DATA TRANSLATION

UM-17546-N

DT3000 Series User's Manual

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Radio and Television Interference

This equipment has been tested and found to comply with CISPR EN55022 Class A and EN50082-1 (CE) 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.

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.

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

This manual describes how to set up and install the following components:

- DT3000 Series software
- DT3000 Series board
- DT3000 Series device driver
- DT730 or DT730-T screw terminal panel
- 5B01 or 5B08 signal conditioning backplane
- 7BP16-1, 7BP08-1, or 7BP04-1 signal conditioning backplane

It describes how to wire signals to the board and how to verify the board's operation using the Quick DataAcq application.

This manual also describes the features of the DT3001, DT3001-PGL, DT3002, DT3003, DT3003-PGL, DT3004, and DT3005 boards (collectively referred to as the DT3000 Series or PCI-EZ Series). It describes the capabilities of the DT3000 Series Device Driver and how to program the board using DT-Open Layers for .NET Class Library™ software. Troubleshooting information is also provided.

Note: For information on checking system requirements, installing the software, and viewing the documentation, refer to the README file on the OMNI CD.

For more information on the class library, refer to the *DT-Open Layers for .NET Class Library User's Manual*. If you are using the DataAcq SDK or a software application to program your device, refer to the documentation for that software for more information.

Intended Audience

This document is intended for engineers, scientists, technicians, or others responsible for using and/or programming the DT3000 Series boards for data acquisition operations in Microsoft® Windows® XP, Windows Vista®, or Windows 7. It is assumed that you have some familiarity with data acquisition principles and that you understand your application.

How this Manual is Organized

This manual is organized as follows:

- Chapter 1, "Overview," describes the major features of the boards, as well as the supported software and accessories for the boards, and provides an overview of the DT3000 Series getting started procedure.
- Chapter 2, "Installing the Board and Loading the Device Driver," describes how to install the DT3000 Series board and load the DT3000 Series device driver.

- Chapter 3, "Attaching and Configuring a Screw Terminal Panel/ Backplane," describes how to attach a DT730 or DT730-T screw terminal panel to a DT3000 Series board, how to attach 5B or 7B Series conditioning backplanes, and how to configure these accessories for use with a DT3000 Series board.
- Chapter 4, "Wiring Signals," describes how to wire signals to a DT3000 Series board using the DT730 screw terminal panel.
- Chapter 5, "Verifying the Operation of a DT3000 Series Board," describes how to verify the operation of a DT3000 Series board with the Quick DataAcq application
- Chapter 6, "Principles of Operation," describes all of the features of the boards and how to use them in your application.
- Chapter 7, "Supported Device Driver Capabilities," lists the data acquisition subsystems and the associated features accessible using the DT3000 Series Device Driver.
- Chapter 8, "Calibration," provides information that allows you to calibrate the analog I/O circuitry of the boards and to calibrate the DT730-T screw terminal panel.
- Chapter 9, "Troubleshooting," provides information that you can use to resolve problems with the boards and the device driver, should they occur.
- Appendix A, "Specifications," lists the specifications of the boards.
- Appendix B, "Connector Pin Assignments," shows the pin assignments for the connectors on the boards and for the DT730 and DT730-T screw terminal panel.
- Appendix C, "Using Your Own Screw Terminal Panel," describes additional considerations to keep in mind when designing your own screw terminal panel for use with a DT3000 Series board.
- 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 the DT3000 Series board:

- *Measure Foundry Manual* (UM-19298) and online help. These documents describe how to use Measure Foundry™ to build drag-and-drop test and measurement applications for Data Translation® data acquisition devices.
- DT-Open Layers for .NET User's Manual (UM-22161). For programmers who are developing their own application programs using Visual C# or Visual Basic .NET, this manual describes how to use the DT-Open Layers for .NET Class Library to access the capabilities of Data Translation data acquisition devices.

- *DataAcq SDK User's Manual* (UM-18326). For programmers who are developing their own application programs using the Microsoft C compiler, this manual describes how to use the DT-Open Layers™ Data Acq SDK to access the capabilities of Data Translation data acquisition boards. This manual is provided on the Data Acquisition OMNI CD.
- *DTx-EZ Getting Started Manual* (UM-15428). This manual describes how to use the ActiveX controls provided in DTx-EZ™ to access the capabilities of Data Translation data acquisition boards in Microsoft® Visual Basic® or Visual C++®.
- *LV-Link Online Help*. This help file describes how to use LV-Link™ with the LabVIEW™ graphical programming language to access the capabilities of Data Translation data acquisition devices.
- *PCI Specification:* PCI Local Bus Specification, PCI Special Interest Group, Portland, OR. (Revision 2.1, June 1, 1995).
- Microsoft Windows XP, Windows Vista, or Windows 7 documentation.

Where To Get Help

Should you run into problems installing or using a DT3000 Series board, our Technical Support Department is available to provide technical assistance. Refer to Chapter 9 starting on page 111 for more information. If you are outside the U.S. or Canada, call your local distributor, whose number is listed on our web site (www.datatranslation.com).

1

Overview

Features

The DT3000 Series (PCI-EZ) data acquisition boards were designed for high-channel count, high-speed data acquisition applications on the PCI bus. They are ideal for data logging and signal analysis applications in the medical, process automation, and aerospace industries.

The major features of the DT3000 Series boards are as follows:

- Two ±10 V analog outputs (all but the DT3002) at 200kHz each
- 8 user-selectable digital input/output signals
- A 16-bit counter/timer for external functions
- An onboard digital signal processor (DSP) that operates as a slave to the host processor (user access to the DSP is not supported)

Table 1: Differentiating Features of DT3000 Series Boards

Board	Analog Inputs	A/D Sample Frequency	A/D Ranges
DT3001[a]	16 SE / 8 DI	330 kHz[b]	±1.25 V, ±2.5 V, ±5 V, ±10 V
DT3001-PGL[a]	16 SE / 8 DI	330 kHz[b]	±0.02 V, ±0.1 V, ±1 V, ±10 V
DT3002[a]	32 SE / 16 DI	330 kHz[c]	±1.25 V, ±2.5 V, ±5 V, ±10 V
DT3003[a]	64 SE / 32 DI	330 kHz[c]	±1.25 V, ±2.5 V, ±5 V, ±10 V
DT3003-PGL[a]	64 SE / 32 DI	330 kHz[c]	±0.02 V, ±0.1 V, ±1 V, ±10 V
DT3004[d]	16 SE / 8 DI	100 kHz[e]	±1.25 V, ±2.5 V, ±5 V, ±10 V
DT3005[d]	16 SE / 8 DI	200 kHz[c]	±1.25 V, ±2.5 V, ±5 V, ±10 V

a. The analog I/O resolution is 12 bits.
b. Maximum 250 kHz for multiple channels.
c. Maximum 100 kHz for multiple channels.
d. The analog I/O resolution is 16 bits.
e. Maximum 50 kHz for multiple channels.

Supported Software

The following software is available for use with the DT3000 Series board and shipped on the Data Acquisition OMNI CD:

- **DT3000 Series Device Driver –** The device driver is installed automatically when you install the software from the Data Acquisition OMNI CD. You need the device driver to use the DT3000 Series board with any of the supported software packages or utilities
- **The Quick DataAcq application –** This application provides a quick way to get a DT3000 Series board up and running. Using the Quick DataAcq application, you can verify the features of the board, display data on the screen, and save data to disk.
- **The quickDAQ application –** An evaluation version of this .NET application is included on the Data Acquisition OMNI CD. quickDAQ lets you acquire analog data from all devices supported by DT-Open Layers for .NET software at high speed, plot it during acquisition, analyze it, and/or save it to disk for later analysis.
- **Measure Foundry –** An evaluation version of this software is included on the Data Acquisition OMNI CD. Measure Foundry is drag-and-drop test and measurement application builder designed to give you top performance with ease-of-use development. Order the full development version of this software package to develop your own application using real hardware.
- **DT-Open Layers for .NET Class Library** – Use this class library if you want to use Visual C# or Visual Basic for .NET to develop your own application software for a DT3000 Series board using Visual Studio 2003 or Visual Studio 2005; the class library complies with the DT-Open Layers standard.
- **DataAcq SDK** – Use the Data Acq SDK if you want to use Visual Studio 6.0 and Microsoft C or C++ to develop your own application software for a DT3000 Series board using Windows XP, Windows Vista, or Windows 7; the DataAcq SDK complies with the DT-Open Layers standard.
- **DTx-EZ –** DTx-EZ provides ActiveX controls, which allow you to access the capabilities of the DT3000 Series boards using Microsoft Visual Basic or Visual C++; DTx-EZ complies with the DT-Open Layers standard.
- **DAQ Adaptor for MATLAB –** Data Translation's DAQ Adaptor provides an interface between the MATLAB Data Acquisition (DAQ) subsystem from The MathWorks and Data Translation's DT-Open Layers architecture.
- **LV-Link –** An evaluation version of LV-Link is included on the Data Acquisition OMNI CD. Use LV-Link if you want to use the LabVIEW graphical programming language to access the capabilities of the DT3000 Series boards.

Refer to the Data Translation web site (www.datatranslation.com) for information about selecting the right software package for your needs.

Accessories

The following optional accessories are available for the DT3000 Series board:

- **DT730 or DT730-T screw terminal panel –** General-purpose screw terminal panel providing analog, digital, counter/timer, external trigger, and external clock connections. The DT730-T is the same as the DT730, but also provides cold-junction compensation for thermocouple connections. Connector J1 accommodates the analog and digital I/O signals from the DT3000 Series board; connector J2 allows you to connect 5B and 7B Series signal conditioning backplanes.
- **EP291 cable –** A 0.95 m (3.2-foot) cable with two 100-pin connectors to connect the J1 connector for the DT3000 Series board to the J1 connector on the DT730 or DT730-T screw terminal panel.
- **5B01 or 5B08 backplane and 5B Series modules –** The 5B01 is a 16-channel backplane; the 5B08 is an 8-channel backplane. Both backplanes accept 5B modules for signal conditioning applications, including measuring thermocouples, RTDs, voltage input, current input, strain gage input, and frequency input.

  To use the 5B series backplanes and modules with the DT730 or DT730-T screw terminal panel, you need the following additional accessories available from Data Translation:

  – **AC1315 cable –** A 2-foot cable with a 26-pin connector on each end that connects a 5B Series signal conditioning backplane to the DT730 or DT730-T screw terminal panel.

  – **PWR-977 power supply –** A 5 V, 3 A power supply for powering the 5B Series backplanes.
- **7BP16-1, 7BP08-1, or 7BP04-1 backplane and 7B Series modules –** The 7BP16-1 is a 16-channel backplane, the 7BP08-1 is an 8-channel backplane, and the 7BP04-1 is a 4-channel backplane. All three backplanes accept 7B modules for signal conditioning applications, including measuring thermocouples, RTDs, voltage input, current input, strain gage input, and frequency input.

  To use the 7B series backplanes and modules with the DT730 or DT730-T, you need the following additional accessories available from Data Translation:

  – **AC1315 –** a 2-foot, 26-pin female to 26-pin female cable that connects a 7B Series backplane to the AC1393 cable.

  – **AC1393 –** a 6-inch, 26-pin male to 25-pin female adapter cable that connects a 7B Series backplane to the AC1315 cable; the AC1315 cable then connects to the DT730 or DT730-T screw terminal panel.

  – **HES14-21 power supply –** A linear ac/dc power supply that provides +24 Vdc for powering 7B Series backplanes.
- **Enclosure O-O 94-14-110 –** A rugged plastic enclosure from EAI Plastic Enclosures with the following dimensions: 7.48 in. X 5.43 in. X 1.77 in. This enclosure is recommended for use with the DT730-T screw terminal panel. Higher boxes are available. Part number 91-14-111 is an optional aluminum plate for the enclosure. You can reach EAI Plastic Enclosures at (708) 295-6664.

Getting Started Procedure

The flow diagram shown in Figure 1 illustrates the steps needed to get started using a DT3000 Series board. 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.

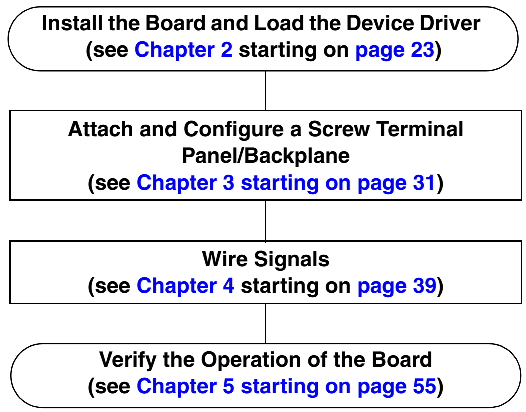
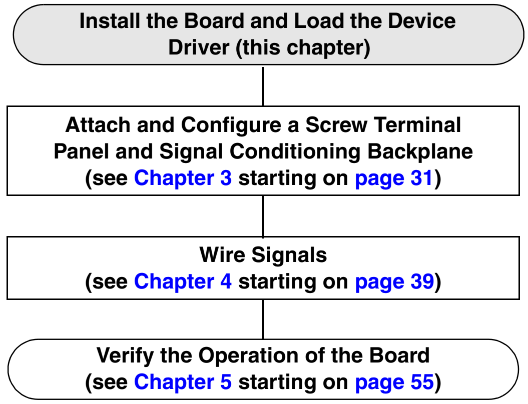


Figure 1: Getting Started Flow Diagram

Part 1: Getting Started

2

Installing the Board and Loading the Device Driver



Note: All DT3000 Series boards are factory-calibrated and require no further adjustment prior to installation. If you are using the DT3000 Series board and decide later to recalibrate it, refer to Chapter 8 starting on page 105 for instructions.

Unpacking

Open the shipping box and remove the wrapped DT3000 Series board.

CAUTION:

Keep the board in its protective antistatic bag until you are ready to install it; this minimizes the likelihood of electrostatic damage.

Verify that the following items are present:

- DT3000 Series data acquisition board
- Data Acquisition OMNI CD

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 board, check the system requirements, as described in the next section.

Setting up the Computer

> **CAUTION:**
>
> **To prevent electrostatic damage that can occur when handling electronic equipment, use a ground strap or similar device when performing this installation procedure.**

To set up the computer, do the following:

1. Install the software from the Data Acquisition OMNI CD or Data Translation web site.

Note: If you are using Windows 7, you **must** install the device driver before installing the board in the computer.

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2. Turn off the computer.
3. Turn off all peripherals (printer, modem, monitor, and so on) connected to the computer.
4. Unplug the computer and all peripherals.
5. Remove the cover from you computer. Refer to your computer's user manual for instructions.

Setting up an Expansion Slot

Once you have set up the computer, set up an expansion slot by doing the following:

1. Select a 32-bit or 64-bit PCI expansion slot.

   PCI slots are shorter than ISA or EISA slots and are usually white or ivory. Commonly, three PCI slots (one of which may be a shared ISA/PCI slot) are available. If an ISA board exists in the shared slot, you cannot use the slot for a PCI board; if a PCI board exists in the shared slot, you cannot use the slot for an ISA board.

2. Remove the cover plate from the selected expansion slot. Retain the screw that held it in place; you will use it later to install the board.

Inserting the Board into the Computer

Once you have set up an expansion slot, do the following to insert the DT3000 Series board into the computer:

1. Discharge any static electricity by holding the wrapped board in one hand while placing your other hand firmly on a metal portion of the computer chassis.
2. Carefully remove the antistatic packing material from the board. (It is recommended that you save the original packing material in the unlikely event that your board requires servicing in the future.)
3. Hold the board by its edges and do not touch any of the components on the board.
4. Position the board so that the cable connectors are facing the rear of the computer, as shown in Figure 2.

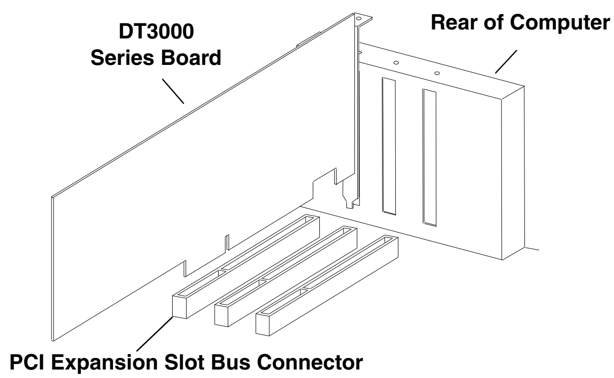


Figure 2: Inserting the DT3000 Series Board in the Computer

5. Carefully lower the board into the PCI expansion slot using the card guide to properly align the board in the slot.
6. When the bottom of the board contacts the bus connector, gently press down on the board until it clicks into place.

CAUTION:

Do not force the board into place. Moving the board from side to side during installation may damage the bus connector. If you encounter resistance when inserting the board, remove the board and try again.

7. Secure the board in place at the rear panel of the system unit using the screw removed from the slot cover.
8. Power up the computer.
9. Follow the steps on page 29.

Loading the Device Driver

To load the DT3000 Series device driver in:

- Windows XP, follow the steps on page 29.
- Windows Vista, follow the steps on page 29.
- Windows 7, follow the steps on page 30.

Windows XP

Once you have installed the software from the Data Acquisition OMNI CD, installed a DT3000 Series board, and powered up the host computer, the New Hardware Found dialog box appears. Do the following to load the device driver in Windows XP:

1. Click **Next**.
2. Click **Search for a suitable driver for my device (recommended)**.
3. Click **Specify a location**, and click **Next**.
4. Browse to Windows\Inf\DT3000.Inf, and then click **Open**.
5. Click **OK**.
6. Click **Next**.
   The files are copied.
7. Click **Finish**.

Once the driver is loaded, perform the steps in Chapter 3 starting on page 31 to attach and configure the screw terminal panel and signal conditioning backplane.

Windows Vista

Once you have installed the software from the Data Acquisition OMNI CD, installed a DT3000 Series board, and powered up the host computer, the New Hardware Found dialog box appears. Do the following to load the device driver in Windows Vista:

1. Click **Locate and install driver software (recommended)**.
   The popup message "Windows needs your permission to continue" appears.
2. Click **Continue**.
   The Windows Security dialog box appears.
3. Click **Install this driver software anyway**.
   The driver files are installed.

Once the driver is loaded, perform the steps in Chapter 3 starting on page 31 to attach and configure the screw terminal panel and signal conditioning backplane.

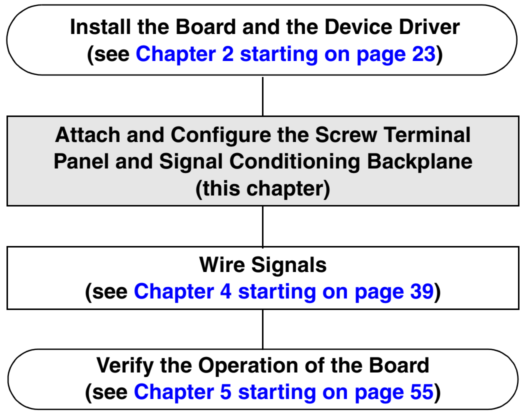
Windows 7

Once you have installed the software from the Data Acquisition OMNI CD, installed a DT3000 Series board, and powered up the host computer, the hardware is found automatically.

Perform the steps in Chapter 3 starting on page 31 to attach and configure the screw terminal panel and signal conditioning backplane.

3

Attaching and Configuring a Screw Terminal Panel/ Backplane


Install the Board and the Device Driver
(see Chapter 2 starting on page 23)
Attach and Configure the Screw Terminal Panel and Signal Conditioning Backplane
(this chapter)
Wire Signals
(see Chapter 4 starting on page 39)
Verify the Operation of the Board
(see Chapter 5 starting on page 55)

Using the DT730 or DT730-T Screw Terminal Panel

The DT730 and DT730-T screw terminal panels are accessory products that provide convenient screw terminal connections for DT3000 Series boards. The DT730 is a general-purpose screw terminal panel providing analog, digital, counter/timer, external trigger, and external clock connections. The DT730-T is the same as the DT730, but also provides cold-junction compensation (CJC) for thermocouple connections.

The DT730 and DT730-T provide a J1 connector for connecting to your DT3000 Series board using the EP291 cable (included with the screw terminal panel). The DT730 and DT730-T also provide a 26-pin, J2 connector to allow connection to standard 5B and 7B Series signal conditioning backplanes.

The following section describes how to attach a DT730 or DT730-T screw terminal panel to a DT3000 Series board. The section on page 34 describes how to configure a DT730 or DT730-T screw terminal panel for use with a DT3000 Series board.

Attaching a DT730 or DT730-T Screw Terminal Panel

To connect the DT730 or DT730-T screw terminal panel to a DT3000 Series board, do the following:

1. Plug one end of the EP291 flat ribbon cable into the connector at the rear of the DT3000 Series board and the other end into the DT730 or DT730-T, as shown in Figure 3.

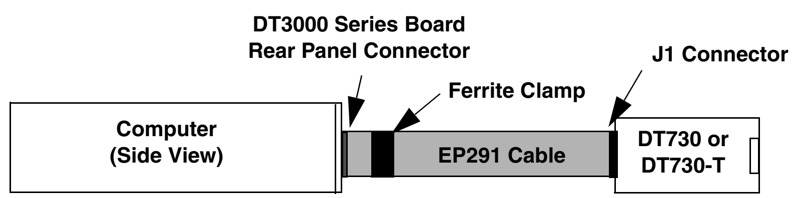


Figure 3: Connecting the DT730 or DT730-T to the DT3000 Series Board

2. To reduce EMI emissions, place the ferrite clamp, shipped with the DT3000 Series board, no more than six inches from the DT3000 Series board connector. The ferrite clamp attaches to the cable with an integral latch and grips the cable to prevent sliding.

Configuring a DT730 or DT730-T Screw Terminal Panel

Figure 4 illustrates the screw terminal and component locations for the DT730 and DT730-T.

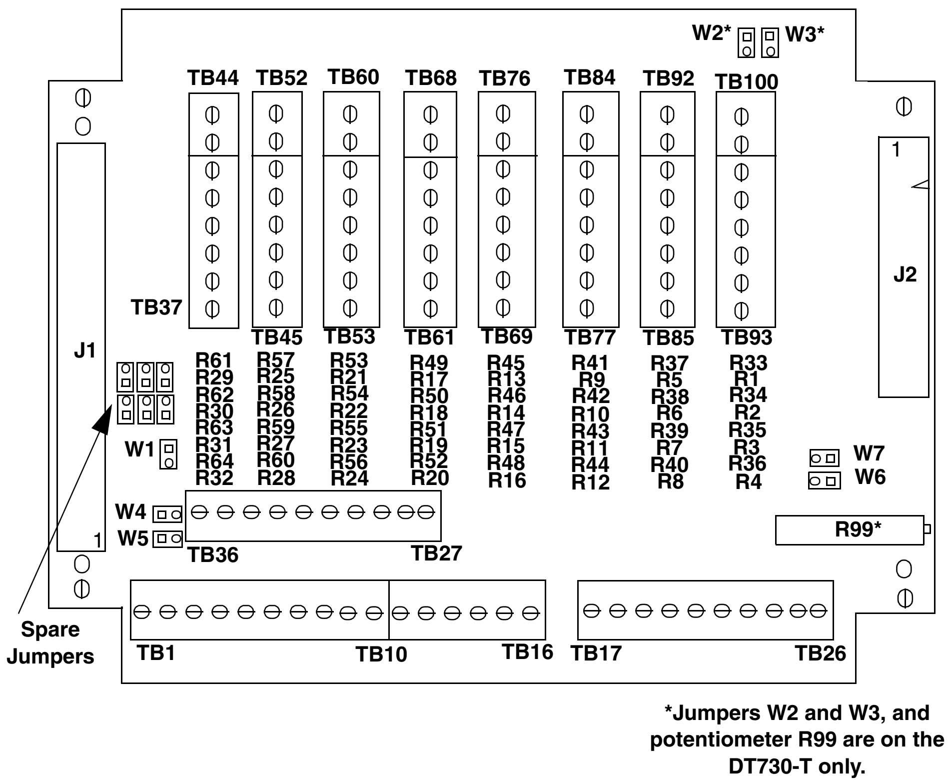


Figure 4: DT730 and DT730-T Screw Terminal Panels

Jumpers

The DT730 and DT730-T screw terminal panels contain jumpers W1, and W4 to W7. The DT730-T screw terminal panel also contains jumpers W2 and W3. Jumper W1 provides the CJC circuitry, and jumpers W4 to W7 are associated with analog outputs on the 5B01 and 7BP16-1 signal conditioning backplanes. The following subsections describe these jumpers.

Note: The screw terminal panels were initially shipped with enough jumper plugs to select every possible configuration. Spare jumper plugs are stored on the panel itself (on the posts marked spare). Save these jumper plugs for future use.

Configuring Jumper W1 - Common Ground Sense

Jumper W1 is installed when the board is shipped from the factory. This jumper connects Amp Low (TB35) to Analog Ground (TB36) on the screw terminal panel. Amp Low is connected to the low side of the board's input amplifier.

When connecting pseudo-differential analog inputs directly to the screw terminal panel, remove jumper W1 and connect Amp Low to a remote common-mode voltage to reject offset voltages common to all 64 input channels. Refer to page 46 for an example of using jumper W1.

Note: If you are using a 5B Series backplane, install jumper W3 on the backplane to connect Amp Low to Analog Ground on the backplane.

Configuring Jumpers W2 and W3 - CJC

The DT730-T screw terminal panel is provided for thermocouple connections and includes a CJC circuit for measuring temperature at the connector blocks on the screw terminal panel. Power is derived from ±Vcc on the DT3000 Series board.

Installing jumpers W2 and W3 connects the CJC circuit to channel 0. Jumper W2 connects the temperature sensor to channel 0 high; jumper W3 connects channel 0 low to analog ground.

The output is 0.50 mV/°C or 12.5 mV at 25°C.

After scaling for the gain and thermocouple type, you must add this voltage to the thermocouple voltage to remove the offset created by the temperature of the screw terminal panel when measuring thermocouple inputs on the DT730-T directly.

Note: 5B and 7B thermocouple modules provide their own CJC and return a voltage that already compensates for the CJC. Therefore, if you are using the DT730-T with a 5B or 7B thermocouple module, you do not have to compensate for offsets as you do when measuring thermocouples on the DT730-T directly.

Configuring Jumpers W4 to W7 - Analog Outputs on the 5B01 or 7BP16-1 Backplane

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Note: You cannot use analog output modules on the 5B08, 7BP08-1, or 7BP04-1 backplane.

Jumpers W4 to W7 are provided if you are using the DT730 or DT730-T screw terminal panel with analog output modules on a 5B01 or 7BP16-1 signal conditioning backplane.

Install jumpers W4 and W5 to connect DAC0 from the data acquisition board to channel 14 on the 5B01 or 7BP16-1 backplane. Jumper W4 connects DAC0 to channel 14; jumper W5 connects DAC0's return.

Install jumpers W6 and W7 to connect DAC1 from the data acquisition board to channel 15 on the 5B01 or 7BP16-1 backplane. Jumper W6 connects DAC0 to channel 15; jumper W7 connects DAC1's return.

Note: If you are using analog output modules on the 5B01or 7BP16-1 backplane, ensure that you make no connections to the screw terminals corresponding to that signal on the screw terminal panel. For example, if you are using channel 14 on the 5B01 for analog output, do not use screw terminals corresponding to DAC0 on the screw terminal panel. You can read the output of the DACs as inputs.

Resistors

Locations are provided on the DT730 and DT730-T for user-installed bias return and current shunt resistors. (Resistors must be 1/4 W size.) The following subsections describe these resistors and their use.

Configuring Resistors R1 to R32 - Input Bias Return

Differential mode permits low-level signal measurement by limiting common-mode input noise. This mode provides a separate return path for each channel.

For floating signal sources, where the voltage source has no connection with earth ground, you need to provide a bias return path by adding input bias return resistors. Input bias resistors R1 through R32 connect the low sides of channels 0 to 31 to analog ground, where R1 corresponds to channel 0 and R32 corresponds to channel 31. When input bias resistors are installed for an analog input channel, the high (or positive) side of the analog input channel returns the source input impedance through the bias return resistor to the low side of the channel, and then to analog ground.

Typical resistor values are 1 kΩ to 100 kΩ depending on the application. Refer to page 47 for an example of using an input bias return resistor.

Configuring Resistors R33 to R64 - Current Shunt

In single-ended mode, inputs share a common return path. Single-ended connections should be restricted to applications with high-level voltage inputs and short lead lengths.

Current shunt resistors R33 to R64 connect the high side of analog input channels 0 to 31 to the low side of each input. Resistor R33 corresponds to analog input channel 0; resistor R64 corresponds to analog input channel 31. Current shunt resistors typically convert 4 to 20 mA to 1 to 5 V for A/D conversion.

Note that, depending on your application, a bias current return resistor may also be required in addition to the current shunt resistor.

The typical current shunt resistor value is 250 Ω. If, for example, you add a 250 Ω resistor to location R33 and connect a 4 to 20 mA current loop input to channel 0, the input range for channel 0 is converted to 1 to 5 V. Refer to page 49 for an example of using a current shunt resistor.

Using 5B and 7B Series Conditioning Backplanes

This section describes how to attach a 5B or 7B Series signal conditioning backplane to a DT730 or DT730-T screw terminal panel and considerations when using signal conditioning accessories with DT3000 Series boards.

Attaching a 5B Series Backplane

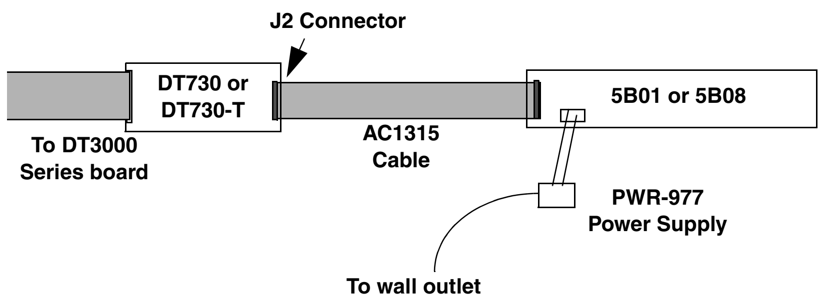


Figure 5: Connecting the 5B Series Backplane to the DT730 or DT730-T Screw Terminal Panel

To connect a 5B Series signal conditioning backplane to the DT730 or DT730-T screw terminal panel, do the following while referring to Figure 5:

1. Plug one end of the AC1315 cable into the J2 connector of the DT730 or DT730-T screw terminal panel.
2. Plug the other end of the AC1315 cable into the 26-pin connector on the 5B Series backplane.
3. Connect power supply PWR-977 to the +5 V and power ground screw terminals on the 5B Series backplane and to the wall outlet.

Attaching a 7B Series Backplane

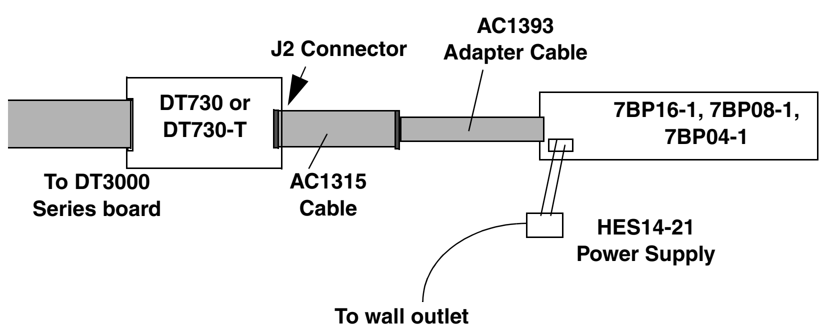


Figure 6: Connecting the 7B Series Backplane to the DT730 or DT730-T Screw Terminal Panel

To connect a 7B Series signal conditioning backplane to the DT730 or DT730-T screw terminal panel, do the following while referring to Figure 6:

1. Plug one end of the AC1315 cable into the J2 connector of the DT730 or DT730-T screw terminal panel.
2. Plug the other end of the AC1315 cable into the 26-pin connector of the AC1393 adapter cable; then, attach the 25-pin connector of the AC1393 adapter cable to the 7B Series backplane.
3. Connect power supply HES14-21 to the V+A and COM screw terminals on the 7B Series backplane and to the wall outlet.

Considerations When Using 5B or 7B Series Accessories

When using the DT730 or DT730-T screw terminal panel with 5B or 7B Series signal conditioning accessories, keep the following considerations in mind:

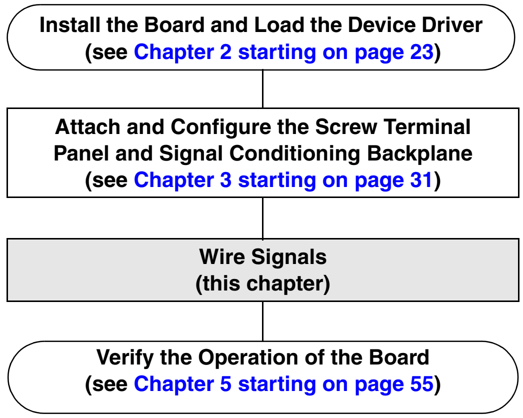
- Configure your DT3000 Series board to use single-ended mode. You must remove jumper W1 on the DT730 or DT730-T screw terminal panel, as described on page 35. If you are using a 5B Series backplane, you must also install jumper W3 on the 5B Series backplane to connect Amp Low to Analog Ground.
- The 5B08 and 7BP08-1 map to single-ended analog input channels 0 to 7, and the 7BP04-1 maps to single-ended analog input channels 0 to 3. If you are using a signal conditioning module for an analog input channel, ensure that you connect the analog input signal to the module on the signal conditioning backplane. For channels that do not use signal conditioning, connect the analog input signals to the DT730 or DT730-T screw terminal panel.
- By default, the 5B01 and 7BP16-1 backplanes map to single-ended analog input channels 0 to 15. However, by configuring jumpers W4 to W7 on the DT730 or DT730-T, as described on page 35, you can use channels 14 and 15 on the 5B01 or 7BP16-1 backplane as analog output channels 0 and 1.

Note: You cannot use analog output modules on the 5B08, 7BP08-1, or 7BP04-1 backplane.

- 5B thermocouple modules provide their own CJC and return a voltage that already compensates for CJC. Therefore, when using 5B Series modules, you do not have to compensate for offsets as you do when measuring thermocouples on the DT730-T directly.
- The output of many 5B modules is ±5 V. The output of many 7B modules is 0 to 10 V. Ensure that you select an input range that matches the output of the 5B or 7B modules that you are using. For example, if you are using 5B modules that have an output of ±5 V, use a bipolar input range and a gain of 2 on the DT300 Series board.
- Connect all unused inputs to analog common. Reading an open channel can cause settling problems on the next valid channel.
- Refer to the user’s manuals and data sheets for the 5B and 7B Series for more information.

4

Wiring Signals



This chapter describes how to wire signals to the DT730 or DT730-T screw terminal panel. For information on how to wire signals to the 5B or 7B Series signal conditioning modules, refer to the data sheets and user's manuals for the 5B and 7B Series.

Before Wiring

This section describes wiring recommendations and the pin assignments of the DT730 and DT730-T screw terminal panel.

Wiring Recommendations

Keep the following recommendations in mind when wiring signals to the DT730 or DT730-T screw terminal panel:

- Follow standard ESD procedures when wiring signals to the board.
- Use individually shielded twisted-pair wire (size 14 to 26 AWG) when using the DT3000 Series board in highly noisy electrical environments.
- Separate power and signal lines by using physically different wiring paths or conduits.
- To avoid noise, do not locate the DT730 or DT730-T screw terminal panel 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 metal shield.
- Connect the analog shield to screw terminals TB35, TB36, and TB51 through TB56 on the DT730 or DT730-T screw terminal panel.
- Connect the digital shield to the digital ground screw terminals on the screw terminal panel.
- Connect the analog and digital shields to one end only (either at the DT730, DT730-T, or the signal source).
- When first installing the board, it is recommended that you do the following:
  – Wire a function generator or a known voltage source to analog input channel 0 (use the differential configuration).
  – Wire an oscilloscope or voltage meter to analog output channel 0.
  – Wire a digital input to digital I/O Port A.
  – Wire a external clock or scope to counter/timer channel 0.
  – If you have not done so already, install the DT3000 Series software.
  – Run the Quick DataAcq application (described in Chapter 5 starting on page 55) to verify that the board is operating properly.
  – Once you have determined that the board is operating properly, wire the signals according to your application's requirements.

DT730 and DT730-T Screw Terminal Assignments

Table 2 describes each of the screw terminal assignments and identifies the resistors that are associated with each channel.

Table 2: Screw Terminal Descriptions and Resistor Use for the DT730 and DT730-T

Screw Terminal Number[a]	Signal Name		Resistor Used	
	Single-Ended	Differential	Bias Return	Current Shunt
1	Digital Ground		Not Applicable	
2	Digital Ground			
3	UCLK_OUT			
4	IADCLK0			
5	USER_GATE			
6	EADTRIG/EDATRIG			
7	USER_CLK1			
8	EADCLK1			
9	Digital Ground			
10	Digital Ground			
11	RESERVED			
12	RESERVED			
13	+5V_OUT			
14	+5V_OUT			
15	Digital Ground			
16	Digital Ground			
17	DIG_IOB3			
18	DIG_IOA3			
19	DIG_IOB2			
20	DIG_IOA2			
21	DIG_IOB1			
22	DIG_IOA1			
23	DIG_IOB0			
24	DIG_IOA0			
25	Digital Ground			
26	Digital Ground			
27	–15V_OUT			

Table 2: Screw Terminal Descriptions and Resistor Use for the DT730 and DT730-T (cont.)

Screw Terminal Number[a]	Signal Name		Resistor Used	
	Single-Ended	Differential	Bias Return	Current Shunt
28	+15V_OUT		Not Applicable	
29	Analog Common			
30	Analog Common			
31	DAC1_GND			
32	DAC1_OUT			
33	DAC0_GND			
34	DAC0_OUT			
35	Amp Low		Note: Jumper W1 Connects Amp Low to Analog Gnd	
36	Analog Gnd			
37	AIN63	AIN31_L	R32	R64
38	AIN55	AIN31_H		
39	AIN62	AIN30_L	R31	R63
40	AIN54	AIN30_H		
41	AIN61	AIN29_L	R30	R62
42	AIN53	AIN29_H		
43	AIN60	AIN28_L	R29	R61
44	AIN52	AIN28_H		
45	AIN59	AIN27_L	R28	R60
46	AIN51	AIN27_H		
47	AIN58	AIN26_L	R27	R59
48	AIN50	AIN26_H		
49	AIN57	AIN25_L	R26	R58
50	AIN49	AIN25_H		
51	AIN56	AIN24_L	R25	R57
52	AIN48	AIN24_H		
53	AIN47	AIN23_L	R24	R56
54	AIN39	AIN23_H		
55	AIN46	AIN22_L	R23	R55
56	AIN38	AIN22_H		
57	AIN45	AIN21_L	R22	R54
58	AIN37	AIN21_H		

Table 2: Screw Terminal Descriptions and Resistor Use for the DT730 and DT730-T (cont.)

Screw Terminal Number[a]	Signal Name		Resistor Used	
	Single-Ended	Differential	Bias Return	Current Shunt
59	AIN44	AIN20_L	R21	R53
60	AIN36	AIN20_H		
61	AIN43	AIN19_L	R20	R52
62	AIN35	AIN19_H		
63	AIN42	AIN18_L	R19	R51
64	AIN34	AIN18_H		
65	AIN41	AIN17_L	R18	R50
66	AIN33	AIN17_H		
67	AIN40	AIN16_L	R17	R49
68	AIN32	AIN16_H		
69	AIN31	AIN15_L	R16	R48
70	AIN23	AIN15_H		
71	AIN30	AIN14_L	R15	R47
72	AIN22	AIN14_H		
73	AIN29	AIN13_L	R14	R46
74	AIN21	AIN13_H		
75	AIN28	AIN12_L	R13	R45
76	AIN20	AIN12_H		
77	AIN27	AIN11_L	R12	R44
78	AIN19	AIN11_H		
79	AIN26	AIN10_L	R11	R43
80	AIN18	AIN10_H		
81	AIN25	AIN09_L	R10	R42
82	AIN17	AIN09_H		
83	AIN24	AIN08_L	R9	R41
84	AIN16	AIN08_H		
85	AIN15	AIN07_L	R8	R40
86	AIN07	AIN07_H		
87	AIN14	AIN06_L	R7	R39
88	AIN06	AIN06_H		

Table 2: Screw Terminal Descriptions and Resistor Use for the DT730 and DT730-T (cont.)

Screw Terminal Number[a]	Signal Name		Resistor Used	
	Single-Ended	Differential	Bias Return	Current Shunt
89	AIN13	AIN05_L	R6	R38
90	AIN05	AIN05_H		
91	AIN12	AIN04_L	R5	R37
92	AIN04	AIN04_H		
93	AIN11	AIN03_L	R4	R36
94	AIN03	AIN03_H		
95	AIN10	AIN02_L	R3	R35
96	AIN02	AIN02_H		
97	AIN09	AIN01_L	R2	R34
98	AIN01	AIN01_H		
99	AIN08	AIN00_L	R1	R33
100	AIN00	AIN00_H		

a. The screw terminal assignments match the pin numbers of the J1 connector.

Connecting Analog Input Signals

The DT730 screw terminal panel supports both voltage and current loop inputs. You can connect analog input voltage signals to the DT730 in the following configurations:

- **Single-ended** – Choose this configuration when you want to measure high-level signals, noise is not significant, the source of the input is close to the DT730 or DT730-T screw terminal panel, and all the input signals are referred to the same common ground. When you choose the single-ended configuration, all 32 analog input channels are available.
- **Pseudo-Differential** – Choose this configuration when noise or common-mode voltage (the difference between the ground potential of the signal source and the ground of the DT730 or DT730-T screw terminal panel or the difference between the grounds of other signals) exists and the differential configuration is not suitable for your application. This option provides less noise rejection than the differential configuration; however, all 32 analog input channels are available.
- **Differential** – Choose this configuration when you want to measure low-level signals (less than 1 V), you are using an A/D converter with high resolution (> 12 bits), noise is a significant part of the signal, or common-mode voltage exists and you want the most noise rejection. When you choose the differential configuration, 16 analog input channels are available.

Note: We recommend that you connect all unused analog input channels to analog ground.

This section describes how to connect single-ended, pseudo-differential, and differential voltage inputs, as well as current loop inputs to the DT730 or DT730-T screw terminal panel.

Connecting Single-Ended Voltage Inputs

Figure 7 shows how to connect single-ended voltage inputs (channels 0, 1, and 8, in this case) to the DT730 and DT730-T screw terminal panel.

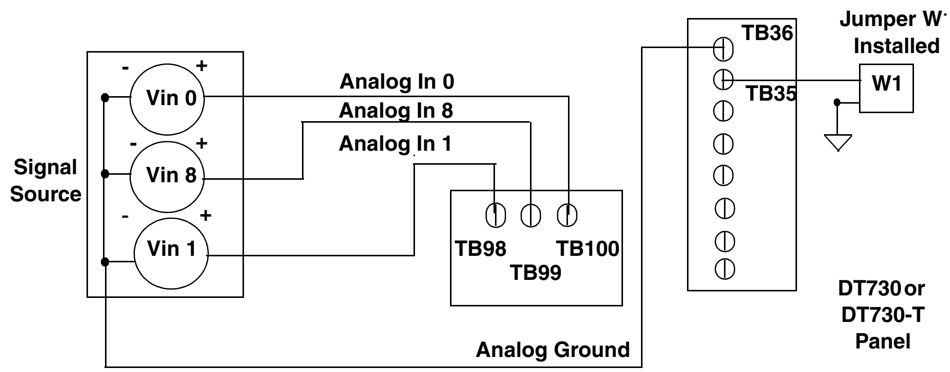


Figure 7: Connecting Single-Ended Voltage Inputs (Shown for Channels 0, 1, and 8)

Connecting Pseudo-Differential Voltage Inputs

Figure 8 shows how to connect pseudo-differential voltage inputs (channels 0, 1, and 8, in this case) to the DT730 or DT730-T screw terminal panel.

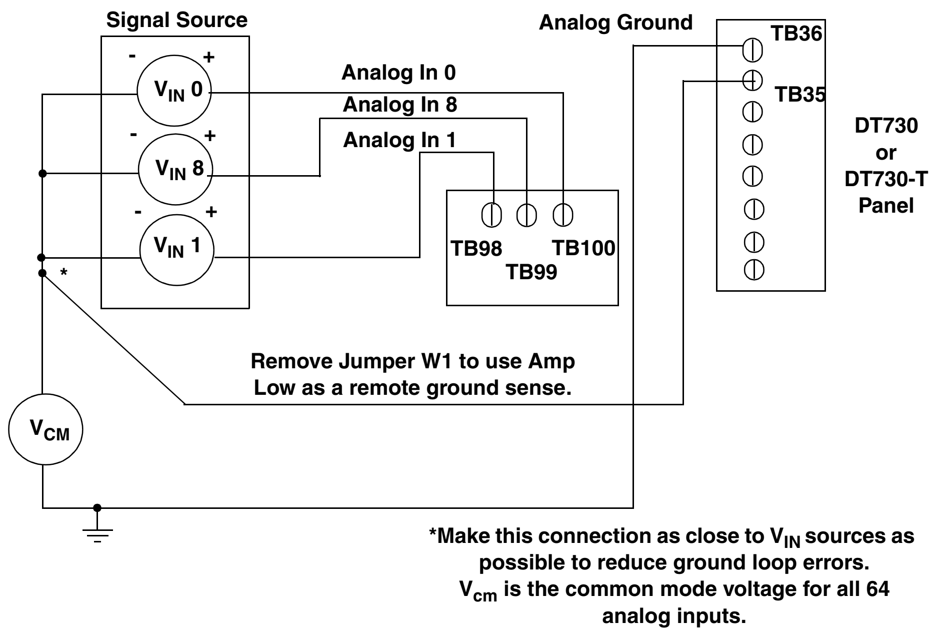


Figure 8: Connecting Pseudo-Differential Voltage Inputs (Shown for Channels 0, 1, and 8)

Connecting Differential Voltage Inputs

Figure 9A illustrates how to connect a floating signal source to the DT730 or DT730-T screw terminal panel using differential inputs and a bias return resistor.

In Figure 9B, the signal source itself provides the bias return path; therefore, you do not need to use bias return resistors. R_s is the signal source resistance while R_v is the resistance required to balance the bridge. Note that the negative side of the bridge supply must be returned to analog ground.

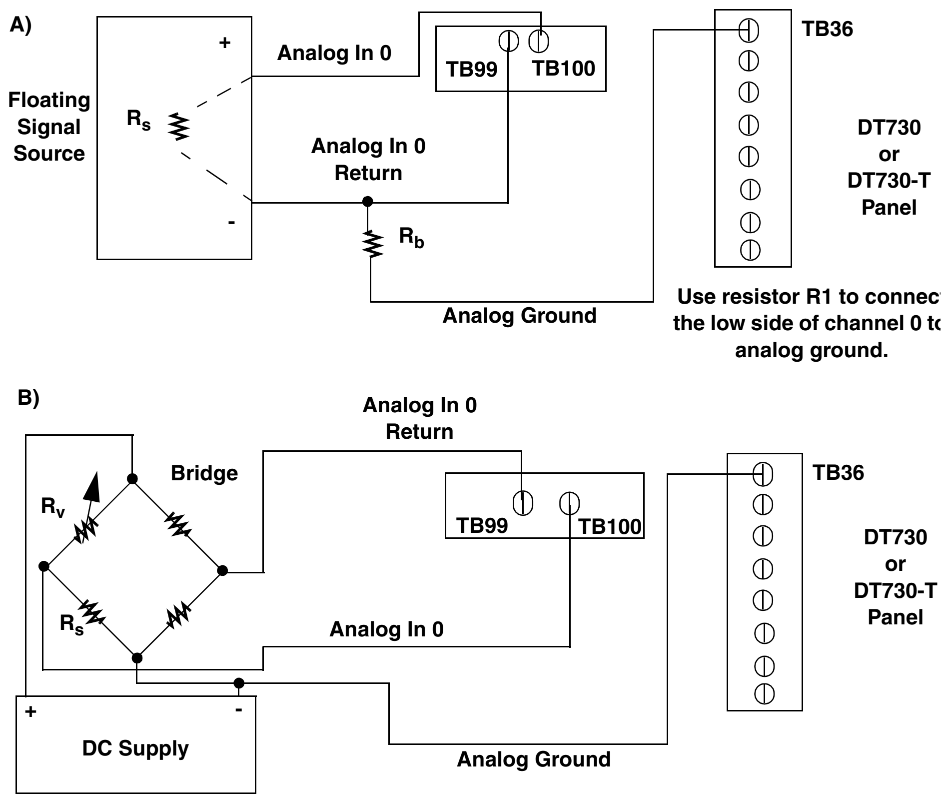


Figure 9: Connecting Differential Voltage Inputs (Shown for Channel 0) with and without Input Bias Return Resistors

Note that since they measure the difference between the signals at the high (+) and low (–) inputs, differential connections usually cancel any common-mode voltages, leaving only the signal. However, if you are using a grounded signal source and ground loop problems arise, connect the differential signals to the DT730 or DT730-T screw terminal panel as shown in Figure 10, using an input bias return resistor if the external ground signal is floating. In this case, make sure that the low side of the signal (–) is connected to ground at the signal source, not at the DT730 or DT730-T screw terminal panel, and do not tie the two grounds together.

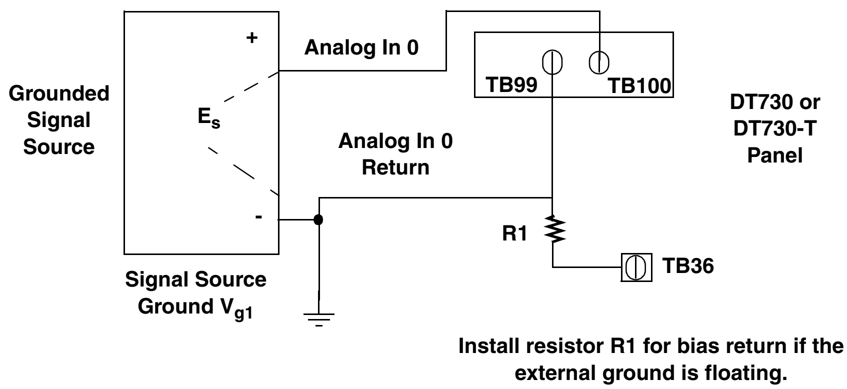


Figure 10: Connecting Differential Voltage Inputs from a Grounded Signal Source (Shown for Channel 0)

Connecting Current Loop Inputs

Figure 11 shows how to connect a current loop input (channel 0, in this case) to the DT730 or DT730-T screw terminal panel.

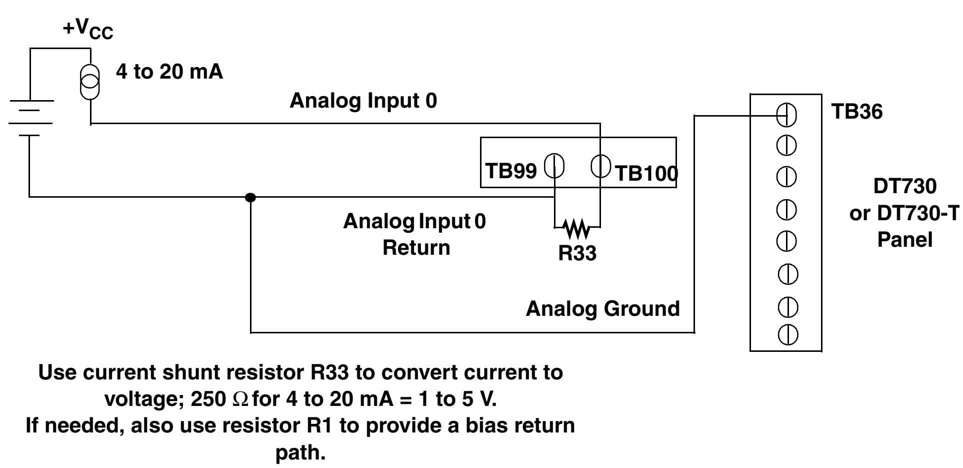


Figure 11: Connecting Current Inputs to the DT730 or DT730-T Screw Terminal Panel (Shown for Channel 0)

Connecting Analog Output Signals

Figure 12 shows how to connect an analog output voltage signal (channel 0, in this case) to the DT730 screw terminal panel.

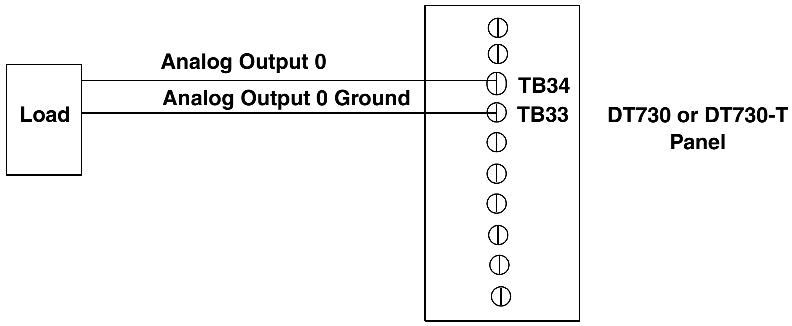


Figure 12: Connecting Analog Output Voltages (Shown for Channel 0)

Connecting Digital I/O Signals

Figure 13 shows how to connect a digital input signal (channels 0 and 1 of digital port A, in this case) to the DT730 or DT730-T screw terminal panel.

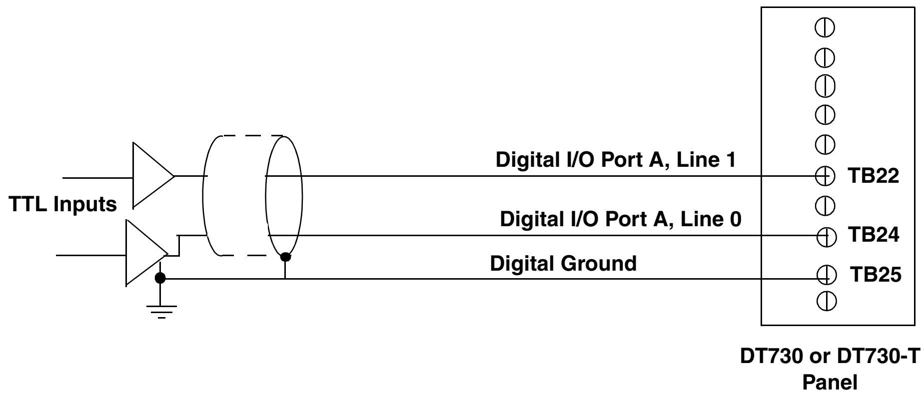


Figure 13: Connecting Digital Inputs (Channels 0 and 1, Port A Shown)

Figure 14 shows how to connect a digital output signal (channel 0 of digital port 1, in this case) to the DT730 or DT730-T screw terminal panel.

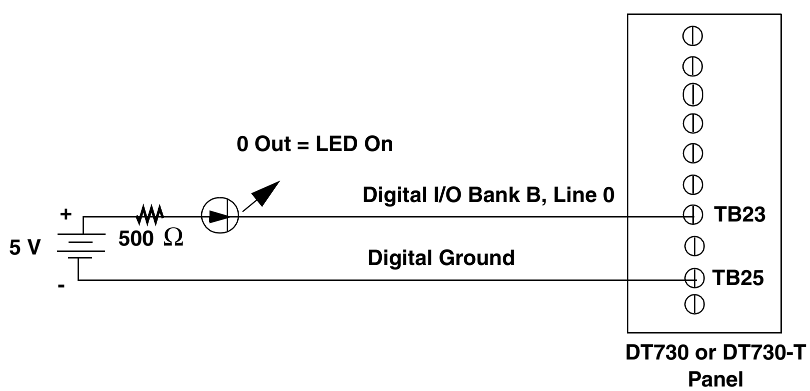


Figure 14: Connecting Digital Outputs (Channel 0, Port 1 Shown)

Connecting Counter/Timer Signals

The DT3000 Series board and DT730 screw terminal panel provide one user counter/timer channel that you can use for the following operations:

- Event counting
- Frequency measurement
- Pulse output (rate generation, one-shot, and repetitive one-shot)

This section describes how to connect counter/timer signals to perform these operations. Refer to page 83 for more information on using the counter/timers.

Connecting Event Counting Signals

Figure 15 shows one example of connecting event counting signals to the DT730 or DT730-T screw terminal panel. In this example, clock edges are counted while the gate is active.

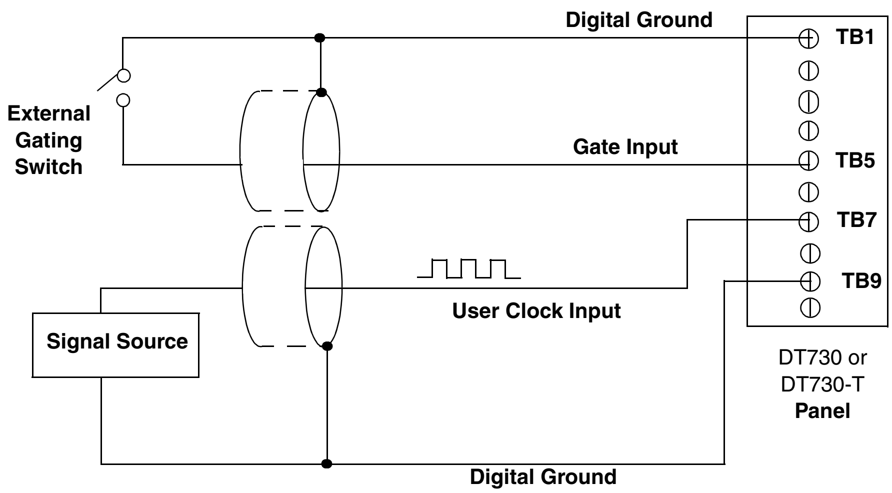


Figure 15: Connecting Event Counting Signals (Shown Using an External Gate)

Figure 16 shows another example of connecting event counting signals to the DT730 or DT730-T screw terminal panel. In this example, a software gate is used to start the event counting operation.

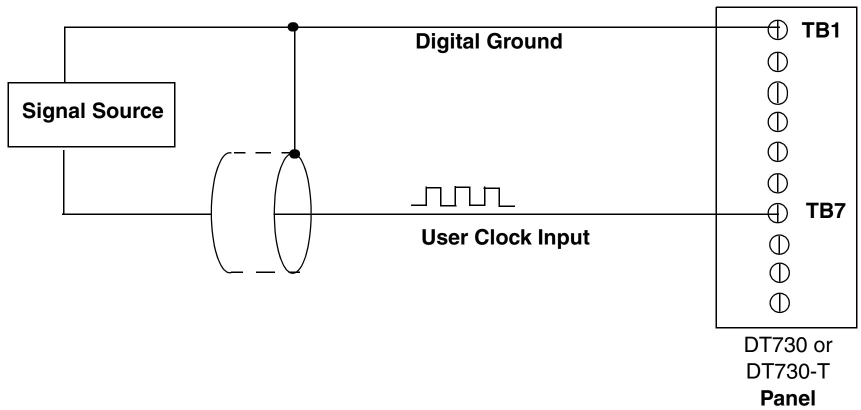


Figure 16: Connecting Event Counting Signals without an External Gate Input

Connecting Frequency Measurement Signals

On the DT3000 Series, a frequency measurement application uses the same wiring as an event counting application that does not use an external gate signal (see Figure 16).

The software uses the Windows timer to specify the duration of the frequency measurement. The frequency of the clock input is the number of counts divided by the duration of the Windows timer.

Connecting Pulse Output Signals

Figure 17 shows one example of connecting pulse output signals to the DT730 or DT730-T screw terminal panel using an external gate type.

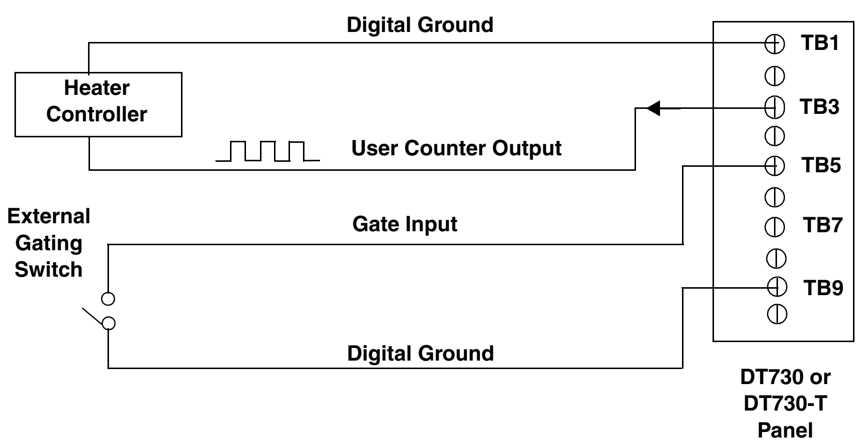


Figure 17: Connecting Pulse Output Signals (Using an External Gate)

Figure 18 shows another example of connecting a pulse output operation to the DT730 or DT730-T screw terminal panel using a software gate type.

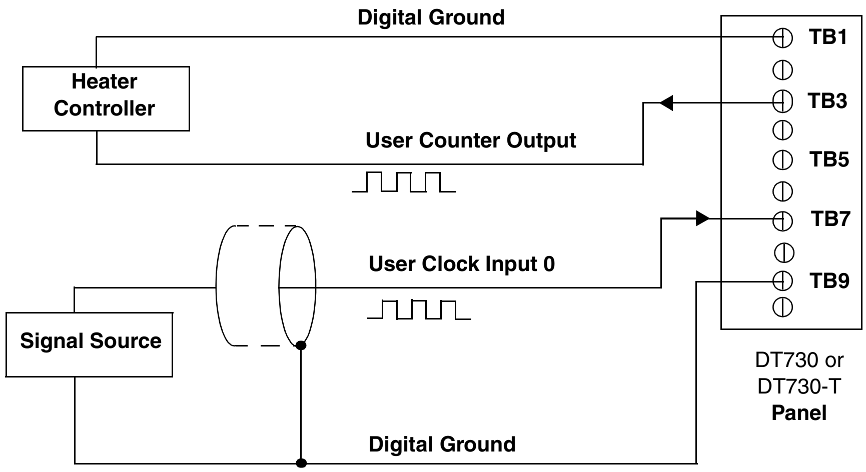
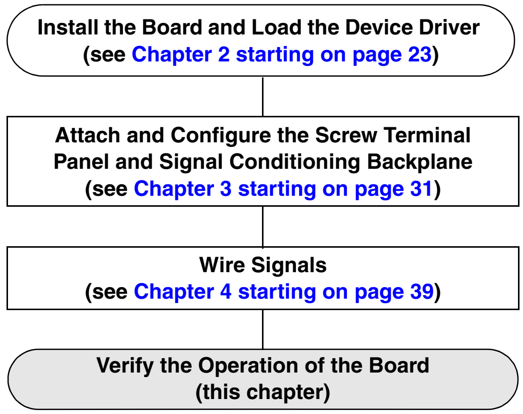


Figure 18: Connecting Pulse Output Signals (Using an External Gate)

5

Verifying the Operation of a DT3000 Series Board



You can verify the operation of a DT3000 Series board using the Quick DataAcq application. Quick DataAcq allows you to do the following:

- Acquire data from a single analog input channel or digital input port
- Acquire data continuously from one or more analog input channels using an oscilloscope, strip chart, or Fast Fourier Transform (FFT) view
- Measure the frequency of events
- Output data from a single analog output channel or digital output port
- Output pulses either continuously or as a one-shot
- Save the input data to disk

Running the Quick DataAcq Application

The Quick DataAcq application is installed automatically when you install the driver software.

To run the Quick DataAcq application, do the following:

1. If you have not already done so, power up your computer and any attached peripherals.
2. Click **Start** from the Task Bar.
3. Browse to **Programs | Data Translation, Inc | DT-Open Layers for Win32 | QuickDataAcq**.
   The main menu appears.

Note: The Quick DataAcq application allows you to verify basic operations on the board; however, it may not support all of the board's features.

For information on each of the features provided, use the online help for the Quick DataAcq application by pressing F1 from any view or selecting the **Help** menu. If the system has trouble finding the help file, navigate to C:\Program Files\Data Translation\Win32\dtdataacq.hlp, where C: is the letter of your hard disk drive.

Testing Single-Value Analog Input

To verify that the board can read a single analog input value, do the following:

1. Connect a voltage source, such as a function generator, to analog input channel 0 (differential mode) on the DT3000 Series board. Refer to page 47 for an example of how to connect a differential analog input.
2. In the Quick DataAcq application, choose **Single Analog Input** from the **Acquisition** menu.
3. Select the appropriate DT3000 Series board from the Board list box.
4. In the Channel list box, select analog input channel 0.
5. In the Range list box, select the range for the channel.
   The default is ±10 V.
6. Select **Differential**.
7. Click **Get** to acquire a single value from analog input channel 0.
   The application displays the value on the screen in both text and graphical form.

Testing Single-Value Analog Output

To verify that the board can output a single analog output value, do the following:

1. Connect an oscilloscope or voltmeter to DAC0 on the board. Refer to page 50 for an example of how to connect analog output signals.
2. In the Quick DataAcq application, choose **Single Analog Output** from the **Control** menu.
3. Select the appropriate DT3000 Series board from the Board list box.
4. In the Channel list box, select analog output channel 0.
5. In the Range list box, select the output range of DAC0.
   The default is ±10 V.
6. Enter an output value, or use the slider to select a value to output from DAC0.
7. Click **Send** to output a single value from DAC0.
   The application displays the output value on the screen in both text and graphical form.

Testing Continuous Analog Input

To verify that the board can perform a continuous analog input operation, do the following:

1. Connect known voltage sources, such as the outputs of a function generator, to analog input channels 0 and 1 on the DT3000 Series board (using the differential configuration). Refer to page 47 for an example of how to connect a differential analog input.
2. In the Quick DataAcq application, choose **Scope** from the **Acquisition** menu.
3. Select the appropriate DT3000 Series board from the Board list box.
4. In the Sec/Div list box, select the number of seconds per division (.1 to .00001) for the display.
5. In the Channels list box, select analog input channel 1, and then click **Add** to add the channel to the channel list.
Channel 0 is automatically added to the channel list.
6. Click **Config** from the Toolbar.
7. From the Config menu, select **ChannelType**, and then select **Differential**.
8. From the Config menu, select **Range**, and then select **Bipolar** or **Unipolar** depending on the configuration of your board.
The default is Bipolar.
9. From the Scope view, double-click the input range of the channel to change the input range of the board (±10 V, ±5 V, ±2.5 V, ±1.25 V for bipolar ranges or 0 to 10 V, 0 to 5 V, 0 to 2.5 V or 0 to 1.25 V for unipolar ranges).
The default is ±10 V. Note that the display changes to reflect the selected range for all the analog input channels on the board.
10. In the Trigger box, select **Auto** to acquire data continuously from the specified channels or **Manual** to acquire a burst of data from the specified channels.
11. Click **Start** from the Toolbar to start the continuous analog input operation.
The application displays the values acquired from each channel in a unique color on the oscilloscope view.
12. Click **Stop** from the Toolbar to stop the operation.

Testing Single-Value Digital Input

To verify that the board can read a single digital input value, do the following:

1. Connect a digital input to digital input line 0 of port A on the DT3000 Series board. Refer to page 51 for an example of how to connect a digital input.
2. In the Quick DataAcq application, click the **Acquisition** menu.
3. Click **Digital Input**.
4. Select the appropriate DT3000 Series board from the Board list box.
5. Select digital input port A by clicking **Port A**.
6. Click **Get**.
   The application displays the value of each digital input line in port A on the screen in both text and graphical form.

Testing Single-Value Digital Output

To verify that the board can output a single digital output value, do the following:

1. Connect a digital output to digital output line 0 of port B on the DT3000 Series board. Refer to page 51 for an example of how to connect a digital output.
2. In the Quick DataAcq application, choose **Digital Output** from the **Control** menu.
3. Select the appropriate DT3000 Series board from the Board list box.
4. Select digital output port B by clicking **Port B**.
5. Click the appropriate bits to select the digital output lines to write to. If the bit is selected, a high-level signal is output to the digital output line; if the bit is not selected, a low-level signal is output to the digital output line. Optionally, you can enter an output value in the Hex text box.
6. Click **Send**.
   The application displays the value of each digital output line of digital port B on the screen in both text and graphical form.

Testing Frequency Measurement

To verify that the board can perform a frequency measurement operation, do the following:

1. Wire an external clock source to counter/timer 0 on the DT3000 Series board. Refer to page 53 for an example of how to connect a an external clock for a frequency measurement operation.

Note: The Quick DataAcq application works only with counter/timer 0.

---

2. In the Quick DataAcq application, choose **Frequency Counter** from the **Acquisition** menu.
3. Select the appropriate DT3000 Series board from the Board list box.
4. In the Count Duration text box, enter the number of seconds during which events will be counted.
5. Click **Start** to start the frequency measurement operation.
   The operation automatically stops after the number of seconds you specified has elapsed, and the frequency is displayed on the screen.

If you want to stop the frequency measurement operation when it is in progress, click **Stop**.

Testing Pulse Output

To verify that the board can perform a pulse output operation, do the following:

1. Connect a scope to counter/timer 0 on the DT3000 Series board. Refer to page 53 for an example of how to connect a scope (a pulse output) to counter/timer 0.

Note: The Quick DataAcq application works only with counter/timer 0.

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2. In the Quick DataAcq application, choose **Pulse Generator** from the **Control** menu.
3. Select the appropriate DT3000 Series board from the Board list box.
4. Select either **Continuous** to output a continuous pulse stream or **One Shot** to output one pulse.
5. Select either **Low-to-high** to output a rising-edge pulse (the high portion of the total pulse output period is the active portion of the signal) or **High-to-low** to output a falling-edge pulse (the low portion of the total pulse output period is the active portion of the signal).
6. Enter a percentage or use the slider to select a percentage for the pulse width. The pulse width determines the duty cycle of the pulse.
7. Click **Start** to generate the pulse(s).
   The application displays the results both in text and graphical form.
8. Click **Stop** to stop a continuous pulse output operation. One-shot pulse output operations stop automatically.

Part 2: Using Your Board

6

Principles of Operation

This chapter describes the analog input, analog output, digital I/O, counter/timer, and interrupt features of the DT3000 Series boards. To frame the discussions, refer to the block diagram shown in Figure 19. Note that bold entries indicate signals you can access.

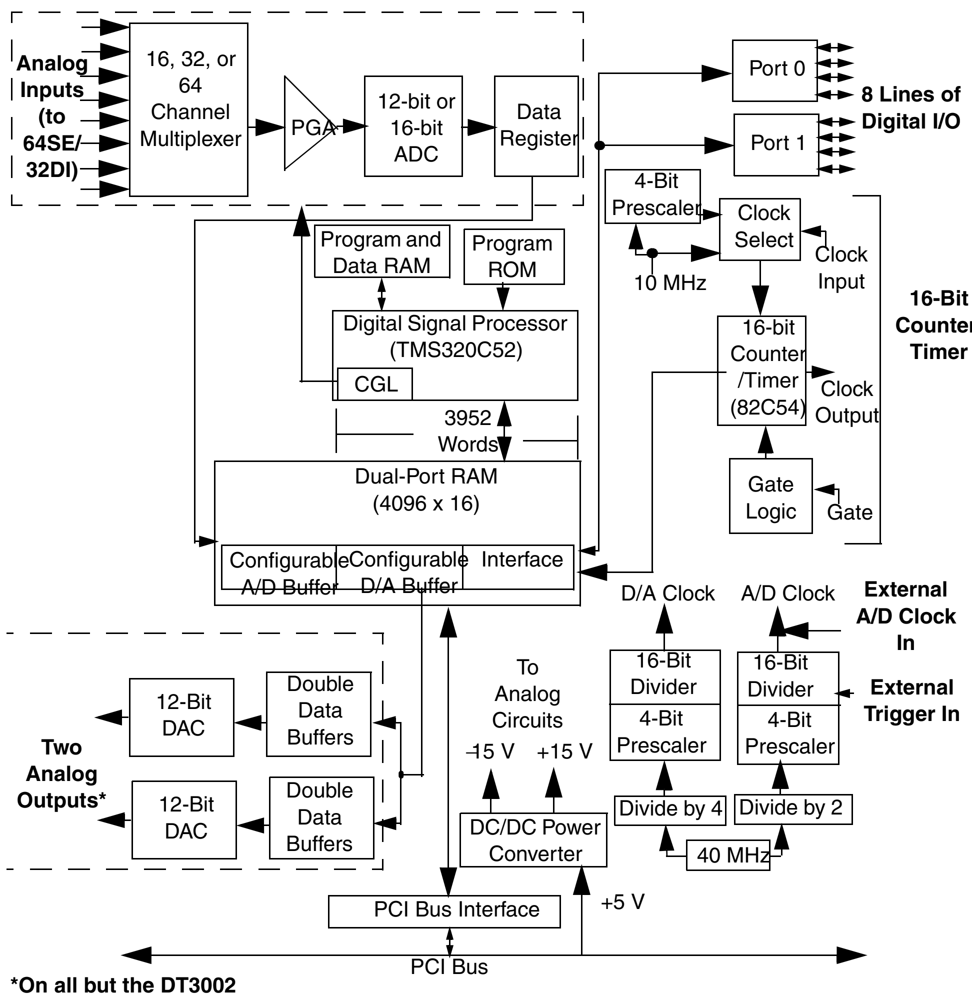

Figure 19: Block Diagram of the DT3000 Series Boards

Analog Input Features

This section describes the features of the analog input (A/D) subsystem, including the following:

- Analog input resolution
- Analog input channels
- Input ranges and gains
- A/D sample clock sources
- Analog input conversion modes
- Trigger sources and trigger acquisition modes
- Data formats and transfer

Analog Input Resolution

The DT3001, DT3001-PGL, DT3002, DT3003, and DT3003-PGL boards have a fixed analog input resolution of 12 bits. The DT3004 and DT3005 boards have a fixed analog input resolution of 16 bits. The analog input resolution cannot be changed.

Analog Input Channels

DT3001, DT3001-PGL, DT3004, and DT3005 boards support 16 single-ended or pseudo-differential analog input channels or 8 differential analog input channels. The DT3002 board supports 32 single-ended or pseudo-differential analog input channels or 16 differential analog input channels. The DT3003 and DT3003-PGL boards support 64 single-ended or pseudo-differential analog input channels or 32 differential analog input channels. Table 3 summarizes the number of channels supported.

Table 3: Number of Channels Supported

Board	Single-Ended Channels	Pseudo-Differential Channels	Differential Channels
DT3001	16	16	8
DT3001-PGL	16	16	8
DT3002	32	32	16
DT3003	64	64	32
DT3003-PGL	64	64	32
DT3004	16	16	8
DT3005	16	16	8

Refer to Chapter 4 starting on page 39 for a description of how to wire these signals. Use software to specify the channel type.

Note: For pseudo-differential inputs, specify single-ended in software; in this case, how you wire these signals determines the configuration.

All input channels have high impedance. Each incorporates ±35 V over-voltage protection when the board is on and ±20 V over-voltage protection when the board is off.

DT3000 Series boards can acquire data from a single analog input channel or from a group of analog input channels. Depending on the number of channels supported by the board, channels are numbered 0 to 15, 0 to 31, or 0 to 63 for single-ended and pseudo-differential inputs and 0 to 7, 0 to 15, or 0 to 31 for differential inputs. The following subsections describe how to specify the channels.

Specifying a Single Channel

The simplest way to acquire data from a single channel is to specify the channel for a single-value analog input operation using software; refer to page 73 for more information on single-value operations.

You can also specify a single channel using the analog input channel list, described in the next section.

Specifying One or More Channels

DT3000 Series boards can read data from one or more analog input channels using an analog input channel list. You can group the channels in the list sequentially (either starting with 0 or with any other analog input channel) or randomly. You can also specify a channel more than once in the list.

Using software, specify the channels in the order you want to sample them. The analog input channel list corresponds to the Channel-Gain List (CGL) on the board. You can enter up to 512 entries in the list. The channels are read in order (using continuously paced scan mode or triggered scan mode) from the first entry to the last entry in the channel list. The board reads the entries in the channel list once per trigger using triggered scan mode. Refer to page 73 for more information on the supported conversion modes.

Input Ranges and Gains

Each channel on the DT3000 Series board can measure bipolar analog input signals between –10 V to +10 V. A bipolar signal extends between the negative and positive peak values of the range.

You specify the range in software. Note that the range applies to the entire analog input subsystem, not to a specific channel.

The DT3001, DT3002, DT3003, DT3004, and DT3005 boards provide gains 1, 2, 4, and 8; the DT3001-PGL and DT3003-PGL boards provide gains of 1, 10, 100, and 500. Gains on all DT3000 Series boards are programmable per channel. Table 4 lists the effective ranges supported by DT3000 Series boards using these gains.

Table 4: Gains and Effective Ranges

Gain	Bipolar Analog Input Range	Gain	Bipolar Analog Input Range
1	±10 V	1	±10 V
2	±5 V	10	±1 V
4	±2.5 V	100	±0.1 V
8	±1.25 V	500	±0.02 V

For each channel, choose the gain that has the smallest effective range that includes the signal you want to measure. For example, if the range of your analog input signal on a DT3001 board is ±1.5 V, specify a range of –10 V to +10 V for the board and use a gain of 4 for the channel; the effective input range for this channel is then ±2.5 V, which provides the best sampling accuracy for that channel.

The way you specify gain depends on how you specified the channels, as described in the following subsections.

Specifying the Gain for a Single Channel

The simplest way to specify gain for a single channel is to specify the gain for a single-value analog input operation using software; refer to page 73 for more information on single-value operations.

Specifying the Gain for One or More Channels

For DT3000 Series boards, you can use software to specify the gain for each analog input channel entry in the analog input channel list.

A/D Sample Clock Sources

DT3000 Series boards provide two clock sources for pacing analog input operations in continuous mode:

- An internal A/D sample clock that uses the 16-bit A/D Counter (with a 4-bit prescaler) on the board
- An external A/D sample clock that you can connect to the screw terminal panel

The A/D sample clock paces the acquisition of each channel in the channel list; this clock is also called the A/D pacer clock.

The following subsections describe the internal and external A/D sample clocks in more detail.

Internal A/D Sample Clock

The internal A/D sample clock uses a 20 MHz time base. Conversions start on the falling edge of the counter output.

Using software, specify the clock source as internal and the clock frequency at which to pace the operation. The minimum frequency supported is 19.07 Hz (19.07 Samples/s). The maximum frequency supported varies depending on the board type, as shown in Table 5.

Table 5: Maximum Sampling Frequency

Board	Single Channel Frequency[a]	Multiple Channel Frequency[a]
DT3001	330 kHz	250 kHz
DT3001-PGL	330 kHz	250 kHz[b]
DT3002	330 kHz	100 kHz
DT3003	330 kHz	100 kHz
DT3003-PGL	330 kHz	100 kHz[c]
DT3004	100 kHz	50 kHz
DT3005	200 kHz	100 kHz

a. Unless otherwise indicated, these rates assume a gain of 1.
b. Using a gain of 100, the maximum frequency is 20 kHz; using a gain of 500, the maximum frequency is 4 kHz.
c. Using a gain of 100, the maximum frequency is 10 kHz; using a gain of 500, the maximum frequency is 2.5 kHz.

According to sampling theory (Nyquist Theorem), specify a frequency that is at least twice as fast as the input's highest frequency component. For example, to accurately sample a 20 kHz signal, specify a sampling frequency of at least 40 kHz. Doing so avoids an error condition called *aliasing*, in which high frequency input components erroneously appear as lower frequencies after sampling.

External A/D Sample Clock

The external A/D sample clock is useful when you want to pace acquisitions at rates not available with the internal A/D sample clock or when you want to pace at uneven intervals.

Connect an external A/D sample clock to screw terminal TB8 on the DT730 or DT730-T screw terminal panel (pin 8 of connector J1 on the DT3000 Series board). Conversions start on the falling edge of the external A/D sample clock input signal.

Using software, specify the clock source as external. The clock frequency is always equal to the frequency of the external A/D sample clock input signal that you connect to the board through the screw terminal panel.

Analog Input Conversion Modes

DT3000 Series boards support the following conversion modes:

- **Single-value operations** are the simplest to use but offer the least flexibility and efficiency. Use software to specify the range, gain, and analog input channel (among other parameters); acquire the data from that channel; and convert the result. The data is returned immediately. For a single-value operation, you cannot specify a clock source, trigger source, trigger acquisition mode, scan mode, or buffer.

  Single-value operations stop automatically when finished; you cannot stop a single-value operation.

- **Scan mode** takes full advantage of the capabilities of the DT3000 Series boards. In a scan, you can specify a channel list, clock source, trigger source, scan mode, and buffer. Two scan modes are supported: continuously paced scan mode and triggered scan mode. These modes are described in the following subsections.

  Using software, you can stop a scan mode operation by performing either an orderly stop or an abrupt stop. In an orderly stop, the board finishes acquiring the specified number of samples, stops all subsequent acquisition, and transfers the acquired data to host memory; all subsequent triggers or retriggers are ignored. In an abrupt stop, the board stops acquiring samples immediately; the acquired data is not transferred to host memory, but all subsequent triggers or retriggers are ignored.

Continuously Paced Scan Mode

Use continuously paced scan mode if you want to accurately control the period between conversions of individual channels in a scan.

When it detects an initial trigger, the board cycles through the channel list, acquiring and converting the value for each entry in the channel list; this process is defined as the scan. The board then wraps to the start of the channel list and repeats the process continuously until either the allocated buffers are filled or until you stop the operation. Refer to page 77 for more information on buffers.

The conversion rate is determined by the frequency of the A/D sample clock; refer to page 71 for more information on the A/D sample clock. The sample rate, which is the rate at which a single entry in the channel list is sampled, is determined by the frequency of the A/D sample clock divided by the number of entries in the channel list.

To select continuously paced scan mode, use software to specify the dataflow as continuous and to specify the trigger source as either internal or external. Refer to page 77 for more information on the supported trigger sources.

Figure 20 illustrates continuously paced scan mode using a channel list with three entries: channel 0, channel 1, and channel 2. In this example, analog input data is acquired on each clock pulse of the A/D sample clock. The board wraps to the beginning of the channel list and repeats continuously.

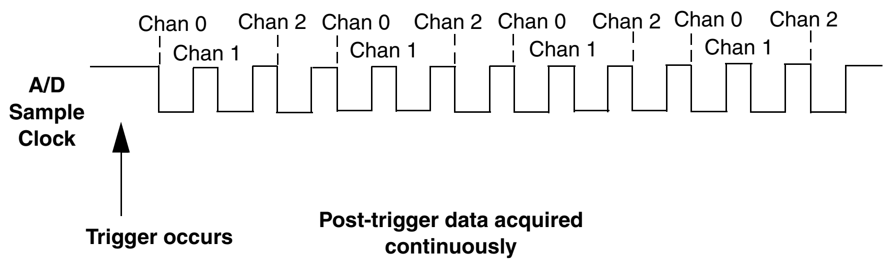

Figure 20: Continuously Paced Scan Mode

Triggered Scan Mode

DT3000 Series boards support two triggered scan modes: software retriggered and externally retriggered. These modes are described in the following subsections.

Software-Retriggered Scan Mode

Use software-retriggered scan mode if you want to accurately control both the period between conversions of individual channels in a scan and the period between each scan. Specify any supported trigger source as the initial trigger. The retrigger source is the retrigger clock on the board.

When it detects an initial trigger, the board scans the channel list once, then waits for a software retrigger to occur. When the board detects a software retrigger, the board scans the channel list once, then waits for another software retrigger to occur. The process repeats continuously until either the allocated buffers are filled or until you stop the operation; refer to page 77 for more information on buffers.

The sample rate is determined by the frequency of the A/D sample clock divided by the number of entries in the channel list; refer to page 71 for more information on the A/D sample clock. The conversion rate of each scan is determined by the frequency of the 16-bit A/D Trigger Clock (with 4-bit prescaler) on the board; it uses a 10 MHz timebase.

Using software, specify the frequency of the software retrigger. The minimum retrigger frequency is 9.54 Hz. The maximum retrigger frequency varies depending on the board type, as shown in Table 6.

Table 6: Maximum Retrigger Frequency

Board	Single Channel Retrigger Frequency[a]	Multiple Channel Retrigger Frequency[a]
DT3001	330 kHz	250 kHz
DT3001-PGL	330 kHz	250 kHz[b]
DT3002	330 kHz	100 kHz

Table 6: Maximum Retrigger Frequency (cont.)

Board	Single Channel Retrigger Frequency[a]	Multiple Channel Retrigger Frequency[a]
DT3003	330 kHz	100 kHz
DT3003-PGL	330 kHz	100 kHz[c]
DT3004	100 kHz	50 kHz
DT3005	200 kHz	100 kHz

a. Unless otherwise indicated, these rates assume a gain of 1.
b. Using a gain of 100, the maximum frequency is 20 kHz; using a gain of 500, the maximum frequency is 4 kHz.
c. Using a gain of 100, the maximum frequency is 10 kHz; using a gain of 500, the maximum frequency is 2.5 kHz.

Note: For proper operation, ensure that the retrigger period is longer than the number of entries in the channel list multiplied by the sample period. For example, if you have a channel list with five entries and a sample period of 16 μs, the retrigger period must be greater than 80 μs (5 x 16 μs).

To select internally retriggered scan mode, use software to specify the following parameters:

- The dataflow as Continuous.
- Triggered scan mode usage as enabled.
- The retrigger source as Software.
- The number of times to scan per trigger or retrigger (also called the multiscan count) as 1.
- The frequency of the software retrigger.
- The initial trigger source (refer to page 77 for more information).

Figure 21 illustrates software-retriggered scan mode using a channel list with three entries: channel 0, channel 1, and channel 2. In this example, analog input data is acquired on each clock pulse of the A/D sample clock until the channel list has been scanned once; then, the board waits for the retrigger period to elapse. When the retrigger period elapses, the retrigger event occurs, and the board scans the channel list once more, acquiring data on each pulse of the A/D sample clock. The process repeats continuously with every specified retrigger event.

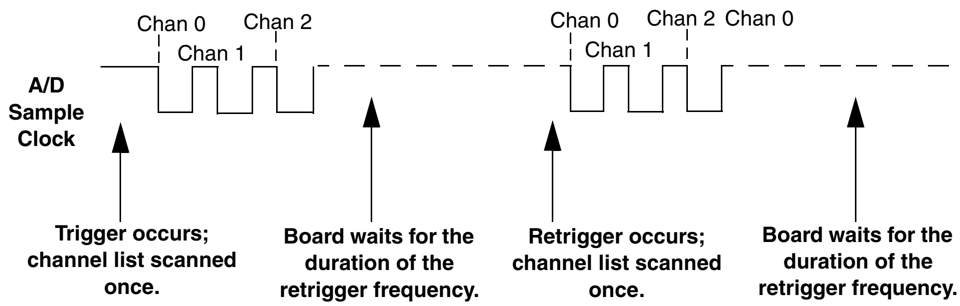

Figure 21: Software-Retriggered Scan Mode

Externally-Retriggered Scan Mode

Use externally-retriggered scan mode if you want to accurately control the period between conversions of individual channels and retrigger the scan based on an external event.

When it detects the initial trigger, the board scans the channel list once, then waits for the external retrigger to occur. On DT3000 Series boards, the initial trigger and the retrigger source must be an external digital TTL trigger (TB6 on the DT730 and DT730-T screw terminal or pin 6 of connector J1 on the DT3000 Series board).

When the retrigger occurs, the board scans the channel list once, then waits for another external retrigger to occur. The process repeats continuously until either the allocated buffers are filled or you stop the operation; refer to page 77 for more information on buffers.

The conversion rate of each channel is determined by the frequency of the A/D sample clock; refer to page 71 for more information on the A/D sample clock. The conversion rate of each scan is determined by the period between external retriggers; therefore, it cannot be accurately controlled. The board ignores external triggers that occur while it is acquiring data. Only external retrigger events that occur when the board is waiting for a retrigger are detected and acted on.

To select externally retriggered scan mode, use software to specify the following parameters:

- The dataflow as Continuous.
- Triggered scan mode as enabled.
- The retrigger mode as an external retrigger.
- The number of times to scan per trigger or retrigger (also called the multiscan count) as 1.
- The initial trigger source as the external digital (TTL) trigger.

Trigger Sources

A trigger is an event that occurs based on a specified set of conditions. DT3000 Series boards support the following trigger sources:

- **Software trigger** – A software trigger event occurs when you start the analog input operation (the computer issues a write to the board to begin conversions). Specify the software trigger source in software.
- **External digital (TTL) trigger** – For analog input operations, an external trigger event occurs when the DT3000 Series board detects either a rising or falling edge on the external trigger input signal connected to TB6 on the DT730 or DT730-T screw terminal panel (pin 6 of connector J1 on the DT3000 Series board). The trigger signal is TTL-compatible.

  The trigger pulse is recognized when it is of the correct polarity and has a pulse width greater than 500 ns. When it is recognized, the A/D sample clock is enabled. Subsequent triggers are ignored (trigger lockout) until the operation is complete. Once the operation is complete, the board can detect another trigger.

  Using software, specify the trigger source as an external, positive digital (TTL) trigger for a rising-edge external trigger or an external, negative digital (TTL) trigger for a falling-edge external trigger.

Note: The external digital trigger is also used to trigger analog output operations.

Data Format and Transfer

DT3001, DT3001-PGL, DT3002, DT3003, and DT3003-PGL boards use offset binary data encoding to represent bipolar signals. DT3004 and DT3005 boards use twos complement data encoding to represent bipolar signals. Use software to specify the data encoding type.

The board is mapped into memory space to allow the use of the multiple read bus instruction. The data transfer starts when a user-defined number of samples has accumulated. The accumulated sample data is stored in an onboard circular buffer, which is accessible for read operations by the host computer. An interrupt is sent to the host computer, notifying it with a message indicating that sample data is ready to be read. The host computer then commands the PCI bus master to transfer the sampled data from the onboard buffer to its destination in memory. Digital samples are received from the 12-bit A/D section and are sign-extended to 16 bits.

The DT3000 Series Device Driver accesses the onboard circular buffer to fill user buffers that you allocate in software. It is recommended that you allocate a minimum of two buffers for analog input operations and add them to the subsystem queue using software. Data is written to the queued input buffers continuously; when no more empty buffers are available on the queue, the operation stops. The data is gap-free.

Analog Output Features

An analog output (D/A) subsystem is provided on all DT3000 Series boards except the DT3002 board, which does not support analog output.

This section describes the following features of the D/A subsystem:

- Analog output resolution
- Analog output channels
- Output ranges and gains
- D/A output clock sources
- Trigger sources
- Analog output conversion modes
- Data formats and transfer

Analog Output Resolution

All DT3000 Series boards (except the DT3002) have a fixed analog output resolution of 12 bits. The analog output resolution cannot be changed in software.

Analog Output Channels

DT3000 Series boards (except the DT3002) support two analog output channels (DAC0 and DAC1). Refer to Chapter 4 starting on page 39 for information on how to wire analog output signals to the board using the screw terminal panel. Use software to specify the configuration of the analog output channels as differential.

Within each DAC, the digital data is double buffered to prevent spurious outputs, then output as an analog signal. Both DACs have a single dedicated timer that latches the digital values into each DAC. The DACs are initialized to 0 V on power up or reset.

DT3000 Series boards can output data from a single analog output channel or from both analog output channels. The following subsections describe how to specify the channels.

Specifying a Single Channel

The simplest way to output data to a single analog output channel is to specify the channel for a single-value analog output operation using software; refer to page 80 for more information on single-value operations.

Specifying One or More Channels

You can specify one or both analog output channels in the analog output channel list, either starting with DAC0 or with DAC1.

Values are output simultaneously to the entries in the channel list.

Output Ranges and Gains

Each DAC on the DT3000 Series board can output bipolar analog output signals in the range of ±10 V.

Through software, specify the range for the entire analog output subsystem as –10 V to +10 V and the gain for each DAC as 1.

If you are using a single-value operation, specify a gain of 1; refer to page 80 for more information on single-value operations.

If you are using an analog output channel list, the subsystem defaults to a gain of 1 for each channel; therefore, you do not have to specify the gain.

D/A Output Clock Sources

DT3000 Series boards (except the DT3002) provide an internal D/A output clock for pacing analog output operations.

The internal D/A output clock uses the 16-bit D/A counter (with 4-bit prescaler) on the board; this clock uses a 10 MHz time base. Conversions start on the falling edge of the counter output.

Through software, specify the clock source as internal and the clock frequency at which to pace the analog output operation. The minimum frequency supported is 9.54 Hz (9.54 Samples/s); the maximum frequency supported is 200 kHz (200 kSamples/s).

Note: When run simultaneously with the A/D subsystem in triggered scan mode, the maximum throughput of the D/A subsystem is 100 kSamples/s.

Trigger Sources

A trigger is an event that occurs based on a specified set of conditions. DT3000 Series boards support the following trigger sources:

- **Software trigger –** A software trigger event occurs when you start the analog output operation (the computer issues a write to the board to begin conversions). Specify the software trigger source in software.
- **External digital (TTL) trigger –** For analog output operations, an external trigger event occurs when the DT3000 Series board detects either a rising or falling edge on the external trigger input signal connected to TB6 on the DT730 or DT730-T screw terminal panel (pin 6 of connector J1 on the DT3000 Series board). The trigger signal is TTL-compatible.

  The trigger pulse is recognized when it is of the correct polarity and has a pulse width greater than 500 ns. When it is recognized, the D/A output clock is enabled. Subsequent triggers are ignored (trigger lockout) until the operation is complete. Once the operation is complete, the board can detect another trigger.

Using software, specify the trigger source as an external, positive digital (TTL) trigger for a rising-edge external trigger or an external, negative digital (TTL) trigger for a falling-edge external trigger.

Note: The external digital trigger is also used to trigger analog input operations.

- **External User Gate –** This trigger type is supported using the DataAcq SDK only for analog output operations. An external trigger event can occur when the DT3000 Series board detects either a rising or falling edge on the external gate input signal connected to TB5 on the DT730 or DT730-T screw terminal panel (pin 5 of connector J1 on the DT3000 Series board). The gate signal is TTL-compatible.

  When it is recognized, the D/A output clock is enabled. Subsequent triggers are ignored (trigger lockout) until the operation is complete. Once the operation is complete, the board can detect another trigger event.

  Using software, specify the trigger source as a falling-edge external gate (extra+1 for DataAcq SDK users) or rising-edge external gate (extra+2 for DataAcq SDK users).

Note: The external user gate is also used to trigger counter/timer operations.

Analog Output Conversion Modes

DT3000 Series boards support single-value and continuously paced conversion modes. These modes are described in the following subsections.

Single-Value Operations

Single-value operations are the simplest to use but offer the least flexibility and efficiency. Use software to specify the range, gain, and analog output channel (among other parameters), and output the data from that channel. For a single-value operation, you cannot specify a clock source, trigger source, or buffer.

Single-value operations stop automatically when finished; you cannot stop a single-value operation.

Continuously Paced Operations

Continuous analog output operations take full advantage of the capabilities of the DT3000 Series boards. In this mode, you can specify a channel list, clock source, trigger source, buffer, and buffer wrap mode.

Use continuously paced analog output mode if you want to accurately control the period between conversions of individual analog output channels in the analog output channel list.

The host computer transfers digital values to write to the DACs from allocated circular buffers in computer memory to the DAC buffer on the board. Use software to allocate the number of host buffers and to specify the values to write to the DACs.

When it detects a trigger, the board outputs the values in the onboard buffer to the DACs at the same time. The operation repeats continuously until you stop the operation. Refer to page 81 for more information on buffers.

Ensure that the host computer transfers data to the onboard buffer fast enough so that it does not empty completely; otherwise, an error may result.

The conversion rate is determined by the frequency of the D/A output clock. For DT3000 Series boards, the maximum throughput rate in this mode is 200 kSamples/s for a single channel or 100 kSamples/s for both channels. Note that rate is system dependent. Refer to page 79 for more information on the D/A output clock.

To select continuously paced analog output mode, use software to specify the following parameters:

- The dataflow as Continuous.
- Set WrapSingleBuffer to False, if you want to output data from multiple buffers. Set WrapSingleBuffer to True, if you want to output data from a single buffer continuously; this mode is sometimes called waveform generation mode.
- The trigger source as any of the supported trigger sources. Refer to page 77 for more information on the supported trigger sources.

To stop a continuously paced analog output operation, you can stop sending data to the board, letting the board stop when it runs out of data, or you can perform either an orderly stop or an abrupt stop using software. In an orderly stop, the board finishes outputting the specified number of samples, then stops; all subsequent triggers are ignored. In an abrupt stop, the board stops outputting samples immediately; all subsequent triggers are ignored.

Data Format and Transfer

Data from the host computer must use binary data encoding for analog output signals. Use software to specify the data encoding.

The host computer writes analog output data to the DAC circular buffer on the board. The destination analog output channel is determined by the order of the data written into the circular buffer. During analog output operations, the board reads the data from the DAC circular buffer and writes it to the respective DACs.

Note that for continuously paced analog output operations, the data from the circular buffers in host computer memory can wrap multiple times. That is, if you are using a single buffer, all the data in buffer is written to the output FIFO on the board. The board outputs all the data, and the process repeats continuously starting with the first location in buffer, until you stop it. If you are using multiple buffers, data is output from each of the buffers on the queue; when no more buffers are on the queue, the operation stops.

Digital I/O Features

This section describes the following features of the digital I/O subsystem:

- Digital I/O lines
- Digital I/O resolution
- Digital I/O operation modes

Digital I/O Lines

DT3000 Series boards support eight digital I/O lines through the digital input (DIN) and output (DOUT) subsystems; both subsystems use the same digital I/O lines. These lines are divided into two banks of four: Bank A, lines 0 to 3; and Bank B, lines 0 to 3. You can use each bank as either an input port or an output port; all four lines within a bank have the same configuration. For example, if you use Bank A as an input port (port 0), lines 0 to 3 of Bank A are configured as inputs. Likewise, if you use Bank B as an output port (port 1), lines 0 to 3 of Bank B are configured as outputs.

Digital input signals are TTL-compatible. Digital outputs are TTL-compatible signals capable of sinking at least 10 mA each. All digital I/O signals are configured as inputs on power up.

Use software to specify the configuration of the digital I/O lines as differential.

Digital I/O Resolution

Using software, specify the number of banks to read by specifying the resolution as 4 (for four lines) or 8 (for eight lines). If you specify a resolution of 4, two digital I/O subsystems are available. Element 0 (the first subsystem) corresponds to the Bank A, lines 0 to 3. Element 1 (the second subsystem) corresponds to Bank B, lines 0 to 3. If you specify a resolution of 8, one subsystem (element 0) is available.

Note: When the resolution is 8, digital I/O lines 0 to 3 of Bank B are represented as bits 4 to 7 of the digital value.

Digital I/O Operation Modes

DT3000 Series boards support single-value digital I/O operations only. When you start a single-value digital I/O operation, data is read from or written to the digital I/O lines. For a single-value operation, you cannot specify a clock or trigger source.

Single-value operations stop automatically when finished; you cannot stop a single-value operation.

Counter/Timer Features

The counter/timer circuitry on the board provides the clocking circuitry used by the A/D and D/A subsystems as well as several user counter/timer features. This section describes the following user counter/timer features:

- Counter/timer channels
- C/T clock sources
- Gate types
- Pulse types and duty cycles
- Counter/timer operation modes

Counter/Timer Channels

DT3000 Series boards support one 16-bit user counter/timer channel (called counter 0). Counter 0 corresponds to C/T subsystem element 0.

The counter accepts a clock input signal and gate input signal and outputs a clock output signal (also called a pulse output signal), as shown in Figure 22.

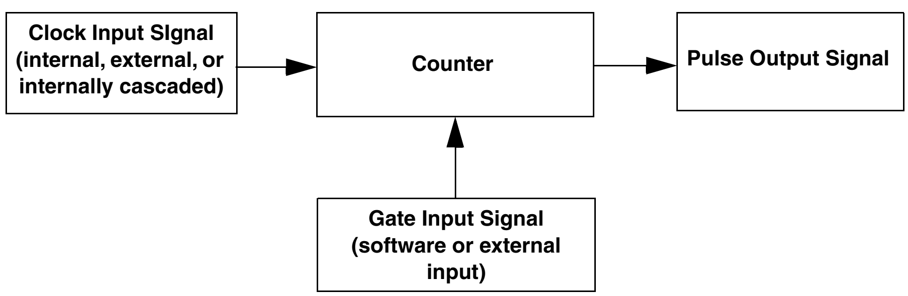

Figure 22: Counter/Timer Channel

C/T Clock Sources

The following clock sources are available for the user counters:

- Internal C/T clock
- External C/T clock

Refer to the following subsections for more information on these clock sources.

Internal C/T Clock

The internal C/T clock is a 16-bit clock with a 4-bit prescaler; it uses a 10 MHz time base. The prescaler effectively extends the counter to 20 bits. Counter/timer operations start on the rising edge of the clock input signal.

Through software, specify the clock source as internal and the frequency at which to pace the counter/timer operation (this is the frequency of the clock output signal). The maximum frequency that you can specify for the clock output signal is 5 MHz. The minimum frequency that you can specify for the clock output signal is 9.54 Hz.

External C/T Clock

The external C/T clock is useful when you want to pace counter/timer operations at rates not available with the internal C/T clock or if you want to pace at uneven intervals. Counter/timer operations start on the rising edge of the clock input signal.

Using software, specify the clock source as external and the clock divider used to determine the frequency at which to pace the operation (this is the frequency of the clock output signal). The minimum clock divider that you can specify is 2.0; the maximum clock divider that you can specify is 65,535. For example, if you supply an external C/T clock with a frequency of 2 MHz and specify a clock divider of 2, the resulting frequency of the external C/T clock output signal is 1 MHz.

Connect the external clock input signal to TB7 of the DT730 or DT730-T screw terminal panel (pin 7 of connector J1 on the DT3000 Series board).

Gate Types

The active edge or level of the gate input to the counter enables counter/timer operations. The operation starts when the clock input signal is received. DT3000 Series boards provide the following gate input types:

- **None** – A software command enables any specified counter/timer operation immediately after execution. This gate type is useful for all counter/timer modes.
- **Logic-low level external gate input** – Enables a counter/timer operation when the external gate signal is low and disables the counter/timer operation when the external gate signal is high. Note that this gate type is used only for event counting, frequency measurement, and rate generation; refer to page 86 for more information on these modes.
- **Logic-high level external gate input** – Enables a counter/timer operation when the external gate signal is high and disables a counter/timer operation when the external gate signal is low. Note that this gate type is used only for event counting, frequency measurement, and rate generation; refer to page 86 for more information on these modes.
- **Falling-edge external gate input** – Triggers a counter/timer operation on the transition from the high level to the low level (falling edge). In software, this is called a low-edge gate type. Note that this gate type is used only for one-shot and repetitive one-shot mode; refer to page 86 for more information on these modes.

- **Rising-edge external gate input –** Triggers a counter/timer operation on the transition from the low level to the high level (rising edge). In software, this is called a high-edge gate type. Note that this gate type is used only for one-shot and repetitive one-shot mode; refer to page 86 for more information on these modes.

Specify the gate type in software. Connect the external gate signal to TB5 of the DT730 or DT730-T screw terminal panel (pin 5 of connector J1 on the DT3000 Series board).

Pulse Output Signals and Duty Cycles

DT3000 Series boards provide one pulse output signal. The pulse signal is output on TB3 of the DT730 and DT730-T screw terminal panel (pin 3 of connector J1 on the DT3000 Series board).

DT3000 Series boards support high-to-low pulse output signals only. With a high-to-low transition, the low portion of the total pulse output period is the active portion of the counter/timer clock output signal.

The duty cycle (or pulse width) indicates the percentage of the total pulse output period that is active. For example, a duty cycle of 50 indicates that half of the total pulse is low and half of the total pulse output is high. Figure 23 illustrates a high-to-low pulse with a duty cycle of approximately 50%.

Note: For rate generation mode, the duty cycle must be 50 or 100 only. For one-shot and repetitive one-shot mode, the duty cycle must be 100.

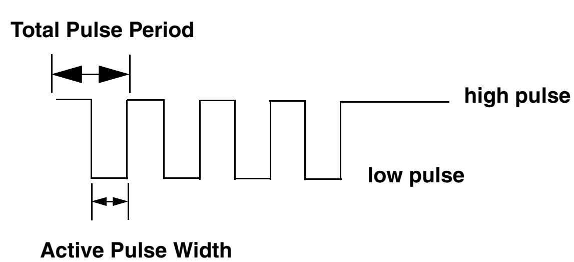

Figure 23: Example of a High-to-Low Pulse Output Signal

Counter/Timer Operation Modes

DT3000 Series boards support the following counter/timer operation modes:

- Event counting
- Frequency measurement
- Rate generation
- One-shot
- Repetitive one-shot

Event Counting

Use event counting mode to count events from the counter's associated clock input source. You can count a maximum of 65,536 events before the counter rolls over to 0 and starts counting again.

In event counting mode, use an external clock source; refer to page 84 for more information on the external clock source.

Using software, specify the counter/timer mode as event counting (count), the clock source as external, and the gate type that enables the operation. Refer to page 84 for information on gates.

Ensure that the signals are wired appropriately.

Figure 24 shows an example of an event counting operation. In this example, the gate type is low level.

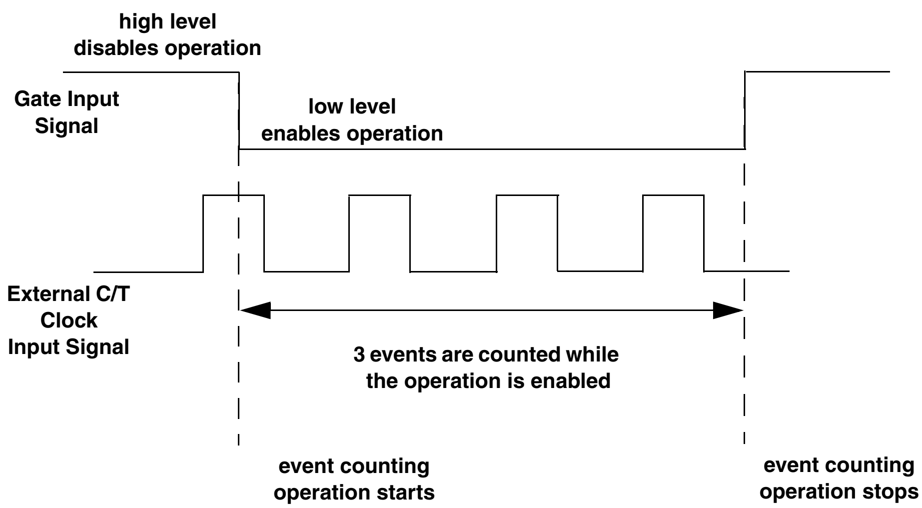

Figure 24: Example of Event Counting

Frequency Measurement

Use frequency measurement mode to measure the frequency of the signal from counter's associated clock input source over a specified duration. In this mode, use an external C/T clock source; refer to page 83 for more information on the external C/T clock source.

To perform a frequency measurement on the DT3000 Series, use the same wiring as an event counting application that does not use an external gate signal.

Use software to specify the counter/timer mode as frequency measurement or event counting, and specify the duration of the Windows timer over which to measure the frequency. (The Windows timer uses a resolution of 1 ms.) Frequency is determined using the following equation:

$$\text{Frequency Measurement} = \frac{\text{Number of Events}}{\text{Duration of the Windows Timer}}$$

Figure 25 shows an example of a frequency measurement operation. In this example, three events are counted during a duration of 300 ms. The frequency is 10 Hz, since 10 Hz = 3/(.3 s).

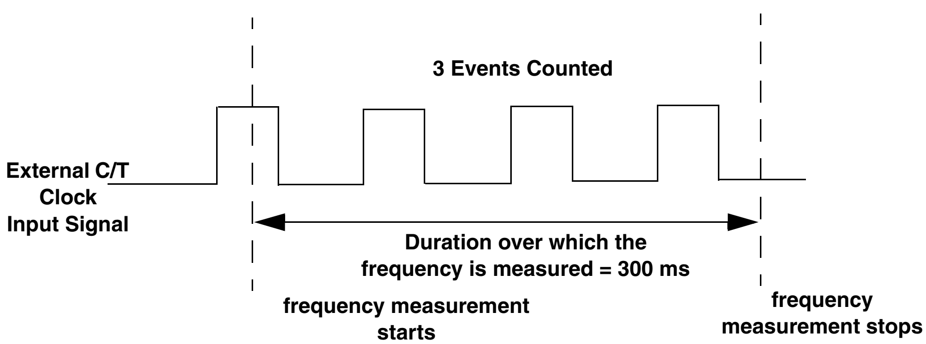

Figure 25: Example of Frequency Measurement

Rate Generation

Use rate generation mode to generate a continuous pulse output signal from the counter; this mode is sometimes referred to as continuous pulse output or pulse train output. You can use this pulse output signal as an external clock to pace other operations, such as analog input.

While the pulse output operation is enabled, the counter outputs a pulse of the specified type and frequency continuously. As soon as the operation is disabled, rate generation stops.

The period of the output pulse is determined by the clock input signal and the external clock divider. You can output pulses using a maximum frequency of 5 MHz (this is the frequency of the clock output signal). In rate generation mode, either the internal or external clock input source is appropriate, depending on your application; refer to page 83 for more information on the C/T clock source.

Using software, specify the counter/timer mode as rate generation (rate), the C/T clock source as either internal or external, the polarity of the output pulses (high-to-low transitions), the duty cycle of the output pulses (50 or 100 only), and the gate type that enables the operation. Refer to page 85 for more information on pulse output signals and to page 84 for more information on gate types.

Ensure that the signals are wired appropriately.

Figure 26 shows an example of an enabled rate generation operation using an external C/T clock source with an input frequency of 4 kHz, a clock divider of 4, a high-to-low pulse type, and a duty cycle of 50%. (The gate type does not matter for this example.) A 1 kHz square wave is the generated output.

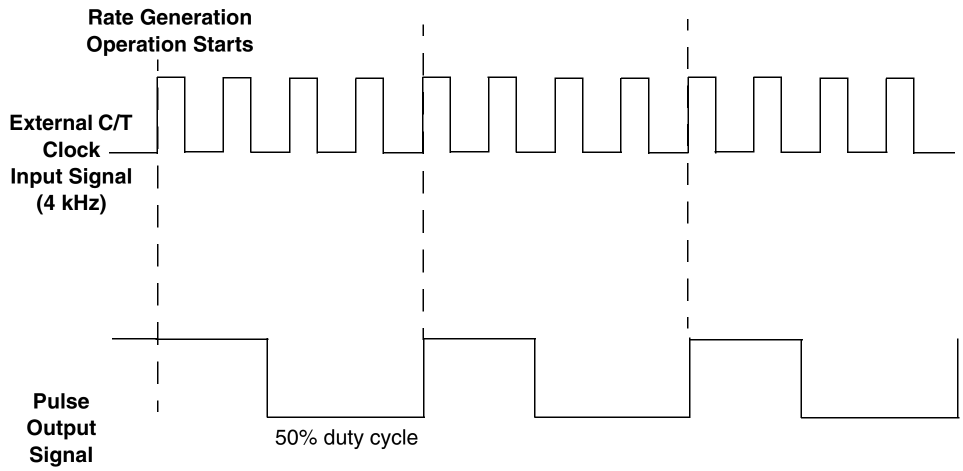

Figure 26: Example of Rate Generation Mode with a 50% Duty Cycle

One-Shot

Use one-shot mode to generate a single pulse output signal from the counter when the operation is triggered (determined by the gate input signal). You can use this pulse output signal as an external digital (TTL) trigger to start other operations, such as analog input.

When the one-shot operation is triggered, a single pulse is output; then, the one-shot operation stops. All subsequent clock input signals and gate input signals are ignored.

The period of the output pulse is determined by the clock input signal. In one-shot mode, the internal C/T clock source is more useful than an external C/T clock source; refer to page 83 for more information on the internal C/T clock source.

Using software, specify the counter/timer mode as one-shot, the clock source as internal, the polarity of the output pulse (high-to-low transitions), and the gate type to trigger the operation. Refer to page 85 for more information on pulse output types and to page 84 for more information on gate types.

Note: In the case of a one-shot operation, the pulse width is automatically set to 100%.

Ensure that the signals are wired appropriately.

Figure 27 shows an example of a one-shot operation using an external gate input (rising edge), a clock output frequency of 1 kHz (pulse period of 1 ms), and a high-to-low pulse type.

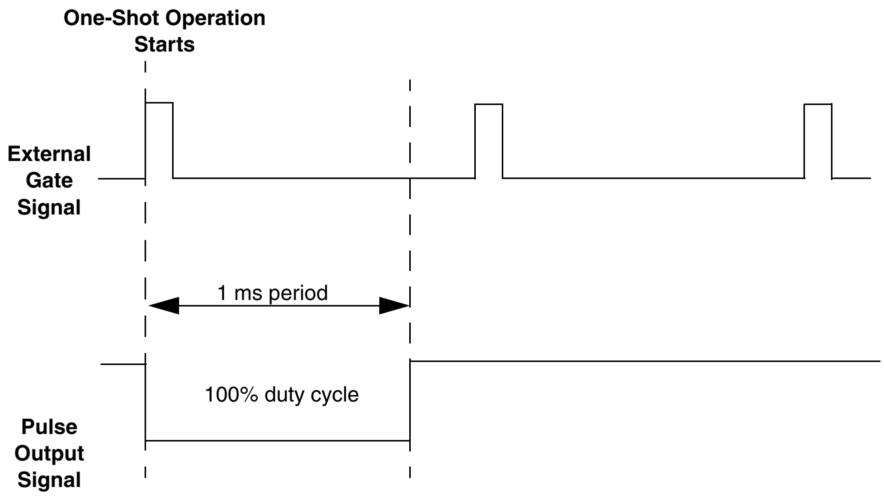

Figure 27: Example of One-Shot Mode

Repetitive One-Shot

Use repetitive one-shot mode to generate a pulse output signal each time the board detects a trigger (determined by the gate input signal). You can use this mode to clean up a poor clock input signal by changing its pulse width, then outputting it.

In repetitive one-shot mode, the internal C/T clock source is more useful than an external C/T clock source; refer to page 83 for more information on the internal C/T clock source.

Use software to specify the counter/timer mode as repetitive one-shot, the polarity of the output pulses (high-to-low transitions), the duty cycle of the output pulses (100 only), the C/T clock source, and the gate type to trigger the operation. Refer to page 85 for more information on pulse output types and to page 84 for more information on gates.

When the one-shot operation is triggered (determined by the gate input signal), a pulse is output. When the board detects the next trigger, another pulse is output. This operation continues until you stop the operation.

Note: In the case of a repetitive one-shot operation, the pulse width is automatically set to 100%.

Triggers that occur while the pulse is being output are not detected by the board.

Ensure that the signals are wired appropriately.

Figure 28 shows an example of a repetitive one-shot operation using an external gate (rising edge); a clock output frequency of 1 kHz (one pulse every 1 ms), and a high-to-low pulse type.

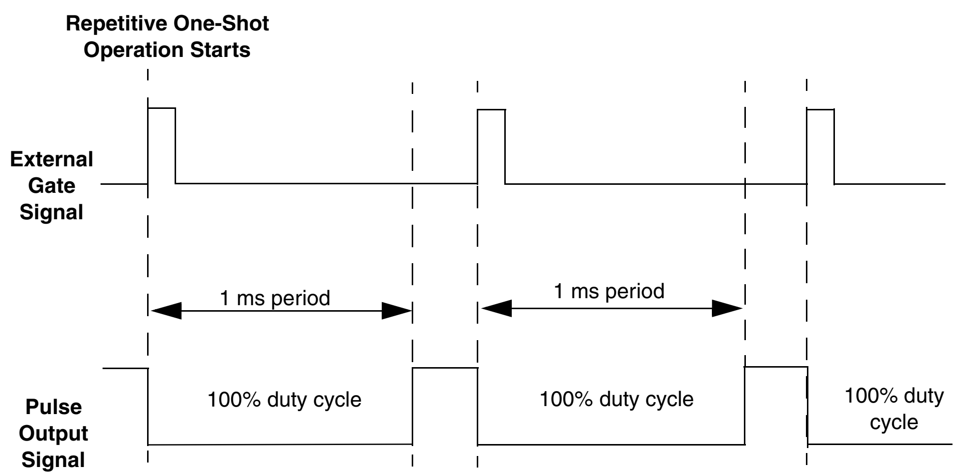

Figure 28: Example of Repetitive One-Shot Mode

Interrupts

A DT3000 Series board functions as a +5 V, 32-bit PCI target device to any master on the PCI bus. It supports PCI burst transfers to and from memory space and accesses to configuration memory space.

A single, level-sensitive interrupt to the PCI bus master is asserted under any combination of the following conditions:

- The number of A/D samples specified by the software has been collected and is waiting to be transferred to the host.
- An A/D scan has been completed.
- A counter has reached its terminal count.
- A D/A event has been completed.
- The board has detected an error.

Interrupts are not generated for digital I/O operations.

7

Supported Device Driver Capabilities

The DT3000 Series Device Driver provides support for the analog input (A/D), analog output (D/A), digital input (DIN), digital output (DOUT), and counter/timer (C/T) subsystems.

Table 7: DT3000 Series Subsystems

DT3000 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Total Subsystems on Board	1	1[a]	2[b]	2[b]	1	0

a. The DT3002 board does not support D/A subsystems.
b. DIN and DOUT subsystems use the same DIO lines.

The tables in this chapter summarize the features available for use with the DT-Open Layers for .NET Class Library and the DT3000 Series boards. The DT-Open Layers for .NET Class Library provides properties that return support information for specified subsystem capabilities.

The first row in each table lists the subsystem types. The first column in each table lists all possible subsystem capabilities. A description of each capability is followed by the property used to describe that capability in the DT-Open Layers for .NET Class Library.

Note: Blank fields represent unsupported options.

For more information, refer to the description of these properties in the DT-Open Layers for .NET Class Library online help or *DT-Open Layers for .NET Class Library User's Manual*.

Data Flow and Operation Options

Table 8: DT3000 Series Data Flow and Operation Options

DT3000 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Single-Value Operation Support **SupportsSingleValue**	Yes	Yes	Yes	Yes		
Simultaneous Single-Value Output Operations SupportsSetSingleValues						
Continuous Operation Support **SupportsContinuous**	Yes	Yes			Yes	
Continuous Operation until Trigger **SupportsContinuousPreTrigger**						
Continuous Operation before & after Trigger **SupportsContinuousPrePostTrigger**						
Waveform Operations Using FIFO Only **SupportsWaveformModeOnly**						
Simultaneous Start List Support **SupportsSimultaneousStart**						
Supports Programmable Synchronization Modes **SupportsSynchronization**						
Synchronization Modes **SynchronizationMode**						
Interrupt Support **SupportsInterruptOnChange**						
Output FIFO Size **FifoSize**						
Auto-Calibrate Support **SupportsAutoCalibrate**						

Buffering

Table 9: DT3000 Series Buffering Options

DT3000 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Buffer Support **SupportsBuffering**	Yes	Yes				
Single Buffer Wrap Mode Support **SupportsWrapSingle**		Yes				
Inprocess Buffer Flush Support **SupportsInProcessFlush**	Yes					

Triggered Scan Mode

Table 10: DT3000 Series Triggered Scan Mode Options

DT3000 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Triggered Scan Support **SupportsTriggeredScan**	Yes[a]					
Maximum Number of CGL Scans per Trigger **MaxMultiScanCount**	1	0	0	0	0	0
Maximum Retrigger Frequency **MaxRetriggerFreq**	333 kHz, 100 kHz, 200 kHz[b],[c]	0	0	0	0	0
Minimum Retrigger Frequency **MinRetriggerFreq**	9.54 Hz	0	0	0	0	0

a. When run simultaneously with the A/D subsystem in triggered scan mode, the maximum throughput of the D/A subsystem is 100 kHz. Some older revision boards allow a maximum D/A throughput of 155 Hz

b. Using a gain of 1, the maximum single-channel throughput is 333.4 kHz for DT3001, DT3001-PGL, DT3002, DT3003, and DT3003-PGL boards; 100 kHz for DT3004 boards; and 200 kHz for DT3005 boards.
Using a gain of 1, the maximum multiple-channel throughput is 250 kHz for DT3001 and DT3001-PGL boards; 100 kHz for DT3002, DT3003, DT3003-PGL, and DT3005 boards; and 50 kHz for DT3004 boards.
Using a gain of 500, the maximum throughput is 4 kHz for DT3001-PGL boards and 2.5 kHz for DT3003-PGL boards.
Using a gain of 100, the maximum throughput is 20 kHz for DT3001-PGL boards and 10 kHz for a DT3003-PGL boards.

c. Ensure that the retrigger period is longer than the number of entries in the channel list multiplied by the sample period.

Data Encoding

Table 11: DT3000 Series Data Encoding Options

DT3000 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Binary Encoding Support **SupportsBinaryEncoding**	Yes[a]	Yes	Yes	Yes	Yes	
Twos Complement Support **SupportsTwosCompEncoding**	Yes[b]					
Returns Floating-Point Values **ReturnsFloats**						

a. Binary data encoding is supported on DT3001, DT3001-PGL, DT3003, and DT3003-PGL boards only.
b. Twos complement data encoding is supported on DT3004 and DT3005 boards only.

Channels

Table 12: DT3000 Series Channel Options

DT3000 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Number of Channels **NumberOfChannels**	16, 32, 64[a]	2	1	1	0	0
SE Support **SupportsSingleEnded**	Yes					
SE Channels **MaxSingleEndedChannels**	16, 32, 64[a]	0	0	0	0	0
DI Support **SupportsDifferential**	Yes	Yes	Yes	Yes		
DI Channels **MaxDifferentialChannels**	8, 16, 32[b]	2	1	1	0	0
Maximum Channel-Gain List Depth **CGLDepth**	512	2	1	1	0	0
Simultaneous Sample-and-Hold Support **SupportsSimultaneousSampleHold**						
Channel-List Inhibit **SupportsChannelListInhibit**						

a. The maximum number of single-ended or pseudo-differential channels is 16 for DT3001, DT3001-PGL, DT3004, and DT3005 boards; 32 for DT3002 boards; and 64 for DT3003 and DT3003-PGL boards.
b. The maximum number of differential channels is 8 for DT3001, DT3001-PGL, DT3004, and DT3005 boards; 16 for DT3002 boards; and 32 for DT3003 and DT3003 -PGL boards.

Gain

Table 13: DT3000 Series Gain Options

DT3000 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Programmable Gain Support **SupportsProgrammableGain**	Yes					
Number of Gains **NumberOfSupportedGains**	4[a]	1	1	1	0	0
Gains Available **SupportedGains**	1, 2, 4, 8, or 1, 10, 100, 500[a]	1	1	1		

a. The DT3001-PGL and DT3003-PGL boards have gains of 1, 10, 100, and 500. All other DT3000 Series boards have gains of 1, 2, 4, and 8.

Ranges

Table 14: DT3000 Series Range Options

DT3000 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Number of Voltage Ranges **NumberOfRanges**	1	1	0	0	0	0
Available Ranges **SupportedVoltageRanges**	±10 V	±10 V				
Current Output Support **SupportsCurrentOutput**						

Resolution

Table 15: DT3000 Series Resolution Options

DT3000 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Software Programmable Resolution **SupportsSoftwareResolution**			Yes	Yes		
Number of Resolutions **NumberOfResolutions**	1	1	2[a]	2[a]	1	0
Available Resolutions **SupportedResolutions**	12 or 16[b]	12	4, 8	4, 8	16	

a. When configured for 4 bits of resolution, element 0 uses bits 3 to 0 and element 1 uses bits 7 to 4. When configured for 8 bits of resolution, element 0 uses bits 7 to 0 and element 1 is not used.

b. The DT3001, DT3001-PGL, DT3002, DT3003, and DT3003-PGL boards have a fixed analog input resolution of 12 bits. The DT3004 and DT3005 boards have a fixed analog input resolution of 16 bits.

Thermocouple Support

Table 16: DT3000 Series Thermocouple Support Options

DT3000 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Thermocouple Support **SupportsThermocouple**	Yes[a]					
RTD Support **SupportsRTD**						
Resistance Support **ReturnsOhms**						
Voltage Converted to Temperature in Hardware **SupportsTemperatureDataInStream**						
Supported Thermocouple Types **ThermocoupleType**	J, K, B, E, N, R, S, T					
Supported RTD Types **RTDType**						
Supports CJC Source Internally in Hardware **SupportsCjcSourceInternal**						
Supports CJC Channel **SupportsCjcSourceChannel**	Yes					
Available CJC Channels **CjcChannel**	0					
Supports Interleaved CJC Values in Data Stream **SupportsInterleavedCjcTemperaturesInStream**						
Supports Programmable Filters **SupportsTemperatureFilters**						
Programmable Filter Types **TemperatureFilterType**						

a. Thermocouple inputs are supported on the DT3001-PGL and DT3003-PGL boards.

IEPE Support

Table 17: DT3000 Series IEPE Support Options

DT3000 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Software Programmable AC Coupling **SupportsACCoupling**						
Software Programmable DC Coupling **SupportsDCCoupling**						
Software Programmable External Excitation Current Source **SupportsExternalExcitationCurrentSrc**						
Software Programmable Internal Excitation Current Source **SupportsInternalExcitationCurrentSrc**						
Available Excitation Current Source Values **SupportedExcitationCurrentValues**						

Triggers

Table 18: DT3000 Series Trigger Options

DT3000 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Software Trigger Support **SupportsSoftwareTrigger**	Yes	Yes	Yes	Yes		
External Positive TTL Trigger Support **SupportsPosExternalTTLTrigger**	Yes	Yes				
External Negative TTL Trigger Support **SupportsNegExternalTTLTrigger**	Yes	Yes				
External Positive TTL Trigger Support for Single-Value Operations **SupportsSvPosExternalTTLTrigger**						
External Negative TTL Trigger Support for Single-Value Operations **SupportsSvNegExternalTTLTrigger**						
Positive Threshold Trigger Support **SupportsPosThresholdTrigger**						
Negative Threshold Trigger Support **SupportsNegThresholdTrigger**						
Digital Event Trigger Support **SupportsDigitalEventTrigger**						

Clocks

Table 19: DT3000 Series Clock Options

DT3000 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Internal Clock Support **SupportsInternalClock**	Yes	Yes			Yes	
External Clock Support **SupportsExternalClock**	Yes				Yes	
Simultaneous Input/Output on a Single Clock Signal **SupportsSimultaneousClocking**						
Base Clock Frequency **BaseClockFrequency**	20 MHz	10 MHz	0	0	10 MHz	0
Maximum Clock Divider **MaxExtClockDivider**	1	1	1	1	65535	0
Minimum Clock Divider **MinExtClockDivider**	1	1	1	1	2	0
Maximum Frequency **MaxFrequency**	333.4 kHz, 100 kHz, 200 kHz[a]	200 kHz[b]	0	0	5 MHz	0
Minimum Frequency **MinFrequency**	19.1 Hz	9.54 Hz	0	0	9.54 Hz	0

a. Using a gain of 1, the maximum single-channel throughput is 333.4 kHz for DT3001, DT3001-PGL, DT3002, DT3003, and DT3003-PGL boards; 100 kHz for DT3004 boards; and 200 kHz for DT3005 boards.
Using a gain of 1, the maximum multiple-channel throughput is 250 kHz for DT3001 and DT3001-PGL boards; 100 kHz for DT3002, DT3003, DT3003-PGL, and DT3005 boards; and 50 kHz for DT3004 boards.
Using a gain of 500, the maximum throughput is 4 kHz for DT3001-PGL boards and 2.5 kHz for DT3003-PGL boards.
Using a gain of 100, the maximum throughput is 20 kHz for DT3001-PGL boards and 10 kHz for a DT3003-PGL boards.

b. When run simultaneously with the A/D subsystem in triggered scan mode, the maximum throughput of the D/A subsystem is 100 kHz. Some older revision boards allow a maximum D/A throughput of 155 Hz.

Counter/Timers

Table 20: DT3000 Series Counter/Timer Options

DT3000 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Cascading Support **SupportsCascading**						
Event Count Mode Support **SupportsCount**					Yes	
Generate Rate Mode Support **SupportsRateGenerate**					Yes	
One-Shot Mode Support **SupportsOneShot**					Yes[a]	
Repetitive One-Shot Mode Support **SupportsOneShotRepeat**					Yes[b]	
Up/Down Counting Mode Support **SupportsUpDown**						
Edge-to-Edge Measurement Mode Support **SupportsMeasure**						
Continuous Edge-to-Edge Measurement Mode Support **SupportsContinuousMeasure**						
High to Low Output Pulse Support **SupportsHighToLowPulse**					Yes	
Low to High Output Pulse Support **SupportsLowToHighPulse**						
Variable Pulse Width Support **SupportsVariablePulseWidth**					Yes[c,d]	
None (internal) Gate Type Support SupportsGateNone					Yes[a]	
High Level Gate Type Support **SupportsGateHighLevel**					Yes[e]	
Low Level Gate Type Support **SupportsGateLowLevel**					Yes[e]	
High Edge Gate Type Support **SupportsGateHighEdge**					Yes[f]	
Low Edge Gate Type Support **SupportsGateLowEdge**					Yes[f]	
Level Change Gate Type Support **SupportsGateLevel**						
Clock-Falling Edge Type **SupportsClockFalling**						
Clock-Rising Edge Type **SupportsClockRising**						
Gate-Falling Edge Type **SupportsGateFalling**						

Table 20: DT3000 Series Counter/Timer Options (cont.)

DT3000 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Gate-Rising Edge Type **SupportsGateRising**						
Interrupt-Driven Operations **SupportsInterrupt**					Yes	

a. You can use one-shot mode only with a software gate type (none).
b. You cannot use a software gate type (none) with repetitive one-shot mode
c. In rate generation mode, you can use a duty cycle of 50% or 100% only. If you use a duty cycle of 50%, the output of the specified C/T subsystem is a square wave with a 50% duty cycle. The frequency of this square wave is determined differently depending on the clock source.
If you use a duty cycle of 100%, the output of the specified C/T subsystem is a square wave that is low (active) for a specified period, determined by the clock source. If you use an internal clock, the active period is typically 100 ns; however, for slower frequencies the period may increase to as much as 1.6 µs. If you use an external clock, the active period is 1/external clock frequency. The remainder of the period is 1/(external clock frequency/external clock divider).
d. In one-shot and repetitive one-shot mode, you can use a duty cycle of 100% only. The output of the specified C/T subsystem goes low (active) for a period of 1/clock frequency, then goes high (inactive) for the remainder of the period, which is determined by the gate signal (for repetitive one-shot operations). The clock frequency depends on the clock source.
e. You cannot use a level gate type with one-shot or repetitive one-shot mode.
f. You can use an edge gate type only with one-shot and repetitive one-shot mode.

8

Calibration

To calibrate your DT3000 Series board, you need a precision voltage source and a precision voltmeter (±10.0 V range for both). The accuracy of your calibration depends on the precision of this equipment and the care you take making the adjustments.

You can connect signals to the DT730 or DT730-T screw terminal panel, or directly to the J1 connector on the board. The adjustment potentiometers are clearly labeled on the board.

This chapter describes how to calibrate the A/D and D/A subsystems of the DT3000 Series boards, and how to calibrate the DT730-T screw terminal panel.

Calibrating the A/D Subsystem

To calibrate the A/D subsystem on the board, do the following:

1. Connect the precision voltage source to the channel 0 A/D input (screw terminal/J1 pin 100 for AIN00 high and 99 for AIN00 low).
   The A/D is configured for differential inputs during calibration.
2. Set the voltage source to 0.000 V.
3. Adjust potentiometer R4, shown in Figure 29, until the A/D output voltage is 0.000 V.

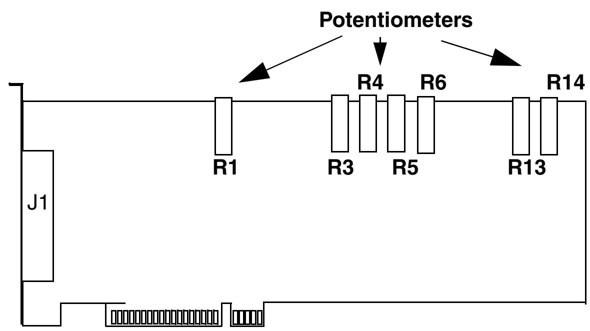

Figure 29: Potentiometers for Calibrating the DT3000 Series Boards

4. Set the voltage source to 9.950 V.
5. Adjust potentiometer R3, shown in Figure 29, until the A/D output voltage is 9.950 V.
6. For DT3001, DT3002, DT3003, DT3004, and DT3005 boards, set the gain to 8; for the DT3001-PGL and DT3003-PGL boards, set the gain to 500.
7. Set the voltage source to 0.000 V.
8. Adjust potentiometer R1, shown in Figure 29, until the A/D output voltage is 0.000 V.

Calibrating the D/A Subsystem

Do the following to calibrate the D/A subsystem on the board:

1. Connect a precision voltmeter to DAC 0 (screw terminal/pin 34 for ANO0+ and 33 for ANO0–).
2. Set the value to the minus full-scale range (all zeros).
3. Adjust potentiometer R5, shown in Figure 29, until the analog output voltage is –10 V.
4. Set the value to the plus full-scale range (all ones).
5. Adjust potentiometer R6, shown in Figure 29, until the analog output voltage is 9.995 ς.
6. Connect a precision voltmeter to DAC 1 (screw terminal/pin 32 for ANO1+ and 31 for ANO1–).
7. Set the value to the minus full-scale range (all zeros).
8. Adjust potentiometer R13, shown in Figure 29, until the analog output voltage is –10 V.
9. Set the value to the plus full-scale range (all ones).
10. Adjust potentiometer R14, shown in Figure 29, until the analog output voltage is 9.995 ς.

Calibrating the DT730-T

The DT730-T screw terminal panel is factory calibrated for optimum compensation. Therefore, you do not need to calibrate the panel initially. If you wish to calibrate the DT730-T at a later time, do the following:

1. Allow the DT730-T screw terminal panel to warm up for 10 minutes, then measure the temperature at the DT730-T.
2. Adjust potentiometer R99 on the screw terminal panel (shown in Figure 30) 0.50 mV for each degree measured above 0° C (12.5 mV at 25° C).
   At a gain of 500, the output should be D00h; at a gain of 100, the output should be 900h.

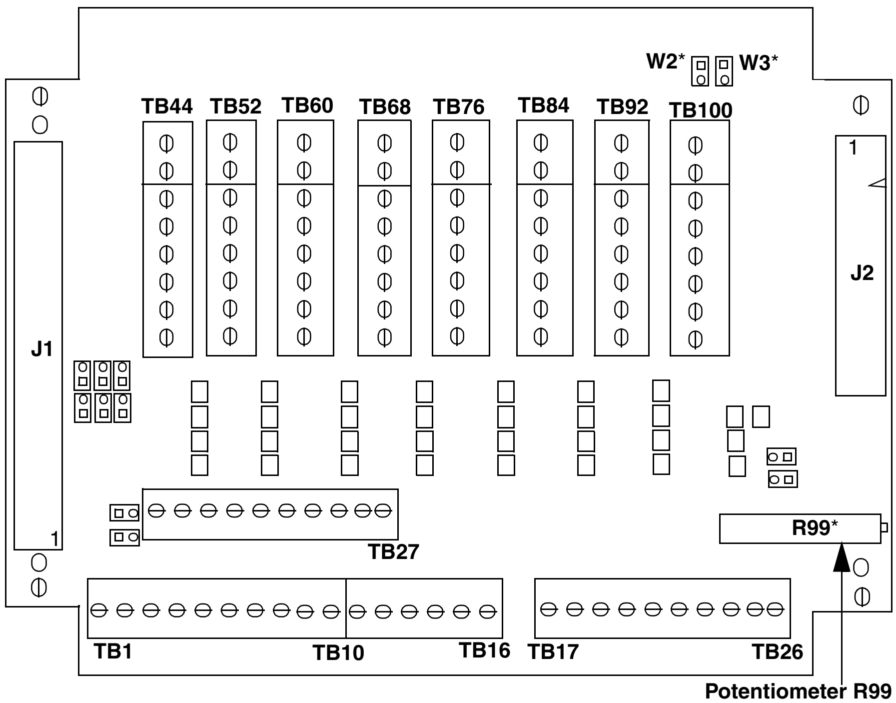

Figure 30: Potentiometer R99 on the DT730-T Screw Terminal Panel

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Note: The available enclosure is highly recommended for the DT730-T screw terminal panel. See page 18 for ordering information.

9

Troubleshooting

General Checklist

Should you experience problems using a DT3000 Series board, follow these steps:

1. Read all the documentation provided for your product. Make sure that you have added any "Read This First" information to your manual and that you have used this information.
2. Check the Data Acquisition OMNI 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 the README file on the OMNI CD.
4. Check that you have installed your hardware properly using the instructions in Chapter 2.
5. Check that you have loaded the device driver properly using the instructions in Chapter 2.
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 21 to isolate and solve the problem. If you cannot identify the problem, refer to page 115.

Table 21: Troubleshooting Problems

Symptom	Possible Cause	Possible Solution
Board does not respond.	The board configuration is incorrect.	Check the configuration of your device driver to ensure that the board name and type are correct.
	The board is incorrectly aligned in a PCI expansion slot.	Check that the slot in which your DT3000 Series board is located is a PCI slot and that the board is correctly seated in the slot.
	The board is damaged.	Contact Data Translation for technical support; refer to page 115.
	The interrupt level is unacceptable.	An interrupt conflict exists in your system. The most common interrupt conflict occurs with a PCI device and a device that is plugged into the ISA bus. To resolve this problem, change the interrupt setting (usually by changing a jumper) on the ISA device.
		An interrupt conflict can also occur if a PCI device was not designed to share interrupts. To resolve this problem, select a different interrupt for each PCI slot in the PCI BIOS. To do this, enter the system BIOS program; this is usually done by pressing the DEL key when rebooting your system. Once in the system BIOS, enter the PCI/PnP BIOS setup, and select a unique interrupt for each PCI slot. The PCI BIOS assigns the interrupt; the device on the PCI bus does not have control over the interrupt assignment.

Table 21: Troubleshooting Problems (cont.)

Symptom	Possible Cause	Possible Solution
Board does not respond (cont.)	The interrupt level is unacceptable (cont.).	Some network devices do not share interrupts. If you still have an interrupt conflict, try removing the network device, installing the DT3000 Series board and rebooting the system, then reinserting the network device.
Intermittent operation.	Loose connections or vibrations exist.	Check your wiring and tighten any loose connections or cushion vibration sources.
	The board is overheating.	Check environmental and ambient temperature; consult the board's specifications on page 127 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.
Data appears to be invalid.	An open connection exists.	Check your wiring and fix any open connections.
Computer does not boot.	Board is not seated properly.	Check that the slot in which your DT3000 Series board is located is a PCI slot, that the board is correctly seated in the slot, and that the board is secured in the slot with a screw.
	The power supply of the computer is too small to handle all the system resources.	Check the power requirements of your system resources and, if needed, get a larger power supply; consult the board's specifications on page 127 of this manual.
System lockup.	Board is not seated properly.	Check that the slot in which your DT3000 Series board is located is a PCI slot, that the board is correctly seated in the slot, and that the board is secured in the slot with a screw.
	Interrupt level is unacceptable.	An interrupt conflict exists in your system. The most common interrupt conflict occurs with a PCI device and a device that is plugged into the ISA bus. To correct this problem, change the interrupt setting (usually by changing a jumper) on the ISA device.
		An interrupt conflict can also occur if a PCI device was not designed to share interrupts. To resolve this problem, select a different interrupt for each PCI slot in the PCI BIOS. To do this, enter the system BIOS program; this is usually done by pressing the DEL key when rebooting your system. Once in the system BIOS, enter the PCI/PnP BIOS setup, and select a unique interrupt for each PCI slot. The PCI BIOS assigns the interrupt; the device on the PCI bus does not have control over the interrupt assignment.

Table 21: Troubleshooting Problems (cont.)

Symptom	Possible Cause	Possible Solution
System lockup (cont.).	Interrupt level is unacceptable.	Some network devices do not share interrupts. If you still have an interrupt conflict, try removing the network device, installing the DT3000 Series board and rebooting the system, then reinserting the network device.
Calibration routine will not run.	VxD is missing.	Ensure that you download the latest version of VDTDAD.386 from our web site (www.datatranslation.com\tech).

Technical Support

If you have difficulty using a DT3000 Series board, 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 OMNI 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 Board Needs Factory Service

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

1. Record the board'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 module as follows:
   - Wrap the board in an electrically conductive plastic material. Handle with ground protection. A static discharge can destroy components on the module.
   - Place in a secure shipping container.

3. Return the board 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

Analog Input Specifications

Table 22 lists the analog input specifications for the DT3000 Series boards.

Table 22: Analog Input Specifications

Feature	DT3001, DT3001-PGL, DT3002, DT3003 DT3003-PGL	DT3004, DT3005
Resolution (Coding)	12 bits (offset binary)	16 bits (twos complement)
System Accuracy (% FSR)	Guaranteed: 0.03% @Gain=1 0.04% @Gain=10 0.05% @Gain=100 0.10% @Gain=500 See Table 24 for typical values.	0.017% @Gain=1
Integral Nonlinearity	±0.03% of FSR maximum	±0.01% of FSR maximum
Differential Nonlinearity	±0.75 LSB (No missing codes to 12 bits)	±1.5 LSB (Monotonic to 15 bits)
Range (Bipolar Only)	± 10 V	
A/D Zero Drift	±20.0 μV_{rms} (±10 μV_{rms} * Gain)/° C	(±10 μV_{rms}* Gain)/° C
Gain Drift	± 30 ppm/° C	± 20 ppm/° C
Number of Analog Inputs	16 SE / 8 DI (DT3001 and DT3001-PGL) 32 SE / 16 DI (DT3002) 64 SE / 32 DI (DT3003 and DT3003-PGL)	16 SE / 8 DI
Gain Ranges	1, 2, 4, 8 (1, 10, 100, 500 for DT3001-PGL and DT3003-PGL)	1, 2, 4, 8
Input Impedance	100 MΩ, 10 pF, Off 100 MΩ, 400 pF, On (with 100 Ω series resistor)	100 MΩ, 10 pF, Off 100 MΩ, 100 pF, On (with 330 Ω series resistor)
Input Bias Current	± 20 nA	
Common Mode Voltage	± 10.5 V maximum (operational)	± 11 V maximum (operational)
ESD Protection (Mil 38510, class 2)	1500 V maximum	
Common Mode Rejection Ratio (@ 60 Hz, 1 kΩ balanced)	74 db	
Maximum Input Voltage	± 35 V maximum (protection)	
A/D Converter Noise	0.3 LSB RMS	
Amplifier Input Noise	15.0 μV_{rms} + (5 μV_{rms}*Gain) 20.0 pA_{rms} (current)	20.0 μV_{rms} (voltage) 20.0 pA_{rms} (current)

Table 22: Analog Input Specifications (cont.)

Feature	DT3001, DT3001-PGL, DT3002, DT3003 DT3003-PGL	DT3004, DT3005
Channel-to-Channel Offset	± 80.0 µV	±40.0 µV
Channel Acquisition Time	3 µs	10 µs for DT3004 5 µs for DT3005
A/D Conversion Time	3 µs	10 µs for DT3004 5 µs for DT3005
Total Harmonic Distortion @ 1kHz input, 100kHz rate	–74 dB typical	–84 dB typical
Channel Crosstalk	–80 dB @ 1 kHz	
Data Throughput (Single Channel)	330 kS/s	100 kS/s for DT3004; 200 kS/s for DT3005
Data Throughput (Scan)	300 kS/s (see Table 24 for typical accuracy.)	50 kS/s for DT3004; 100 kS/s for DT3005
Effective Number of Bits	11.5	13.5

Table 23: Typical Single-Channel Accuracy

Model	Gain	Channel-Gain List Single Channel		
		330 kHz	100 kHz	200 kHz
DT3001	1	0.03	N/A	N/A
	2	0.04	N/A	N/A
	4	0.04	N/A	N/A
	8	0.05	N/A	N/A
DT3002	1	0.03	N/A	N/A
	2	0.04	N/A	N/A
	4	0.04	N/A	N/A
	8	0.05	N/A	N/A
DT3003	1	0.03	N/A	N/A
	2	0.04	N/A	N/A
	4	0.04	N/A	N/A
	8	0.05	N/A	N/A
DT3001-PGL	1	0.03	N/A	N/A
	10	0.04	N/A	N/A
	100	0.05	N/A	N/A
	500	0.10	N/A	N/A
DT3003-PGL	1	0.03	N/A	N/A
	10	0.04	N/A	N/A
	100	0.05	N/A	N/A
	500	0.10	N/A	N/A
DT3004	1	N/A	0.01	N/A
	2	N/A	0.017	N/A
	4	N/A	0.022	N/A
	8	N/A	0.03	N/A
DT3005	1	N/A	N/A	0.01
	2	N/A	N/A	0.017
	4	N/A	N/A	0.022
	8	N/A	N/A	0.03

Table 24: Typical Channel-Gain Scan Accuracy

		Scan (%) (Source Impedance = 100 ohms)									
Model	**Gain**	**300 kHz**	**250 kHz**	**150 kHz**	**100 kHz**	**75 kHz**	**50 kHz**	**20 kHz**	**10 kHz**	**4 kHz**	**2.5 kHz**
DT3001	1	0.08	0.03								
	2	0.10	0.04								
	4	0.15	0.04								
	8	0.20	0.05								
DT3002	1	0.10	0.08	N/A	0.03						
	2	0.12	0.09	N/A	0.04						
	4	0.13	0.10	N/A	0.04						
	8	0.14	0.12	N/A	0.05						
DT3003	1	0.15	0.09	N/A	0.03						
	2	0.17	0.12	N/A	0.04						
	4	0.18	0.14	N/A	0.04						
	8	0.20	0.16	N/A	0.05						
DT3001 -PGL	1	0.10	0.03	N/A	0.03						
	10	N/A	0.25	N/A	0.05						
	100	N/A	N/A	N/A	N/A	N/A	N/A	0.05			
	500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.00	0.10	
DT3003 -PGL	1	0.15	0.09	N/A	0.03						
	10	N/A	0.30	N/A	0.05						
	100	N/A	N/A	N/A	N/A	N/A	N/A	0.10	0.05		
	500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.00	0.20	0.10
DT3004	1	N/A	N/A	N/A	N/A	0.02	0.01				
	2	N/A	N/A	N/A	N/A	0.27	0.17				
	4	N/A	N/A	N/A	N/A	0.32	0.22				
	8	N/A	N/A	N/A	N/A	0.04	0.39				
DT3005	1	N/A	N/A	0.02	0.01						
	2	N/A	N/A	0.27	0.12						
	4	N/A	N/A	0.32	0.22						
	8	N/A	N/A	0.04	0.03						

Analog Output Specifications

Table 25 lists the analog output specifications for the DT3001, DT3001-PGL, DT3003, DT3003-PGL, DT3004, and DT3005 boards. Note that the DT3002 does not provide analog output features.

Table 25: Analog Output Specifications

Feature	Specifications
Resolution (Coding)	12 bits (Offset Binary)
Integral Nonlinearity	±0.03% FSR
Differential Nonlinearity	±0.75 LSB (monotonic)
Gain Error	Adjustable to 0
Zero Error	Adjustable to 0
Number of Analog Outputs	2, voltage out
Output Ranges	±10 V (bipolar)
Input Data Coding	Offset binary
Throughput	200 kS/s maximum, single channel (100 kS/s maximum, multiple channel)
Current Output	±5 mA maximum
Output Impedance	0.1 Ω maximum
Capacitive Drive Capability	0.004 µF (no oscillations)
Protection	Short circuit to analog common
Power On Voltage	±10 mV maximum
Settling Time to 0.01% FSR	5 µs, 20 V step 2.5 µs, 100 mV step
Slew Rate	10 V/µs

Digital I/O Specifications

Table 26 lists the digital I/O specifications for the DT3000 Series boards.

Table 26: Digital I/O Specifications

Feature	Specifications
Number of Lines	8
Number of Ports	2 4-bit ports or 1 8-bit port
Inputs	
Input Type	Level Sensitive
Logic Sense	Positive True
Logic Load	1 ABT Load
High-Level Input Voltage	2.0 V minimum
Low-Level Input Voltage	0.8 V maximum
High-Level Input Current	100 μA
Low-Level Input Current	–100 μA
Termination	None
Outputs	
High-Level Output Voltage	2.0 V minimum
Low-Level Output Voltage	0.55 V maximum
High-Level Output Current	–32 mA maximum
Low-Level Output Current	64 mA maximum

User Counter/Timer Specifications

Table 27 lists the user counter/timer specifications for the DT3000 Series boards.

Table 27: User Counter/Timer Specifications

Features	Specifications
Inputs (1 Source, 1 Gate)	
High-Level Input Voltage	2.0 V minimum
Low-Level Input Voltage	0.8 V maximum
Output Leakage Current	25 µA maximum
Input Load Current	±10 µA maximum
Output (1 Counter/Timer Output)	
High-Level Output Voltage	2.0 V minimum
Low-Level Output Voltage	0.4 V maximum
High-Level Output Current	–15 mA maximum
Low-Level Output Current	24 mA maximum
External Counter/Timer Clock	
Input Type	Schmitt Trigger, Rising-Edge Sensitive
Logic Load	1 LSTTL Load
Positive Threshold	3.0 V
Negative Threshold	1.5 V
High-Level Input Current	25 µA maximum
Low-Level Input Current	–0.25 mA maximum
Minimum Pulse Width High: Low:	 40 ns 40 ns
Maximum Frequency	10 MHz
Termination	22 kΩ pullup to + 5 V

External Trigger Specifications

Table 28 lists the external trigger specifications for the DT3000 Series boards.

Table 28: External Trigger Specifications

Features	Specifications
Input Type	Edge Sensitive, Selectable
Logic Load	1 ABT Load
High-Level Input Voltage	2.0 V minimum
Low-Level Input Voltage	0.8 V maximum
High-Level Input Current	100 µA
Low-Level Input Current	–100 µA
Minimum Pulse Width High: Low:	 500 ns 500 ns
Termination	22 kΩ pullup to +5 V

Power Consumption

Table 29 lists the power specifications for the DT3000 Series boards.

Table 29: Power Specifications

Feature	Specifications
+5 V, ±0.25 V	1.5 A maximum
+12 V	not applicable
−12 V	not applicable

Physical Specifications

Table 30 lists the physical specifications for the DT3000 Series boards.

Table 30: Physical Specifications

Feature	Specifications
Dimensions	4.2 in. (L) x 9.15 in. (W) x 0.5 in. (D)
Weight	5.6 oz (159 g)
Operating Temperature Range	0° C to 70 ° C
Storage Temperature Range	–25° C to 85° C
Relative Humidity	To 95%, noncondensing

DT730 and DT730-T Specifications

Table 31 lists the specifications for the DT730 screw terminal panel.

Table 31: DT730 and DT730-T Specifications

Feature	Specification
Current Loop Resistor value: Resistor tolerance: Resistor power dissipation: Resistor temperature coefficient:	 250 Ω (0 to 20 mA current range) ±0.02% or better 1/4 W minimum ±15 ppm/°C or better
Temperature Accuracy (DT730-T only) Temperature range: Initial accuracy: Accuracy: Output voltage: Bias current:	 0 to 55°C (32°F to 131°F) ±1°C @ 25°C (factory set) ±1°C (0 to 55°C) 0.5 mV/°C (12.5 mV @ 25°C) +250 nA (10 M to +2.5 V)
Operating and Storage Temperature: Relative humidity:	 –25°C to +85°C up to 95%, noncondensing
Power +15 Volts @ Pin 28 –15 Volts @ Pin 27	 3 mA maximum
Physical Overall size of PC board: Enclosure dimensions: Weight: Screw terminals: J1 connector: J2 connector: Acceptable wire size: Mounting:	 0.9 in. (H) x 4.9 in. (W) x 6.9 in. (L) (1.90 cm x 12.70 cm x 22.86 cm) 7.48 in. X 5.43 in. X 1.77 in. 7 oz (198 g) 100 Screw Clamp Connections 100-pin, 50 mil spacing (AMP # 1-104069-7) Amp 26-pin connector (AMP # 104341-6) 14 to 22 AWG via four 4-40 screws

EP291 Cable Specifications

Table 32 lists the specifications for the EP291 cable.

Table 32: EP291 Cable Specifications

Feature	Specification
Length	1 meter
Conductors	100, Solid, #30 AWG on 25 mil centers
Connectors	100-pin, Self Locking, (AMP # 1-111196-6)

B

Connector Pin Assignments

Board Connector J1

J1 is a 100-pin, double-row connector on the rear of the board. This connector accepts signals through the EP291 cable or a user-designed cable. Table 33 lists the pin assignments of connector J1.

Table 33: Connector J1 Pin Assignments

Pin	Signal Name	Description	Pin	Signal Name	Description
100	ANIN00	Analog In 00	99	ANIN08	Analog In 08/00 Return
98	ANIN01	Analog In 01	97	ANIN09	Analog In 09/01 Return
96	ANIN02	Analog In 02	95	ANIN10	Analog In 10/02 Return
94	ANIN03	Analog In 03	93	ANIN11	Analog In 11/03 Return
92	ANIN04	Analog In 04	91	ANIN12	Analog In 12/04 Return
90	ANIN05	Analog In 05	89	ANIN13	Analog In 13/05 Return
88	ANIN06	Analog In 06	87	ANIN14	Analog In 14/06 Return
86	ANIN07	Analog In 07	85	ANIN15	Analog In 15/07 Return
84	ANIN16	Analog In 16	83	ANIN24	Analog In 24/16 Return
82	ANIN17	Analog In 17	81	ANIN25	Analog In 25/17 Return
89	ANIN18	Analog In 18	79	ANIN26	Analog In 26/18 Return
78	ANIN19	Analog In 19	77	ANIN27	Analog In 27/19 Return
76	ANIN20	Analog In 20	75	ANIN28	Analog In 28/20 Return
74	ANIN21	Analog In 21	73	ANIN29	Analog In 29/21 Return
72	ANIN22	Analog In 22	71	ANIN30	Analog In 30/22 Return
70	ANIN23	Analog In 23	69	ANIN31	Analog In 31/23 Return
68	ANIN32	Analog In 32	67	ANIN40	Analog In 40/32 Return
66	ANIN33	Analog In 33	65	ANIN41	Analog In 41/33 Return
64	ANIN34	Analog In 34	63	ANIN42	Analog In 42/34 Return
62	ANIN35	Analog In 35	61	ANIN43	Analog In 43/35 Return
60	ANIN36	Analog In 36	59	ANIN44	Analog In 44/36 Return
58	ANIN37	Analog In 37	57	ANIN45	Analog In 45/37 Return
56	ANIN38	Analog In 38	55	ANIN46	Analog In 46/38 Return
54	ANIN39	Analog In 39	53	ANIN47	Analog In 47/39 Return
52	ANIN48	Analog In 48	51	ANIN56	Analog In 56/48 Return
50	ANIN49	Analog In 49	49	ANIN57	Analog In 57/49 Return
48	ANIN50	Analog In 50	47	ANIN58	Analog In 58/50 Return

Table 33: Connector J1 Pin Assignments (cont.)

Pin	Signal Name	Description	Pin	Signal Name	Description
46	ANIN51	Analog In 51	45	ANIN59	Analog In 59/51 Return
44	ANIN52	Analog In 52	43	ANIN60	Analog In 60/52 Return
42	ANIN53	Analog In 53	41	ANIN61	Analog In 61/53 Return
40	ANIN54	Analog In 54	39	ANIN62	Analog In 62/54 Return
38	ANIN55	Analog In 55	37	ANIN63	Analog In 63/55 Return
36	AGND	Analog Ground	35	AMPLO	Amp Low
34	ANO0+	Analog Output 0 +	33	ANO0-	Analog Output 0 Return
32	ANO1+	Analog Output 1 +	31	ANO1-	Analog Output 1 Return
30	AGND	Analog Ground	29	AGND	Analog Ground
28	+15V	+15 volts out	27	-15V	–15 volts out
26	DGND	Digital Ground	25	DGND	Digital Ground
24	DIO0	Digital I/O Bank A 0	23	DIO4	Digital I/O Bank B 0
22	DIO1	Digital I/O Bank A 1	21	DIO5	Digital I/O Bank B 1
20	DIO2	Digital I/O Bank A 2	19	DIO6	Digital I/O Bank B 2
18	DIO3	Digital I/O Bank A 3	17	DIO7	Digital I/O Bank B 3
16	DGND	Digital Ground	15	DGND	Digital Ground
14	+5V	+5 volts out	13	+5V	+5 volts out
12	Reserved	Reserved	11	Reserved	Reserved
10	DGND	Digital Ground	9	DGND	Digital Ground
08	EADCLKI	External A/D Sample Clock In	07	UCLKI	User Clock Input
06	EADTRIG	External A/D or D/A Trigger	05	UGATE	External User Gate
04	Reserved	Reserved	03	UCLKO	User Counter Output
02	DGND	Digital Ground	01	DGND	Digital Ground

DT730 and DT730-T Screw Terminals

Table 34 describes each of the screw terminal assignments and identifies the resistors that are associated with each channel on the DT730 and DT730-T screw terminal panels.

Table 34: Screw Terminal Descriptions and Resistor Use for the DT730 and DT730-T

Screw Terminal Number[a]	Signal Name		Resistor Used	
	Single-Ended	Differential	Bias Return	Current Shunt
1	Digital Ground		Not Applicable	
2	Digital Ground			
3	UCLK_OUT			
4	RESERVED			
5	USER_GATE			
6	EADTRIG/EDATRIG			
7	USER_CLK1			
8	EADCLK1			
9	Digital Ground			
10	Digital Ground			
11	RESERVED			
12	RESERVED			
13	+5V_OUT			
14	+5V_OUT			
15	Digital Ground			
16	Digital Ground			
17	DIG_IOB3			
18	DIG_IOA3			
19	DIG_IOB2			
20	DIG_IOA2			
21	DIG_IOB1			
22	DIG_IOA1			
23	DIG_IOB0			
24	DIG_IOA0			
25	Digital Ground			
26	Digital Ground			
27	−15V_OUT			

Table 34: Screw Terminal Descriptions and Resistor Use for the DT730 and DT730-T (cont.)

Screw Terminal Number[a]	Signal Name		Resistor Used	
	Single-Ended	Differential	Bias Return	Current Shunt
28	+15V_OUT		Not Applicable	
29	Analog Common			
30	Analog Common			
31	DAC1_GND			
32	DAC1_OUT			
33	DAC0_GND			
34	DAC0_OUT			
35	Amp Low		Note: Jumper W1 Connects Amp Low to Analog Gnd	
36	Analog Gnd			
37	AIN63	AIN31_L	R32	R64
38	AIN55	AIN31_H		
39	AIN62	AIN30_L	R31	R63
40	AIN54	AIN30_H		
41	AIN61	AIN29_L	R30	R62
42	AIN53	AIN29_H		
43	AIN60	AIN28_L	R29	R61
44	AIN52	AIN28_H		
45	AIN59	AIN27_L	R28	R60
46	AIN51	AIN27_H		
47	AIN58	AIN26_L	R27	R59
48	AIN50	AIN26_H		
49	AIN57	AIN25_L	R26	R58
50	AIN49	AIN25_H		
51	AIN56	AIN24_L	R25	R57
52	AIN48	AIN24_H		
53	AIN47	AIN23_L	R24	R56
54	AIN39	AIN23_H		
55	AIN46	AIN22_L	R23	R55
56	AIN38	AIN22_H		
57	AIN45	AIN21_L	R22	R54
58	AIN37	AIN21_H		

Table 34: Screw Terminal Descriptions and Resistor Use for the DT730 and DT730-T (cont.)

Screw Terminal Number[a]	Signal Name		Resistor Used	
	Single-Ended	Differential	Bias Return	Current Shunt
59	AIN44	AIN20_L	R21	R53
60	AIN36	AIN20_H		
61	AIN43	AIN19_L	R20	R52
62	AIN35	AIN19_H		
63	AIN42	AIN18_L	R19	R51
64	AIN34	AIN18_H		
65	AIN41	AIN17_L	R18	R50
66	AIN33	AIN17_H		
67	AIN40	AIN16_L	R17	R49
68	AIN32	AIN16_H		
69	AIN31	AIN15_L	R16	R48
70	AIN23	AIN15_H		
71	AIN30	AIN14_L	R15	R47
72	AIN22	AIN14_H		
73	AIN29	AIN13_L	R14	R46
74	AIN21	AIN13_H		
75	AIN28	AIN12_L	R13	R45
76	AIN20	AIN12_H		
77	AIN27	AIN11_L	R12	R44
78	AIN19	AIN11_H		
79	AIN26	AIN10_L	R11	R43
80	AIN18	AIN10_H		
81	AIN25	AIN09_L	R10	R42
82	AIN17	AIN09_H		
83	AIN24	AIN08_L	R9	R41
84	AIN16	AIN08_H		
85	AIN15	AIN07_L	R8	R40
86	AIN07	AIN07_H		
87	AIN14	AIN06_L	R7	R39
88	AIN06	AIN06_H		

Table 34: Screw Terminal Descriptions and Resistor Use for the DT730 and DT730-T (cont.)

Screw Terminal Number[a]	Signal Name		Resistor Used	
	Single-Ended	Differential	Bias Return	Current Shunt
89	AIN13	AIN05_L	R6	R38
90	AIN05	AIN05_H		
91	AIN12	AIN04_L	R5	R37
92	AIN04	AIN04_H		
93	AIN11	AIN03_L	R4	R36
94	AIN03	AIN03_H		
95	AIN10	AIN02_L	R3	R35
96	AIN02	AIN02_H		
97	AIN09	AIN01_L	R2	R34
98	AIN01	AIN01_H		
99	AIN08	AIN00_L	R1	R33
100	AIN00	AIN00_H		

a. The screw terminal assignments match the pin numbers of the J1 connector.

DT730 and DT730-T Connector J2 Pins

Connector J2 on the DT730 and DT730-T screw terminal panel is provided for connecting a 5B or 7B Series signal conditioning backplane. Table 35 describes the pin assignments of connector J2.

Table 35: Connector J2 Pin Assignments

Pin[a]	Description	Pin	Description
1	AIN00_H	14	AIN12_H
2	AIN08_H	15	Analog Gnd
3	Analog Gnd	16	AIN13_H
4	AIN09_H	17	AIN05_H
5	AIN01_H	18	Analog Gnd
6	Analog Gnd	19	AIN06_H
7	AIN02_H	20	AIN14_H
8	AIN10_H	21	Analog Gnd
9	Analog Gnd	22	AIN15_H
10	AIN11_H	23	AIN07_H
11	AIN03_H	24	Analog Gnd
12	Analog Gnd	25	Amp Low
13	AIN04_H	26	Not Connected

a. Signals AIN08_H to AIN15_H are not available on the 5B08, 7BP08-1, or 7BP04-1 backplane.

C

Using Your Own Screw Terminal Panel

Data acquisition boards can perform only as well as the input connections and signal integrity you provide. If you choose not to use the DT730 or DT730-T screw terminal panel, consideration must be given to how the signals interact in the real world as well as how they interact with each other.

This appendix describes additional considerations to keep in mind when designing your own screw terminal panel for use with a DT3000 Series board. Refer to Appendix B for connector and cable specifications.

Analog Inputs

DT3000 Series boards have three different types of analog input configurations that you can use:

- Single-ended
- Pseudo-differential
- Differential

This section describes wiring considerations for these analog input configurations.

Single-Ended Inputs

With single-ended inputs, you have the maximum number of inputs but the worst-case noise immunity without external signal conditioning.

The major problem with this configuration it that you need a common ground between the external inputs and the data acquisition board. Even with conditioning, you must consider the cable length and how the cable is routed. If the cable is over 3 feet, you must consider the ringing and cross-talk in the cable. A typical cable has 30 pF per foot of capacitance. If the source impedance is 1,000 Ω and the cable is 3 feet, then the cross talk based on the source impedance is 1,000 Ω x (30 pF x 3 ft) = 90 ns.

This seems negligible, but when you consider that it requires nine time constants to settle within 0.01%, the cross-talk becomes almost 10% of the settling time when switching channels at 100 kHz.

In addition, coupling must be considered when adjacent channels have high-speed signals, especially if these signals are TTL-type with high-speed edges.

If it is provided and not used, ensure that you connect Amp Low to the analog common of the DT3000 Series board or to ground when running in single-ended mode.

Pseudo-Differential Inputs

Pseudo-differential inputs allow one common-mode voltage for all single-ended inputs. With this type of connection, the low side of the instrumentation amplifier is used to sense an external common-mode voltage. For example, if you have a signal-conditioning rack, the Amp Low signal connects to the analog common of the external rack.

The pseudo-differential configuration allows you to use the maximum number of input channels, while placing an impedance between the external ground and the data acquisition ground or analog common. Even if it is 100 Ω, this impedance provides the bias return currents for the inputs and causes only 10 mA of current to flow with a ground potential difference of 1 V. (The input bias current is typically in milliamperes.) This is usually manageable by the common-mode range of the instrumentation amplifier and analog ground system. Consider the problems with 1 Ω of impedance between 1 V of potential difference. The resulting 1 A of current causes many problems in the analog signal integrity.

If it is available, use Amp Low as a remote ground sense when running in pseudo-differential mode.

Differential Inputs

Differential inputs offer the maximum noise rejection at the expense of half your total channel count. For the best results, shielded twisted pairs are a must. The shield must connect at one end so that ground currents do not travel over the shield. In low-level voltage applications, differential inputs reduce problems not only due to electrostatic and magnetic noise, but due to cross-talk and thermal errors.

One problem to consider with differential inputs is the bias current error. The differential impedance is usually hundreds of megaohms. With a very small bias current multiplied by this high input impedance, the voltage produced is out of the common-mode input range of the instrumentation amplifier.

You must provide an external resistor to return this bias current to the analog common of the data acquisition board. This resistor is typically in the order of 1 kΩ to 100 kΩ from the input low side to analog common. Alternatively, you can return the external common through a 10 Ω to 100 kΩ resistor to analog common (it cannot be 0 Ω due to ground currents).

Analog Outputs

The analog output channels on DT3000 Series boards have a resolution of 12 bits (even though the accuracy may be less).

Data Translation ensures that the analog outputs do not break into a high frequency oscillation with high capacitance loads that occur with long cables. Typically, the analog outputs drive 1,000 pF without degradation and bandwidth-limit with higher capacitive loads.

The grounds of most boards are optimized for analog inputs at the expense of some logic or high-frequency noise on the analog outputs. This is because the analog and digital grounds of the board are connected at the ADC's input.

The analog outputs are brought out as a high and a low signal, but the low side is the analog ground at the DAC's output buffer. To remove the high-frequency noise and smooth the glitch energy on the analog outputs, you can install a 15 kHz RC filter on the output, a 100 Ω resistor in series with the output, and a 0.1 μF capacitor between the output side of the 100 Ω resistor and output low.

Digital Inputs and Counter/Timer Inputs

To prevent damage when power is removed, you must provide current limiting circuitry for TTL-type input.

On high-speed clock inputs, a ground that is located in the connector next to the clock must be connected as a twisted pair with the high-speed clock input.

Digital Outputs

If you are using the high drive capability of a DT3000 Series board, ensure that the load is returned to the digital ground provided in the connector next to the outputs.

If just eight of the digital outputs are switching 16 mA per output, then 128 mA of current flows. To minimize problems with ringing, loading, and EMI, a 22 Ω resistor is used in series with all digital outputs. You must consider this 22 Ω resistor if you are matching cable impedance to the far end.

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