DATA TRANSLATION

UM-23654-W

# User's Manual for Standard TEMPpoint, VOLTpoint, and MEASURpoint USB Instruments

## DT9871, DT9871U, DT9872, DT9873, DT9874

**Twenty First Edition**
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## Radio and Television Interference

This equipment has been tested and found to comply with CISPR EN55022 Class A and EN61000-6-1 requirements and also with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

Changes or modifications to this equipment not expressly approved by Data Translation could void your authority to operate the equipment under Part 15 of the FCC Rules.

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**Note:** This product was verified to meet FCC requirements under test conditions that included use of shielded cables and connectors between system components. It is important that you use shielded cables and connectors to reduce the possibility of causing interference to radio, television, and other electronic devices.

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## Canadian Department of Communications Statement

This digital apparatus does not exceed the Class A limits for radio noise emissions from digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de la class A prescrites dans le Règlement sur le brouillage radioélectrique édicté par le Ministère des Communications du Canada.

# Table of Contents

# About this Manual

TEMPpoint™ is a family of temperature measurement instruments that includes the DT9871U, DT9871, DT8871U, DT8871, DT9872, and DT8872. This manual describes the DT9871U, DT9871, and DT9872 USB models.

VOLTpoint™ is a family of voltage measurement instruments that includes the DT9873 and DT8873. This manual describes the DT9873 USB model.

MEASURpoint™ a family of mixed temperature and voltage measurement instruments that includes the DT9874, DT8874, DT8875, and DT8876. This manual describes the DT9874 USB model.

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**Note:** For information on the DT8871U, DT8871, DT8872, DT8873, and DT8874 LXI models of TEMPpoint, VOLTpoint, and MEASURpoint, refer to the *User's Manual for Standard TEMPpoint, VOLTpoint, and MEASURpoint LXI Instruments*.

For information on the DT8875 LXI model of MEASURpoint, refer to the *DT8875 LXI Instrument User's Manual*.

For information on the DT8876 LXI model of MEASURpoint, refer to the *DT8876 LXI Instrument User's Manual*.

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The first part of this manual describes how to install and set up your instrument, and verify that the instrument is working properly.

The second part of this manual describes the features and capabilities of your instrument using the IVI-COM instrument driver software. Troubleshooting information is also provided.

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**Note:** If you are programming the instrument using the IVI-COM driver, refer to the DtxMeasurement IVI-COM driver online help for more information.

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## Intended Audience

This document is intended for engineers, scientists, technicians, or others responsible for using and/or programming a TEMPpoint, VOLTpoint, or MEASURpoint instrument in the Microsoft® Windows® XP, Windows Vista®, Windows 7, or Windows 8 operating system. It is assumed that you have some familiarity with thermocouples, RTDs, and/or voltages and that you understand your application.

## How this Manual is Organized

This manual is organized as follows:

- Chapter 1, "Overview," summarizes the major features of the TEMPpoint, VOLTpoint, and MEASURpoint instruments, as well as the supported software and accessories.
- Chapter 2, "Preparing to Use the Instrument," describes how to unpack the instrument, check the system requirements, install the software, and view the documentation online.
- Chapter 3, "Setting Up and Installing the Instrument," describes how to apply power to the instrument and connect the instrument to your computer.
- Chapter 4, "Wiring Signals," describes how to wire signals to the instrument.
- Chapter 5, "Verifying the Operation of Your Instrument," describes how to verify the operation of the instrument.
- Chapter 6, "Principles of Operation," describes the analog input and digital I/O features of the TEMPpoint, VOLTpoint, and MEASURpoint instruments in detail.
- Chapter 7, "Troubleshooting," provides information that you can use to resolve problems with your instrument, should they occur.
- Appendix A, "Specifications," lists the specifications of the TEMPpoint, VOLTpoint, and MEASURpoint instruments.
- Appendix B, "Connector Pin Assignments," describes the pin assignments of the digital I/O connector on the TEMPpoint, VOLTpoint, and MEASURpoint instruments.
- Appendix C, "About ISO-Channel Technology," describes the benefits of ISO-Channel™ technology.
- An index completes this manual.

## Conventions Used in this Manual

The following conventions are used in this manual:

- Notes provide useful information or information that requires special emphasis, cautions provide information to help you avoid losing data or damaging your equipment, and warnings provide information to help you avoid catastrophic damage to yourself or your equipment.
- Items that you select or type are shown in **bold**.

## Related Information

Refer to the following documents for more information on using a TEMPpoint, VOLTpoint, or MEASURpoint USB instrument:

- DtxMeasurement IVI-COM Driver online help. This document describes how to use the IVI-COM driver to access the capabilities of a TEMPpoint, VOLTpoint, or MEASURpoint instrument.

  The IVI-COM driver works with any development environment that supports COM programming, including MATLAB® from The MathWorks™, Microsoft® Visual C#®.NET or Visual Basic®.NET, Agilent® VEE Pro, National Instruments™ LabVIEW™ or LabWindows™, and so on.
- *QuickDAQ User's Manual* (UM-24774). This manual describes how to create a QuickDAQ application to acquire and analyze data from a TEMPpoint, VOLTpoint, or MEASURpoint instrument.
- IVI foundation (www.ivifoundation.org)
- *Omega Complete Temperature Measurement Handbook and Encyclopedia®* or the Omega Engineering web site: http://www.omega.com. Both resources provide valuable information on thermocouple types, RTD types, standards, and linearization.

## Where To Get Help

Should you run into problems installing or using a TEMPpoint, VOLTpoint, or MEASURpoint instrument, the Data Translation Technical Support Department is available to provide technical assistance. Refer to Chapter 7 for more information. If you are outside the United States or Canada, call your local distributor, whose number is listed on our web site (www.datatranslation.com).

# 1

# *Overview*

# Hardware Features

Data Translation provides a number of USB instruments to meet your measurement needs, including the following:

- TEMPpoint – a family of temperature measurement instruments
- VOLTpoint – a family of voltage measurement instruments
- MEASURpoint – a family of mixed temperature and voltage measurement instruments

All of these instruments support Version 2.0 and 1.1 of the USB bus.

The following sections summarize the features of the TEMPpoint, VOLTpoint, and MEASURpoint USB instruments.

## TEMPpoint Features

TEMPpoint instruments include the following models: DT9871U, DT9871, and DT9872. Figure 1 shows a DT9871U instrument.

**Figure 1: TEMPpoint Instrument**

The key features of TEMPpoint instruments are as follows:

- *DT9871U and DT9871:*
  - Configurable analog input channels for thermocouple or differential voltage inputs; easy-access jacks for each channel for quick wiring
  - One CJC (cold junction compensation) input for each thermocouple channel

- B, E, J, K, N, R, S, and T thermocouple types supported; the instrument automatically linearizes the measurements and returns the data as a 32-bit, floating-point temperature values
- Input range of ±0.075 V for the DT9871U (with 0.25 µV RMS A/D noise using no software filtering) and ±1.25 V for the DT9871 (with 5 µV RMS A/D noise using no software filtering)
- Break-detection circuitry to detect open thermocouple inputs

- *DT9872:*
  - Configurable analog input channels for RTDs and differential voltage inputs; easy-access jacks for each channel for quick wiring
  - 100 Ω, 500 Ω, and 1000 Ω platinum RTD types supported using alpha curves of 0.00385 (European) or 0.00392 (American)
  - 4-wire, 3-wire, or 2-wire configurations; the DT9872 automatically linearizes the measurements and returns the data as 32-bit, floating-point temperature, resistance, or voltage values
  - Input range of ±1.25 V
- One 24-bit, Delta-Sigma A/D converter per channel for simultaneous, high-resolution measurements
- ±500 V galvanic isolation channel-to-channel and to the host computer to protect signal integrity
- Throughput rate of up to 10 Samples/s for all channels.
- Software or external, digital trigger on digital input line 0 starts acquisition
- Auto-calibrating front-end resets the zero point on each power-up; in addition, the instrument supports anytime calibration, performing an auto-calibration function on software command
- Measurement Calibration Utility allows you to calibrate the instrument in the field (see page 20 for more information on this utility)
- 8 opto-isolated digital input lines; you can read the digital input port through the analog input data stream for correlating analog and digital measurements
- 8 opto-isolated digital output lines; the outputs are solid-state relays that operate from ±30 V at currents up to 400 mA (peak) AC or DC

## VOLTpoint Features

Figure 2 shows a VOLTpoint instrument.


**Figure 2: VOLTpoint Instrument**

The key features of VOLTpoint (DT9873) instruments are as follows:

- Direct connection of analog input channels for differential voltage inputs; removable screw terminal blocks for each channel for quick wiring
- One 24-bit, Delta-Sigma A/D converter per channel for simultaneous, high-resolution measurements
- ±500 V galvanic isolation channel-to-channel and to the host computer to protect signal integrity
- Software-selectable input range of ±10 V, ±100 V, or ±400 V per channel
- Throughput rate of up to 10 Samples/s for all channels
- Software or external, digital trigger on digital input line 0 starts acquisition
- Auto-calibrating front-end resets the zero point on each power-up; in addition, the instrument supports anytime calibration, performing an auto-calibration function on software command
- Measurement Calibration Utility allows you to calibrate the instrument in the field (see page 20 for more information on this utility)
- 8 opto-isolated digital input lines; you can read the digital input port through the analog input data stream for correlating analog and digital measurements
- 8 opto-isolated digital output lines; the outputs are solid-state relays that operate from ±30 V at currents up to 400 mA (peak) AC or DC

## MEASURpoint Features

The standard MEASURpoint (DT9874) instrument provides 16 thermocouple channels, 16 RTD channels, and 16 voltage channels. Figure 3 shows a MEASURpoint instrument.


**Figure 3: MEASURpoint Instrument**

The key features of MEASURpoint instruments are as follows:

- *Analog Input Channels 0 to 15:*
  - Configurable channels for thermocouple or differential voltage inputs; easy-access jacks for each channel for quick wiring
  - One CJC (cold junction compensation) input for each thermocouple channel
  - B, E, J, K, N, R, S, and T thermocouple types supported; the instrument automatically linearizes the measurements and returns the data as a 32-bit, floating-point temperature values
  - Input range of ±0.075 V (with 0.25 μV RMS A/D noise using no software filtering)
  - Break-detection circuitry to detect open thermocouple inputs
- *Analog Input Channels 16 to 31:*
  - Configurable analog input channels for RTDs and differential voltage inputs; easy-access jacks for each channel for quick wiring
  - 100 Ω, 500 Ω, and 1000 Ω platinum RTD types supported using alpha curves of 0.00385 (European) or 0.00392 (American)

- 4-wire, 3-wire, or 2-wire configurations; the DT9872 automatically linearizes the measurements and returns the data as 32-bit, floating-point temperature, resistance, or voltage values
- Input range of ±1.25 V

- *Analog Input Channels 31 to 48:*
  - Direct connection of analog input channels for differential voltage inputs; removable screw terminal blocks for each channel for quick wiring
  - Software-selectable input range of ±10 V, ±100 V, or ±400 V per channel
- One 24-bit, Delta-Sigma A/D converter per channel for simultaneous, high-resolution measurements
- ±500 V galvanic isolation channel-to-channel and to the host computer to protect signal integrity
- Throughput rate of up to 10 Samples/s for all channels
- Software or external, digital trigger on digital input line 0 starts acquisition
- Auto-calibrating front-end resets the zero point on each power-up; in addition, the instrument supports anytime calibration, performing an auto-calibration function on software command
- Measurement Calibration Utility allows you to calibrate the instrument in the field (see page 20 for more information on this utility)
- 8 opto-isolated digital input lines; you can read the digital input port through the analog input data stream for correlating analog and digital measurements
- 8 opto-isolated digital output lines; the outputs are solid-state relays that operate from ±30 V at currents up to 400 mA (peak) AC or DC

# Supported Software

The following software is available for use with the TEMPpoint, VOLTpoint, and MEASURpoint USB instruments:

- **QuickDAQ Base Version –** The base version of QuickDAQ is free-of-charge and allows you to acquire and analyze data from all Data Translation USB and Ethernet devices, except the DT9841 Series, DT9817, DT9835, and DT9853/54. Using the base version of QuickDAQ, you can perform the following functions:
  – Discover and select your devices.
  – Configure all input channel settings for the attached sensors.
  – Load/save multiple hardware configurations.
  – Generate output stimuli (fixed waveforms, swept sine waves, or noise signals).
  – On each supported data acquisition device, acquire data from all channels supported in the input channel list.
  – Choose to acquire data continuously or for a specified duration.
  – Choose software or triggered acquisition.
  – Log acquired data to disk in an .hpf file.
  – Display acquired data during acquisition in either a digital display using the Channel Display window or as a waveform in the Channel Plot window.
  – Choose linear or logarithmic scaling for the horizontal and vertical axes.
  – View statistics about the acquired data, including the minimum, maximum, delta, and mean values and the standard deviation in the Statistics window.
  – Export time data to a .csv or .txt file; you can open the recorded data in Microsoft Excel® for further analysis.
  – Read a previously recorded .hpf data file.
  – Customize many aspects of the acquisition, display, and recording functions to suit your needs, including the acquisition duration, sampling frequency, trigger settings, filter type, and temperature units to use.
- **QuickDAQ FFT Analysis Option –** When enabled with a purchased license key, the QuickDAQ FFT Analysis option includes all the features of the QuickDAQ Base version plus these features:
  – The ability to switch between the Data Logger time-based interface and the FFT Analyzer block/average-based interface.
  – Supports software, freerun, or triggered acquisition with accept and reject controls for impact testing applications.
  – Allows you to perform single-channel FFT (Fast Fourier Transform) operations, including AutoSpectrum, Spectrum, and Power Spectral Density, on the acquired analog input data. You can configure a number of parameters for the FFT, including the FFT size, windowing type, averaging type, integration type, and so on.
  – Allows you to display frequency-domain data as amplitude or phase.

- Supports dB or linear scaling with RMS (root mean squared), peak, and peak-to-peak scaling options
- Supports linear or exponential averaging with RMS, vector, and peak hold averaging options.
- Supports windowed time channels.
- Supports the following response window types: Hanning, Hamming, Bartlett, Blackman, Blackman Harris, and Flat top.
- Supports the ability to lock the waveform output to the analysis frame time.
- Allows you to configure and view dynamic performance statistics, including the input below full-scale (IBF), total harmonic distortion (THD), spurious free dynamic range (SFDR), signal-to-noise and distortion ratio (SINAD), signal-to-noise ratio (SNR), and the effective number of bits (ENOB), for selected time-domain channels in the Statistics window.
- Supports digital IIR (infinite impulse response) filters.

- **QuickDAQ Advanced FFT Analysis Option –** When enabled with a purchased software license, the QuickDAQ Advanced FFT Analysis option includes all the features of the QuickDAQ Base version with the FFT Analysis option plus these features:
  - Allows you to designate a channel as a Reference or Response channel.
  - Allows you to perform two-channel FFT analysis functions, including Frequency Response Functions (Inertance, Mobility, Compliance, Apparent Mass, Impedance, Dynamic Stiffness, or custom FRF) with H1, H2, or H3 estimator types, Cross-Spectrum, Cross Power Spectral Density, Coherence, and Coherent Output Power.
  - Supports the Exponential response window type.
  - Supports the following reference window types: Hanning, Hamming, Bartlett, Blackman, Blackman Harris, FlatTop, Exponential, Force, and Cosine Taper windows.
  - Supports real, imaginary, and Nyquist display functions.
  - Allows you to save data in the .uff file format.
- **DtxMeasurement IVI-COM driver** – This driver provides access to the instrument's functions through a COM server. The IVI-COM driver works in any 32-bit development environment that supports COM programming, including MATLAB, Visual Basic.NET, Visual C#.NET, Agilent VEE Pro, LabVIEW, LabWindows, and others.
- **Measurement Calibration Utility –** Users can calibrate a TEMPpoint, VOLTpoint, or MEASURpoint instrument in the field using precise calibration equipment and the Measurement Calibration Utility. Since each instrument consists of up to 48 individual channels, great care must be taken to ensure that proper warm-up times are followed and precise calibration equipment is used.

  The calibration utility ships with a comprehensive help file that describes the required equipment and calibration procedure, including warm-up times, for each instrument.

  The calibration utility allows you to revert to the factory calibration for any or all channels, or revert back to the last user calibration values, if desired. In addition, this utility generates a report that lists the starting and ending calibration values for each channel, allowing traceability.

# Accessories

The following optional accessories are available for TEMPpoint, VOLTpoint, or MEASURpoint instruments:

- **STP37 screw terminal panel** – The STP37, shown in Figure 4, permits easy screw terminal connections for accessing the digital I/O signals of a TEMPpoint, VOLTpoint, or MEASURpoint instrument.

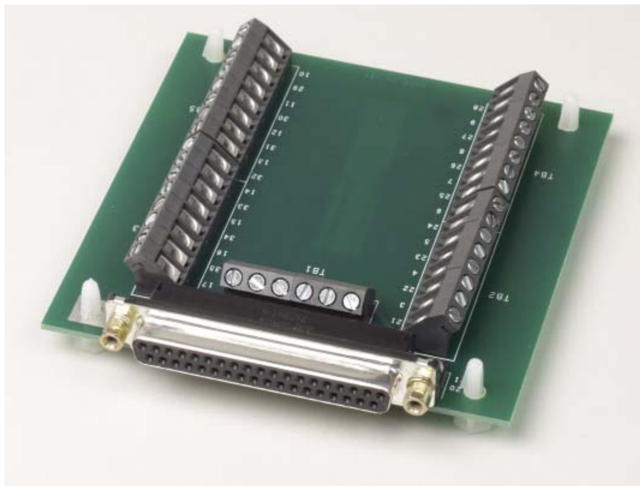

**Figure 4: STP37 Screw Terminal Panel**

- **EP333 cable** – The EP333, shown in Figure 5, is a 2-meter shielded cable with two 37-pin connectors that connects the STP37 screw terminal panel to the digital I/O connector of the instrument.

**Figure 5: STP37 Screw Terminal Panel**

- **EP373 Single Rack-mount Kit** – Mounts one TEMPpoint, VOLTpoint, or MEASURpoint instrument in a rack.
- **EP374 Dual Rack-mount Kit** – Mounts two TEMPpoint, VOLTpoint, or MEASURpoint instruments side-by-side in a rack.

# Getting Started Procedure

The flow diagram shown in Figure 6 illustrates the steps needed to get started using a TEMPpoint, VOLTpoint, or MEASURpoint instrument. This diagram is repeated in each Getting Started chapter; the shaded area in the diagram shows you where you are in the getting started procedure.

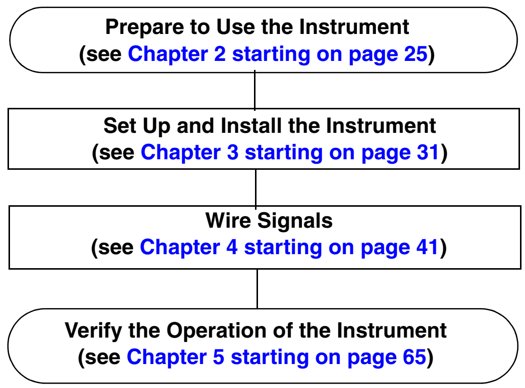


**Figure 6: Getting Started Flow Diagram**

# *Part 1: Getting Started*

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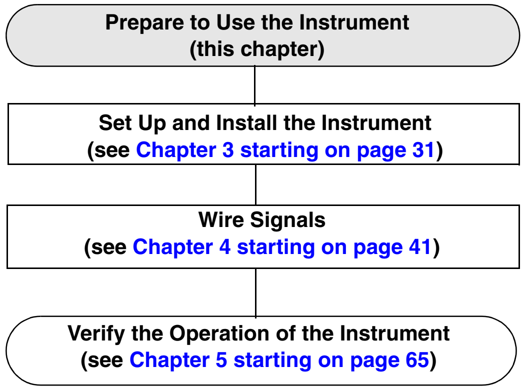
# Preparing to Use the Instrument


Prepare to Use the Instrument
(this chapter)
Set Up and Install the Instrument
(see Chapter 3 starting on page 31)
Wire Signals
(see Chapter 4 starting on page 41)
Verify the Operation of the Instrument
(see Chapter 5 starting on page 65)

# Unpacking

Open the shipping box and verify that the following items are present:

- TEMPpoint, VOLTpoint, or MEASURpoint instrument
- USB cable
- EP361 +5V power supply and cable
- MEASURpoint Software CD-ROM
- For DT9872, DT9874, and DT9874 instruments, a bag of pluggable screw terminable blocks and a screwdriver.

If an item is missing or damaged, contact Data Translation. If you are in the United States, call the Customer Service Department at (508) 481-3700, ext. 1323. An application engineer will guide you through the appropriate steps for replacing missing or damaged items. If you are located outside the United States, call your local distributor, listed on Data Translation's web site (www.datatranslation.com).

Once you have unpacked your instrument, check the system requirements, as described in the next section.

# Checking the System Requirements

For reliable operation, ensure that your computer meets the following system requirements:

- Processor: Pentium 4/M or equivalent
- RAM: 1 GB
- Screen Resolution: 1024 x 768 pixels
- Operating System: Windows 8, Windows 7, Windows Vista (32- and 64-bit)
  Windows XP SP3 (32-bit)
- Disk Space: 4 GB
- Acrobat Reader 5.0 or later for viewing documentation

# *Installing the Software*

You can install all the software for your instrument either from the web (at **http://www.datatranslation.com/cd/measurpoint**) or from the **MEASURpoint Software CD** that is shipped with the instrument. To ensure that you get the latest updates, it is recommended that you install the software from the web.

The installation program guides you through the installation process.

# Viewing the Documentation

**Note:** To view the documentation, you must have Adobe Reader 5.0 or greater installed on your system.

You can access the documentation for your instrument from the Windows Start menu as follows:

- For documentation about the TEMPpoint, VOLTpoint, or MEASURpoint instrument, click **Programs -> Data Translation, Inc -> Hardware Documentation -> Measurement User's Manual for USB Instruments**.
- For documentation on QuickDAQ, click **Programs -> Data Translation, Inc -> QuickDAQ -> QuickDAQ User's Manual**
- For documentation on the DtxMeasurement IVI-COM driver, click **Programs -> IVI -> DtxMeasurement -> Documentation**.

The following may be helpful when using Adobe Reader:

- To navigate to a specific section of the document, click a heading from the table of contents on the left side of the document.
- Within the document, click the text shown in blue to jump to the appropriate reference (the pointer changes from a hand to an index finger).
- To go back to the page from which the jump was made, click the right mouse button and **Go Back,** or from the main menu, click **Document**, and then **Go Back.**
- To increase or decrease the size of the displayed document, from the main menu, click **View**, and then **Zoom**.
- By default, Adobe Reader smooths text and monochrome images, sometimes resulting in blurry images. If you wish, you can turn smoothing off by clicking **File**, and then **Preferences/General**, and unchecking **Smooth Text and Images**.

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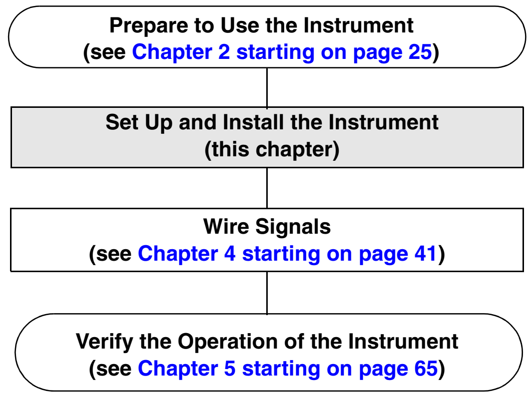
# Setting Up and Installing the Instrument

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**Note:** Your TEMPpoint, VOLTpoint, and MEASURpoint instruments are factory-calibrated. Thereafter, yearly recalibration is recommended. Refer to page 96 for more information on calibration.

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# Applying Power

TEMPpoint, VOLTpoint, and MEASURpoint instruments are shipped with an EP361 +5V power supply and cable. To apply power to the instrument, do the following:

1. Connect the +5 V power supply to the power connector on the rear panel of the instrument. Refer to Figure 7.


**Figure 7: Attaching a +5 V Power Supply to the Instrument**

2. Plug the power supply into a wall outlet.

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**IMPORTANT:** For proper grounding of your measurement instrument, ensure that you use the power supply and cable (EP361) that is provided with the instrument and that you use all three prongs of the cable when connecting it to your wall outlet.

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3. Press the Power Switch to turn on the instrument.
*The Power LED on the front panel lights to indicate that power is on.*

Figure 8 shows the location of the Power LED on the front panel of the instrument; a MEASURpoint instrument is shown in this example.


**Figure 8: Power LED on the Front Panel of the Instrument**

# Attaching the Instrument to the Computer

This section describes how to attach a TEMPpoint, VOLTpoint, or MEASURpoint instrument to the host computer.

**Notes:** Most computers have several USB ports that allow direct connection to USB devices. If your application requires more TEMPpoint, VOLTpoint, or MEASURpoint instruments than you have USB ports for, you can expand the number of USB devices attached to a single USB port by using expansion hubs. For more information, refer to page 38.

You can unplug a USB instrument, then plug it in again, if you wish, without causing damage. This process is called hot-swapping. Your application may take a few seconds to recognize an instrument once it is plugged back in.

You must install the device driver before connecting your instrument to the host computer. See page 29 for more information.

## Connecting Directly to the USB Ports

To connect a TEMPpoint, VOLTpoint, or MEASURpoint instrument directly to a USB port on your computer, do the following:

1. Make sure that you have attached a power supply to the instrument.
2. Attach one end of the USB cable to the USB port on the rear panel of the instrument, as shown in Figure 9.


**Figure 9: Attaching the Instrument to the Host Computer**

3. Attach the other end of the USB cable to one of the USB ports on the host computer.
*The operating system automatically detects the instrument and starts the Found New Hardware wizard.*

4. <u>*For Windows Vista*</u>:

   a. Click **Locate and install driver software (recommended)**.
   *The popup message "Windows needs your permission to continue" appears.*

   b. Click **Continue**.
   *The Windows Security dialog box appears.*

   c. Click **Install this driver software anyway**.

   <u>*For Windows XP:*</u>

   a. Click **Next** and/or **Finish** as required in the wizard.
   *Once the firmware is loaded, the wizard restarts to initiate the firmware to accept commands.*

   b. Click **Next** and/or **Finish** again.

**Note:** Windows 7 and Windows 8 find the device automatically.

If the power supply and the instrument are attached correctly, the USB LED on the rear panel, shown in Figure 10, turns green.


**Figure 10: LEDs on the Rear Panel of the Instrument**

5. Repeat the steps to attach another TEMPpoint, VOLTpoint, or MEASURpoint instrument to the host computer, if desired.

## Connecting to an Expansion Hub

Expansion hubs are powered by their own external power supply. Theoretically, you can connect up to five expansion hubs to a USB port on the host computer. However, the practical number of instruments that you can connect to a single USB port depends on the throughput you want to achieve. Each of the hubs supports up to four instruments.

To connect multiple TEMPpoint, VOLTpoint, or MEASURpoint instruments to an expansion hub, do the following:

1. Make sure that you have attached a power supply to the instrument.
2. Attach one end of the USB cable to the instrument and the other end of the USB cable to an expansion hub.
3. Connect the power supply for the expansion hub to an external power supply.
4. Connect the expansion hub to the USB port on the host computer using another USB cable.
   *The operating system automatically detects the instrument and starts the Found New Hardware wizard.*
5. For Windows Vista:
   a. Click **Locate and install driver software (recommended)**.
      *The popup message "Windows needs your permission to continue" appears.*
   b. Click **Continue**.
      *The Windows Security dialog box appears.*
   c. Click **Install this driver software anyway**.

   For Windows XP:
   a. Click **Next** and/or **Finish** as required in the wizard.
      *Once the firmware is loaded, the wizard restarts to initiate the firmware to accept commands.*
   b. Click **Next** and/or **Finish** again.

   **Note:** Windows 7 and Windows 8 find the device automatically.

   *If the power supply and the instrument are attached correctly, the USB LED on the rear panel, shown in Figure 10, turns green.*
6. Repeat these steps until you have attached the number of expansion hubs (up to five) and instruments (up to four per hub) that you require. Refer to Figure 11.
   *The operating system automatically detects the instruments as they are installed.*

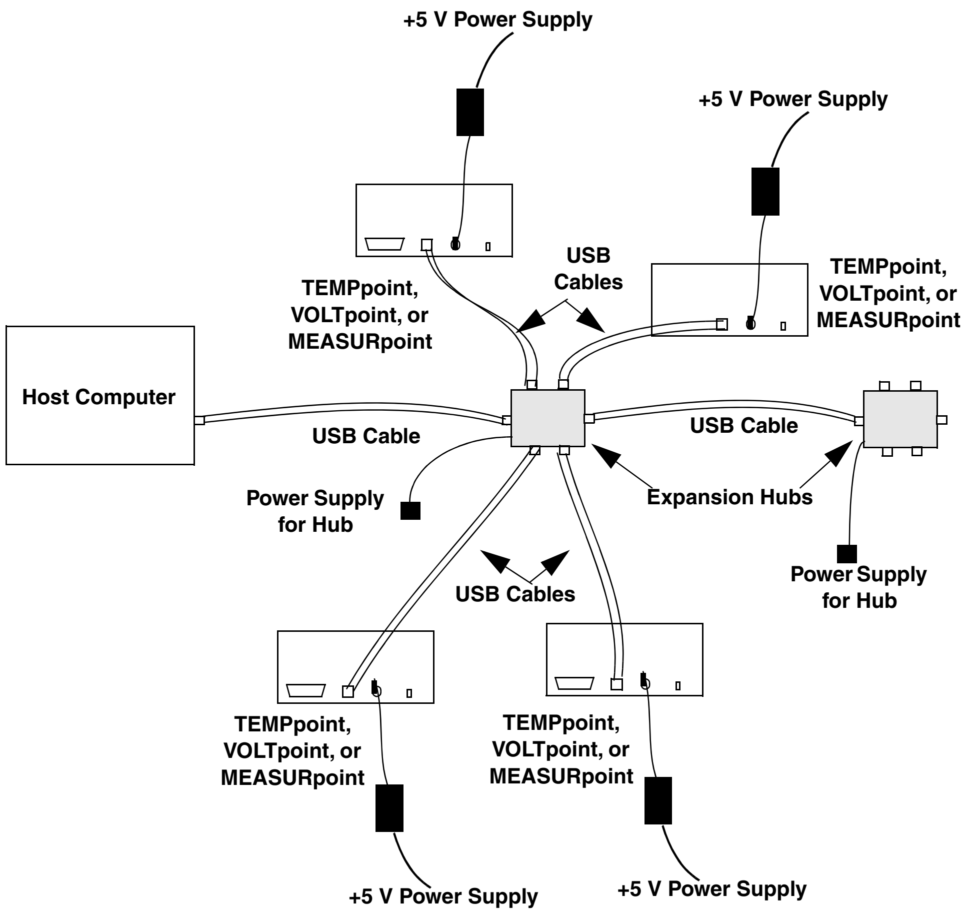


**Figure 11: Attaching Multiple Instruments Using Expansion Hubs**

# Configuring the Device Driver

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**Note:** In Windows 7, Windows 8, and Vista, you must have administrator privileges to run the Open Layers Control Panel. When you double-click the Open Layers Control Panel icon, you may see the Program Compatibility Assistant. If you do, select **Open the control panel using recommended settings**. You may also see a Windows message asking you if you want to run the Open Layers Control Panel as a "legacy CPL elevated." If you get this message, click **Yes**.

If you do not get this message and have trouble making changes in the Open Layers Control Panel, right click the DTOLCPL.CPL file and select **Run as administrator**. By default, this file is installed in the following location:

<u>Windows 7, Windows 8, and Vista (32-bit)</u>
C:\Windows\System32\Dtolcpl.cpl

<u>Windows 7, Windows 8, and Vista (64-bit)</u>
C:\Windows\SysWOW64\Dtolcpl.cpl

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To configure the device driver for a TEMPpoint, VOLTpoint, or MEASURpoint instrument, do the following:

1. If you have not already done so, power up the host computer and all peripherals.
2. From the Windows Start menu, select **Settings -> Control Panel**.
3. From the Control Panel, double-click **Open Layers Control Panel**.
   *The Data Acquisition Control Panel dialog box appears.*
4. Click the name of the instrument that you want to configure, and then click **Advanced**.
   *The Configurable Board Options dialog box appears.*
5. For each channel, set the **Channel Configuration** as voltage (the default) or one of the supported sensor types for that channel.

---

**Note:** If you wish, you can overwrite these channel input types programmatically using your software development environment or application.

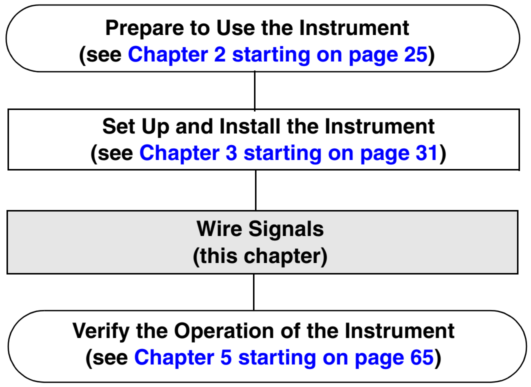
---

6. Click **OK**.
7. If you want to rename the instrument, click **Edit Name**, enter a new name for the instrument, and then click **OK**. The name is used to identify the instrument in all subsequent applications.
8. Repeat steps 4 to 7 for the other instrument that you want to configure.
9. When you are finished configuring the instrument, click **Close**.

Continue with the instructions on wiring in Chapter 4 starting on page 41.

# 4

# *Wiring Signals*


Prepare to Use the Instrument
(see Chapter 2 starting on page 25)
Set Up and Install the Instrument
(see Chapter 3 starting on page 31)
Wire Signals
(this chapter)
Verify the Operation of the Instrument
(see Chapter 5 starting on page 65)

# General Wiring Recommendations

Keep the following recommendations in mind when wiring signals to a TEMPpoint, VOLTpoint, or MEASURpoint instrument:

- Separate power and signal lines by using physically different wiring paths or conduits.
- To avoid noise, do not locate the instrument and cabling next to sources that produce high electromagnetic fields, such as large electric motors, power lines, solenoids, and electric arcs, unless the signals are enclosed in a mumetal shield.
- Locate the instrument's front panel as far away as possible from sources of high or low temperatures or strong air currents, such as fans.
- Prevent electrostatic discharge to the I/O while the instrument is operational.
- When wiring thermocouples, select an appropriate wire length and gauge for each thermocouple; in general, use the shortest wire length and largest gauge for the application to yield best results.
- Use shielded wire for maximum rejection of electrical interference.

# Warm-Up Time

For accurate thermocouple measurements, MEASURpoint instruments require a warm-up time of 1 hour for the analog circuitry to stabilize.

For accurate RTD measurements, ensure that your RTD sensors and external calibration resistors warm up for 1 minute after the MEASURpoint instrument has been warmed up for 1 hour.

# Connecting Thermocouple Inputs

The DT9871U, DT9871, and DT9874 instruments contain thermocouple jacks for connecting thermocouple inputs.

**Note:** On the standard DT9874 instrument, channels 0 to 15 correspond to the thermocouple input channels.

Internally, these signals are connected in differential mode. You can mix and match the following thermocouple types across channels: B, E, J, K, N, R, S, and/or T.

Each thermocouple input jack is polarized and accepts a mating plug in the appropriate orientation. Table 1 lists the color designations for the + and – polarities of the supported thermocouple types for both the ANSI (American) and IEC (International) standards.

**Table 1: Thermocouple Color Designation Standards**

| Thermocouple Standard | Thermocouple Type | Wire Color Coding + Polarity | Wire Color Coding – Polarity |
|---|---|---|---|
| ANSI | Type J | White | Red |
| | Type K | Yellow | Red |
| | Type T | Blue | Red |
| | Type E | Violet | Red |
| | Type S | Black | Red |
| | Type R | Black | Red |
| | Type B | Gray | Red |
| | Type N | Orange | Red |
| IEC | Type J | Black | White |
| | Type K | Green | White |
| | Type T | Brown | White |
| | Type E | Violet | White |
| | Type S | Orange | White |
| | Type R | Orange | White |
| | Type B | Gray | White |
| | Type N | Pink | White |

For more information on thermocouple standards, refer to the following web site: http://www.omega.com/thermocouples.html.

**CAUTION:**

**When connecting inputs to the thermocouple connectors on a MEASURpoint or TEMPpoint instrument, it is highly recommended that you use only original Omega thermocouple plugs (SMPW), as connectors from other suppliers may not be equivalent mechanically. Refer to page 128 for more information on the connectors.**

**If you use connectors from suppliers other than Omega, there is a risk that you may mechanically damage the thermocouple connectors on the MEASURpoint or TEMPpoint instrument.**

Figure 12 shows how to connect a thermocouple input to a thermocouple channel.

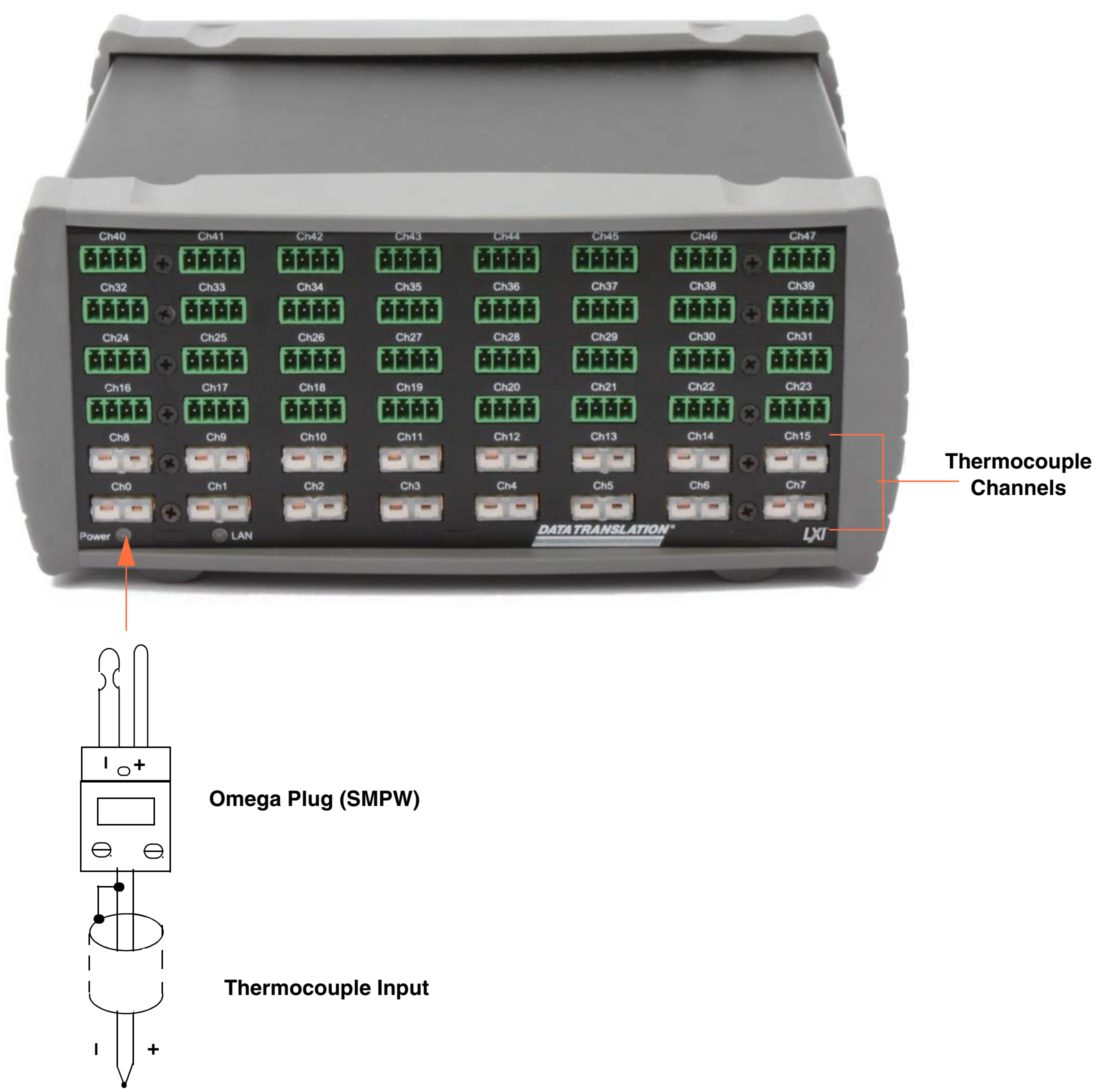



**Figure 12: Connecting Thermocouple Inputs**

# Connecting RTD Inputs

Each DT9872 and DT9874 contains pluggable screw terminals for connecting RTD inputs. Internally, these signals are connected in differential mode.

---

**Note:** On the standard DT9874 instrument, channels 16 to 31 correspond to the RTD input channels.

---

Figure 13 shows the numbering of the screw terminal blocks for RTD connections.

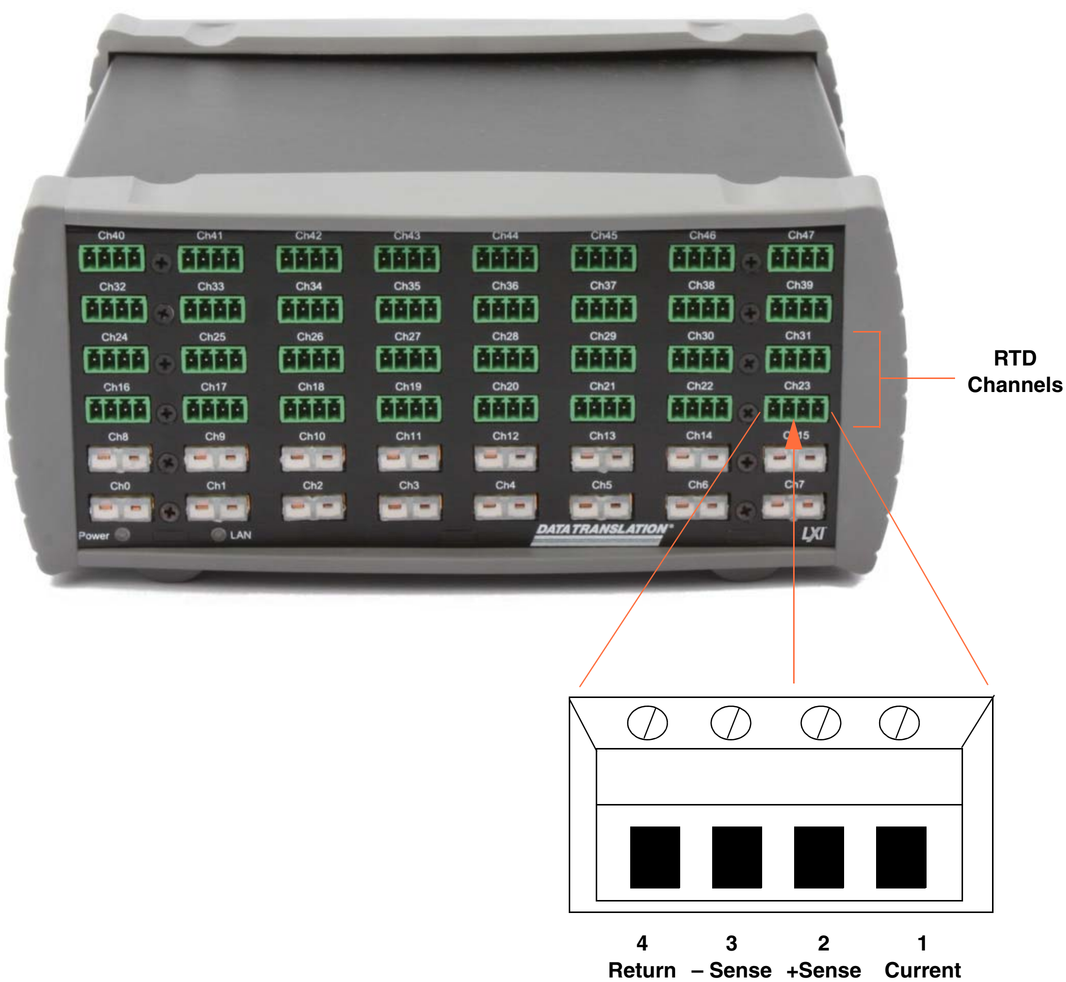



**Figure 13: Screw Terminal Block Numbering for RTD Connections**

**Note:** To make wiring easier, use the supplied screwdriver to attach your signals to the screw terminal blocks. When you are finished, plug the screw terminal block into the screw terminal header that corresponds to the channel to which you are wiring.

The DT9872 supplies each RTD channel with 425 µA of excitation current to prevent self-heating. The resistance of the RTD circuit increases gradually, repeatably, and linearly with temperature. As the resistance increases, the voltage drop across the RTD also increases. The DT9872 reads this voltage drop and automatically converts the voltage to the appropriate temperature based on the RTD type.

The DT9872 and DT9874 support Pt100 (100 Ω Platinum), Pt500 (500 Ω Platinum), and Pt1000 (1000 Ω Platinum) RTD types using Alpha coefficients of 0.00385 and 0.00392; you can mix and match RTD types across RTD channels. Refer to the following web site for more information on RTD types: http://www.omega.com.

To connect an RTD input, you can use a 4-wire, 3-wire, or 2-wire connection scheme, described in the following subsections. For the best accuracy, use 4-wire RTD connections; this connection scheme enables Kelvin sensing to minimize errors due to lead wire resistance.

## 4-Wire RTD Connections

The 4-wire configuration offers the best accuracy with long connection wires, compared to the 3- and 2-wire configurations. The 4-wire connection scheme eliminates errors due to lead wire resistance ($R_L$) and thermal heating. Wire impedance of up to 100 Ω anywhere in the hookup is automatically cancelled as long as the sense wires are connected.

Figure 14 shows a 4-wire RTD connection.

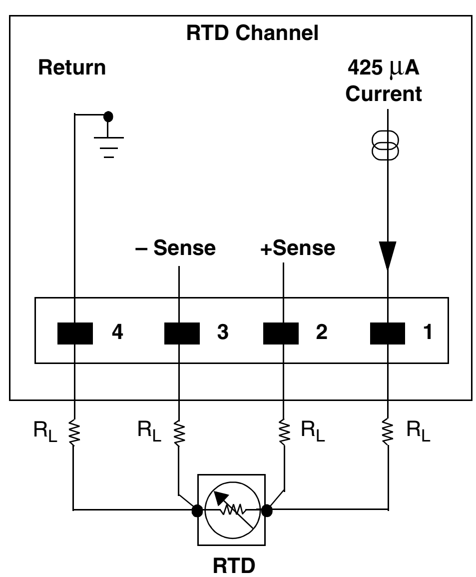



**Figure 14: 4-Wire RTD Connection**

## 3-Wire RTD Connections

The 3-wire configuration eliminates one wire from the 4-wire RTD connection. Lead wire resistance ($R_L$) errors in the return wire from –Sense may be introduced unless the voltage drop is essentially equal and opposite to the voltage drop across +Sense.

Figure 15 shows a 3-wire RTD connection.

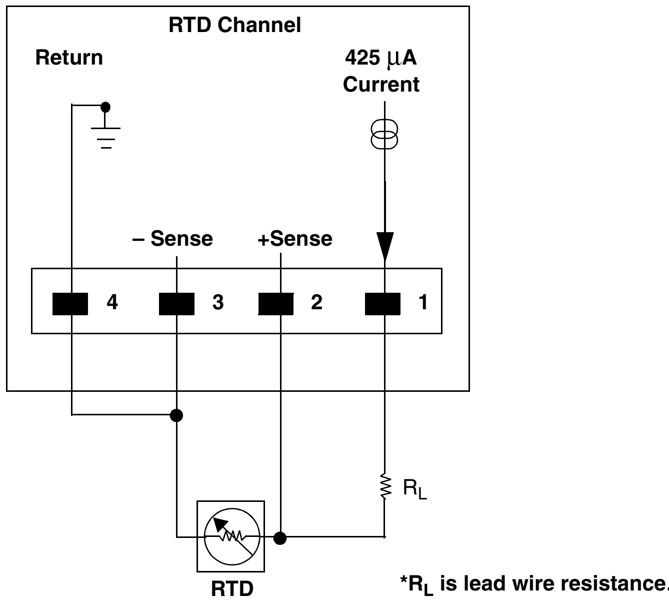



**Figure 15: 3-Wire RTD Connection**

## 2-Wire RTD Connections

The 2-wire configuration is the least accurate of the RTD wiring configurations because the lead wire resistance ($R_L$) and its variation with temperature contribute significant measurement errors, particularly if the lead wire is long. If you decide to use the 2-wire connection scheme, ensure that you use short lead wire connections.

For example, if the lead resistance is 0.5 Ω in each wire, the lead resistance adds a 1 Ω of error to the resistance measurement. Using a 100 Ω RTD (Pt100) with a 0.00385/°C European curve coefficient, the resistance represents an initial error of 1 Ω /(0.385Ω /°C) or 2.6°C. Since the lead wire resistance changes with ambient temperature, additional errors are also introduced in the measurement.

Figure 16 shows a 2-wire RTD connection.

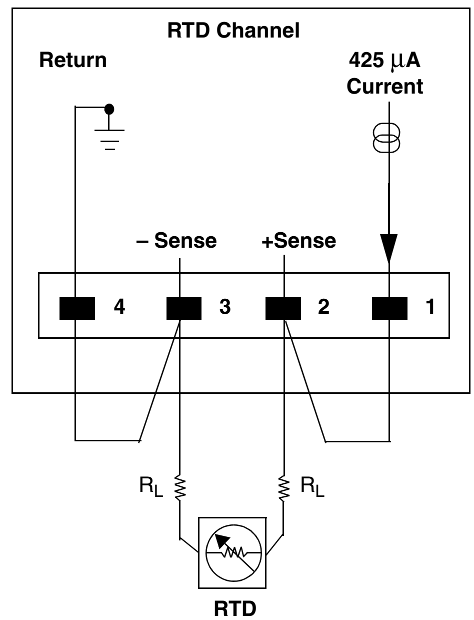



**Figure 16: 2-Wire RTD Connection**

# Connecting Voltage Inputs

The way you connect voltage inputs depends on the channel type you are using. This section describes how to connect voltage inputs to thermocouple input channels, RTD input channels, and voltage input channels.

## Connecting Voltage Inputs to Thermocouple Channels

Figure 17 shows how to connect a differential voltage input to a thermocouple input channel on the DT9871U, DT9871, or DT9874 instrument.

**Note:** On the standard DT9874 instrument, channels 0 to 15 correspond to the thermocouple input channels.

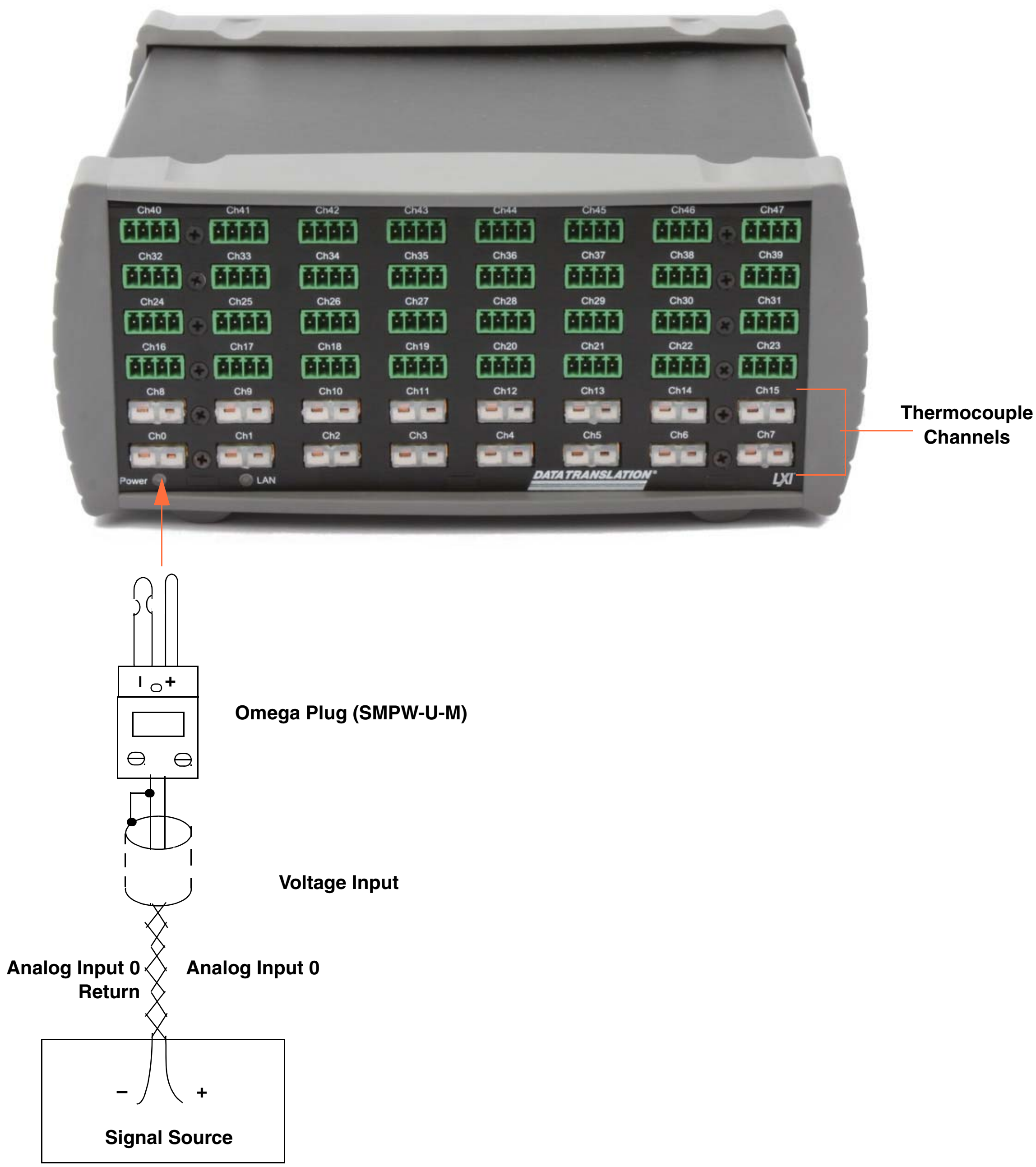



**Figure 17: Connecting Voltage Inputs to a Thermocouple Channel**

## Connecting Voltage Inputs to RTD Channels

Figure 18 shows how to connect a voltage input to an RTD channel on a DT9872 or DT9874 instrument.

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**Note:** On the standard DT9874 instrument, channels 16 to 31 correspond to the RTD input channels.

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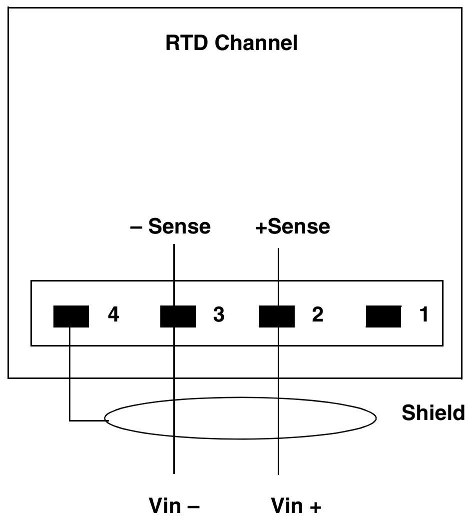



**Figure 18: Connecting Voltage Inputs to an RTD Channel**

The input impedance is well over 100 MΩ using the voltage –Sense and +Sense inputs.

For best accuracy when connecting voltage inputs, use twisted-pair wires with a dead-ended shield connected to pin 4 of the screw terminal block.

## Connecting Voltage Inputs to Voltage Channels

Each DT9873 and DT9874 contains pluggable screw terminals for connecting voltage inputs.

---

**Note:** On the standard DT9874 instrument, channels 32 to 47 correspond to the voltage input channels.

---

Figure 19 shows the numbering of the screw terminal blocks for voltage input connections.

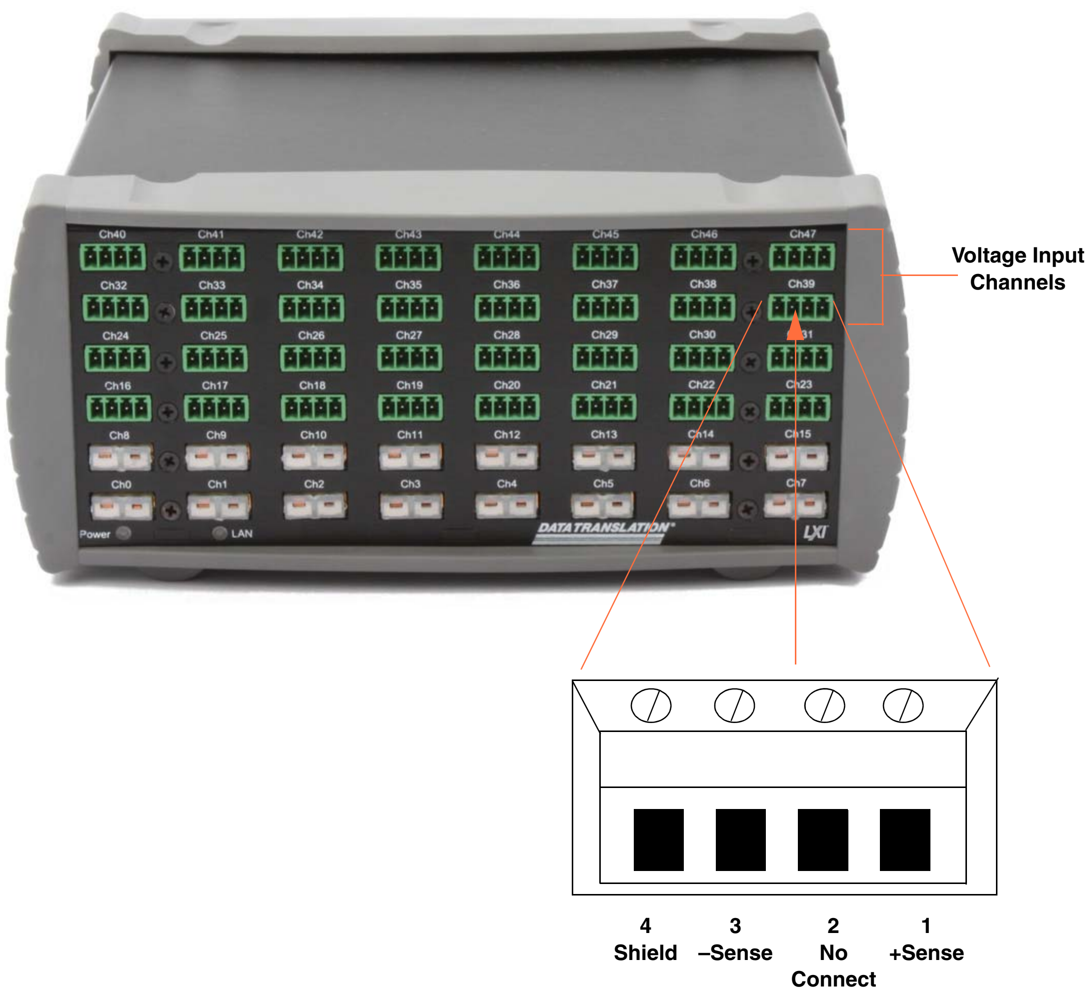



**Figure 19: Screw Terminal Block Numbering for Voltage Connections**

**Note:** To make wiring easier, use the supplied screwdriver to attach your signals to the screw terminal block. When you are finished, plug the screw terminal block into the screw terminal header that corresponds to the channel to which you are wiring.

Figure 20 shows how to connect voltage inputs to the DT9873 and DT9874.

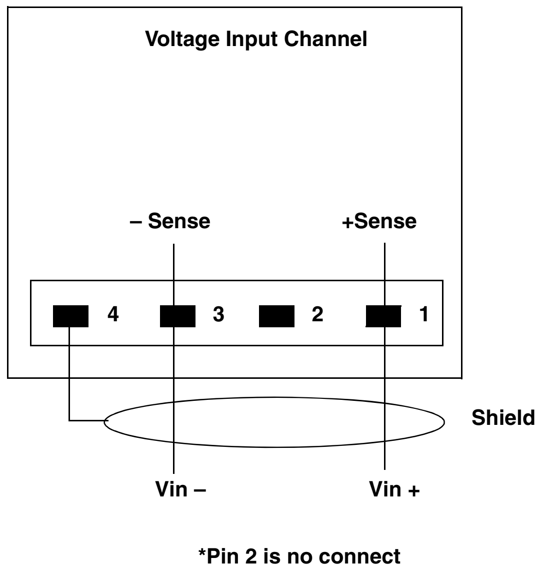



**Figure 20: Connecting Voltage Inputs**

The input impedance is well over 100 MΩ using the voltage –Sense and +Sense inputs.

**Note:** For best accuracy when connecting voltage inputs, use twisted-pair wires with a dead-ended shield connected to pin 4 of the screw terminal block.

# Connecting Current Loop Inputs

In some applications, such as solar cell, fuel cell, and car battery testing applications, you may want to accurately sense and measure current in a high voltage loop.

TEMPpoint, VOLTpoint, and MEASURpoint instruments provide channel-to-channel isolation of ±500 V, meaning that each input can be referenced to ±500 V.

The way you connect current loop inputs depends on the channel type you are using. This section describes how to connect current loop inputs to thermocouple input channels, RTD input channels, and voltage input channels.

## Connecting Current Loop Inputs to Thermocouple Channels

Thermocouple input channels on the DT9871U and DT9874 have an input range of ±0.075 V. Therefore, you can use a 1 Ω series resistor to measure ±0.075 A. Similarly, you can use a 0.1 Ω series resistor to measure ±0.75 A.

Thermocouple input channels on the DT9871 have an input range of ±1.25 V. Therefore, you can use a 1 Ω series resistor to measure ±1.25 A. Similarly, you can use a 0.1 Ω series resistor to measure ±12.5 A or a 10 Ω series resistor to measure ±0.125 A.

Figure 21 shows how to wire your signals to measure a current loop. In this example, the input is referenced to ±80 V.

**Note:** On the standard DT9874 instrument, channels 0 to 15 correspond to the thermocouple input channels.

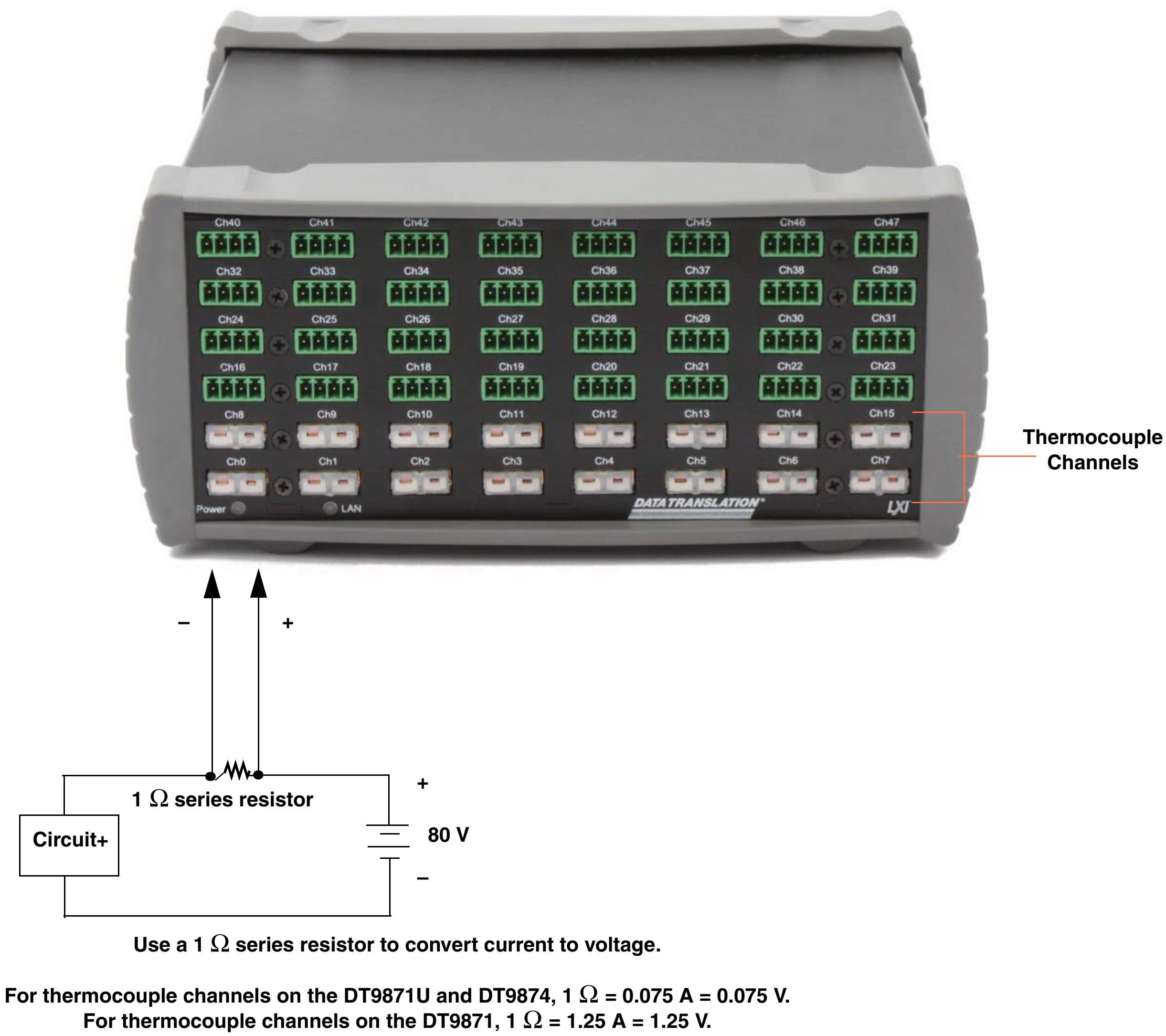



**Figure 21: Connecting Current Loop Inputs to Thermocouple Channels**

## Connecting Current Loop Inputs to RTD Channels

RTD channels on the DT9872 and DT9874 instruments have an input range of ±1.25 V. Therefore, you can use a 1 Ω shunt resistor to measure ±1.25 A. Similarly, you can use a 0.1 Ω shunt resistor to measure ±12.5 A or a 10 Ω shunt resistor to measure ±0.125 A.

Figure 22 shows how to wire your signals to measure a current loop. In this example, the input is referenced to ±80 V.

---

**Note:** On the standard DT9874 instrument, channels 16 to 31 correspond to the RTD input channels.

---

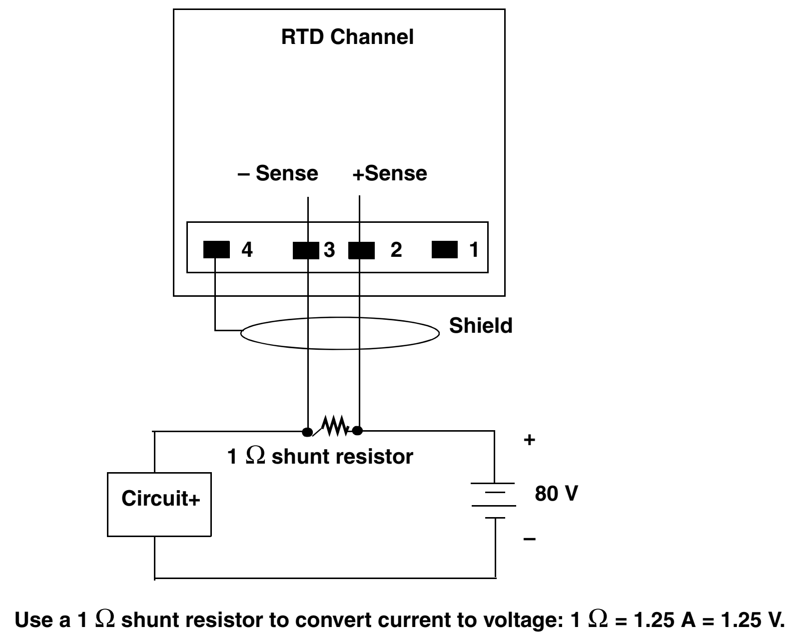



**Figure 22: Connecting Current Loop Inputs to RTD Channels**

## Connecting Current Loop Inputs to Voltage Channels

Voltage channels on the DT9873 and DT9874 instruments have an input range of ±10 V, ±100 V, or ±400 V. You select the input range for each channel using software.

---

**Note:** On older versions of the instrument, the input range was fixed and depended on the model you purchased.

---

With the 24-bit A/D converter, high current, high side current shunts can be used for resolutions of less than 0.01 A on a 100 A range.

Typical Shunts:

- Vishay WSMS5515
  .2 mΩ - 2W - 100A - 20mV
- Vishay CSM2512S
  10 mΩ - 1W - 10A - 100mV
- Deltec MUB-500-50
  .1 mΩ - 25W - 500A - 50mV

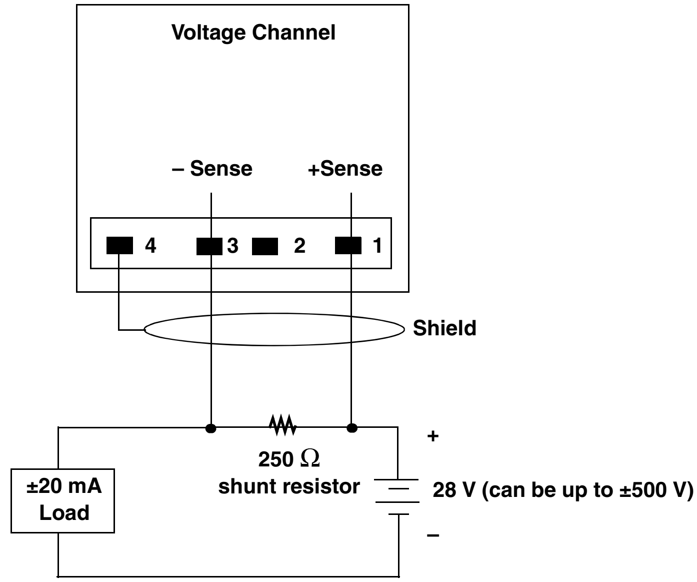
---

**Notes:** The resolution is ±2 mV on a ±100 V range and ±0.3 mV on the ±10 V range. Since the resolution of the ±400 V range is ±8 mV, using current loop inputs with this range is impractical in most applications.

On the standard DT9874 instrument, channels 32 to 47 correspond to the voltage input channels.

---

Figure 23 shows an example of wiring signals to measure ±20 mA using the ±10 V input range.




In this example, the input range is ±10 V.

**Figure 23: Connecting a Current Loop Input to a Voltage Channel to Measure ±20 mA**

# Connecting Digital I/O Signals

To make digital I/O connections easier, you can use the optional STP37 screw terminal panel and EP333 cable with your TEMPpoint, VOLTpoint, or MEASURpoint instrument. Connect the STP37 to the digital I/O connector of the instrument as shown in Figure 24:

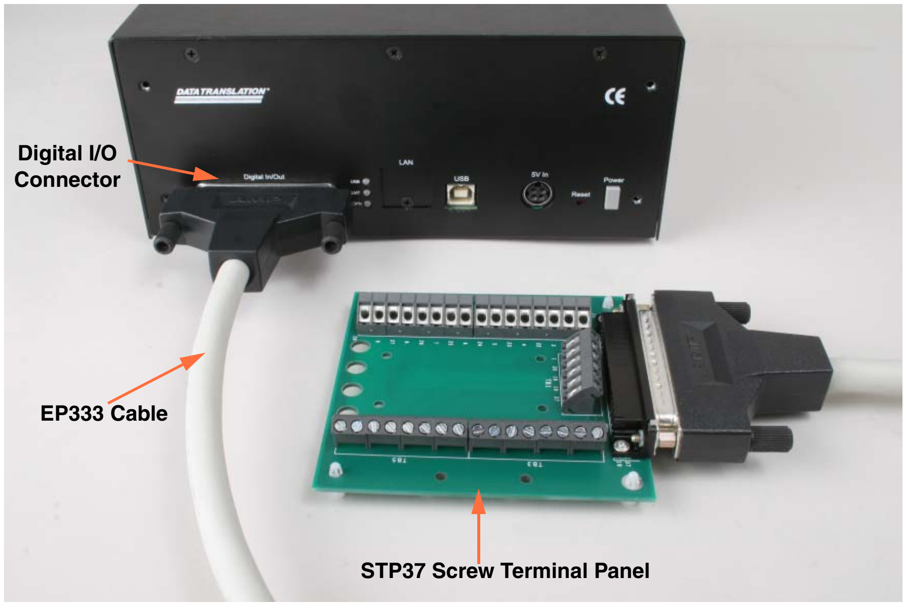



**Figure 24: Connecting the Instrument to the STP37**

Figure 25 shows the layout of the STP37 screw terminal panel and lists the assignments of each screw terminal.

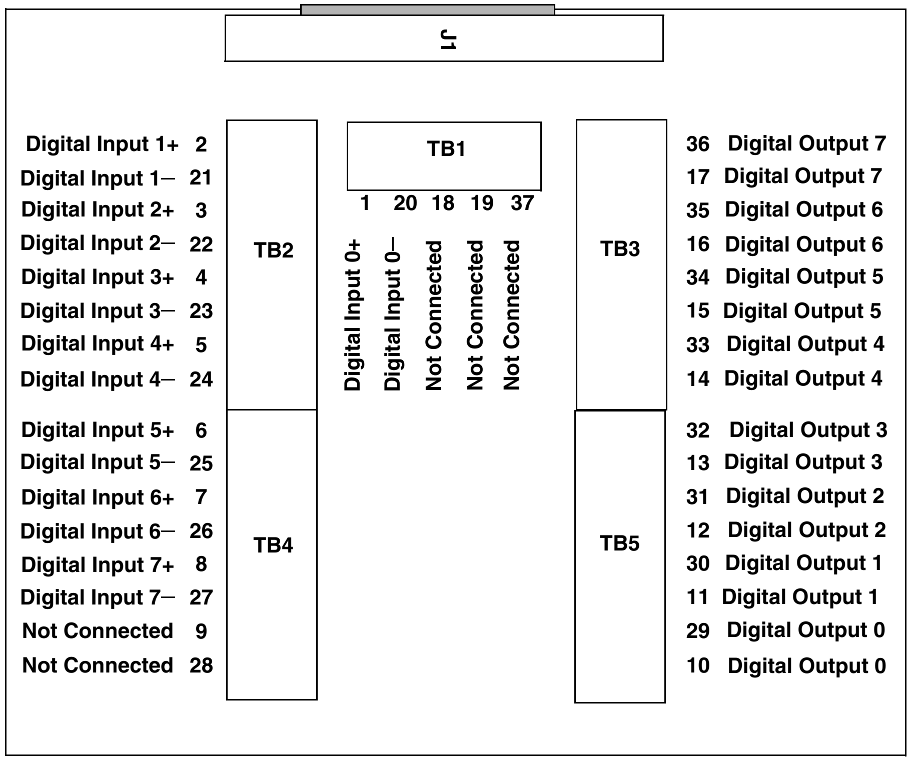



**Figure 25: STP37 Screw Terminal Panel**

## Connecting Digital Input Signals

Figure 26 shows how to connect digital input signals (lines 0 and 1, in this case) to the digital I/O connector on the TEMPpoint, VOLTpoint, or MEASURpoint instrument.

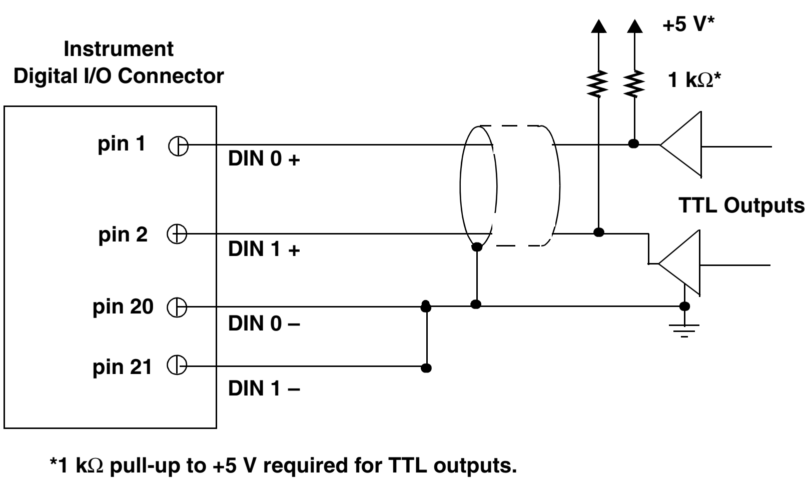



**Figure 26: Connecting Digital Inputs**

## Connecting Digital Output Signals

The digital output lines of a TEMPpoint, VOLTpoint, or MEASURpoint instrument act as solid-state relays. The customer-supplied signal can be ±30 V at up to 400 mA (peak) AC or DC.

You can use the digital output lines of the instrument to control solid-state or mechanical relays or high-current electric motors. Figure 27 shows how to connect digital output signals to line 0 of the instrument to control a motor relay.

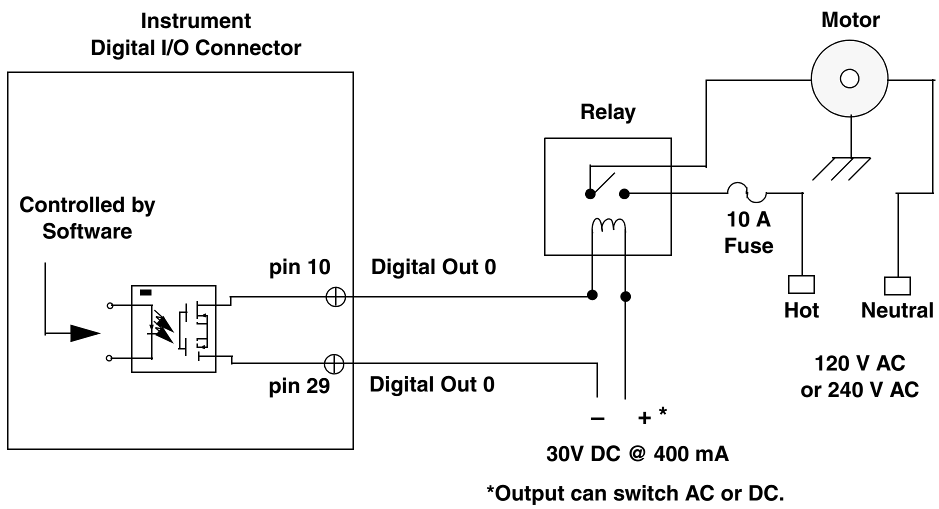
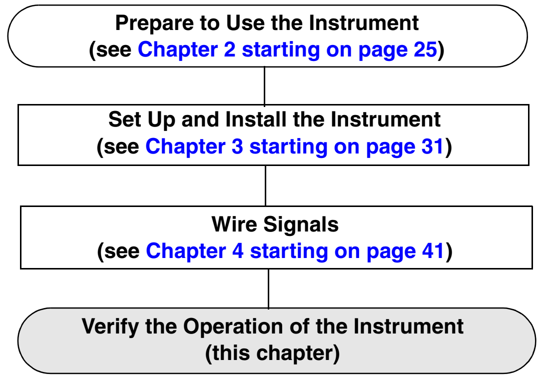



**Figure 27: Switching up to 30 V at 400 mA**

# 5

# Verifying the Operation of Your Instrument


Prepare to Use the Instrument
(see Chapter 2 starting on page 25)
Set Up and Install the Instrument
(see Chapter 3 starting on page 31)
Wire Signals
(see Chapter 4 starting on page 41)
Verify the Operation of the Instrument
(this chapter)

# Overview

You can verify the operation of your TEMPpoint, VOLTpoint, or MEASURpoint instrument using the base version of the QuickDAQ application that is provided with the instrument. (Refer to page 29 for information on installing the QuickDAQ application.)

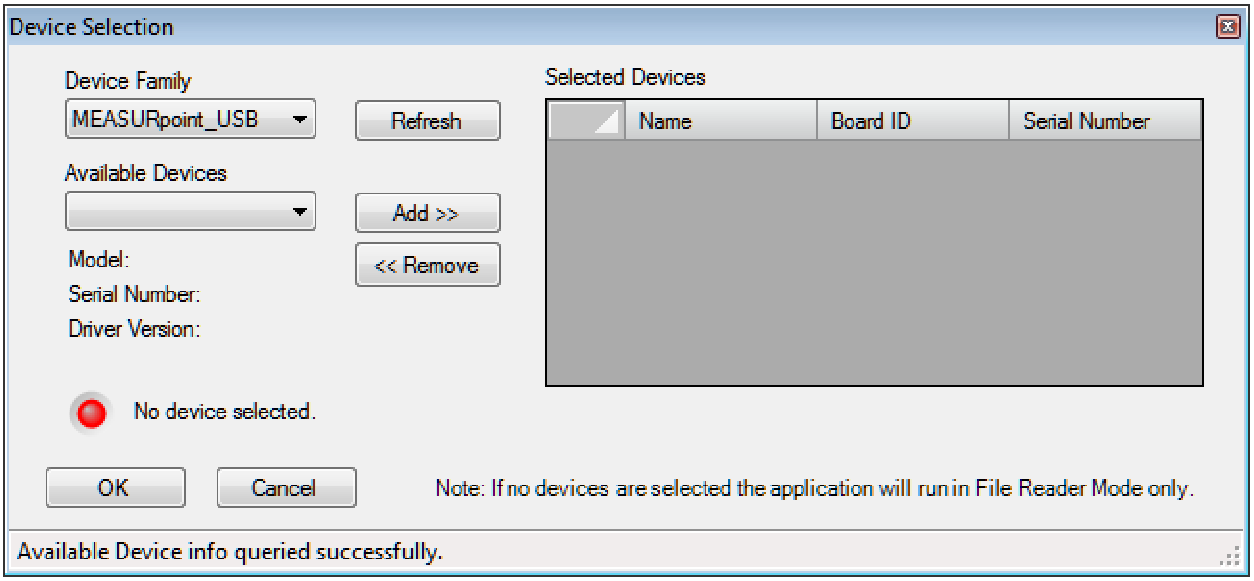
This chapter describes how to use QuickDAQ to measure and display temperature and voltage data from a data acquisition device. For this example, the following sensors are connected to a DT9874 MEASURpoint instrument:

- T thermocouple is connected to analog input channel 0
- 4-wire, Euro PT1000 RTD is connected to analog input channel 8
- ±10 V input signal is connected to analog input channel 16

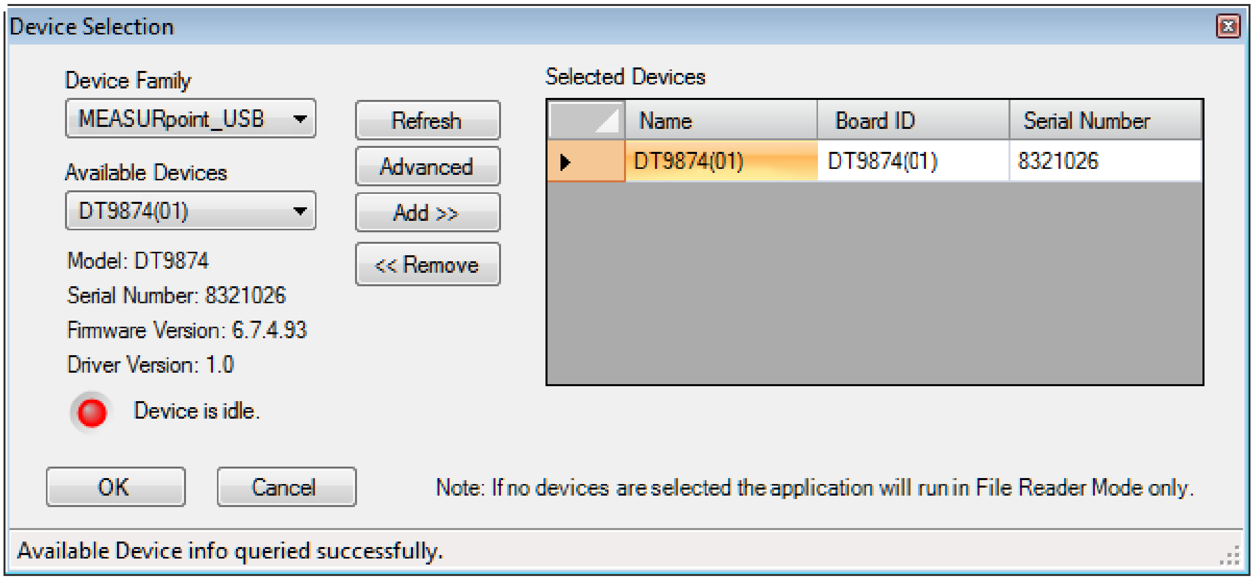
# Select the Instrument

To get started with QuickDAQ, follow these steps:

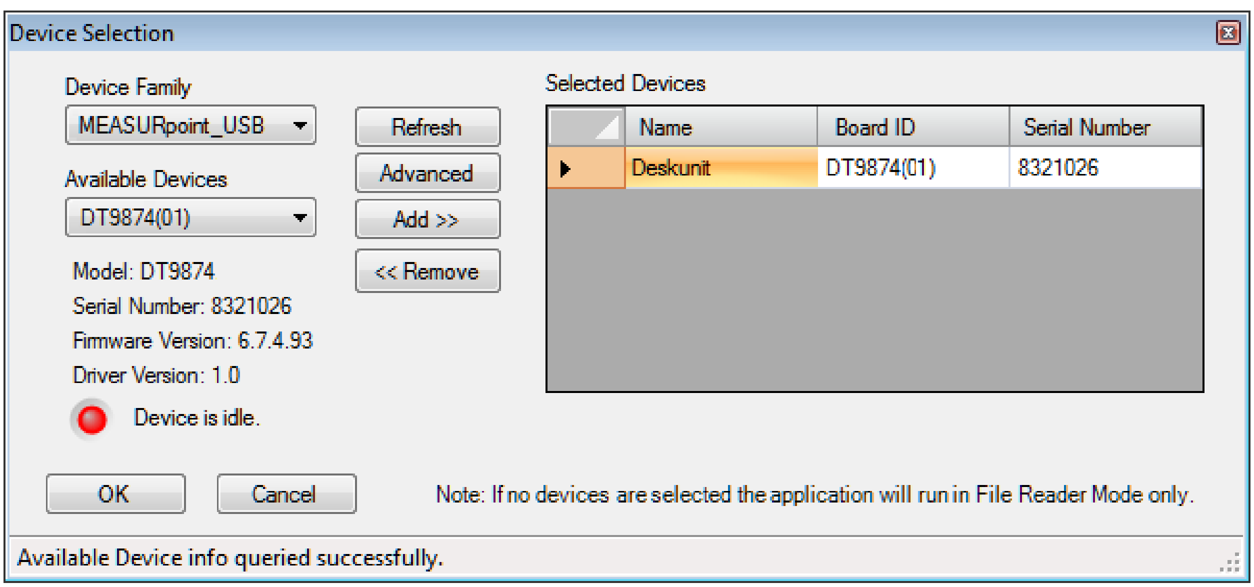
1. Connect your instrument to the USB port of your computer, and connect your sensors to the instrument.
2. Start QuickDAQ.
   *The Device Selection window appears.*
3. Select **MEASURpoint_USB** for the Device Family name.




4. By default, the application "discovers" all devices that are available for the specified device family and displays the module name of the USB devices in the drop-down list. If you want to refresh this list to determine if other devices are available, click **Refresh**.
5. Select the module name that corresponds to your instrument, and click **Add**.
   *Information about the device, including the model number, serial number, firmware version, driver version, and scanning status is displayed.*




6. If you want to rename your device, do the following:
   a. Click the Row Selector button for the device.
   b. Click the module name in the **Name** column to highlight it and enter a meaningful name to represent each available device.
   *In this example, Deskunit is used as the device name.*

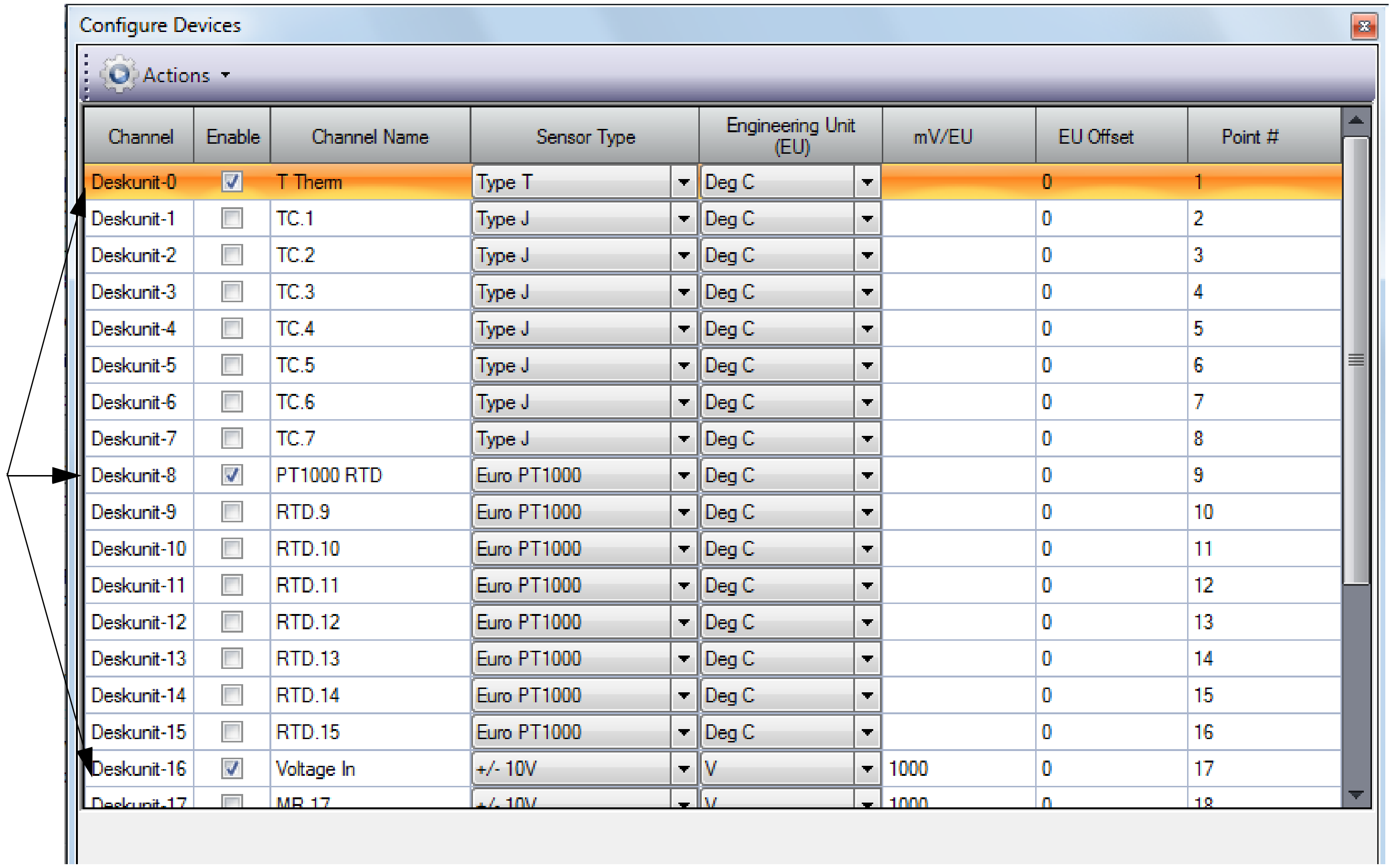



7. Click **OK**.
   *The QuickDAQ interface is displayed.*

# Configure the Channels

Configure the channels as follows:

1. Configure each analog input channel by clicking the **Configuration** menu, and clicking **Input Channel Configuration**, or by clicking the **Input Channel Configuration** toolbar button ( ).
2. Enable analog input channels 0, 8, and 16 by clicking the checkbox under the **Enable** column.




| Channel | Enable | Channel Name | Sensor Type | Engineering Unit (EU) | mV/EU | EU Offset | Point # |
|---|---|---|---|---|---|---|---|
| Deskunit-0 | ☑ | T Therm | Type T | Deg C | | 0 | 1 |
| Deskunit-1 | ☐ | TC.1 | Type J | Deg C | | 0 | 2 |
| Deskunit-2 | ☐ | TC.2 | Type J | Deg C | | 0 | 3 |
| Deskunit-3 | ☐ | TC.3 | Type J | Deg C | | 0 | 4 |
| Deskunit-4 | ☐ | TC.4 | Type J | Deg C | | 0 | 5 |
| Deskunit-5 | ☐ | TC.5 | Type J | Deg C | | 0 | 6 |
| Deskunit-6 | ☐ | TC.6 | Type J | Deg C | | 0 | 7 |
| Deskunit-7 | ☐ | TC.7 | Type J | Deg C | | 0 | 8 |
| Deskunit-8 | ☑ | PT1000 RTD | Euro PT1000 | Deg C | | 0 | 9 |
| Deskunit-9 | ☐ | RTD.9 | Euro PT1000 | Deg C | | 0 | 10 |
| Deskunit-10 | ☐ | RTD.10 | Euro PT1000 | Deg C | | 0 | 11 |
| Deskunit-11 | ☐ | RTD.11 | Euro PT1000 | Deg C | | 0 | 12 |
| Deskunit-12 | ☐ | RTD.12 | Euro PT1000 | Deg C | | 0 | 13 |
| Deskunit-13 | ☐ | RTD.13 | Euro PT1000 | Deg C | | 0 | 14 |
| Deskunit-14 | ☐ | RTD.14 | Euro PT1000 | Deg C | | 0 | 15 |
| Deskunit-15 | ☐ | RTD.15 | Euro PT1000 | Deg C | | 0 | 16 |
| Deskunit-16 | ☑ | Voltage In | +/- 10V | V | 1000 | 0 | 17 |
| Deskunit-17 | ☐ | MR.17 | +/- 10V | V | 1000 | 0 | 18 |

3. Under the **Channel Name** column, enter a meaningful name for each channel. For this example, enter the following names:
   – For analog input channel 0, enter **T Therm** as the channel name.
   – For analog input channel 8, enter **PT1000 RTD** as the channel name.
   – For analog input channel 16, enter **Voltage In** as the channel name.
4. Under the **Sensor** column, select the following sensor types for the analog input channels:
   – For analog input channel 0, select **Type T** as the thermocouple type.
   – For analog input channel 8, select **Euro PT1000** as the RTD type.
   – For analog input channel 16, select **+/-10V** as the input voltage range.

5. Under the **Engineering Units** column, **Deg C** is selected by default. If you want to change this setting, change the temperature units under the **Acquisition Config - Acquisition** tab.
   *In this example, **Deg C** is used.*

6. If you know the offset for your calibrated thermocouple and RTD, enter it under the **EU Offset** column. For this example, leave **0** as the EU offset for the thermocouple and RTD channels and **1000** as the EU offset for the voltage input channel.

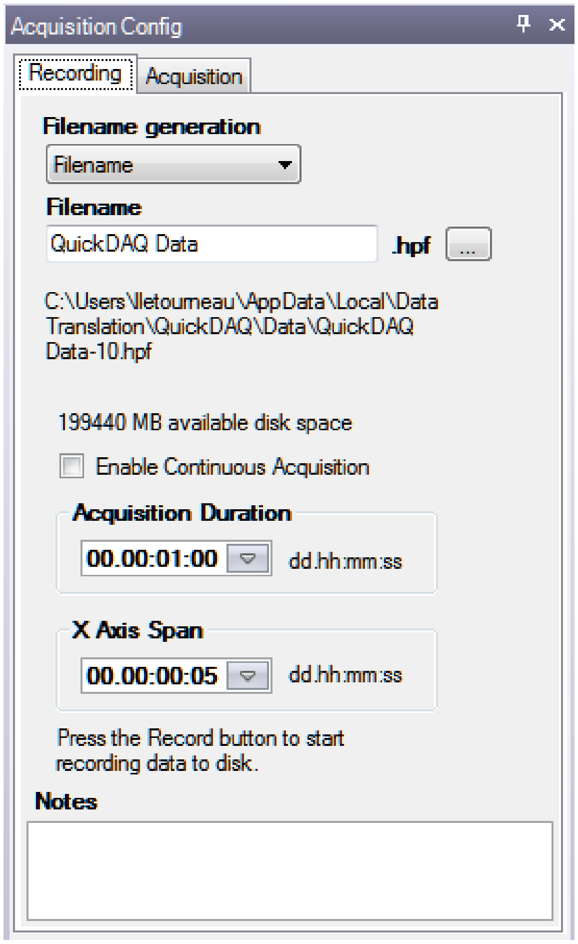
7. Leave the test point values for each channel unchanged.

8. Click **Close** to close the Channel Configuration dialog box.

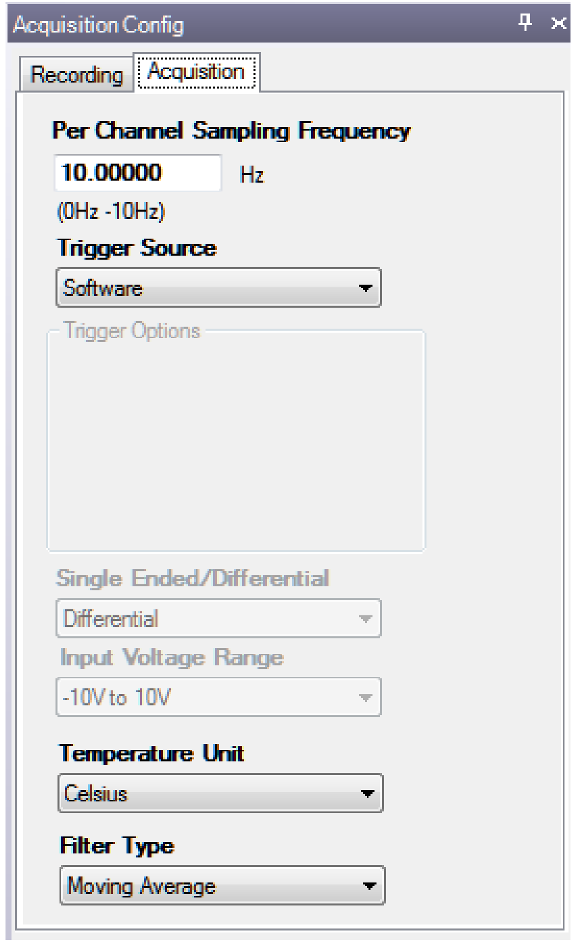
# Configure the Parameters of the Acquisition Config Window

For this example, set the Acquisition Config parameters as follows:

1. Click the **Recording** tab.




2. For **Filename generation**, select **Filename**.
3. Enter a meaningful name for the data file.
   *In this example, QuickDAQ Data.hpf is used.*
4. Leave the **Enable Continuous Acquisition** checkbox unchecked.
5. For **Acquisition Duration**, select **1 minute** as the time to acquire the measurement data.
   *The amount of available disk space is shown; in addition, the number of scans in the Acquisition Info area is updated based on the acquisition duration that is selected.*
6. For **X Axis Span**, enter **5 seconds** as the span for the x-axis.
7. Click the **Acquisition** tab.

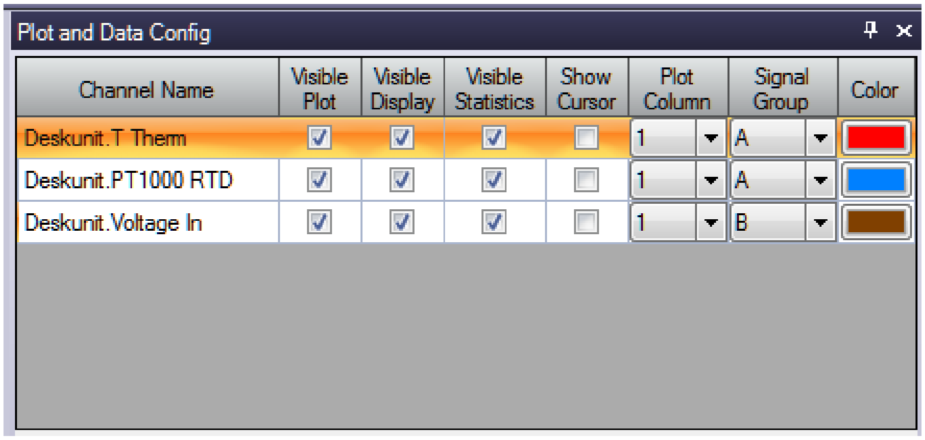



8. For this example, ensure that the following default settings are used:
   - **Sampling Frequency:** 10 Hz
   - **Trigger Source:** Software
   - **Temperature Unit:** Celsius
   - **Filter Type:** Moving Average
9. If desired, hide the **Acquisition Config** window by clicking the **Auto-Hide** pin ( ) in the top, right corner of the window.

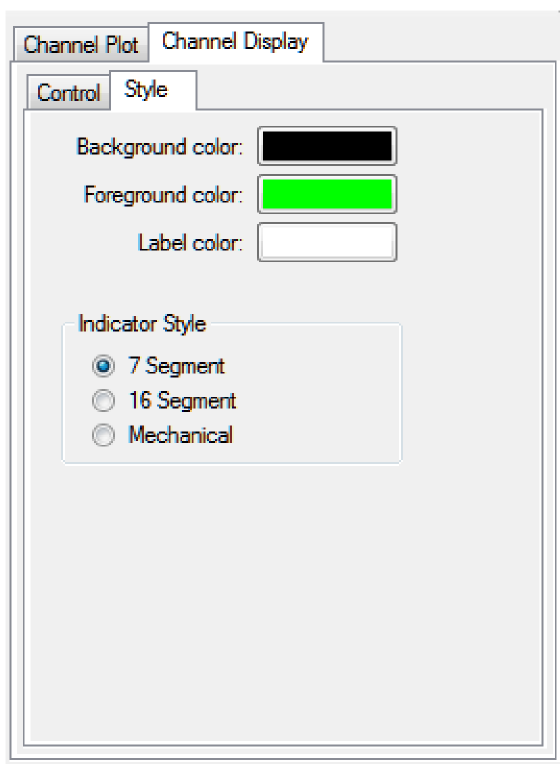
# *Configure the Appearance of the Channel Display Window*

Configure the appearance of the Channel Display window as follows:

1. Ensure that the **Visible Display** column in the **Plot and Data Config** window is checked for all three enabled channels.




2. Click the **Channel Display - Style** tab, and select the color scheme that you want for the Channel Display window.
   *In this example, black is used for the background color, green is used for the foreground color, and white is used for the label color.*




3. Leave the indicator style as **7 segment**.

# *Configure the Appearance of the Channel Plot Window*

Configure the appearance of the Channel Plot window as follows:

1. In the **Plot and Data Config** window, set up the following parameters:

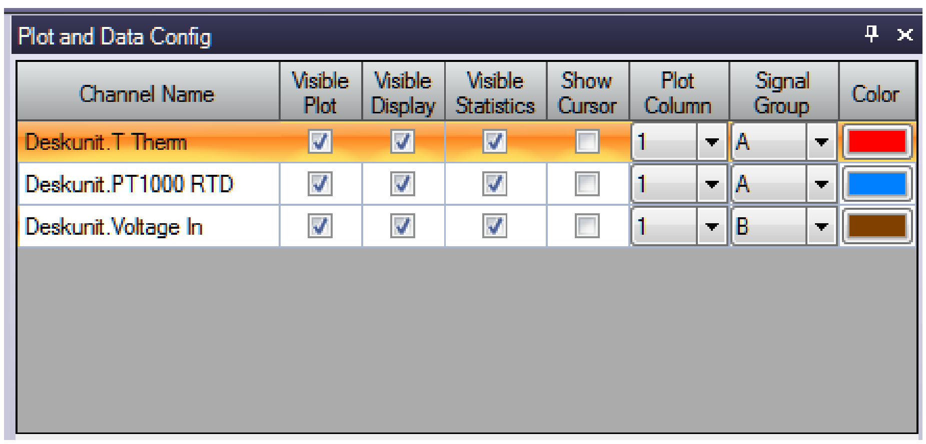
   a. Ensure that the **Visible Plot** column is checked for all three enabled channels.

   b. Leave the **Show Cursor** column unchecked for all three enabled channels.

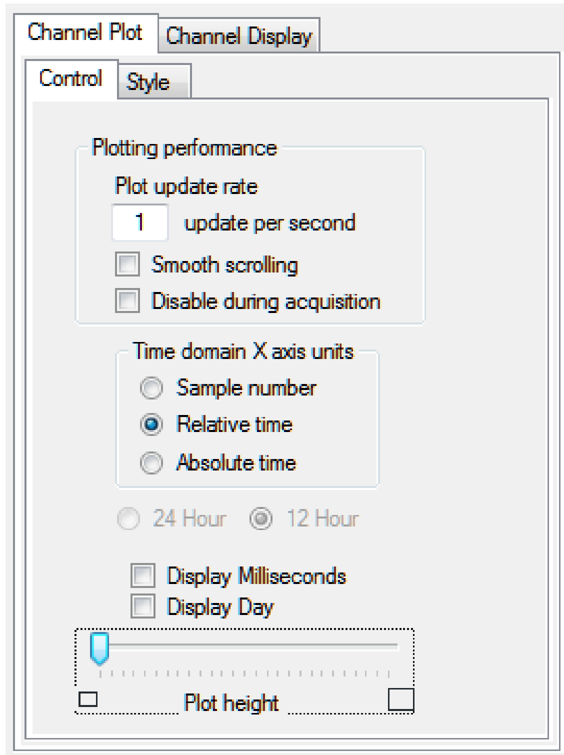
   c. Under **Plot Column**, use the default plot column setting of 1 for all three enabled channels.

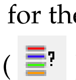
   d. Under the **Signal Group** column, select **A** for the thermocouple and RTD channels, and select **B** for the voltage input channel.

   e. Under the **Color** column, assign a unique color to each trace.

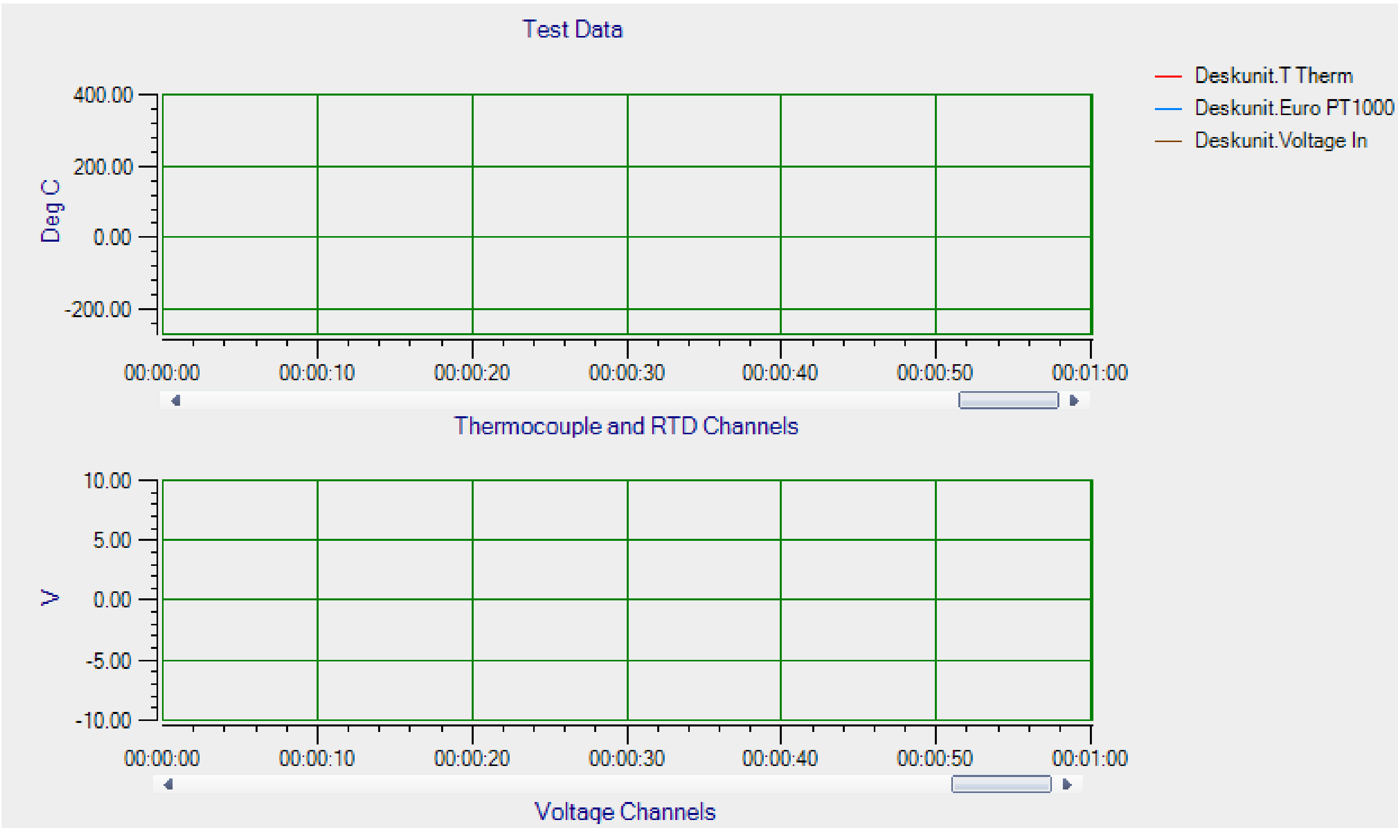



2. Click the **Channel Plot - Control** tab, and slide the **Plot height** bar to the left until you can see both plots on the screen at once.




3. Leave the following settings unchanged:
   - **Plot update rate:** 1
   - **Smooth scrolling:** unchecked
   - **Disable during acquisition:** unchecked
   - **Time domain X axis units:** Relative time
   - **Display Milliseconds**: unchecked
   - **Display Days**: unchecked
4. In the display area, click the tab for the **Channel Plot** window.
5. Click the **Show Legend** control (  ) on the toolbar.
6. For the top plot in this window, change the text for the label on the x-axis, by doing the following:
   a. Right-click on the label.
   b. Select **Edit Label**.
   c. Enter the following text: **Thermocouple and RTD Channels**
7. For the bottom plot in this window, change the text for the label on the x-axis, by doing the following:
   a. Right-click on the label.
   b. Select **Edit Label**.

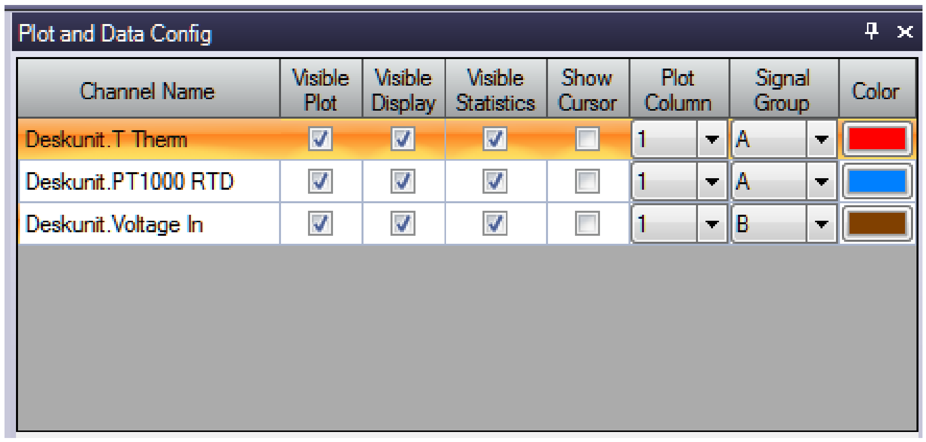
c. Enter the following text: **Voltage Channels**
*The Channel Plot window should appear as follows:*



# *Configure the Appearance of the Statistics Window*

Configure the appearance of the Statistics window as follows:

1. Ensure that the **Visible Statistics** column in the **Plot and Data Config** window is checked for all three enabled channels:

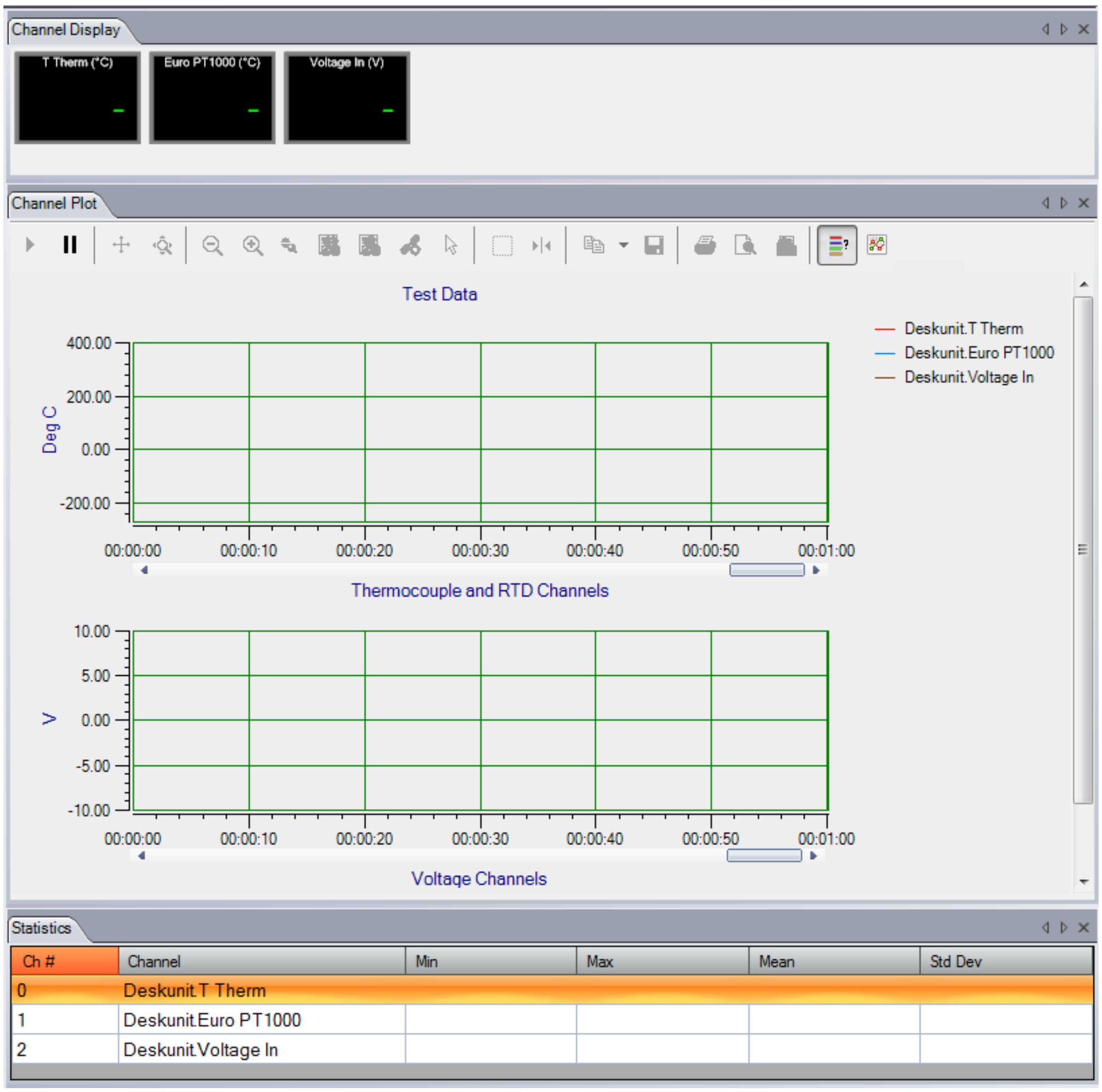



2. If desired, hide the **Plot and Data Config** window by clicking the **Auto-Hide** pin ( ) in the top, right corner of the window.

# Position the Windows

If you want see the data that is displayed in the Channel Display, Channel Plot, and Statistics windows at once, you need to move the windows to different locations in the display area.

In the following example, the Channel Display window is located at the top of the display area, the Channel Plot window is located in the middle of the display area, and the Statistics window is located at the bottom of the display area:




Perform the following steps to position the Channel Display window at the top of the display area, the Channel Plot window in the middle of the display area, and the Statistics window at the bottom of the display area:

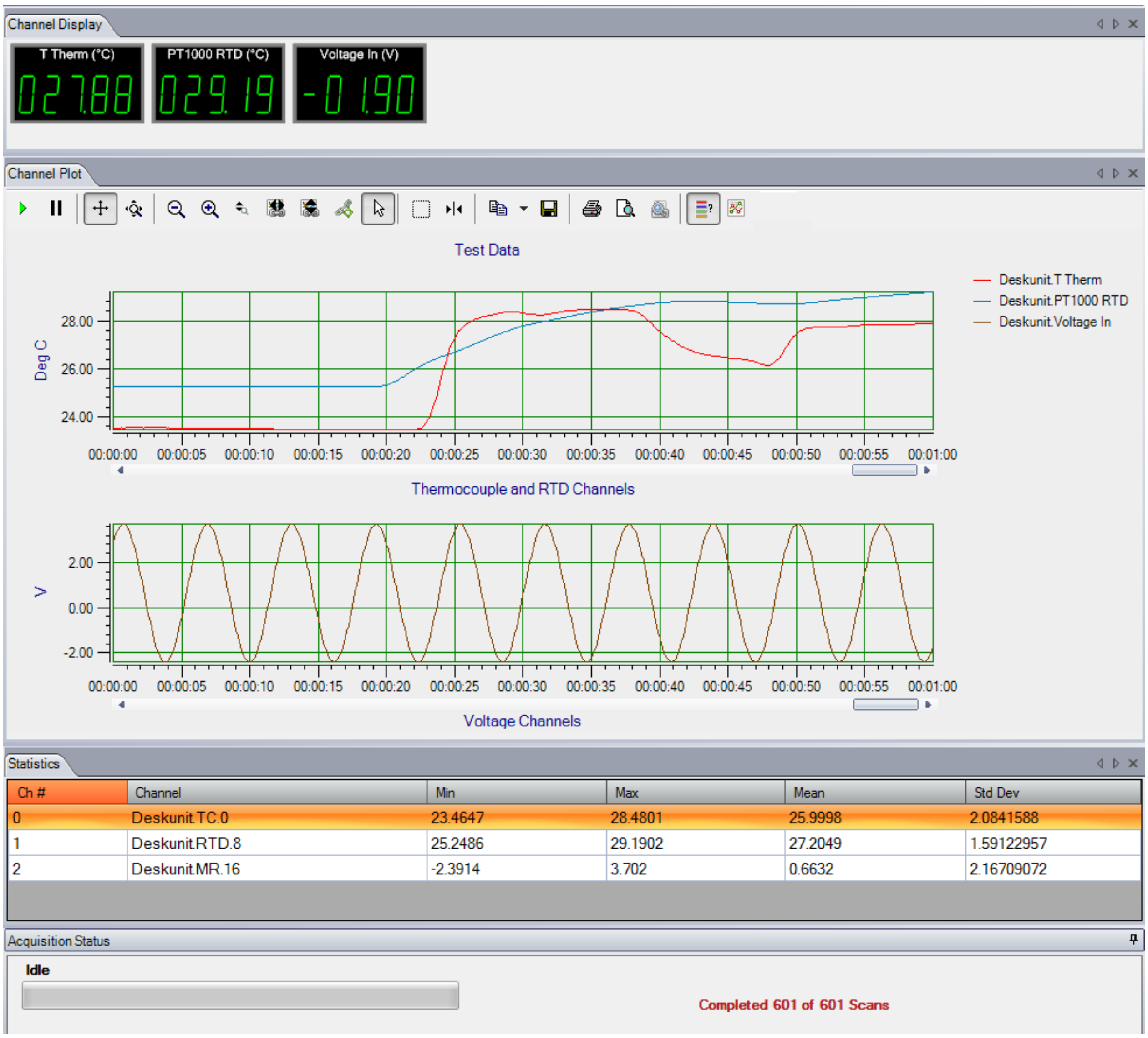
1. Click the tab for the **Statistics** window, drag the window toward the middle of the display area, move the mouse over the guide on the bottom of the guide diamond, and then release the mouse button.
   *The Statistics window is now placed at the bottom of the display area.*

2. Click the tab for the **Channel Plot** window, drag the window toward the middle of the display area, move the mouse over the guide on the bottom of the guide diamond, and then release the mouse button.
   *The Channel Plot window is now placed in the middle of the display area, revealing the Channel Display window at the top of the display area.*

3. Resize each window, as desired.

# Start the Measurement

Once you have configured the channels and the display area, start acquisition and log data to disk by clicking the **Record** toolbar button ( Record ).
*Results similar to the following are displayed in the display area.*




If desired, you can view the data in Excel by clicking the **Open Current Data in Excel** toolbar button (  ).

# Part 2: Using Your Instrument

6

# Principles of Operation

# Block Diagrams

This section includes the block diagrams for the DT9871U, DT9871, and DT9872 TEMPpoint instruments, DT9873 VOLTpoint instrument, and DT9874 MEASURpoint instruments.

## DT9871U Block Diagram

Figure 28 shows the block diagram of the DT9871U TEMPpoint instrument.

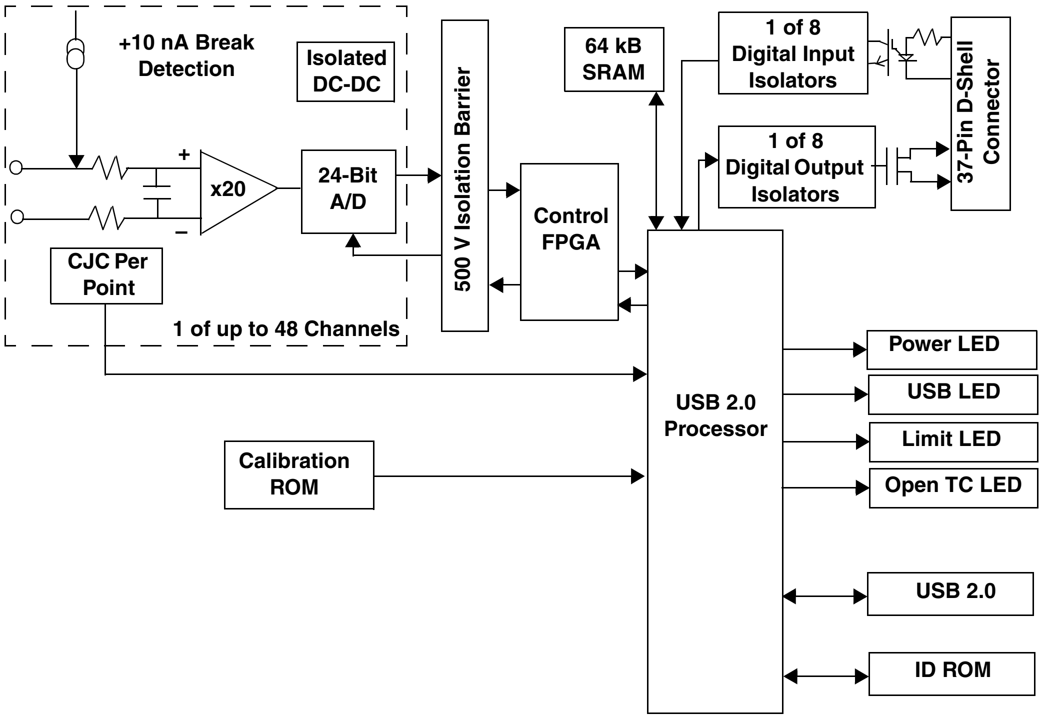



**Figure 28: Block Diagram of the DT9871U TEMPpoint Instrument**

## DT9871 Block Diagram

Figure 29 shows the block diagram of the DT9871 instrument.

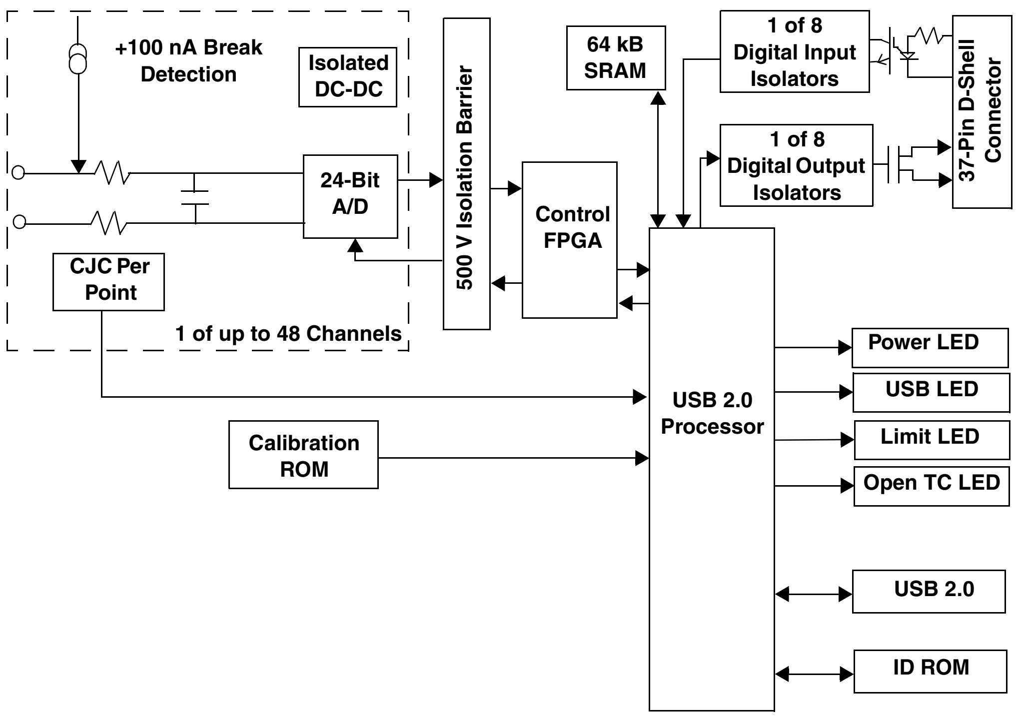



**Figure 29: Block Diagram of the DT9871 TEMPpoint Instrument**

## DT9872 Block Diagram

Figure 30 shows the block diagram of the DT9872 TEMPpoint instrument.

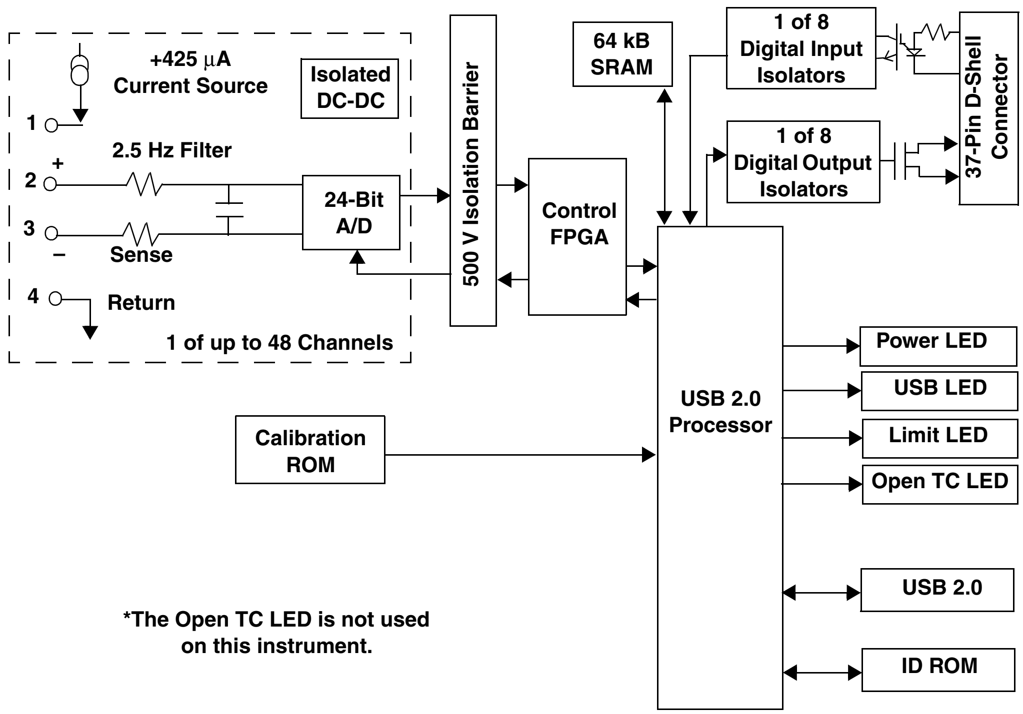



**Figure 30: Block Diagram of the DT9872 TEMPpoint Instrument**

# DT9873 Block Diagram

Figure 31 shows the block diagram of the DT9873 VOLTpoint instrument.

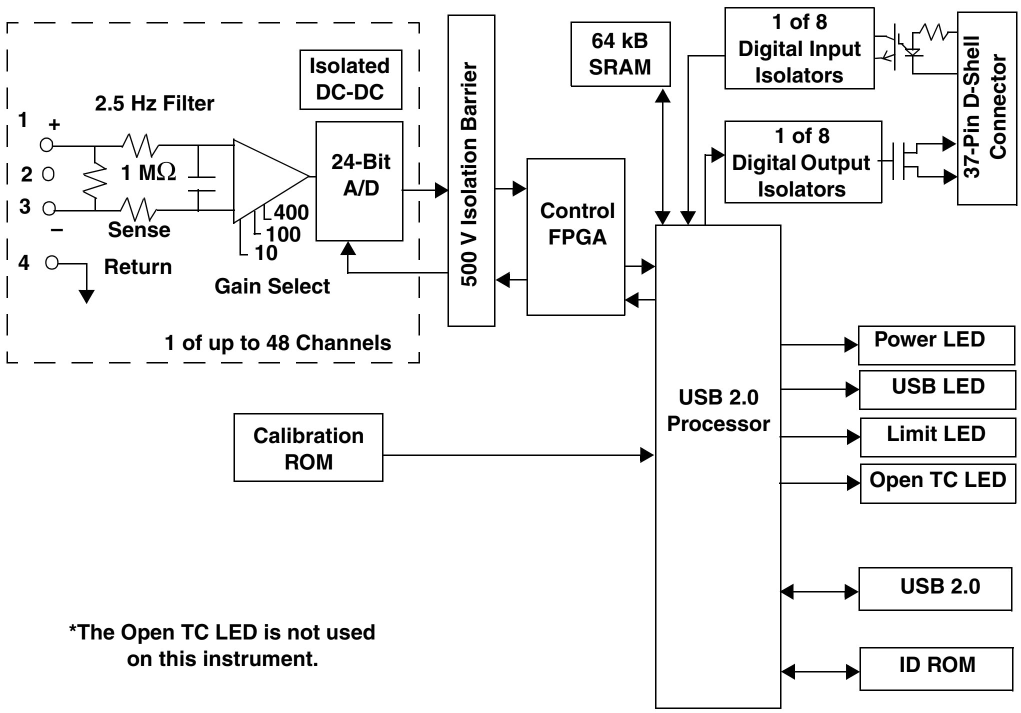



**Figure 31: Block Diagram of the DT9873 VOLTpoint Instrument**

## DT9874 Block Diagram

Figure 32 shows the block diagram of the DT9874 MEASURpoint instrument.

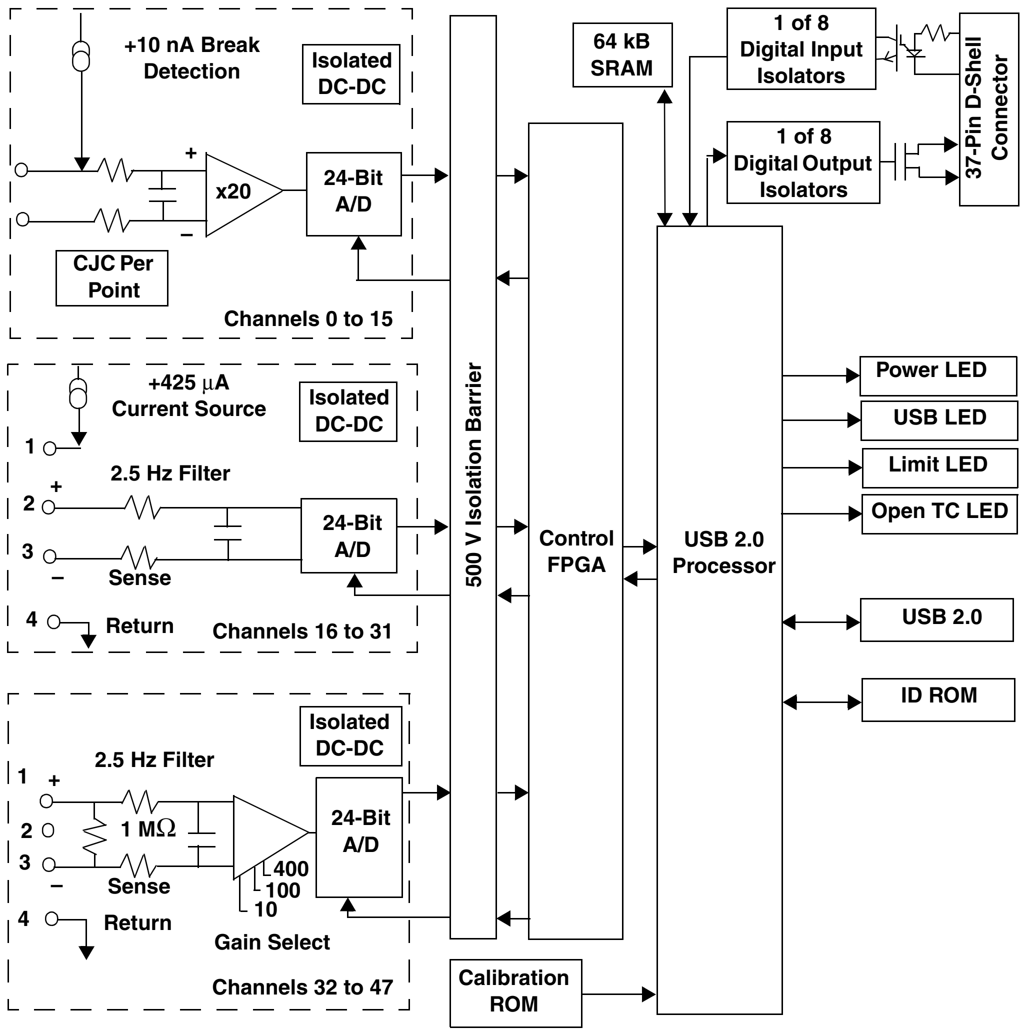



**Figure 32: Block Diagram of the DT9874 MEASURpoint Instrument**

# Analog Input Features

This section describes the following features of the analog input (A/D) subsystem on TEMPpoint, VOLTpoint, and MEASURpoint instruments:

- Analog input channels, described on this page
- Input ranges, described on page 94
- Resolution, described on page 96
- Calibration, described on page 96
- Sample clock, described on page 97
- Trigger source, described on page 97
- Conversion modes, described on page 98
- Filtering, described on page 99
- Data format, described on page 99
- Error conditions, described on page 100

## Analog Input Channels

TEMPpoint, VOLTpoint, and MEASURpoint instruments provide up to 48 analog input channels. The number of channels and the channel types supported (thermocouple, RTD, or voltage input) depend on the specific instrument model you purchased, as shown in Table 2.

**Table 2: Number and Type of Analog Input Channels**

| Instrument Type | Models | # of Analog Input Channels | Channel Types |
|---|---|---|---|
| TEMPpoint | DT9871U-8 and DT9871-8 | 8 | 8 thermocouple inputs (numbered 0 to 7) |
| | DT9871U-16 and DT9871-16 | 16 | 16 thermocouple inputs (numbered 0 to 15) |
| | DT9871U-24 and DT9871-24 | 24 | 24 thermocouple inputs (numbered 0 to 23) |
| | DT9871U-32 and DT9871-32 | 32 | 32 thermocouple inputs (numbered 0 to 31) |
| | DT9871U-40 and DT9871-40 | 40 | 40 thermocouple inputs (numbered 0 to 39) |
| | DT9871U-48 and DT9871-48 | 48 | 48 thermocouple inputs (numbered 0 to 47) |
| | DT9872-8 | 8 | 8 RTD inputs (numbered 0 to 7) |
| | DT9872-16 | 16 | 16 RTD inputs (numbered 0 to 15) |
| | DT9872-24 | 24 | 24 RTD inputs (numbered 0 to 23) |
| | DT9872-32 | 32 | 32 RTD inputs (numbered 0 to 31) |
| | DT9872-40 | 40 | 40 RTD inputs (numbered 0 to 39) |
| | DT9872-48 | 48 | 48 RTD inputs (numbered 0 to 47) |

**Table 2: Number and Type of Analog Input Channels (cont.)**

| Instrument Type | Models | # of Analog Input Channels | Channel Types |
|---|---|---|---|
| VOLTpoint | DT9873-8 | 8 | 8 voltage inputs (numbered 0 to 7) |
| | DT9873-16 | 16 | 16 voltage inputs (numbered 0 to 15) |
| | DT9873-24 | 24 | 24 voltage inputs (numbered 0 to 23) |
| | DT9873-32 | 32 | 32 voltage inputs (numbered 0 to 31) |
| | DT9873-40 | 40 | 40 voltage inputs (numbered 0 to 39) |
| | DT9873-48 | 48 | 48 voltage inputs (numbered 0 to 47) |
| MEASURpoint | DT9874-16T-16R-16V | 48 | 16 thermocouple inputs (numbered 0 to 15) |
| | | | 16 RTD inputs (numbered 16 to 31) |
| | | | 16 voltage inputs (numbered 32 to 47) |

### *Thermocouple Input Channels*

For channels that support thermocouples, you can attach a voltage input or any of the following thermocouple types in a mix and match fashion: B, E, J, K, N, R, S, and/or T.

By default, these channels are configured for voltage inputs. You can specify the thermocouple types for channels using the DT-Open Layers Control Panel applet, described on page 40, the QuickDAQ application, or by using an API call in your application program.

**Note:** In a mix-and-match system, it is easy to accidentally mismatch the software and hardware configuration for a channel. Therefore, it is recommended that you pay particular attention when configuring channels, since the resultant errors may be not large enough to notice initially, but may be significantly larger than the accuracy specification for the instrument.

Since each channel has its own 24-bit A/D, analog inputs are measured simultaneously. Refer to page 98 for more information on specifying the channels for a scan.

Table 3 lists the supported measurement range for each thermocouple type. (Refer to page 94 for information on the supported input range for voltage measurements.)

**Table 3: Supported Measurement Range for Each Thermocouple Type**

| Thermocouple Type | Supported Measurement Range | |
|---|---|---|
| | Minimum | Maximum |
| B | 250° C (482° F) | 1820° C (3308° F) |
| E | –200° C (–328° F) | 1000° C (1832° F) |
| J | –210° C (–346° F) | 1200° C (2192° F) |
| K | –200° C (–328° F) | 1372° C (2502° F) |
| N | –200° C (–328° F) | 1300° C (2372° F) |
| R | –50° C (–58° F) | 1768° C (3214° F) |
| S | –50° C (–58° F) | 1768° C (3214° F) |
| T | –200° C (–328° F) | 400° C (752° F) |

Refer to Appendix A for the thermocouple accuracy of thermocouple channels over the dynamic range of the instrument.

### Cold Junction Compensation

Each thermocouple channel has its own cold-junction compensation (CJC) at the input. The software reads the value of the CJC input along with the value of the analog input channel and automatically corrects for errors based on the specified thermocouple type and the thermocouple linearization data stored in onboard ROM.

A separate multiplexed A/D is used to acquire all the CJC input values. The software takes care of correlating the CJC measurements with the analog input measurements.

---

**Note:** The software provides the option of returning CJC values in the data stream. This option is seldom used, but is provided if you want to implement your own temperature conversion algorithms in software when using continuous operations. Refer to page 99 for more information on this feature.

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### Open Thermocouple Detection

Break detection circuitry (+10 nA on the DT9871U and DT9874; +100 nA on the DT9871) is provided for thermocouple channels to ensure that open thermocouples are detected. The Open (OPN) LED on the rear panel lights when this condition occurs; see Figure 10 on page 37 for the location of this LED.

In addition, the software returns the value SENSOR_IS_OPEN (99999 decimal) for any channel that was configured for a thermocouple input and has either an open thermocouple or no thermocouple connected to it. This value is returned anytime a voltage greater than 100 mV is measure on the input, since this value is greater than any legitimate thermocouple voltage.

If the channel is configured for a voltage input (not a thermocouple type), the Open (OPN) LED never lights and the SENSOR_IS_OPEN value is not returned. Instead, the voltage value is returned. If no input is connected to the channel, the software returns a value of approximately 0.7 V due to the open thermocouple detection pull-up circuit.

### *RTD Channels*

For channels that support RTDs, you can attach a voltage input or any of the following RTD types in a mix and match fashion: Platinum 100 Ω (Pt100), Platinum 500 Ω (Pt500), or Platinum 1000 Ω (Pt1000) RTD using an European alpha curve of 0.00385 or an American alpha curve of 0.00392. The supported temperature measurement range for these RTD types is –200° C (–328° F) to 850° C (1562° F). You can also measure a resistance value between 0 and 4k Ohms, if desired. (Refer to page 94 for information on the supported input range for voltage measurements.)

By default, all channels are configured for voltage inputs. You can specify the RTD types for channels using the DT-Open Layers Control Panel applet, described on page 40, the QuickDAQ application, or by using an API call in your application program

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**Notes:** In a mix-and-match system, it is easy to accidentally mismatch the software and hardware configuration for a channel. Therefore, it is recommended that you pay particular attention when configuring channels, since the resultant errors may be not large enough to notice initially, but may be significantly larger than the accuracy specification for the instrument.

---

Since each channel has its own 24-bit A/D, analog inputs are measured simultaneously. Refer to page 98 for more information on specifying the channels for a scan.

## Input Ranges

The input voltage range that is supported by your TEMPpoint, VOLTpoint, or MEASURpoint instrument depends on the specific instrument model that you purchased, as shown in Table 4.

**Table 4: Supported Input Ranges**

| Instrument Type | Models | Input Range |
|---|---|---|
| TEMPpoint | DT9871U | ±0.75 V for all channels |
| | DT9871 | ±1.25 V for all channels |
| | DT9872 | ±1.25 V for all channels |
| VOLTpoint | DT9873 | ±10 V, ±100 V, or ±400 V<br>(software-selectable for each channel)[a] |
| MEASURpoint | DT9874-16T-16R-16V | ±0.75 V for channels 0 to 15;<br>±1.25 V for channels 15 to 31;<br>±10 V, ±100 V, or ±400 V for channels 32 to 47<br>(software-selectable for each channel) |

a. Older versions of this instrument had fixed input ranges of ±10 V, ±100 V, or ±400 V, depending on the model purchased.

## *Out of Range Data for Thermocouple Channels*

Each thermocouple type corresponds to an allowable voltage range. If a voltage is measured on the input that is outside of the legal range for the selected thermocouple type, the channel may be configured for the wrong type of thermocouple or something other than a thermocouple may be connected to the channel.

For channels configured with a thermocouple type of None (voltage), the Limit (LMT) LED on the rear panel of the instrument lights to alert you when the voltage is out of range; see Figure 10 on page 37 for the location of this LED.

For channels configured with a thermocouple type other than None (voltage), the LMT LED lights when the temperature limit is out of range for the specified thermocouple type.

In addition, if the input voltage is less than the legal voltage range for the selected thermocouple type, the software returns the value TEMP_OUT_OF_RANGE_LOW (–88888 decimal). If the input voltage is greater than the legal voltage range for the selected thermocouple type, the software returns the value TEMP_OUT_OF_RANGE_HIGH (88888 decimal).

---

**Note:** If you are continuously measuring from a properly configured thermocouple input channel and the thermocouple opens or becomes disconnected, the open thermocouple pull-up circuit causes the input voltage to rise to approximately 0.7 V over a few seconds.

In this case, the temperature value rises very quickly, and you will receive the TEMP_OUT_OF_RANGE_HIGH (88888 decimal) value followed by the OPEN_SENSOR (99999 decimal) value. In this case, the OPN LED lights when the open thermocouple is detected and the LMT LED lights when the temperature limit is out of range for the thermocouple type.

---

### Out of Range Data for RTD Channels

Each RTD type corresponds to an allowable voltage range. If a voltage is measured on the input that is outside of the legal range for the selected RTD type, the channel may be configured for the wrong type of RTD or something other than an RTD may be connected to the channel.

For channels configured with a RTD type of voltage, the Limit (LMT) LED on the rear panel of the instrument lights to alert you when the voltage is out of range (greater than +1.25 V or less than –1.25 V); see Figure 10 on page 37 for the location of this LED. For channels configured with an RTD type other than voltage, the LMT LED lights when the temperature limit is out of range for the specified RTD type.

In addition, if the input voltage is less than the legal voltage range for the selected RTD type, the software returns the value TEMP_OUT_OF_RANGE_LOW (–88888.0 decimal). If the input voltage is greater than the legal voltage range for the selected RTD type, the software returns the value TEMP_OUT_OF_RANGE_HIGH (88888.0 decimal).

### Out of Range Data for Voltage Channels

Each voltage input channel has an allowable voltage range (±10 V, ±100 V, or ±400 V). You configure the input range for each channel using software. If a voltage is measured on the input that is outside of the legal range for that channel, the Limit (LMT) LED on the rear panel of the instrument lights to alert you; see Figure 10 on page 37 for the location of this LED.

## Resolution

TEMPpoint, VOLTpoint, and MEASURpoint instruments support a resolution of 24 bits for the analog input subsystem; you cannot specify the resolution in software.

## Calibration

Each TEMPpoint, VOLTpoint, and MEASURpoint instrument is factory-calibrated to meet or exceed its published specifications using standards traceable to NIST.

The calibration process includes multiple steps. First, the A/D on each channel is calibrated for offset and gain; these values (including the zero point) are stored in ROM. Then, each CJC circuit is calibrated for thermocouple input channels, and the reference current is characterized for RTD channels.

While each instrument was designed to preserve high accuracy measurements over time, it is recommended that your instrument be recalibrated every year to ensure that it meets or exceeds specifications.

You can calibrate your instrument in the field using precise calibration equipment and the Measurement Calibration Utility, described on page 15. Optionally, you can return your instrument to Data Translation for recalibration. For information on factory recalibration, contact Data Translation at 508-481-3700, ext. 1323 (if you are in the USA) or call your local distributor (if you are located outside the USA); see our web site (www.datatranslation.com) for the name and telephone number of your nearest distributor.

In addition, each instrument auto-calibrates on each power-up cycle to guarantee high-accuracy measurements. This process, also known as auto-zeroing, resets the zero point of each A/D. You can also auto-calibrate the instrument at any time (as long as acquisition is not in progress) using a software command. Refer to your software documentation for more information on the auto-calibration feature.

## Sample Clock Source

TEMPpoint, VOLTpoint, and MEASURpoint instruments support an internal clock with a maximum sampling rate of 10 Samples/s.

Use software to specify an internal clock source and a clock frequency between 0.000152590219 Hz and 10.0 Hz.

---

**Note:** The clock frequency that you specify is rounded to the closest "correct" value that the instrument can accept without error. Internally, the 10 Hz clock is divided by an integer in the range of 1 to 65535 (the internal clock divider) to determine the closest value. Using software, you can query this setting to determine the actual clock frequency that is used.

---

When the continuous operation is started, all the channels specified in the channel list are read simultaneously at the specified clock frequency.

## Trigger Source

A trigger is an event that occurs based on a specified set of conditions. Acquisition starts when the instrument detects the initial trigger event and stops when you stop the operation.

TEMPpoint, VOLTpoint, and MEASURpoint instruments support the following trigger sources for starting analog input operations:

- **Software trigger –** A software trigger event occurs when you start the analog input operation (the computer issues a write to the instrument to begin conversions).
- **External digital trigger –** An external digital trigger event occurs when the instrument detects a voltage from +3 V to +28 V DC on digital input line 0. Initially, the external signal must be low and then go high for at least 100 ms to be detected as a trigger. Once triggered, the state of digital input 0 is ignored.

## Conversion Modes

TEMPpoint, VOLTpoint, and MEASURpoint instruments support continuous scan conversion modes for reading input measurements.

Continuous scan mode takes full advantage of the capabilities of the TEMPpoint, VOLTpoint, and MEASURpoint instruments. Use continuous scan mode if you want to accurately control the period between successive simultaneous conversions of specific channels.

In addition to the analog input channels, this conversion mode allows you to read the digital input port (all 8 digital input lines) as part of the analog input data stream. This feature is particularly useful when you want to correlate the timing of analog and digital events.

### *Specifying Analog Input Channels*

Using software, enable the analog input channels that you want to sample by specifying the channel numbers in the channel list. You can also read the value of the digital input port through the analog input data stream by specifying the digital input channel in the channel list; the number of the digital input channel depends on how many channels the TEMPpoint, VOLTpoint, or MEASURpoint instrument provides, as shown in Table 5.

**Table 5: Supported Channels for Continuous Operations**

| Total Number of Analog Input Channels | Channel for Reading the Digital Input Port |
|---|---|
| 0 to 7 | 8 |
| 0 to 15 | 16 |
| 0 to 23 | 24 |
| 0 to 31 | 32 |
| 0 to 39 | 40 |
| 0 to 47 | 48 |

The channels are read in order from the lowest channel number to the highest channel number in the list of enabled channels; this process is known as a scan.

### *How Continuous Scan Works*

When you issue a command to start the scan, the instrument simultaneously samples all the analog input channels, CJC inputs (if applicable), and the digital input port, and converts the analog inputs to temperature, resistance, or voltage based on the sensor type. If the channel is enabled, the sampled data is placed in the FIFO on the instrument.

The FIFO on the instrument is used as a circular buffer. Acquisition continues indefinitely until you stop the operation. When the FIFO is full, the operation wraps to the beginning of the FIFO; values are overwritten starting at the first location in the FIFO. It is up to your application to retrieve the data from the FIFO; refer to your software documentation for more information.

The conversion rate is determined by the frequency of the input sample clock; refer to page 97 for more information about the input sample clock. The sample rate, which is the rate at which a single entry in the channel list is sampled, is the same as the conversion rate due to the simultaneous nature of the MEASURpoint instrument.

Figure 33 illustrates scanning a list of three enabled channels: channel 0, channel 1, and channel 2. In this example, analog input data is acquired simultaneously on each clock pulse of the input sample clock. Data is acquired continuously.

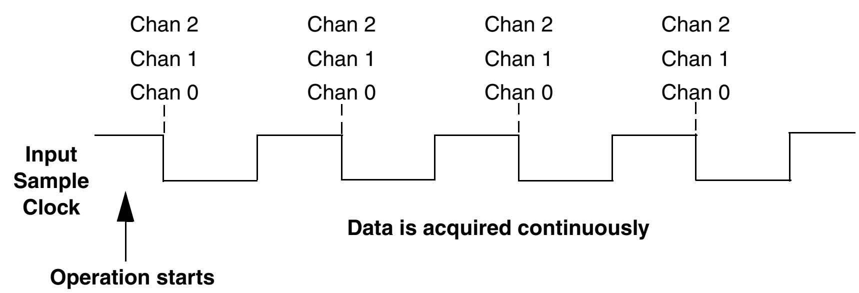



**Figure 33: Continuous Scan Mode**

## Filtering

TEMPpoint, VOLTpoint, and MEASURpoint instruments use a Delta-Sigma analog-to-digital converter (ADC) for each analog input channel to provide simultaneous sampling of all inputs. The Delta-Sigma converter operates at 10 Hz effectively providing a filter that rejects 50 Hz and 60 Hz power line frequency components and that removes *aliasing*, a condition where high frequency input components erroneously appear as lower frequencies after sampling.

In addition to the filter provided in hardware, you can further reduce noise by selecting one of the following filter options in software: Moving Average or Raw. Refer to your software documentation for more information on selecting a filter type.

## Data Format

TEMPpoint, VOLTpoint, and MEASURpoint instruments return data as 32-bit floating-point values. How the data is returned depends on the channel type, as described in the following subsections.

### Data Format for Thermocouple Channels

If you specify a thermocouple type of None for a thermocouple input channel, a voltage measurement is selected and the instrument returns a voltage value. For the DT9871U and DT9874 instruments, the value is in the range of ±0.075 V; for the DT9872 instrument, the value is in the range of ±1.25 V. For all other thermocouple types, a temperature value, in degrees C, or one of the error constants, described on page 101, is returned.

In normal operation, one floating-point value is returned for each enabled channel (including the digital input port). If you enable the capability of returning CJC data in the data stream, described on page 93, two floating-point values are returned in the data stream for each enabled analog input channel. The first value in the pair represents the temperature (or voltage) of the channel; the second value in the pair represents the CJC temperature (in degrees C) for that channel.

### Data Format for RTD Channels

If you specify an RTD type of None for an RTD input channel, a voltage measurement is selected and the instrument returns a voltage value in the range of ±1.25 V. If you specify an RTD type of Ohms, a resistance value is returned. For all other RTD types, a temperature value, in degrees C, or one of the error constants, described on page 101, is returned.

One floating-point value is returned for each enabled channel (including the digital input port).

### Data Format for Voltage Channels

For voltage channels, a voltage value in the range of ±10 V, ±100 V, or ±400 V is returned for each channel, depending on how the channel was configured.

One floating-point value is returned for each enabled channel (including the digital input port).

## Error Conditions

TEMPpoint, VOLTpoint, and MEASURpoint instruments report overrun errors by sending an overrun event to the application program. If this error condition occurs, the instrument stops acquiring and transferring data to the host computer. To avoid this error, try one or more of the following:

- Reduce the sample rate
- Close any other applications that are running
- Run the program on a faster computer

Additionally, the following constants may be reported to the host:

- 99999.0 – SENSOR_IS_OPEN, described on page 93
- 88888.0 – TEMP_OUT_OF_RANGE_HIGH, described on page 95 and page 96
- –88888.0 – TEMP_OUT_OF_RANGE_LOW, described on page 95 and page 96

If any of these constants is reported, the A/D subsystem continues to acquire data; the error condition is cleared when the data falls within range.

# Digital I/O Features

TEMPpoint, VOLTpoint, and MEASURpoint instruments provide 8 digital input lines and 8 digital output lines that you can use to control external equipment, including solid-state or mechanical relays.

This section describes the following digital I/O features:

- Digital input lines, described below
- Digital output lines, described on page 103
- Channel-to-channel isolation, described on page 103
- Resolution, described on page 103
- Operation modes, described on page 103

## Digital Input Lines

TEMPpoint, VOLTpoint, and MEASURpoint instruments feature eight, isolated, digital input lines.

Digital inputs operate from +3 to +28 V DC, with a switching time of 2 ms maximum. Figure 34 shows the digital input circuitry; a 2.2 kΩ resistor is used in series with the LED in the opto-isolator input.

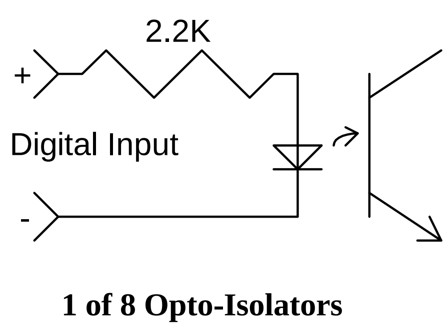


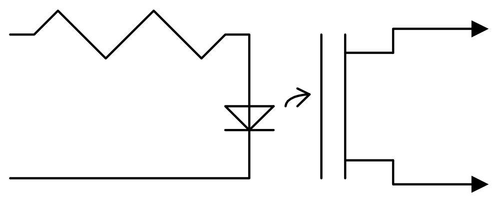

**Figure 34: Digital Input Circuitry**

A digital line is high (switch is closed) if its value is 1; a digital line is low (switch is open) if its value is 0.

## Digital Output Lines

TEMPpoint, VOLTpoint, and MEASURpoint instruments feature eight, latched and isolated digital output lines. The outputs are solid-state relays that operate at ±30 V and 400 mA peak (AC or DC). Switching time is 2 ms maximum.

Figure 35 shows the digital output circuitry.



1 of 8 Solid State Relays

**Figure 35: Digital Output Circuitry**

Digital outputs resemble a switch; the switch is closed if the state of the digital output line is 1, and the switch is open if the state of the digital output line is 0. On power up or reset, the digital outputs are disabled.

## Channel-to-Channel Isolation

Each TEMPpoint, VOLTpoint, and MEASURpoint instrument includes channel-to-channel isolation of up to 250 V between digital I/O lines. If you require greater channel-to-channel isolation, use every other digital line. This reduces the number of digital I/O lines, but provides channel-to-channel isolation of 500 V (one channel can be +250 V while the adjacent channel can be –250 V).

## Resolution

Each TEMPpoint, VOLTpoint, and MEASURpoint instrument provides 8 bits of resolution for the digital input port to accommodate the 8 digital input lines and 8 bits of resolution for the digital output port to accommodate the 8 digital output lines. These lines are organized as isolated, dedicated ports. You cannot configure port resolution through software.

## Operation Modes

Using software, you can read from a single digital input line or the entire digital input port, or write to a single digital output line or the entire digital output port. You can also return the value of the entire digital input port in the analog input data stream if you want to correlate analog input data with digital events; refer to page 98 for more information.

7

# Troubleshooting

# General Checklist

Should you experience problems using a TEMPpoint, VOLTpoint, or MEASURpoint instrument, do the following:

1. Read all the documentation provided for your product, including any "Read This First" information.
2. Check the MEASURpoint Software CD for any README files and ensure that you have used the latest installation and configuration information available.
3. Check that your system meets the requirements stated in Chapter 2.
4. Check that you have installed your hardware properly using the instructions in Chapter 3.
5. Check that you have wired your signals properly using the instructions in Chapter 4.
6. Search the DT Knowledgebase in the Support section of the Data Translation web site (at www.datatranslation.com) for an answer to your problem.

If you still experience problems, try using the information in Table 6 to isolate and solve the problem. If you cannot identify the problem, refer to page 108.

**Table 6: Troubleshooting Problems**

| Symptom | Possible Cause | Possible Solution |
|---|---|---|
| Instrument is not recognized | You plugged the instrument into your computer before installing the device driver. | From the Control Panel > System > Hardware > Device Manager, uninstall any unknown devices (showing a yellow question mark). Then, install the USB device drivers, and reconnect your USB instruments to the computer. |
| Instrument does not respond. | The instrument configuration is incorrect. | Check the configuration of your device driver; see the instructions in Chapter 3. |
| | The instrument is damaged. | Contact Data Translation for technical support; refer to page 108. |
| Intermittent operation. | Loose connections or vibrations exist. | Check your wiring and tighten any loose connections or cushion vibration sources; see the instructions in Chapter 4. |
| | The instrument is overheating. | Check environmental and ambient temperature; consult the specifications on page 126 of this manual and the documentation provided by your computer manufacturer for more information. |
| | Electrical noise exists. | Check your wiring and either provide better shielding or reroute unshielded wiring; see the instructions in Chapter 4. |
| Device failure error reported. | The instrument cannot communicate with the Microsoft bus driver or a problem with the bus driver exists. | Check your cabling and wiring and tighten any loose connections; see the instructions in Chapter 4. |
| | The instrument was removed while an operation was being performed. | Ensure that your instrument is properly connected; see the instructions in Chapter 3. |

**Table 6: Troubleshooting Problems (cont.)**

| Symptom | Possible Cause | Possible Solution |
|---|---|---|
| Data appears to be invalid. | An open connection exists. | Check your wiring and fix any open connections; see the instructions in Chapter 4. |
| | A transducer is not connected to the channel being read. | Check the transducer connections; see the instructions in Chapter 4. |
| | The thermocouple, RTD, or voltage input that you connected to the channel does not match the software configuration for that channel. | Check your wiring and ensure that what you specify in software matches your hardware configuration; see the instructions in Chapter 4. |
| | Your instrument may need recalibration. | The instrument is calibrated at the factory. Thereafter, yearly calibration is recommended. Use the Measurement Calibration Utility, described on page 16, or return your instrument to Data Translation for recalibration.<br><br>For information on factory recalibration, contact Data Translation at 508-481-3700, ext. 1323 (if you are in the USA) of call your local distributor (if you are located outside the USA); see our web site (www.datatranslation.com) for the name and telephone number of your nearest distributor. |
| USB 2.0 is not recognized. | Your operating system does not have the appropriate Service Pack installed. | Ensure that you load the appropriate Windows Service Pack (version 2 for Windows XP). If you are unsure of whether you are using USB 2.0 or USB 1.1, run the Open Layers Control Panel applet, described in Chapter 3. |
| | Standby mode is enabled on your PC. | For some PCs, you may need to disable standby mode on your system for proper USB 2.0 operation. Consult Microsoft for more information. |

# Technical Support

**Note:** TEMPpoint, VOLTpoint, and MEASURpoint instruments have a 1 year warranty from the factory. If you open the instrument's enclosure, you will void this warranty.

If you have difficulty using your TEMPpoint, VOLTpoint, or MEASURpoint instrument, Data Translation's Technical Support Department is available to provide technical assistance.

To request technical support, go to our web site at http://www.datatranslation.com and click on the Support link.

When requesting technical support, be prepared to provide the following information:

- Your product serial number
- The hardware/software product you need help on
- The version of the MEASURpoint Software CD you are using
- Your contract number, if applicable

If you are located outside the USA, contact your local distributor; see our web site (www.datatranslation.com) for the name and telephone number of your nearest distributor.

# If Your Instrument Needs Factory Service

If your MEASURpoint instrument must be returned to Data Translation, do the following:

1. Record the instrument's serial number, and then contact the Customer Service Department at (508) 481-3700, ext. 1323 (if you are in the USA) and obtain a Return Material Authorization (RMA).

   If you are located outside the USA, call your local distributor for authorization and shipping instructions; see our web site (www.datatranslation.com) for the name and telephone number of your nearest distributor. All return shipments to Data Translation must be marked with the correct RMA number to ensure proper processing.

2. Using the original packing materials, if available, package the instrument as follows:
   – Wrap the instrument in an electrically conductive plastic material. Handle with ground protection. A static discharge can destroy components on the instrument.
   – Place in a secure shipping container.

3. Return the instrument to the following address, making sure the RMA number is visible on the outside of the box.

   Customer Service Dept.
   Data Translation, Inc.
   100 Locke Drive
   Marlboro, MA 01752-1192

A

# Specifications



**Note:** All analog input specifications are based on the Moving Average filter type.

# Basic Instrument Specifications

Table 7 lists the basic instrument specifications for the DT9871, DT9871U, DT9872, DT9873, and DT9874 instruments.

**Table 7: Basic Instrument Specifications**

| Feature | Specifications |
| --- | --- |
| Number of channels in channel list | Up to 48 analog input channels and one digital input port |
| A/D converter type | High stability 24-bit Sigma-Delta |

# Thermocouple Specifications

Table 8 lists the thermocouple specifications for thermocouple channels on the DT9871, DT9871U, and DT9874 instruments.

**Table 8: Thermocouple Specifications**

| Feature | Specifications |
|---|---|
| Thermocouple types (software-selectable) | B, E, J, K, N, R, S, T |
| A/D resolution | 24-bits |
| Sample rate | 10 Samples/s[a] |
| Thermal disturbance channel-to-channel | None |
| Upscale break detection current<br>DT9871U and DT9874:<br>DT9871: | <br>+10 nA<br>+100 nA |
| System temperature error<br>DT9871U and DT9874:<br>DT9871: | <br>See Table 9 and Table 10 on page 114<br>See Table 11 on page 116 |

a. Older versions of the DT9871 instrument may support a maximum sampling rate of 7.5 Samples/s.

## System Temperature Error for the DT9871U and DT9874

Table 9 lists the typical accuracy of the DT9871U and DT9874 for each thermocouple type at several temperature points over the dynamic range of the instrument.

**Table 9: Typical Thermocouple Accuracy of the DT9871U and DT9874**

| Input Temp. | Thermocouple Type[a] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | J | K | T | E | S | R | B | N |
| –100° C | ±0.17°C | ±0.17°C | ±0.16°C | ±0.16°C | ---------- | ---------- | ---------- | ±0.16°C |
| 0° C | ±0.15°C | ±0.16°C | ±0.16°C | ±0.15°C | ±0.20°C | ±0.20°C | ---------- | ±0.16°C |
| 100° C | ±0.18°C | ±0.15°C | ±0.16°C | ±0.15°C | ±0.18°C | ±0.18°C | ---------- | ±0.15°C |
| 300° C | ±0.15°C | ±0.17°C | ±0.16°C | ±0.15°C | ±0.18°C | ±0.18°C | ±0.23°C | ±0.15°C |
| 500° C | ±0.15°C | ±0.15°C | ---------- | ±0.15°C | ±0.18°C | ±0.17°C | ±0.21°C | ±0.15°C |
| 700° C | ±0.15°C | ±0.15°C | ---------- | ±0.16°C | ±0.18°C | ±0.18°C | ±0.17°C | ±0.16°C |
| 900° C | ±0.15°C | ±0.17°C | ---------- | ±0.17°C | ±0.18°C | ±0.18°C | ±0.19°C | ±0.16°C |
| 1100° C | ±0.15°C | ±0.16°C | ---------- | ---------- | ±0.19°C | ±0.18°C | ±0.18°C | ±0.16°C |
| 1400° C | ---------- | ---------- | ---------- | ---------- | ±0.18°C | ±0.18°C | ±0.17°C | ---------- |

a. **Conditions for accuracy measurements:**
MEASURpoint warm-up time of 1 hour. Inclusive of typical 0.15°C CJC error. Exclusive of thermocouple errors.

Table 10 lists the maximum accuracy of the DT9871U and DT9874 for each thermocouple type at several temperature points over the dynamic range of the instrument.

**Table 10: Maximum Thermocouple Accuracy of the DT9871U and DT9874**

| Input Temp. | Thermocouple Type[a] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | J | K | T | E | S | R | B | N |
| –100° C | ±0.35°C | ±0.38°C | ±0.39°C | ±0.34°C | ---------- | ---------- | ---------- | ±0.43°C |
| 0° C | ±0.33°C | ±0.35°C | ±0.35°C | ±0.32°C | ±0.96°C | ±0.98°C | ---------- | ±0.40°C |
| 100° C | ±0.34°C | ±0.31°C | ±0.34°C | ±0.31°C | ±0.77°C | ±0.76°C | ---------- | ±0.37°C |
| 300° C | ±0.31°C | ±0.36°C | ±0.32°C | ±0.30°C | ±0.67°C | ±0.65°C | ±1.52°C | ±0.35°C |
| 500° C | ±0.30°C | ±0.33°C | ---------- | ±0.30°C | ±0.64°C | ±0.61°C | ±1.02°C | ±0.34°C |
| 700° C | ±0.30°C | ±0.33°C | ---------- | ±0.31°C | ±0.62°C | ±0.58°C | ±0.80°C | ±0.35°C |
| 900° C | ±0.30°C | ±0.36°C | ---------- | ±0.31°C | ±0.60°C | ±0.56°C | ±0.72°C | ±0.35°C |
| 1100° C | ±0.31°C | ±0.35°C | ---------- | ---------- | ±0.59°C | ±0.54°C | ±0.65°C | ±0.35°C |
| 1400° C | ---------- | ---------- | ---------- | ---------- | ±0.57°C | ±0.53°C | ±0.59°C | ---------- |

a. **Conditions for accuracy measurements:**
MEASURpoint warm-up time of 1 hour. Maximum accuracy inclusive of 0.25°C CJC error. Exclusive of thermocouple errors.

The histograms shown in Figure 36 and Figure 37 characterize the Gaussian system noise distribution for each of the available filter types on the DT9871U and DT9874. Note that converting µV error to temperature error depends on thermocouple type. For example, a K thermocouple changes approximately 39 µV per degrees C; therefore, a noise level of 0.1 µV adds less than 0.003° C error (0.1 µV / 39 µV) for a type K thermocouple.

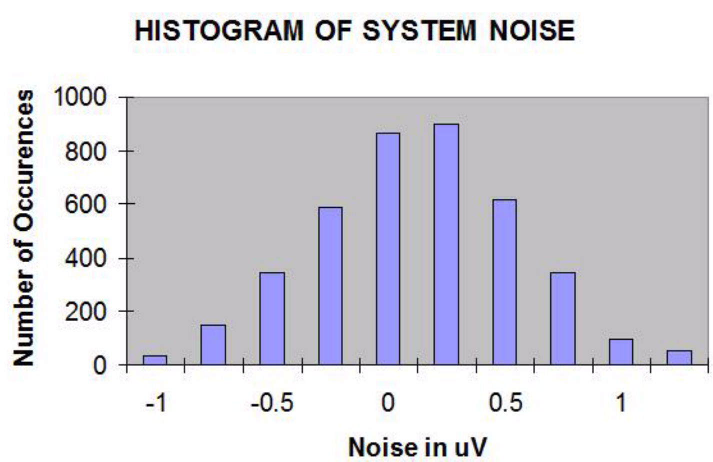



**Figure 36: System Noise on the DT9871U and DT9874 Using No Software Filter (Raw Filter)**

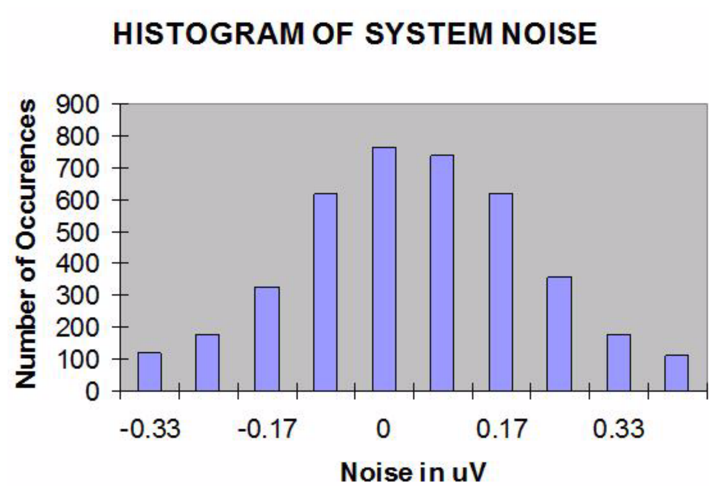



**Figure 37: System Noise on the DT9871U and DT9874 Using the Moving Average Filter**

## System Temperature Error for the DT9871

Table 11 lists the typical accuracy of the DT9871 for each thermocouple type at several temperature points over the dynamic range of the instrument.

**Table 11: Typical Thermocouple Accuracy of the DT9871**

| Input Temperature | Thermocouple Type[a] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | J | K | T | E | S | R | B | N |
| –100° C | ±0.33°C | ±0.37°C | ±0.38°C | ±0.31°C | ----------- | ----------- | ----------- | ±0.44°C |
| 0° C | ±0.30°C | ±0.33°C | ±0.33°C | ±0.28°C | ±1.12°C | ±1.14°C | ----------- | ±0.39°C |
| 100° C | ±0.31°C | ±0.29°C | ±0.31°C | ±0.27°C | ±0.88°C | ±0.86°C | ----------- | ±0.35°C |
| 300° C | ±0.29°C | ±0.34°C | ±0.29°C | ±0.26°C | ±0.75°C | ±0.71°C | ±1.84°C | ±0.33°C |
| 500° C | ±0.28°C | ±0.31°C | ----------- | ±0.26°C | ±0.71°C | ±0.66°C | ±1.20°C | ±0.33°C |
| 700° C | ±0.27°C | ±0.30°C | ----------- | ±0.27°C | ±0.68°C | ±0.63°C | ±0.92°C | ±0.33°C |
| 900° C | ±0.27°C | ±0.34°C | ----------- | ±0.28°C | ±0.66°C | ±0.60°C | ±0.80°C | ±0.33°C |
| 1100° C | ±0.28°C | ±0.34°C | ----------- | ----------- | ±0.64°C | ±0.58°C | ±0.71°C | ±0.34°C |
| 1400° C | ----------- | ----------- | ----------- | ----------- | ±0.62°C | ±0.56°C | ±0.64°C | ----------- |

a. **Conditions for accuracy measurements:**
MEASURpoint warm-up time of 1 hour. Inclusive of typical 0.2°C CJC error (maximum CJC error is 0.3°C). Exclusive of thermocouple errors.

The histograms shown in Figure 38 and Figure 39 characterize the Gaussian system noise distribution for each of the available filter types on the DT9871. Note that converting µV error to temperature error depends on thermocouple type. For example, a K thermocouple changes approximately 39 µV per degrees C; therefore, a noise level of 10 µV adds 0.3° C error (10 µV / 39 µV) for a type K thermocouple.

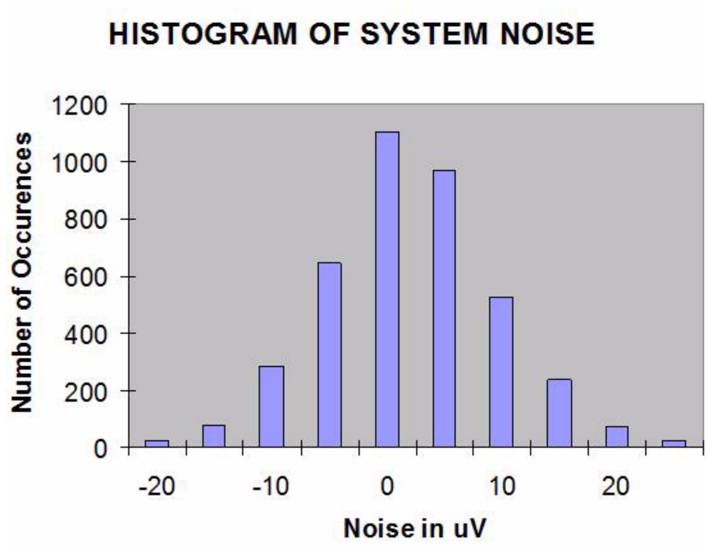



**Figure 38: System Noise on the DT9871 Using No Software Filter (Raw Filter)**

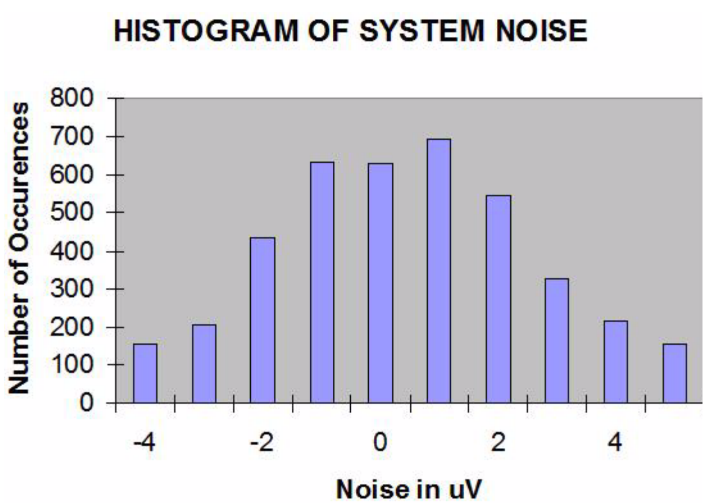



**Figure 39: System Noise on the DT9871 Using the Moving Average Filter**

# RTD Specifications

Table 12 lists the specifications for RTD channels on the DT9872 and DT9874.

**Table 12: RTD Specifications**

| Feature | Specifications |
|---|---|
| RTD types (software-selectable) | Platinum 100 Ω, 500 Ω, and 1000 Ω |
| A/D converter resolution | 24-bits |
| Sample rate | 10 Samples/s[a] |
| Supported temperature range | –200 to +850° C (European standard) |
| Current source<br>Absolute current:<br>Drift:<br>Drift per year: | <br>425 µA, ±0.5% at 25° C (calibrated in firmware)<br>10 ppm/° C maximum<br>±100 ppm typical |
| Internal reference | +1.250 ±0.002 V |
| Thermal disturbance channel-to-channel | None |
| Supported RTD alpha curves | See Table 13 |

a. Older versions of this instrument may support a maximum sampling rate of 7.5 Samples/s.

Table 13 lists the RTD alpha curves that are supported by RTD channels.

**Table 13: Supported RTD Alpha Curves**

| Alpha (Average Temperature Coefficient of Resistance (/°C)) | Nominal Resistance at 0°C | Organization | Standard |
|---|---|---|---|
| 0.00385 | 100 Ω | British Standard | BS1904: 1984 |
| | | Deutschen Institut fur Normung | DIN 43760: 1980 |
| 0.00392 | 98.129 Ω | Scientific Appartus Manufacturers of America | SAMA RC-4-1966 |

# Temperature Specifications

Table 14 lists the temperature specifications for thermocouple channels on the DT9871, DT9871U, and DT9874 instruments.

**Table 14: Temperature Specifications for Thermocouple Channels**

| Feature | Specifications |
|---|---|
| Additional error due to ambient temperature change[a] | |
| J-type thermocouple: | 0.010° C per degree ambient change, typical |
| K-type thermocouple: | 0.011° C per degree ambient change, typical |
| B-type thermocouple: | 0.014° C per degree ambient change, typical |
| E-type thermocouple: | 0.010° C per degree ambient change, typical |
| N-type thermocouple: | 0.011° C per degree ambient change, typical |
| R-type thermocouple: | 0.012° C per degree ambient change, typical |
| S-type thermocouple: | 0.012° C per degree ambient change, typical |
| T-type thermocouple: | 0.010° C per degree ambient change, typical |
| MEASURpoint warm-up time | 1 hour |
| CJC | |
| Error (maximum): | ±0.25° C |
| Accuracy: | Corrected in ROM @ 25° C to zero error |
| Drift per year: | ±50 ppm typical |

a. Includes the A/D reference, gain, and CJC errors.

Table 15 lists the temperature specifications for RTD channels on the DT9872 and DT9874.

**Table 15: Temperature Specifications for RTD Channels**

| Feature | Specifications |
| --- | --- |
| System temperature error[a]<br>Pt100: | Offset (typical): ±0.03° C<br>Offset (maximum): ±0.30° C<br>RMS noise: 0.03° C<br>Temperature resolution: 0.002° C<br>Maximum system error: ±0.80° C[b] |
| Pt500: | Offset (typical): ±0.007° C<br>Offset (maximum): ±0.07° C<br>RMS noise: 0.007° C<br>Temperature resolution: 0.0004° C<br>Maximum system error: ±0.16° C[b] |
| Pt1000: | Offset (typical): ±0.003° C<br>Offset (maximum): ±0.03° C<br>RMS noise: 0.003° C<br>Temperature resolution: 0.0002° C<br>Maximum system error: ±0.08° C[b] |
| Warm-up time<br>MEASURpoint:<br>RTD sensors and external calibration resistors: | <br>1 hour<br>1 minute |

a. Includes the A/D reference and gain errors.
b. Includes a maximum linearity error of 10 ppm and a calibration setup error of 10 ppm. Users must be aware that subtle resistor value tolerances and self-heating of the external calibration resistors contribute calibration setup errors.

# Voltage Measurement Specifications

Table 16 lists the voltage measurement specifications for the DT9871, DT9871U, DT9872, DT9873, and DT9874 instruments.

**Table 16: Voltage Measurement Specifications**

| Feature | Specifications |
|---|---|
| Input voltage range (no compensation)<br>DT9871U and DT9874 thermocouple channels:<br>DT9871:<br>DT9872 and DT9874 RTD channels:<br>DT9873 and DT9874 voltage channels: | <br>±0.0750 V<br>±1.2500 V<br>±1.2500 V<br>±10 V, ±100 V, or ±400 V[a] |
| A/D converter resolution | 24-bits |
| Voltage resolution<br>DT9871U and DT9874 thermocouple channels:<br>DT9871:<br>DT9872 and DT9874 RTD channels:<br>DT9873 and DT9874 voltage channels: | <br>0.015 µV<br>0.3 µV<br>0.3 µV<br>1.2 µV for the ±10 V input range;<br>12 µV for the ±100 V input range;<br>48 µV for the ±400 V input range |
| Sample rate | 10 Samples/s[b] |
| Input impedance<br>DT9871U and DT9874 thermocouple channels:<br>DT9871:<br>DT9872 and DT9874 RTD channels:<br>DT9873 and DT9874 voltage channels: | <br>5 MΩ typical<br>5 MΩ typical<br>>100 MΩ<br>>1 MΩ (Power ON or OFF) |
| Input common mode voltage | ±500 V |
| Common mode rejection @ 60 Hz and 50 Hz | > 150 dB |
| Coupling | DC |
| System linearity<br>DT9871U and DT9874 thermocouple channels:<br>DT9871:<br>DT9872 and DT9874 RTD channels:<br>DT9873 and DT9874 voltage channels: | <br>±0.005%<br>±0.005%<br>±0.001%<br>±0.001% |
| System gain error (includes all noise sources; gain = 1)<br>DT9871U and DT9874 thermocouple channels:<br>DT9871:<br>DT9872 and DT9874 RTD channels:<br>DT9873 and DT9874 voltage channels: | <br>±0.00075% of full-scale range<br>±0.00075%of full-scale range<br>±0.00075% of full-scale range<br>±0.01% of reading |
| System zero error (includes all noise sources; no filter)<br>DT9871U and DT9874 thermocouple channels:<br>DT9871:<br>DT9872 and DT9874 RTD channels:<br>DT9873 and DT9874 voltage channels: | <br><br>0.25 µV RMS<br>5 µV RMS<br>±12 µV<br>±300 µV for the ±10 V input range;<br>±2 mV for the ±100 V input range;<br>±8 mV for the ±400 V input range |

**Table 16: Voltage Measurement Specifications (cont.)**

| Feature | Specifications |
|---|---|
| System drift error, zero<br>DT9871U and DT9874 thermocouple channels:<br>DT9871:<br>DT9872 and DT9874 RTD channels:<br>DT9873 and DT9874 voltage channels: | <br>±0.02 µV/° C typical<br>±0.02 µV/° C typical<br>±0.10 µV/° C<br>±0.5 µV/° C for the ±10 V input range;<br>±5 µV/° C for the ±100 V input range;<br>±20 µV/° C for the ±400 V input range |
| System drift error, gain<br>DT9871U and DT9874 thermocouple channels:<br>DT9871:<br>DT9872 and DT9874 RTD channels:<br>DT9873 and DT9874 voltage channels: | <br>±4 ppm/° C<br>±4 ppm/° C<br>±10 ppm/° C<br>±15 ppm/° C |
| A/D reference<br>Drift:<br>Drift per year: | <br>±8 ppm/° C maximum<br>±100 ppm typical |
| Full-scale long-term stability<br>DT9871U and DT9874 thermocouple channels:<br>DT9871:<br>DT9872 and DT9874 RTD channels:<br>DT9873 and DT9874 voltage channels: | <br>±100 ppm/year typical<br>±100 ppm/year typical<br>±0.05° C per year @ 0° C (±0.27° C per year @ full-scale temperature)<br>±100 ppm/year typical |
| Warm-up time for the DT9873 and DT9874 voltage channels: | 1 hour |

a. You configure the input range for each channel using software.
b. Older versions of the instrument may support a maximum sampling rate of 7.5 Samples/s.

# Isolation and Protection Specifications

Table 17 lists the isolation and protection specifications for the analog input subsystem on the DT9871, DT9871U, DT9872, DT9873, and DT9874 instruments.

**Table 17: Isolation and Protection Specifications**

| Feature | Specifications |
|---|---|
| DT9871U, DT9871, and DT9874 Thermocouple Channels Overvoltage Protection (Power On/Off)<br>Pin 2 referenced to pin 3:<br>Pin 2 and 3 referenced to earth ground: | <br><br>±40 V<br>±500 V |
| DT9872 and DT9874 RTD Channels Overvoltage Protection (Power On/Off)<br>Pin 1 referenced to pin 4:<br>Pin 2 referenced to pin 4:<br>Pin 3 referenced to pin 4:<br>Pin 1, 2, or 3 referenced to earth ground: | <br><br>±4 V[a]<br>±40 V<br>±20 V<br>±500 V |
| DT9873 and DT9874 Voltage Input Channels Overvoltage Protection (Power On/Off)<br>Pin 1 referenced to pin 3:<br>Pins 1 and 3 referenced to earth ground: | <br><br>±600 V<br>±500 V |
| ESD protection per standard EN6100-4-2:2009 (see page 127 for more)<br>Arc:<br>Contact: | <br>8 kV<br>4 kV |
| Isolation voltage to the host computer | ±500 V |
| Channel-to-channel isolation | ±500 V |

a. Determined by internal protection diodes to the power supply. No damage occurs if current is limited to ±10 mA.

# Memory Specifications

Table 18 lists the memory specifications for the analog input subsystem on the DT9871, DT9871U, DT9872, DT9873, and DT9874 instruments.

**Table 18: Memory Specifications**

| Feature | Specifications |
|---|---|
| Data memory onboard | 4 MByte |
| For Data logger built in, maximum time before old data is overwritten[a]<br>48 channels @ 10 Hz:<br>48 channels @ 1 Hz:<br>48 channels @ 0.1 Hz: | <br><br>30 minutes<br>5 hours<br>50 hours |

a. Assumes limit detection is off for all channels, and for thermocouple channels, assumes CJC data is not collected. If power fails, all temperature data in the system is lost. The channel input type and filter settings are still available after power on, but the channel and digital I/O labels and channel limits are lost.

# Digital I/O Specifications

Table 19 lists the specifications for the digital input (DIN) and digital output (DOUT) subsystems on the DT9871, DT9871U, DT9872, DT9873, and DT9874 instruments.

**Table 19: Digital I/O Specifications**

| Feature | Specifications |
|---|---|
| Number of digital I/O lines | 16 (8 In, 8 Out) |
| Number of ports | 2, 8-bit (1 In, 1 Out) |
| Inputs<br>Input type:<br>High input voltage:<br>Low input voltage:<br>High input current:<br>Low input current:<br>Termination | <br>DC<br>+3 to +28 V<br>< +1.5 V<br>2.2 kΩ resistor to 1.2 V<br>2.2 kΩ resistor to 1.2 V<br>Series 2.2 kΩ |
| Outputs<br>Output type:<br>Output driver:<br>High output:<br>Low output:<br>Breakdown voltage:<br>Contact impedance: | <br>Solid-state relay<br>CMOS<br>± 30 V<br>0.4 V @ 400 mA<br>± 60 V<br>1 Ω |
| Isolation voltage<br>To computer ground:<br>Channel to channel | <br>±500 V<br>±250 V[a] |

a. Determined by the pin spacing in the 37-pin digital connector. For greater channel-to-channel isolation, use every other digital I/O line; using every other digital I/O line allows ±500 V isolation channel-to-channel.

# Power, Physical, and Environmental Specifications

Table 20 lists the power, physical, and environmental specifications for the DT9871, DT9871U, DT9872, DT9873, and DT9874 instruments.

**Table 20: Power, Physical, and Environmental Specifications**

| Feature | Specifications |
|---|---|
| USB power<br>+5 V Standby:<br>+5 V Power On:<br>+5 V Enumeration: | <br>500 µA maximum (360 µA typical)<br>2 mA maximum (1 mA typical)<br>2 mA maximum (1 mA typical) |
| External power requirements | +5 V ±0.25V @ 2 A (0.9 mA typical) |
| Physical<br>Dimensions of enclosure:<br><br><br>Weight: | <br>88.14 (H) x 212.85 mm (W) x<br>211.43 mm (D)<br><br>1704 g |
| Environmental<br>Operating temperature range:<br>Storage temperature range:<br>Relative humidity:<br>Altitude: | <br>0° C to 55° C<br>–25° C to 85° C<br>to 95%, noncondensing<br>up to 10,000 feet |

# Regulatory Specifications

The DT9871, DT9871U, DT9872, DT9873, and DT9874 instruments are CE-compliant. Table 21 lists the regulatory specifications for the DT9871, DT9871U, DT9872, DT9873, and DT9874 instruments.

**Table 21: Regulatory Specifications**

| Feature | Specifications |
|---|---|
| Emissions (EMI) | FCC Part 15, Class A<br>EN55011:2007 (Based on CISPR-11, 2003/A2, 2006) |
| Immunity | EN61326-1:2006<br>Electrical Equipment for Measurement, Control, and Laboratory Use<br><br>EMC Requirements<br>EN61000-4-2:2009<br>Electrostatic Discharge (ESD) 4 kV contact discharge,<br>8 kV air discharge, 4 kV horizontal and vertical coupling planes<br><br>EN61000-4-3:2006<br>Radiated electromagnetic fields, 3 V/m, 80 to 1000 MHz;<br>3 V/m, 1.4 GHz to 2 GHz; 1 V/m, 2 GHz to 2.7 GHz<br><br>EN61000-4-4:2004<br>Electrical Fast Transient/Burst (EFT) 1 kV on data cables<br><br>EN61000-4-6:2009<br>Conducted immunity requirements, 3 Vrms on data cables<br>150 kHz to 80 MHz |
| RoHS (EU Directive 2002/95/EG) | Compliant (as of July 1st, 2006) |

# Connector Specifications

This section lists the specifications for the following connector types:

- Thermocouple connectors
- RTD connectors
- Voltage connectors

## Thermocouple Connectors

Table 22 lists the specifications for the thermocouple connectors used on the DT9871, DT9871U, and DT9874 instruments.

**Table 22: Thermocouple Connector Specifications**

| Feature | Specifications |
| --- | --- |
| Thermocouple jacks | Omega plugs<br><br>SMPW-U-M – For voltage measurements<br>SMPW-J-M – For J thermocouple type<br>SMPW-K-M – For K thermocouple type<br>SMPW-T-M – For T thermocouple type<br>SMPW-E-M – For E thermocouple type<br>SMPW-S-M – For S thermocouple type<br>SMPW-R-M – For R thermocouple type<br>SMPW-B-M – For B thermocouple type<br>SMPW-N-M – For N thermocouple type |
| Thermocouple connector | Omega part# PCC-SMP-U-100-R-CE-ROHS |

**CAUTION:**

**When connecting inputs to the thermocouple connectors on a MEASURpoint or TEMPpoint instrument, it is highly recommended that you use only original Omega thermocouple plugs (SMPW), as connectors from other suppliers may not be equivalent mechanically.**

**If you use connectors from suppliers other than Omega, there is a risk that you may mechanically damage the thermocouple connectors on the MEASURpoint or TEMPpoint instrument.**

## RTD Connectors

Table 23 lists the specifications for the RTD connectors used on the DT9872 and DT9874 instruments.

**Table 23: RTD Connector Specifications**

| Feature | Specifications |
|---|---|
| 4-Position screw terminal block header | Phoenix Contact 1803293 |
| 4-Position screw terminal block plug | Phoenix Contact 1803594 |

## Voltage Connectors

Table 24 lists the specifications for the voltage connectors used on the DT9871, DT9871U, DT9872, DT9873, and DT9874 instruments.

**Table 24: Voltage Connector Specifications**

| Feature | Specifications |
|---|---|
| 4-Position screw terminal block header | Phoenix Contact 1803293 |
| 4-Position screw terminal block plug | Phoenix Contact 1803594 |

# External Power Supply Specifications

Table 25 lists the specifications for the EP361 +5 V external power supply that is used with the DT9871, DT9871U, DT9872, DT9873, and DT9874 instruments.

**Table 25: External Power Supply (EP361) Specifications**

| Feature | Specifications |
|---|---|
| Type | Total Power medical power supply (TPES22-050400 or TPEMG24-S050400-7) |
| Input voltage | Typical 90 - 264 V AC |
| Input current<br>TPES22-050400<br><br>TPEMG24-S050400-7 | <br>Typical 0.38 A at 115 V AC, 0.15 A at 230 V AC<br><br>Typical 0.347 A at 115 V AC, 0.215 A at 230 V AC |
| Frequency | 47 to 63 Hz |
| Inrush current<br>TPES22-050400<br><br>TPEMG24-S050400-7 | <br>35 A at 230 V AC typical or less than 30 A by adding thermistor<br><br>6.274 A RMS at 230 V AC |
| Output voltage | 5 V DC |
| Output current | 4.0 A |
| Output wattage<br>TPES22-050400<br><br>TPEMG24-S050400-7 | <br>Typical 22 - 24 W<br><br>Typical 20 - 24 W |
| Noise and ripple | 1% peak to peak |
| Regulatory specifications<br>TPES22-050400<br><br>TPEMG24-S050400-7 | <br>UL, N, CE, FCC Class B<br><br>UL, ITE, CE, FCC Class B, Energy Star compliant |

# B

# *Connector Pin Assignments*

Table 26 lists the pin assignments for the 37-pin digital I/O connector on TEMPpoint, VOLTpoint, and MEASURpoint instruments.

**Table 26: Digital I/O Connector Pin Assignments**

| Pin | Description | Pin | Description |
|---|---|---|---|
| 1 | Digital Input 0+ | – | |
| 2 | Digital Input 1+ | 20 | Digital Input 0– |
| 3 | Digital Input 2+ | 21 | Digital Input 1– |
| 4 | Digital Input 3+ | 22 | Digital Input 2– |
| 5 | Digital Input 4+ | 23 | Digital Input 3– |
| 6 | Digital Input 5+ | 24 | Digital Input 4– |
| 7 | Digital Input 6+ | 25 | Digital Input 5– |
| 8 | Digital Input 7+ | 26 | Digital Input 6– |
| 9 | Not Connected | 27 | Digital Input 7– |
| 10 | Digital Output 0 | 28 | Not Connected |
| 11 | Digital Output 1 | 29 | Digital Output 0 |
| 12 | Digital Output 2 | 30 | Digital Output 1 |
| 13 | Digital Output 3 | 31 | Digital Output 2 |
| 14 | Digital Output 4 | 32 | Digital Output 3 |
| 15 | Digital Output 5 | 33 | Digital Output 4 |
| 16 | Digital Output 6 | 34 | Digital Output 5 |
| 17 | Digital Output 7 | 35 | Digital Output 6 |
| 18 | Not Connected | 36 | Digital Output 7 |
| 19 | Not Connected | 37 | Not Connected |

C

# About ISO-Channel Technology

# ISO-Channel Technology

All TEMPpoint, VOLTpoint, and MEASURpoint products use ISO-Channel™ technology to eliminate common mode noise and ground loop problems.

This appendix includes two white papers that describe the benefits of using ISO-Channel technology.

# Why ISO-Channel Technology is Your Best Return on Investment

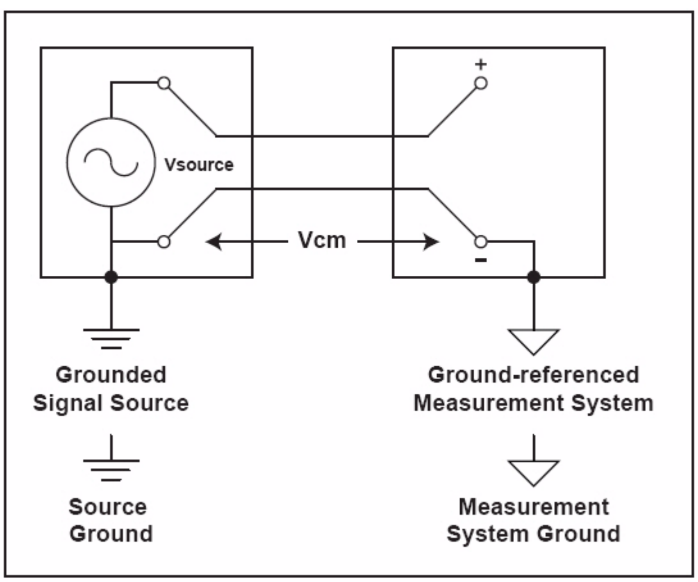
When connecting signal sources to an instrument, it is important to eliminate the sources of error that can contribute to inaccuracies in your measurements. In most measurement instruments, this burden is on the customer. Instruments that use ISO-Channel technology, however, solve this problem for you – saving you tremendous setup and debug time and reducing costly grounding problems when connecting signals.

In today's economy, we understand that every equipment decision needs to make good fiscal sense. This section describes why instruments with ISO-Channel technology offer you the best return on investment.

## Understanding Ground Loops

When measuring signals, users often assume that the grounds of their signals and their measurement system are at the same potential. However, these ground potentials can differ by hundreds of millivolts.

If the difference in ground potential is large enough, current flows between the signal and your measurement system; this is called a ground loop (see Figure 40). Ground loops contribute noise that can greatly affect the accuracy of your measurements, especially when you are trying to measure low level signals precisely. Ground loop problems are the most common source of error in all measurements! Eliminating these errors, therefore, is critical when taking high accuracy measurements.




*When a ground loop exists, the measured voltage, Vout, is the sum of the signal voltage, Vsource, and the ground potential difference, Vcm, which exists between the signal source ground and the measurement system ground. These errors often appear as transients or periodic signals in the measurement. For example, if a ground loop is formed with 50 Hz or 60 Hz AC power lines, the unwanted AC signal appears as a periodic voltage error in the measurement.*

**Figure 40: Measurement System with a Ground Loop**

## ISO-Channel Eliminates Ground Loops and Increases Common-Mode Rejection

ISO-Channel technology eliminates ground loop problems by using a **differential, isolated, floating front-end**. As you can see in Figure 41, a floating voltage signal is not referenced to system ground.

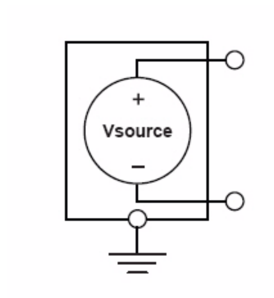



**Figure 41: Floating Signals**

To measure floating signal sources, ISO-Channel technology uses differential analog input signals, a 24-bit Delta-Sigma A/D converter for each channel, and channel-to-channel isolation, as shown in Figure 42.

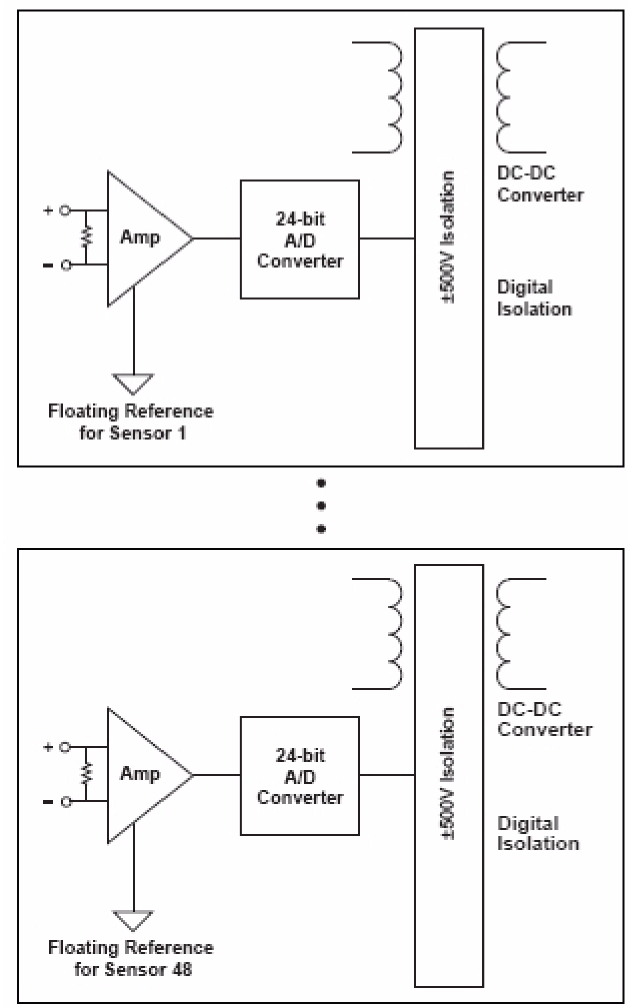



**Figure 42: ISO-Channel Technology**

## *Floating, Differential Signals*

ISO-Channel technology implements a virtually ideal differential measurement system that reads only the potential difference between the positive and negative terminals of the amplifier. For each channel, the differential signals are isolated in that they are referenced to a ground reference point that is not connected to earth ground. Ground loop problems are eliminated by ensuring that only one ground reference is used for each channel in the measurement system. The signal sources are isolated from each other and from the measurement instrument.

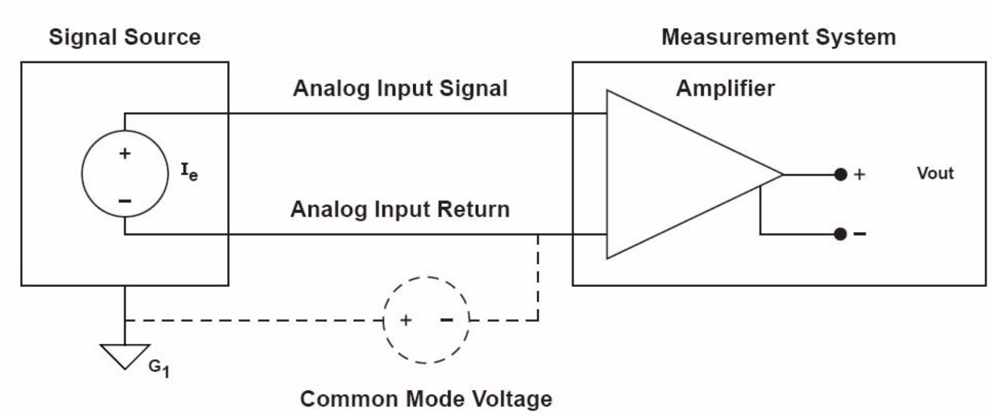



**Figure 43: Differential Signals and Common-Mode Voltage**

When the measurement instrument and signal source are at different ground potentials, the difference in potential is called common-mode voltage. The measurement instrument cannot discern between the signal and the common-mode voltage believing that the sum of these voltages is the actual signal. Of course, the common-mode potential is simply an error.

ISO-Channel technology provides common-mode rejection of 150 dB, which contributes an almost imperceptible error (33.5 million to 1) to Vout. Compare this to traditional data acquisition measurement instruments, which typically provide only 80 dB of common-mode rejection and therefore, contribute much more error on the order of 1 part per 10,000.

## *Simultaneous Architecture*

Many measurement instruments on the market today provide multiplexed architectures, where one A/D is used to measure multiple channels. In this kind of architecture, if one channel goes down, all channels go down.

ISO-Channel technology, on the other hand, uses a simultaneous architecture, where each channel has its own dedicated 24-bit Delta-Sigma A/D, as shown in Figure 44.

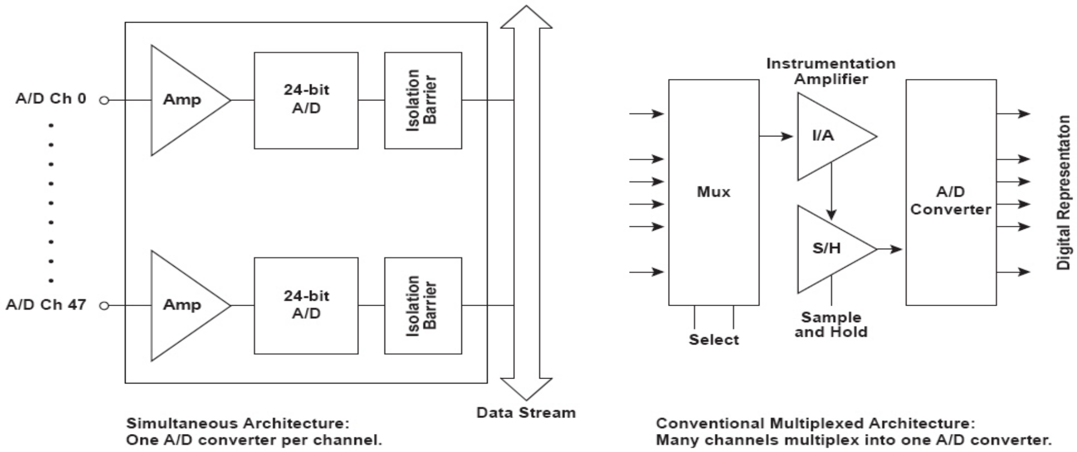



**Figure 44: Simultaneous vs. Multiplexed Architectures**

## *Channel-to-Channel Isolation*

Besides differential inputs, floating channels, and a simultaneous architecture, ISO-Channel technology provides channel-to-channel isolation, not just isolation from the analog front-end to the computer ground. With this kind of isolation, the channels are individually isolated from each other and from other system components.

Typically, instrument manufacturers have used relays, isolation amplifiers, or optical isolation to provide channel-to-channel isolation. These methods have the following advantages and limitations:

- Relays – This technology provides good galvanic separation and can provide good accuracy and thermal properties, but relays are slow as they operate on one channel at a time (10 cycles/s), wear out over time, and are sensitive to magnetic fields. If one relay sticks, staying closed, the entire system fails!
- Isolation amplifiers – Isolation amplifiers are used in multiplexed architectures. While they are solid-state, they are expensive, not as accurate, require more power, and generate more noise and heat than other solutions.
- Optical isolation - Optical isolation is good in digital isolation systems but causes accuracy problems in analog isolation systems. It is also subject to long-term drift and requires considerably more power.

With ISO-Channel technology, the A/D is on the sensor side and has its own custom DC/DC converter. Then, optical or transformer isolation is used to transfer the A/D output data (the sensor data) **digitally**. And, due to the simultaneous architecture of ISO-Channel technology, all data is transferred in parallel.

## Summary

ISO-Channel technology offers built in system redundancy to protect your investment - if one channel fails, the remaining channels are completely unaffected! Instruments with ISO-Channel technology also adapt to the sensors that they are connected to, allowing a different ground reference for each signal without introducing errors! For these key reasons, ISO-Channel technology protects against problems in the field, and thereby, reduces costs – what a great return on your investment.

# Floating Signal Inputs Offer New Application Advantages

Precision measurement systems are often limited in that all inputs are connected to a single ground. Typically, multiplexer input configurations are set up this way, since all signal inputs are connected to the same return. Even differential input configurations use the same ground reference. The result is that accuracy and flexibility for accurate measurements can be severely compromised when noise or common mode voltage is present (see Figure 45).

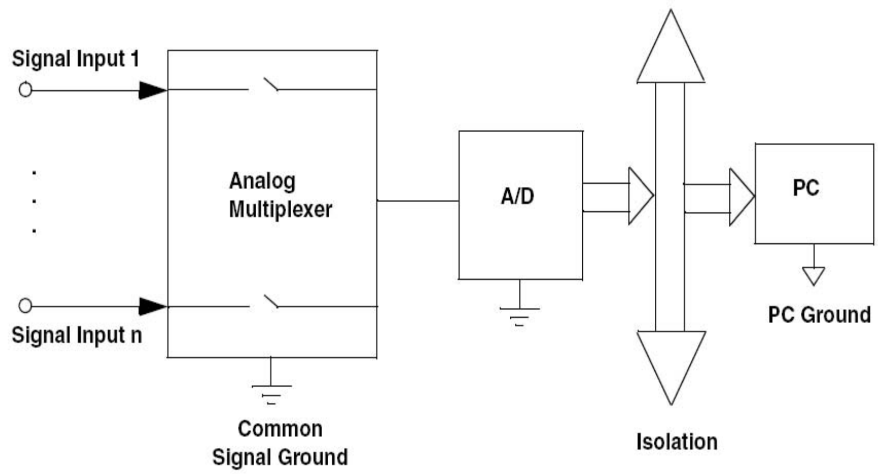



**Figure 45: In multiplexed systems, all inputs are connected to a signal ground, which can cause errors when noise or common mode voltage is present.**

Crosstalk from one input signal can easily be reflected onto another input. The design movement to an A/D per channel can help this problem. But that is not sufficient in many cases (see Figure 46).

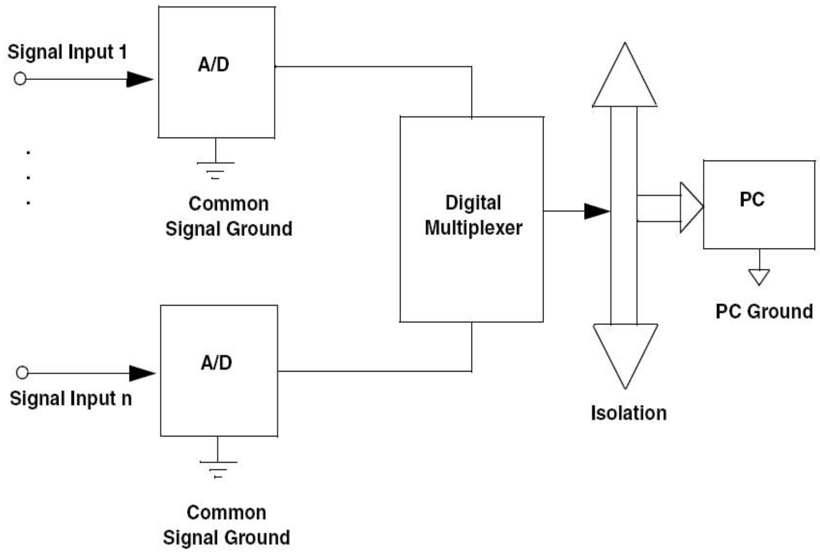



**Figure 46: Even when using an A/D per channel, noise can contribute errors to your measurement results.**

To minimize noise and ground loops, some newer systems offer isolation between the input signal ground reference and the computer ground. This effectively separates the computer ground from the measurement portion of the system. But still, there is no isolation between input sensor channels, which is a common source of error and frustration for user applications. Why?

The assumption is made that all signal sources have the same exact ground reference. After all…ground is ground…isn't it? Often this is not the case. For example, thermocouples for measuring temperature may be dispersed widely throughout an industrial setting, such as in the manufacture of air frames or in curing ovens. Grounds for these sensors may differ by several volts or even hundreds of volts. The resulting common mode voltage causes current to flow in the signal path, producing serious errors, which are very hard to diagnose and correct.

## Isolating Each Input

Oftentimes it is NOT apparent that ground references from various sensors such as thermocouples, RTDs, strain gages, etc., are at different voltage potentials. Factors that can contribute to these ground differences are extensive wiring from long runs, crosstalk from motors or generators, or high source impedance from the signal source. Without recognizing this extraneous voltage, the measurement system "sees" this noise or common mode voltage as the actual signal. These unwanted noise sources lead to measurement errors (see Figure 47).

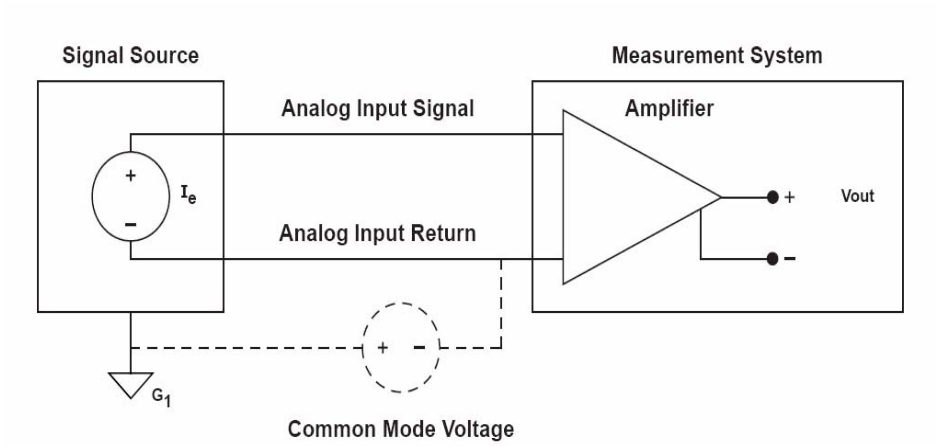



**Figure 47: Common mode voltage is present when different ground potentials exist in your measurement system.**

In many applications, noise is a fact and a common occurrence. To prevent this noise from entering the signal path, the signal must be isolated on a channel-to-channel basis as well as from the PC ground reference.

Technology breakthroughs now allow channel-to-channel isolation to be accomplished effectively. Using an A/D per channel with a DC-DC converter for each A/D allows each signal input channel to be isolated from one another (see Figure 48). With this individual isolation per channel, each input channel can now “float” to its own ground reference. Separate channels are then effectively isolated from each other by the isolation barrier, up to ±500 V for each channel. Now any noise or common mode voltage to that level is eliminated from the system measurement, allowing pristine results from each sensor without any interaction from any other sensor.

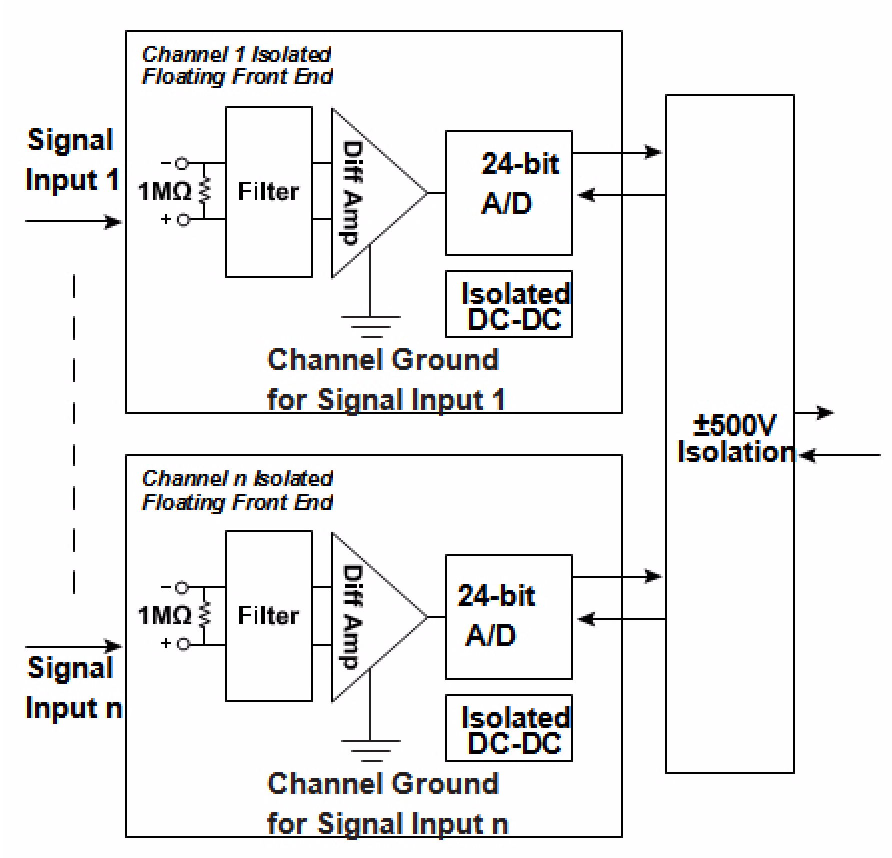



**Figure 48: An A/D per channel and a DC-to-DC converter for each A/D provides channel-to-channel isolation, where each signal can float to its own ground reference (± 500 V for the DT9874)**

Input channel return references are effectively separate instruments when the inputs are isolated. This individual isolation now allows the ground reference of each channel to measure at the level of this common mode voltage, up to ±500 V. This capability allows some new application ideas to flourish.

Measurement of two signals, as shown in Figure 49, can now have essentially 3 separate ground references: each signal input (signal 0 and signal 1) has a separate return reference; additionally, the PC has a third ground reference. This scheme can be extended for many signal inputs, such as 48 inputs in a single small measurement box, for a total of 49 different ground references.

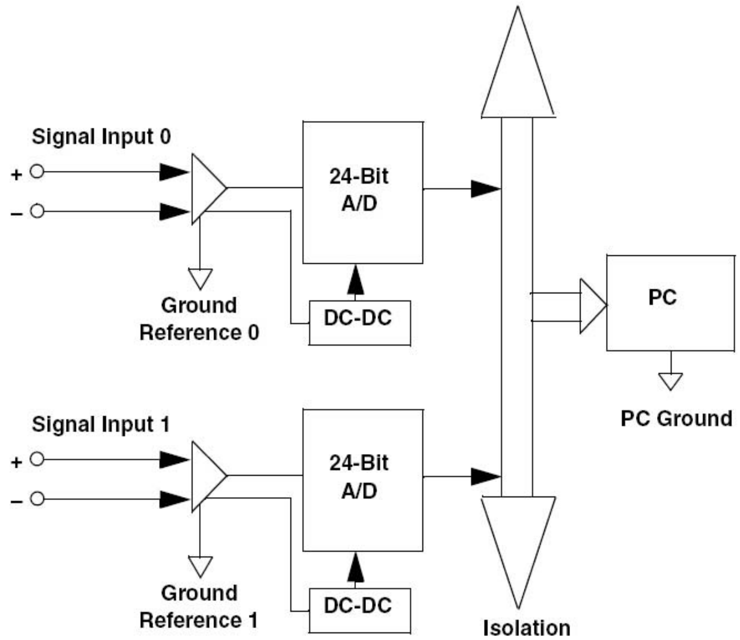



**Figure 49: When measuring two input signals with channel-to-channel isolation, three ground references are provided (signal 0, signal 1, and PC ground).**

## New Application Derived from Isolated Channels

A typical application of measuring 48 channels of varying voltages from sensors, such as batteries, thermocouples, RTDs pressure sensors, etc., often must use different instruments because of the various ranges needed. Standard ranges of ±10 V may handle some applications, but not others, to the required resolution and accuracy.

With isolation per channel, combinations of channels can be used to measure higher voltage ranges. Figure 50 shows a configuration of 2 separate channels "ganged up" to measure a signal of up to 20 V. Normally each input would measure ±10 V. But, by using two identical channels, a range of twice that level can be accommodated. The output readings of each A/D are then summed to give the very accurate result. This is possible because the isolation between channels allows the return of the first channel to "float up" to a level halfway between the input signal. This reflects the accurate impedance balance of each input, and the high common mode rejection of each stage.

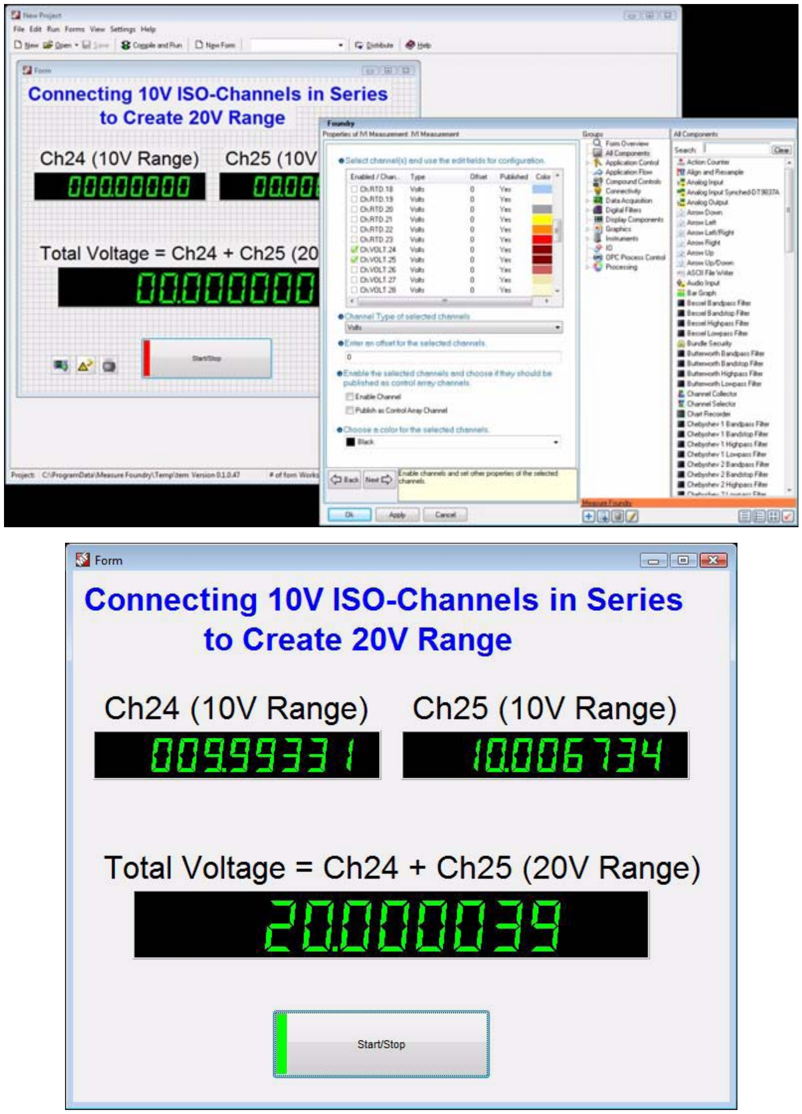



**Figure 50: Because each floating signal input is isolated from each other, you can use two separate channels, normally each configured for ±10V, to measure a ±20V signal. Simply sum the result of each channel to get your result.**

## Summary

When you need the highest accuracy and the most flexibility from your measurement system, ensure that floating signal inputs are provided. This approach allows noise-free measurements in tough industrial settings. It also saves countless days of tracking down erroneous readings that inevitably result if these precautions are not taken from the project's beginning.

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