter response is optimized when sampling frequency is set to ten times the highest frequency of interest.

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**Typical Anti-alias Filter Frequency Response**

![Typical Anti-alias Filter Frequency Response Graph]
Analog-to-digital Converter Characteristics

DI-2108 ADC resolution is a function of sampling rate: Slower sampling rates yield higher resolution measurements. The DI-2108 achieves this using its real time CIC decimation filter to improve signal-to-noise ratio and to increase measurement resolution. Before the DI-2108 such techniques were reserved only for high-end instrumentation due to the cost of the processing power required to provide meaningful, multi-channel results in real time. But that cost has been driven down dramatically so that the 120 MIPS processor embedded in the DI-2108 is both affordable and more than adequate for the task.

The ADC bit resolution referred to here is bipolar. For example, 14 bits of measurement resolution provides a total of 16,384 ADC counts applied across the entire ±10 V range per analog channel.

ADC resolution (R) is a function of selected sample rate per channel (F), and the number of enabled analog channels (C):

\[ R = \frac{\log_{10}(160000)}{\log_{10}(2)} \times \frac{FC}{C} + 12 \]

Where:

<table>
<thead>
<tr>
<th>Enabled Channels</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3-4</td>
<td>3-4</td>
</tr>
<tr>
<td>5-8</td>
<td>5-8</td>
</tr>
</tbody>
</table>

Try out the online calculator at [http://www.dataq.com/products/di-2108/resolution.html](http://www.dataq.com/products/di-2108/resolution.html) to determine the resolution.

DI-2108 Scan List Flexibility

The DI-2108 maintains an internal scan list of as many as eleven different items at once. The maximum sample throughput rate is 220 kHz, 20 kHz per scan list element with all positions enabled. Analog channels support a maximum sample throughput rate of 160 kHz, one analog channel at 160 kHz, two analog channels 80 kHz per channel, etc. The scan list can be populated with any combination of analog input channels, digital input ports, the rate channel, and the counter channel.

<table>
<thead>
<tr>
<th>Item</th>
<th>Scan List Positions</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog channels</td>
<td>Up to eight</td>
<td>One scan list position is consumed for each enabled analog channel</td>
</tr>
<tr>
<td>Digital inputs</td>
<td>One</td>
<td>All seven digital ports are read simultaneously with one entry in the scan list</td>
</tr>
<tr>
<td>Rate channel</td>
<td>One</td>
<td></td>
</tr>
<tr>
<td>Counter channel</td>
<td>One</td>
<td></td>
</tr>
</tbody>
</table>

DI-2108 Analog Measurements

Eight analog input channels with a fixed measurement range of ±10 V full scale are supported by the DI-2108. Each offers differential input capability with rejection of common mode voltages (those that appear simultaneously and in-phase on both inputs.) These channels are also hardened to tolerate excessive voltages to protect against wiring mishaps (see specifications.)

![DI-2108 Analog Measurements Diagram](attachment:image.png)

*Optional (see ordering guide)
DI-2108 Rate and Count Measurements

Digital ports D2 and D3 can be programmed for multiple functions. Both can be programmed as discrete input or outputs. In addition, port D2 as a rate input and port D3 as a counter input. When either is programmed to measure rate and/or count the DI-2108 adds these measurements to its internal scan list along with any other analog and other digital data so that all measurements are acquired in the same time frame. Rate measurements in the range of 10 Hz to 50 kHz are possible across twelve programmable full scale ranges. Use the rate input to extract rpm data from a rotating device, or to acquire flow information from a pulse-type flow sensor. Count measurements up to 65,536 are supported by the D3 port. Use count to integrate flow to get volume, or use it simply to tally events in a given process.

Rpm from rate
The DI-2108’s Rate input is used to acquire a frequency representing rpm, flow, or any other pulse stream.

Flow/volume
Use the DI-2108’s Count input to accumulate a tally of applied discrete pulses to track test cycles, extract volume from flow, or any other general-purpose totalizing application.

General-purpose Digital Port Operation
Each DI-2108 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 25 V and 100 mA. Care should be exercised when configuring the load to be switched to ensure that the digital port is not damaged:
Setup
Double-click and enter the channels you want to acquire into the WinDaq scan list. Click to select an analog, rate, or count channel. Click to define a single to 8-channel display — either triggered sweep (oscilloscope-like) or scrolling (chart recorder-like). Click again to define a sample rate ranging from 18 samples per minute to 160,000 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, Horsepower — 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.
Included WINDAQ Playback Software

**Playback**

Recording is only half the solution. WINDAQ’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 WINDAQ 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 WINDAQ 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 WINDAQ 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 WINDAQ 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-2108 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 that’s necessary to configure the DI-2108, allow it to take measurements, and to retrieve those measurements through a connected PC. You’d use the DI-2108 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-2108 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.

Four Analog Channel Reporting Modes

The DI-2108 can be configured per channel to report just the last sample acquired like other data acquisition products. Unlike other products three additional reporting modes, selectable per analog channel, provide much more flexibility when reporting oversampled data:

- **Anti-alias filter**
  Oversampled data is passed through the DI-2108’s anti-alias CIC filter. Use this mode to dramatically reduce the unwanted effects of alias frequencies.

- **Maximum value**
  Oversampled data is evaluated for the maximum value. Use Maximum to peak-detect complex waveforms.

- **Minimum value**
  Oversampled data is evaluated for the minimum value. Use Minimum to valley-detect complex waveforms.

All four operating modes are supported by WinDaq software. And, since they are applied by DI-2108 firmware, custom programs can easily leverage these features without incremental programming overhead.
**Signal I/O**

**Analog Inputs**

- Number of Channels: 8
- Configuration: Differential
- Measurement range per channel: ±10 V full scale fixed
- Input impedance: 110kΩ
- DC accuracy: ±5 mV at 16-bit resolution
- 25°C, excluding common mode error
- Absolute maximum input without damage: ±100 V dc or peak ac
- Common mode range: ±20 V dc or peak ac
- Common mode rejection ratio: 80 dB (dc - 60 Hz)
- Channel-to-channel crosstalk rejection: -80 dB

**Digital Ports**

- Number of ports: 7
- Type: MOSFET switch
- Configuration: Programmable as digital input or switch
- Pull-up value: 4.7 kΩ
- Input high voltage threshold: 2.4V
- Input low voltage threshold: 0.8V
- Absolute maximum applied voltage (V): 0 ≤ V ≤ 25 V

**Reserved Digital Inputs**

- Port 1: WinDaq remote events
- Port 2: WinDaq remote start/stop
- Port 3: Rate input
- Port 4: Count input

**ADC Characteristics**

**Analog Inputs**

- Resolution: 12- to 16-bit
- Above zero ADC counts: 2,047 to 32,767
- Below zero ADC counts: 2,048 to 32,768
- Maximum sample throughput: 220 kHz (160 kHz throughput for analog channels, plus 20 kHz per enabled digital channel)
- Minimum sample throughput: Hardware only: 20 Hz
- WinDaq software: 2.2 samples per hour
- Sample rate timing accuracy: 50 ppm

**Digital Ports Programmed as Switch**

- Maximum drain voltage: 25 V
- Maximum sink current: 100 mA

**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 with one enabled channel, 20 KHz with 2-4 enabled analog channels, otherwise 10 KHz.
- Minimum rate frequency: 0.5 Hz
- Maximum count frequency: 50 KHz

**Indicators and Connections**

- Interface: USB 2.0 (mini-B style connector)
- Indicator light: Multi-color LED
- Input connections: Two 16-position screw terminal strips

**Power**

- Power consumption: <1.0 Watt, via USB interface

**Environmental**

- Operating temperature: 0 to 50 °C
- Operating humidity: 0 to 90 %RH, non-condensing
- Storage temperature: -20 to 60 °C
- Storage humidity: 0 to 90 %RH, non-condensing

**Physical Characteristics**

- Enclosure: Polycarbonate ABS, 0.080 inch thickness
- Mounting: Desktop; bulkhead
- Dimensions (overall): 6.68W × 3.28D × 1.13H in
  169.67W × 83.31D × 28.7H mm
- Weight: 5.7oz. (162 grams)

**Software Support**

- Programming: Instrument protocol

**Ordering Guide**

**DI-2108 USB data acquisition (DAQ) system**

Includes instruments, 6-ft. USB cable, screwdriver, and WinDaq software via Internet download (run.dataq.com)

**250Ω 4-20 mA shunt resistor**

±0.1%, 0.5 Watts max., ±50 ppm/°C

<table>
<thead>
<tr>
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<tr>
<td>DI-2108 USB data acquisition (DAQ) system</td>
<td>DI-2108</td>
</tr>
<tr>
<td>250Ω 4-20 mA shunt resistor</td>
<td>R250</td>
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<tr>
<td>WinDaq/Unlock</td>
<td>WINDAQ/Unlock-2108-EMAIL</td>
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</tbody>
</table>

**Data Acquisition Product Links**

(click on text to jump to page)

Data Acquisition | Data Logger

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