DATA TRANSLATION

DT9800 Series
User's Manual
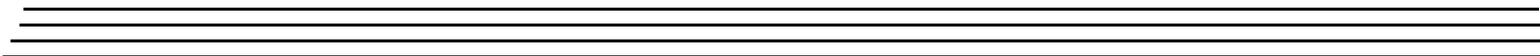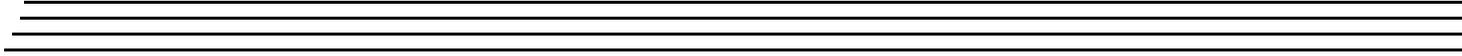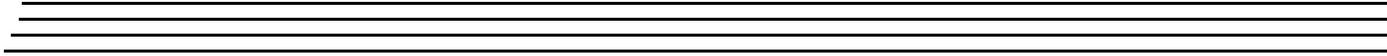
Thirteenth Edition
May, 2010

Data Translation, Inc.
100 Locke Drive
Marlboro, MA 01752-1192
(508) 481-3700
www.datatranslation.com
Fax: (508) 481-8620
E-mail: info@datx.com

Radio and Television Interference

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

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

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

The first part of this manual describes how to install and set up your DT9800 Series module and device driver, and verify that your module is working properly.

The second part of this manual describes the features of the DT9800 Series modules, the capabilities of the DT9800 Series Device Driver, and how to program the DT9800 Series modules using the DT-Open Layers for .NET Class Library™ software. Troubleshooting and calibration 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 DT9800 Series modules for data acquisition operations in the Microsoft® Windows® XP, or Windows Vista®, or Windows 7 operating system. It is assumed that you have some familiarity with data acquisition principles and that you understand your application.

How this Manual is Organized

The manual is organized as follows:

- Chapter 1, "Overview," describes the major features of the modules, as well as the supported software and accessories for the modules.

- Chapter 2, "Installing a Module," describes how to install the DT9800 Series module.

- Chapter 3, "Configuring the Module and/or Device Driver," describes how to configure the device driver and the module.

- Chapter 4, "Wiring Signals," describes how to wire signals to a DT9800 Series module.

- Chapter 5, "Verifying the Operation of a Module," describes how to verify the operation of the module with the Quick DataAcq application.

- Chapter 6, "Principles of Operation," describes all of the features of the modules 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 DT9800 Series Device Driver.

- Chapter 8, "Calibration," describes how to calibrate the analog I/O circuitry of the modules.

- Chapter 9, "Troubleshooting," provides information that you can use to resolve problems with the modules and the device driver, should they occur.

- Appendix A, "Specifications," lists the specifications of the modules.

- Appendix B, "Connector Pin Assignments," shows the pin assignments for the connectors and the screw terminal assignments for the modules.

- 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 DT9800 Series modules:

- *Benefits of the Universal Serial Bus for Data Acquisition.* This white paper describes why USB is an attractive alternative for data acquisition. It is available on the Data Translation web site (www.datatranslation.com).

- *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 DataAcq SDK™ to access the capabilities of Data Translation data acquisition devices.

- *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 devices in Microsoft Visual Basic® or Visual C++®.

- *DAQ Adaptor for MATLAB* (UM-22024). This document describes how to use Data Translation's DAQ Adaptor to provide an interface between the MATLAB Data Acquisition subsystem from The MathWorks and Data Translation's DT-Open Layers architecture.

- *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.

- Microsoft Windows XP, Windows Vista, or Windows 7 documentation.

- USB web site (http://www.usb.org).

- *Omega Complete Temperature Measurement Handbook and Encyclopedia®. This document, published by Omega Engineering, provides information on how to linearize voltage values into temperature readings for various thermocouple types.*

Where To Get Help

Should you run into problems installing or using a DT9800 Series module, the Data Translation Technical Support Department is available to provide technical assistance. Refer to Chapter 9 starting on page 137 for more information. If you are outside the United States or Canada, call your local distributor, whose number is listed on our web site (www.datatranslation.com).

1

Overview

Features

The DT9800 Series is a family of low-cost, multifunction data acquisition modules for the Universal Serial Bus (USB) (Ver. 1.1 or Ver. 2.0).

Most computers have two or more USB ports that allow direct connection to USB devices. You can expand the number of USB devices attached to a single USB port by using expansion hubs. DT9800 Series modules are part of the high-power, bus-powered USB class; therefore, the modules do not require external power, but the expansion hubs do require external power.

DT9800 Series modules reside outside of the PC and install with a single cable to ease installation. Modules can be "hot swapped" or plugged and unplugged while the PC is on, making them useful for many data acquisition applications.

The DT9800 Series includes the following subseries: DT9800 Standard Series, DT9800-EC Series, and DT9800-EC-I Series.

The DT9800-EC Series modules are not isolated; the DT9800 Standard Series and DT9800-EC-I Series modules are isolated. In addition, the DT9800-EC and DT9800-EC-I Series modules support the use of optional backplanes and screw terminal panels that provide signal conditioning and other features. Table 1 lists the modules in each series and the key features of each.

Table 1: Key Features Among the DT9800 Series

Series	Function Modules	# of Analog Inputs	Analog Input Sample Rate	# of Analog Outputs
DT9800 Standard Series	DT9801[a]	16 SE/8 DI	100 kS/s	0
	DT9802[a]	16 SE/8 DI	100 kS/s	2
	DT9803[b]	16 SE/8 DI	100 kS/s	0
	DT9804[b]	16 SE/8 DI	100 kS/s	2
	DT9805[c]	16 SE/8 DI/ 7 thermocouples and 1 CJC	50 kS/s	0
	DT9806[c]	16 SE/8 DI/ 7 thermocouples and 1 CJC	50 kS/s	2
DT9800-EC Series[d]	DT9801-EC[a]	16 SE/8 DI[e]	100 kS/s	0
	DT9802-EC[a]	16 SE/8 DI[e]	100 kS/s	2[f]
	DT9803-EC[b]	16 SE/8 DI[g]	100 kS/s	0
	DT9804-EC[b]	16 SE/8 DI[g]	100 kS/s	2[h]

Table 1: Key Features Among the DT9800 Series (cont.)

Series	Function Modules	# of Analog Inputs	Analog Input Sample Rate	# of Analog Outputs
DT9800-EC-I Series[d]	DT9801-EC-I[a]	16 SE/8 DI[e]	100 kS/s	0
	DT9802-EC-I[a]	16 SE/8 DI[e]	100 kS/s	2[f]
	DT9803-EC-I[b]	16 SE/8 DI[g]	100 kS/s	0
	DT9804-EC-I	16 SE/8 DI[g]	100 kS/s	2[h]

a. The resolution is 12 bits.

b. The resolution is 16 bits.

c. The gains provided on the DT9805 and DT9806 are 1, 10, 100, and 500. All other modules provide gains of 1, 2, 4, and 8.

d. The DT9800-EC Series boards are nonisolated; the DT9800-EC-I Series boards and all other DT9800 Series boards are isolated.

e. The analog input range is 0 to 10 V or ±10 V.

f. The analog output range is 0 to 10 V, 0 to 5 V, ±10 V, or ±5 V.

g. The analog input range is ±10 V.

h. The analog output range is ±10 V.

All DT9800 Series modules share the following major features:

- One 8-bit digital input port and one 8-bit digital output port; the digital input lines can be included as part of the analog input channel-gain list to correlate the timing of analog and digital events; digital outputs can drive external solid-state relays

- Two 16-bit user counter/timers programmable for event counting, frequency measurement, rate generation (continuous pulse output), one-shot, and repetitive-one shot pulse output operations

- USB compatibility and galvanic isolation

- Software configurable termination resistance for differential inputs on a channel-by-channel basis

- Input gains of 1, 2, 4, and 8 for all modules except the DT9805 and DT9806, which support gains of 1, 10, 100, and 500

- Continuously paced and triggered scan capability

- A 32-location channel-gain list that supports sampling analog input channels at the same or different gains in sequential or random order

- Internal and external clock sources for the analog input subsystem

- Digital TTL triggering for the analog input subsystem

- One dynamic digital output line

- Programmable gate types and pulse output types

In addition, the DT9805 and DT9806 modules provide thermocouples and low-level analog input capability. A software calibration utility is provided for calibrating the analog I/O subsystems of all modules.

Supported Software

The following software is available for use with the DT9800 Series modules and is shipped on the Data Acquisition OMNI CD:

- **DT9800 Series Device Driver** – The device driver allows you to use a DT9800 Series module with any of the supported software packages or utilities. Refer to Chapter 2 starting on page 21 for more information on loading and configuring the device driver.

- **Quick DataAcq application** – The Quick DataAcq application provides a quick way to get up and running using a DT9800 Series module. Using this application, you can verify key features of the modules, display data on the screen, and save data to disk. Refer to Chapter 5 starting on page 73 for more information on using the Quick DataAcq application.

- **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.

- **Calibration Utility** – The Calibration Utility allows you to calibrate the analog I/O circuitry of the modules. Refer to Chapter 8 starting on page 129 for more information on this utility.

- **Measure Foundry** – An evaluation version of this software is included or provided via a link 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 DT9800 Series module 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 DT9800 Series module 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 DT9800 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 this software is included or provided via a link 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 DT9800 Series modules.

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

Accessories

One EP365 cable is shipped with each DT9800 Series module. The EP365 is a 1.83-meter, USB cable that connects the USB connector of the DT9800 Series module to the USB connector on the host computer. If you want to buy additional USB cables, EP365 is available as an accessory product for the DT9800 Series.

In addition, you can purchase the following optional items from Data Translation for use with the DT9800 Series:

- **5B01** – A 16-channel backplane that accepts 5B Series signal conditioning modules.

- **5B08** – An 8-channel backplane that accepts 5B Series signal conditioning modules.

- **PWR-977 power supply** – A 5 V, 3 A power supply for powering the 5B Series backplanes.

- **7BP16-1** – A 16-channel backplane that accepts 7B Series signal conditioning modules.

- **7BP08-1** – An 8-channel backplane that accepts 7B Series signal conditioning modules.

- **7BP04-1** – A 4-channel backplane that accepts 7B Series signal conditioning modules.

- **AC1324** – A screw terminal panel that connects to a DT9800-EC or DT9800-EC-I Series module to allow access to the analog
I/O, dynamic digital output, counter/timer, and power signals.

- **PB16H** – A digital backplane that connects to the DT9800-EC or DT9800-EC-I module to allow access to the digital I/O signals.

- **STP-EZ** – A screw terminal panel that connects to a DT9800-EC or DT9800-EC-I Series module to allow access to the
digital I/O signals. A 50-pin ribbon cable is provided with the STP-EZ to allow direct connection to a DT9800-EC or
DT9800-EC-I Series module.

- **AC1315** – A 2-foot, 26-pin female to 26-pin female cable that connects a 5B Series backplane to a DT9800-EC or DT9800-EC-I Series module.

- **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 a DT9800-EC or DT9800-EC-I Series module.

- **HES14-21 power supply** – A linear ac/dc power supply that provides +24 Vdc for powering 7B Series backplanes.

- **EP035** – A 2.4-meter, 50-pin ribbon cable that connects the PB16H Opto 22 backplane to a DT9800-EC or DT9800-EC-I Series module.

Getting Started Procedure

The flow diagram shown in Figure 1 illustrates the steps needed to get started using the DT9800 Series modules. This diagram is repeated in each Getting Started chapter; the shaded area in the diagram shows you where you are in the procedure.

**Install the Module
(see Chapter 2 starting on page 21)**

**Configure the Module and/or Device Driver
see Chapter 3 starting on page 31)**

**Wire Signals
(see Chapter 4 starting on page 37)**

**Verify the Operation of the Module
(see Chapter 5 starting on page 73)**
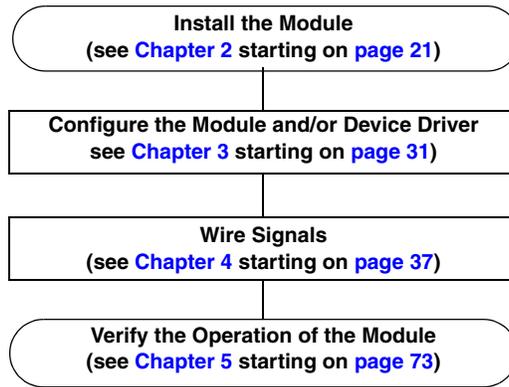
Figure 1: Getting Started Flow Diagram

Part 1: Getting Started

2

Installing a Module

```
┌─────────────────────────────────────┐
│        Install the Module           │
│        (this chapter)               │
└─────────────────────────────────────┘
                 │
┌─────────────────────────────────────┐
│ Configure the Module and/or Device Driver │
│   (see Chapter 3 starting on page 31) │
└─────────────────────────────────────┘
                 │
┌─────────────────────────────────────┐
│           Wire Signals              │
│   (see Chapter 4 starting on page 37) │
└─────────────────────────────────────┘
                 │
┌─────────────────────────────────────┐
│   Verify the Operation of the Module │
│   (see Chapter 5 starting on page 73) │
└─────────────────────────────────────┘
```

Note: All DT9800 Series modules are factory-calibrated and require no further adjustment prior to installation. If you are using the DT9800 Standard, DT9800-EC, or DT9800-EC-I Series modules and decide later to recalibrate them, refer to Chapter 8 starting on page 129 for instructions.

Unpacking

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

- DT9800 Series module

- EP365 USB cable

- 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).

Attaching Modules to the Computer

You can attach a DT9800 Series module to the host computer in one of two ways:

- Connect directly to a USB port of the host computer, described on this page. Use this method if one or two DT9800 Series modules are sufficient for your application.

- Connect to one or more self-powered USB hubs, described on page 25. Use this method if your application requires more DT9800 Series modules than the USB ports on the host computer.

You **must** install the device driver before connecting your DT9800 Series module(s) to the host computer.

Note: DT9800 Series modules are low-power devices (using less than 500 mA); therefore, they do not require external power supplies.

Connecting Directly to the USB Ports

To connect a DT9800 Series module directly to a USB port on your computer, do the following:

1. Attach one end of the EP365 (USB) cable, which is shipped with the DT9800 Series module, to the USB port on the module.

2. Attach the other end of the EP365 cable to one of the USB ports on the host computer, as shown in Figure 2.
   The operating system automatically detects the USB device and starts the Found New Hardware wizard.

USB Ports

Host Computer

DT9800 Series Modules

EP365 Cables
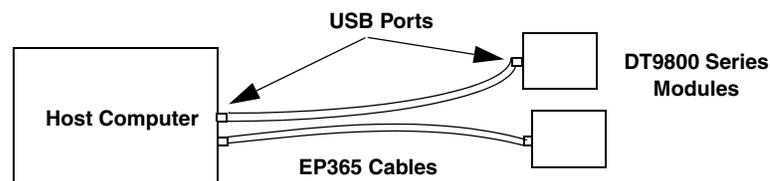
Figure 2: Attaching the Module to the Host Computer

3. *For Windows Vista:*

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

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

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

For Windows XP:

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

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

Note: Windows 7 finds the device automatically.

---

4. Repeat these steps to attach another DT9800 Series module to the host computer, if desired.

Note: You can unplug a module, and then plug it in again, if you wish, without causing damage. This process is called hot-swapping.

Your application may take a few seconds to recognize a module once it is plugged back in.

Connecting to an Expansion Hub

Expansion hubs are powered by their own external power supply. The practical number of DT9800 Series modules that you can connect to a single USB port depends on the throughput you want to achieve.

Note: The bandwidth of the USB Ver. 1.1 bus is 12 Mbits/second. Each DT9800 Series module running at full speed (100 kHz) requires 200 kB of this bandwidth. Therefore, if you want to achieve full throughput on each module, you should connect no more than four DT9800 Series modules to a single USB Ver. 1.1 port.

To connect multiple DT9800 Series modules to an expansion hub, do the following:

1. Attach one end of the USB cable to the DT9800 Series module and the other end of the USB cable to an expansion hub.

2. Connect the power supply for the expansion hub to an external power supply.

3. Connect the hub to the USB port on the host computer using another USB cable.
The operating system automatically detects the USB device and starts the Found New Hardware wizard.

4. *For Windows Vista:*

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

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

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

For Windows XP:

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

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

Note: Windows 7 finds the device automatically.

---

5. Repeat these steps until you have attached the number of hubs and modules that you desire. Refer to Figure 3.
   The operating system automatically detects the USB devices as they are installed.
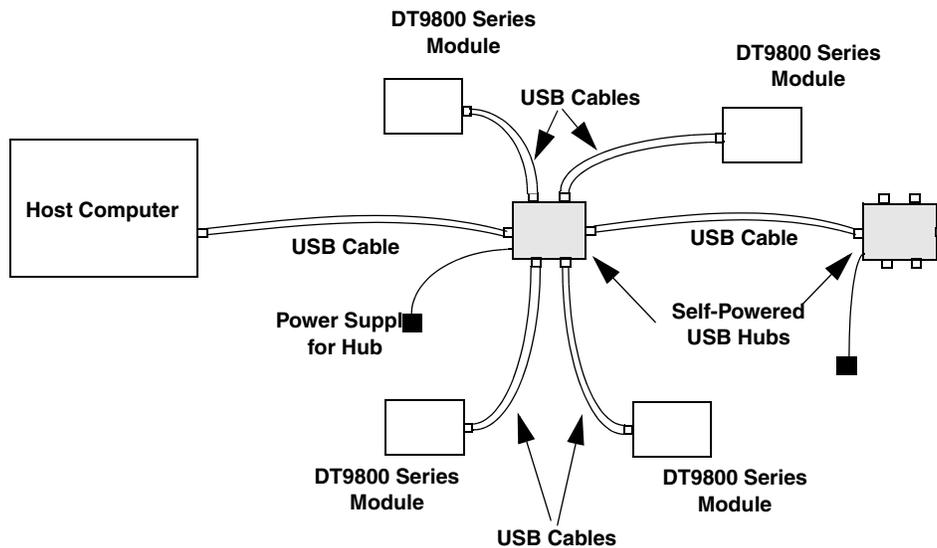
Figure 3: Attaching Multiple Modules Using Expansion Hubs

Note: You can unplug a module, and then plug it in again, if you wish, without causing damage. This process is called hot-swapping.

Your application may take a few seconds to recognize a module once it is plugged back in.

If you are using a DT9800-EC or DT9800-EC-I Series module, continue with the next section. Otherwise, continue with the instructions on wiring in Chapter 4 starting on page 37.

Attaching Backplanes/Panels to the EC or EC-I Series

Only the DT9800-EC and DT9800-EC-I Series modules support Analog Devices 5B and 7B Series backplanes, the Opto-22 PB16H digital I/O backplane, and the Data Translation STP-EZ backplane and AC1324 screw terminal panel.

The DT9800-EC and DT9800-EC-I Series modules provide the following three connectors:

- Connector J6 –Supports 5B and 7B Series backplanes or an AC1324 screw terminal panel for analog input connections.

    Specific 5B and 7B Series backplanes that are supported include the following:

    - 5B01 – a 16-channel backplane for 5B Series signal conditioning modules

    - 5B08 – an 8-channel backplane for 5B Series signal conditioning modules

    - 7BP16-1 – a 16-channel backplane for 7B Series signal conditioning modules

    - 7BP08-1 – an 8-channel backplane for 7B Series signal conditioning modules

    - 7BP04-1 – a 4-channel backplane for 7B Series signal conditioning modules

- Connector J5 – Supports an AC1324 screw terminal panel for analog output, dynamic digital output, counter/timer, and power connections.

- Connector J4 – Supports the STP-EZ and the PB16H digital I/O backplane. The PB16H supports eight digital inputs at locations 0 to 7, and eight digital outputs at locations 8 to 15.

Figure 4 shows the location of these connectors on the DT9800-EC and DT9800-EC-I Series modules.
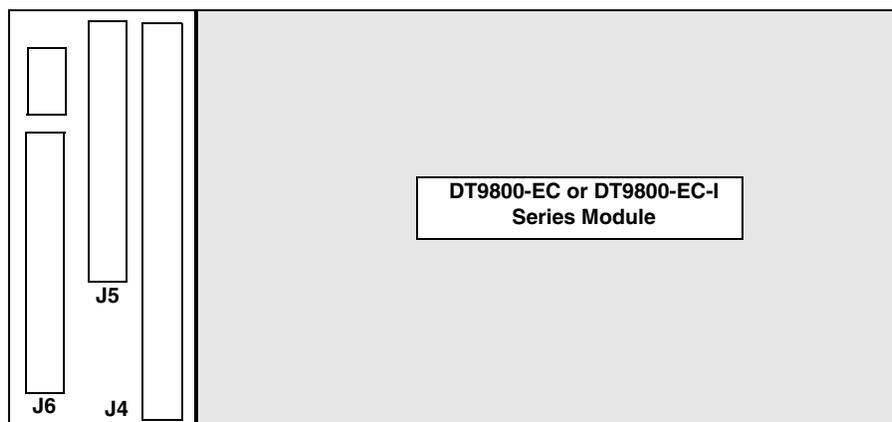
Figure 4: J6, J5, and J4 Connectors

This section describes how to connect a 5B or 7B Series backplane, a AC1324 screw terminal panel, and/or a PB16H Opto-22 backplane to your DT9800-EC or DT9800-EC-I Series module.

Attaching a 5B Series Backplane

To connect a 5B Series signal conditioning backplane to a DT9800-EC or DT9800-EC-I Series module, complete the steps that follow while referring to Figure 5:

USB Cable to Host Computer ... **J6 Connector** ... **DT9800-EC/ DT9800-EC-I** ... **5B Series Backplane** ... **AC1315 Cable** ... **PWR-977 Power Supply** ... **To wall outlet**
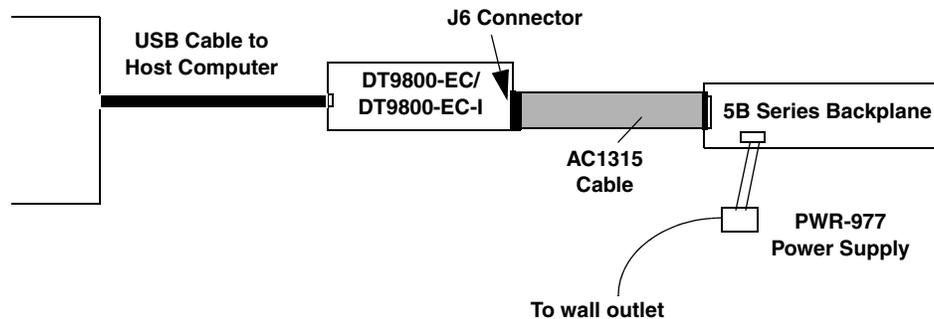
Figure 5: Connecting a 5B Series Backplane to the DT9800-EC or DT9800-EC-I Series Modules

1. Plug one end of an AC1315 cable into the J6 connector of the DT9800-EC or DT9800-EC-I Series module.

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

To connect a 7B Series signal conditioning backplane to a DT9800-EC or DT9800-EC-I Series module, complete the steps that follow while referring to Figure 6:

USB Cable to Host Computer ... **J6 Connector** ... **AC1393 Adapter Cable** ... **DT9800-EC/ DT9800-EC-I** ... **7B Series Backplane** ... **AC1315 Cable** ... **To wall outlet** ... **HES14-21 Power Supply**
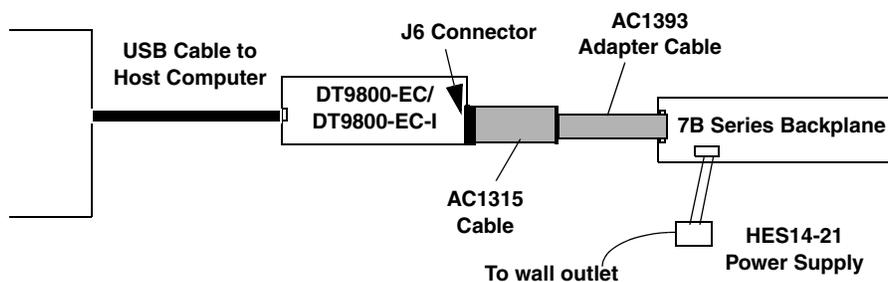
Figure 6: Connecting a 7B Series Backplane to the DT9800-EC or DT9800-EC-I Series Modules

1. Plug one end of an AC1315 cable into the J6 connector of the DT9800-EC or DT9800-EC-I Series module.

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.

Attaching an AC1324 Screw Terminal Panel

To connect an AC1324 screw terminal panel to a DT9800-EC or DT9800-EC-I Series module, do the following:

1. Plug one end of an AC1315 cable into the J6 or J5 connector of the DT9800-EC or DT9800-EC-I Series module.

2. Plug the other end of the AC1315 cable into the 26-pin connector on the AC1324 screw terminal panel, as shown in Figure 7.
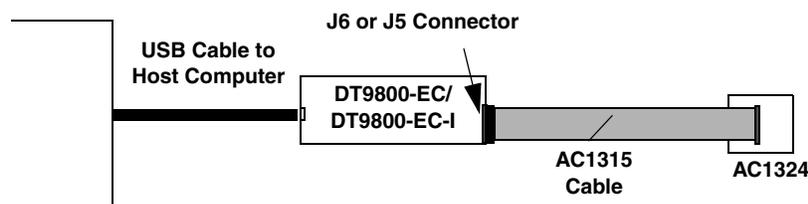
Figure 7: Connecting the AC1324 Screw Terminal Panel to the DT9800-EC or DT9800-EC-I Series Module

Attaching a PB16H Opto-22 Backplane

To connect a PB16H Opto-22 backplane to a DT9800-EC or DT9800-EC-I Series module, do the following:

1. Plug one end of an EP035 cable into the J4 connector of the DT9800-EC or DT9800-EC-I Series module.

2. Plug the other end of the EP035 cable into the 50-pin connector on the PB16H Opto-22 backplane, as shown in Figure 8.
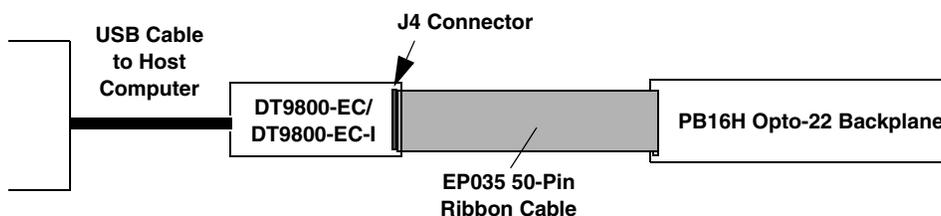
Figure 8: Connecting the PB16H Opto-22 Backplane to the DT9800-EC or DT9800-EC-I Series Module

Attaching an STP-EZ Screw Terminal Panel

To connect an STP-EZ screw terminal panel to a DT9800-EC or DT9800-EC-I Series module, do the following:

1. Attach one end of the 50-pin cable that is shipped with the STP-EZ screw terminal panel into connector J4 on the DT9800-EC or DT9800-EC-I board.

2. Attach the other end of the cable to the J1 connector on the STP-EZ screw terminal panel, as shown in Figure 9.

J4 Connector

USB Cable to Host Computer

DT9800-EC/ DT9800-EC-I

STP-EZ

50-Pin Ribbon Cable

J1 Connector
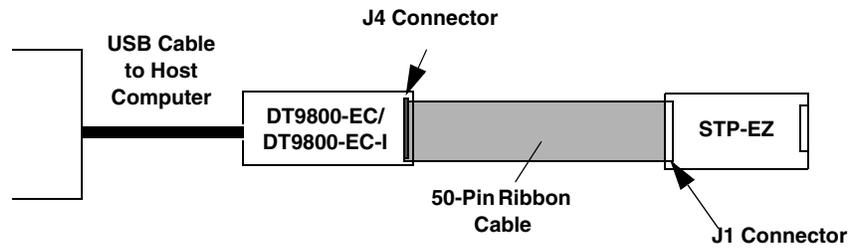
Figure 9: Connecting the STP-EZ to the DT9800-EC or DT9800-EC-I Module

3

Configuring the Module and/or Device Driver

```
┌─────────────────────────────────────────┐
│           Install the Module            │
│  (see Chapter 2 starting on page 21)    │
└─────────────────────────────────────────┘
                     │
┌─────────────────────────────────────────┐
│  Configure the Module and/or Device Driver│
│            (this chapter)               │
└─────────────────────────────────────────┘
                     │
┌─────────────────────────────────────────┐
│             Wire Signals                │
│  (see Chapter 4 starting on page 37)    │
└─────────────────────────────────────────┘
                     │
┌─────────────────────────────────────────┐
│      Verify the Operation of the Module │
│  (see Chapter 5 starting on page 73)    │
└─────────────────────────────────────────┘
```
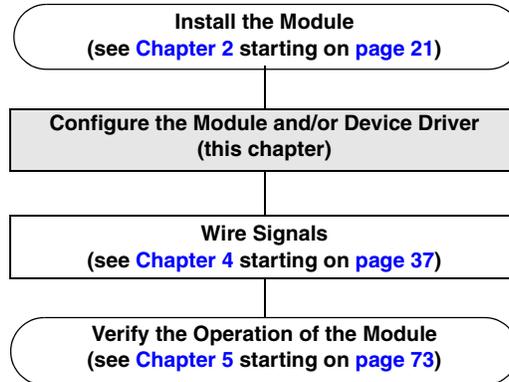
If you are using a DT9800 Standard Series, DT9800-EC Series, or DT9800-EC-I Series module, you must configure the device driver; refer to page 33 for information.

In addition, if you are using a DT9800-EC or DT9800EC-I Series module, you must configure the module; refer to page 34 for information.

Configuring the Device Driver

This section describes how to configure the device driver for a DT9800 Standard Series, DT9800-EC Series, or DT9800-EC-I Series module to use or not use bias-return termination resistance.

To configure the device driver, do the following:

1. If you have not already done so, power up the host computer and all peripherals.

2. From the Windows Control Panel, double-click the **Open Layers Control Panel** icon. *The Data Acquisition Control Panel dialog box appears.*

3. Click the DT9800 Series module that you want to configure, and then click **Advanced**. *The DT9800 Configuration dialog box appears.*

4. If you are using differential analog input channels, we recommend that you select the **10k Ohm Resistor Terminations** checkbox for each analog input channel on the module. This ensures that 10 kΩ of bias return termination resistance is used for the analog input channels. (This is the default configuration.) Bias return termination resistance is particularly useful when your differential source is floating.

    If you are using single-ended analog input channels, clear the checkbox for each analog input channel so that bias return resistance is not used.

5. To continuously power the analog and/or digital outputs, select the **Power Always On** checkbox. The DT9800 Series module will remain on even when you exit from the applications that use the module.

    If you want to shut down power to the module, you must uncheck this checkbox and close the control panel. Once all applications that use this module are exited, the module will power down. The module will remain off until you either run an application that uses the module or click the Advanced button from the Open Layers Data Acquisition Control Panel.

6. Click **OK**.

7. If you want to rename the module, click **Edit Name**; otherwise, go to step 9.

8. Enter a new name for the module, and then click **OK**.

    Note: This name is used to identify the module in all subsequent applications.

    ---

9. When you are finished configuring the module, click **Close**.

10. Repeat steps 3 to 9 for the other modules that you want to configure.

11. Close the Control Panel.

If you are using a DT9800-EC or DT9800-EC-I module, continue with the next section. Otherwise, continue with the instructions on wiring in Chapter 4 starting on page 37.

Configuring the EC and EC-I Series Modules

To use 5B or 7B Series signal conditioning backplanes with a DT9800-EC or DT9800-EC-I Series module, you must configure your USB module for proper operation.

By default, the 5B01 and 7BP16-1 backplanes map to single-ended analog input channels 0 to 15, the 5B08 and 7BP08-1 backplanes map to single-ended analog input channels 0 to 7, and the 7BP04-1 backplane maps to single-ended analog input channels 0 to 3. However, you can use channels 14 and 15 on the 5B01 or 7BP16-1 backplane as analog output channels 0 and 1, if you wish.

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

You can determine how channels 14 and 15 are used on the 5B01 and 7BP16-1 backplanes using DIP switch block SW1 on the DT9800-EC and DT9800-EC-I modules. DIP switch SW1 contains switches 1 to 4.

To use channels 14 and 15 on the 5B01 or 7BP16 as analog inputs, slide all the switches of DIP switch SW1 on the DT9800-EC or DT9800-EC-I Series module to the OFF position. To use channel 14 on the 5B01 or 7BP16 as analog output channel 0, set switches 1 and 3 of DIP switch SW1 on the DT9800-EC or DT9800-EC-I Series module to the ON position.

To use channel 15 on the 5B01 or 7BP16 as analog output channel 1, set switches 2 and 4 of DIP switch SW1 on the DT9800-EC or DT9800-EC-I Series modules to the ON position.

Refer to Figure 10 for the location of DIP switch SW1.

Function	Switch Settings
Channel 14 is an Analog Input	Set switches 1 and 3 of SW1 OFF.
Channel 15 is an Analog Input	Set switches 2 and 4 of SW1 OFF.
Channel 14 is an Analog Output	Set switches 1 and 3 of SW1 ON.
Channel 15 is an Analog Output	Set switches 2 and 4 of SW1 ON.
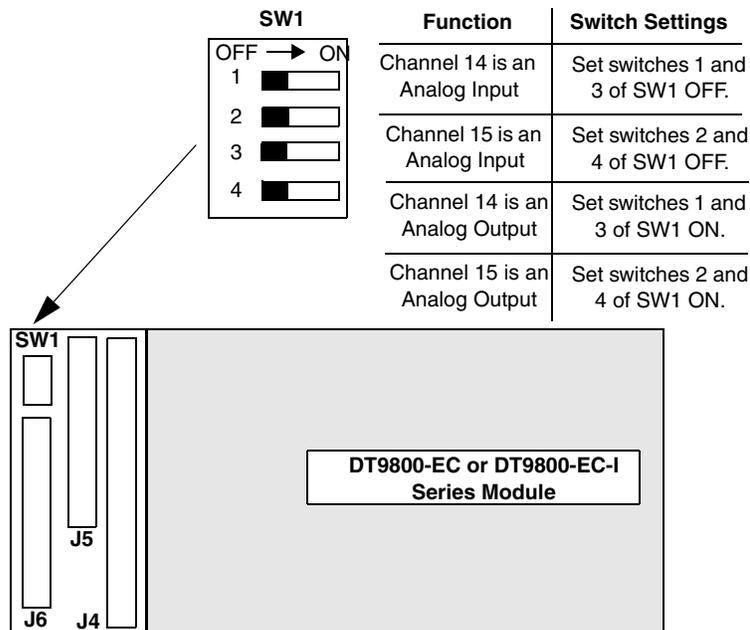
Figure 10: DIP Switch SW1

For example, assume that you are using a 5B01 with the DT9801-EC and that you want to use analog output channels 0 and 1. In this case, ensure that you wire DAC0 signals to channel 14 and DAC1 signals to channel 15 on the 5B01 backplane. Then, set all the switches of DIP switch SW1 on the DT9800-EC or DT9800-EC-I Series module to the ON position.

Also note the following considerations when using 5B and 7B Series signal conditioning accessories:

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

- 5B and 7B thermocouple modules provide their own CJC and return a voltage that already compensates for CJC. Therefore, when using 5B and 7B Series thermocouple modules, you do not have to compensate for offsets.

- 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 DT9800-EC and DT9800-EC-I Series modules.

- Connect all unused inputs to analog common. Reading an open channel can cause settling problems on the next valid channel.

4

Wiring Signals

```
            ╭─────────────────────────────────────╮
            │         Install the Module          │
            │ (see Chapter 2 starting on page 21) │
            ╰─────────────────────────────────────╯
                              │
            ┌─────────────────────────────────────┐
            │ Configure the Module and/or Device Driver │
            │    see Chapter 3 starting on page 31) │
            └─────────────────────────────────────┘
                              │
            ┌─────────────────────────────────────┐
            │             Wire Signals            │
            │            (this chapter)           │
            └─────────────────────────────────────┘
                              │
            ╭─────────────────────────────────────╮
            │     Verify the Operation of the Module │
            │ (see Chapter 5 starting on page 73) │
            ╰─────────────────────────────────────╯
```
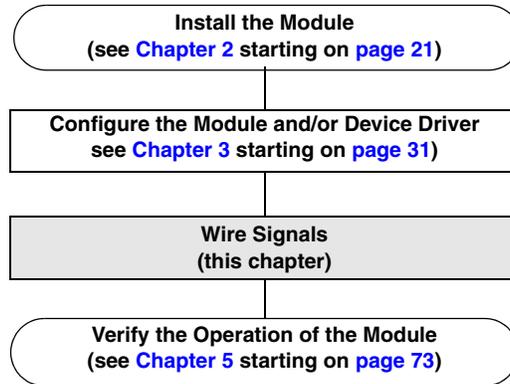
Note: For information about the special DT9804 BNC modules, refer to "DT9804 BNC Modules," in Appendix B.

Wiring Signals to a DT9800 Standard Series Module

Keep the following recommendations in mind when wiring signals to a DT9800 Standard Series module:

- Follow standard ESD procedures when wiring signals to the module.

- Use individually shielded twisted-pair wire (size 14 to 26 AWG) when using the DT9800 Standard Series module 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 DT9800 Standard Series module and cabling next to sources that produce high electromagnetic fields, such as large electric motors, power lines, solenoids, and electric arcs, unless the signals are enclosed in a mumetal shield.

- Prevent electrostatic discharge to the I/O while the module is operational.

- Connect all unused analog input channels to analog ground.

- When first installing the module, try wiring the signals as follows:

  – Wire a function generator or a known voltage source to analog input channel 0 using the differential configuration.

  – Wire an oscilloscope or voltage meter to analog output channel 0.

  – Wire a digital input to digital input line 0 of port A.

  – Wire a digital output to digital output line 0 of port B.

  – Wire an external clock or scope to counter/timer channel 0.

  – Then, run the Quick DataAcq application (described in Chapter 5 starting on page 73) to verify that the module is operating properly.

    Once you have determined that the module is operating properly, wire the signals according to your application's requirements.

Figure 11 shows the assignments of the screw terminals on DT9800 Standard Series modules. The screw terminal blocks are removable for your convenience.

User Clk Input 0	54	1	Channel 00
User Cntr Out 0	53	2	Channel 08/00 Ret
External Gate 0	52	3	Channel 01
Isolated Dig Gnd	51	4	Channel 09/01 Ret
User Clk Input 1	50	5	Channel 02
User Cntr Out 1	49	6	Channel 10/02 Ret
External Gate 1	48	7	Channel 03
Isolated Dig Gnd	47	8	Channel 11/03 Ret
Dynamic Dig Out	46	9	Channel 04
	DT9800 Standard Series Modules		
Digital Output 0	45	10	Channel 12/04 Ret
Digital Output 1	44	11	Channel 05
Digital Output 2	43	12	Channel 13/05 Ret
Digital Output 3	42	13	Channel 06
Digital Output 4	41	14	Channel 14/06 Ret
Digital Output 5	40	15	Channel 07
Digital Output 6	39	16	Channel 15/07 Ret
Digital Output 7	38	17	Isolated An Gnd
Isolated Dig Gnd	37	18	Amp Low

36 Isolated Dig Gnd
35 Digital Input 7
34 Digital Input 6
33 Digital Input 5
32 Digital Input 4
31 Digital Input 3
30 Digital Input 2
29 Digital Input 1
28 Digital Input 0
27 Isolated +5 V Out
26 Isolated Dig Gnd
25 Ext A/D Sample Clk
24 Ext A/D Trigger
23 Isolated Dig Gnd
22 Analog Out 1 Ret
21 Analog Out 1+
20 Analog Out 0 Ret
19 Analog Out 0+

Figure 11: DT9800 Standard Series Screw Terminal Assignments

Note: Screw terminals TB19 through TB22 are not used on DT9801, DT9803, and DT9805 modules since these modules do not support analog output.

Connecting Analog Input Signals

DT9800 Standard Series modules support both voltage and current loop inputs.

You can connect analog input signals to a DT9800 Standard Series module 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 module, and all the input signals are referred to the same common ground. When you choose the single-ended configuration, all 16 analog input channels are available on the DT9800 Standard Series.

- **Pseudo-Differential** – Choose this configuration when noise or common-mode voltage (the difference between the ground potentials of the signal source and the ground of the module or 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 16 analog input channels are available on the DT9800 Standard Series.

- **Differential** – Choose this configuration when you want to measure thermocouple or low-level signals (less than 1 V), you are using an A/D converter with high resolution (greater than 12 bits), noise is a significant part of the signal, or common-mode voltage exists. When you choose the differential configuration, eight analog input channels are available on the DT9800 Standard Series.

This section describes how to connect single-ended, pseudo-differential, and differential voltage inputs, as well as current loop and thermocouple inputs to the DT9800 Standard Series module.

Connecting Single-Ended Voltage Inputs

Figure 12 shows how to connect single-ended voltage inputs (channels 0, 1, and 8, in this case) to a DT9800 Standard Series module.

Note: If you are using single-ended inputs, set up the software so that bias return resistance is not used. For more information, refer to page 33.
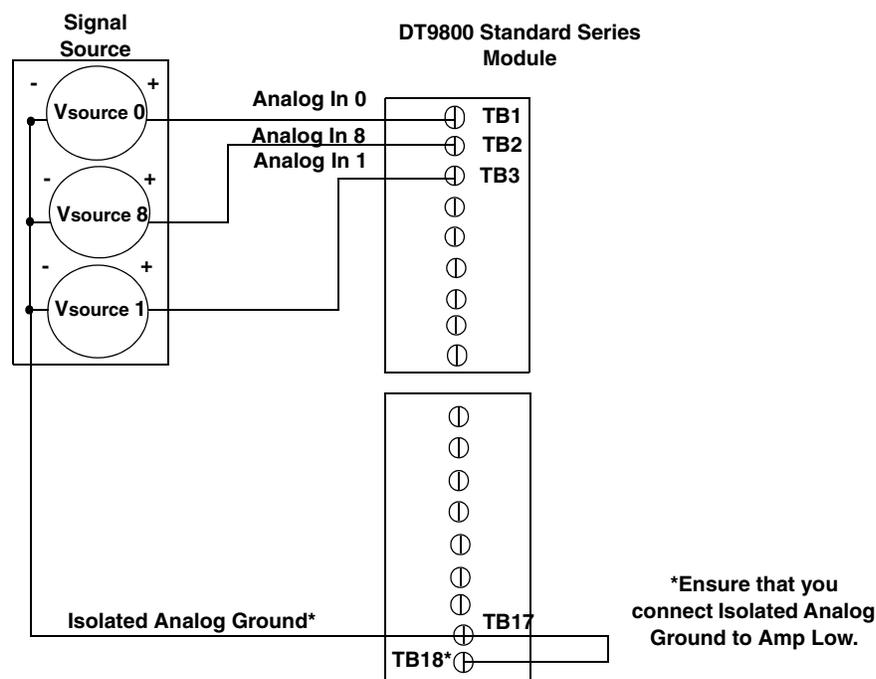
Figure 12: Connecting Single-Ended Voltage Inputs
(Shown for Channels 0, 1, and 8)

Connecting Pseudo-Differential Voltage Inputs

Figure 13 shows how to connect pseudo-differential voltage inputs (channels 0, 1, and 8, in this case) to a DT9800 Standard Series module.

*Make this connection as close to V_{IN} sources as possible to reduce ground loop errors. V_{cm} is the common mode voltage for all 16 analog inputs.

**Figure 13: Connecting Pseudo-Differential Voltage Inputs
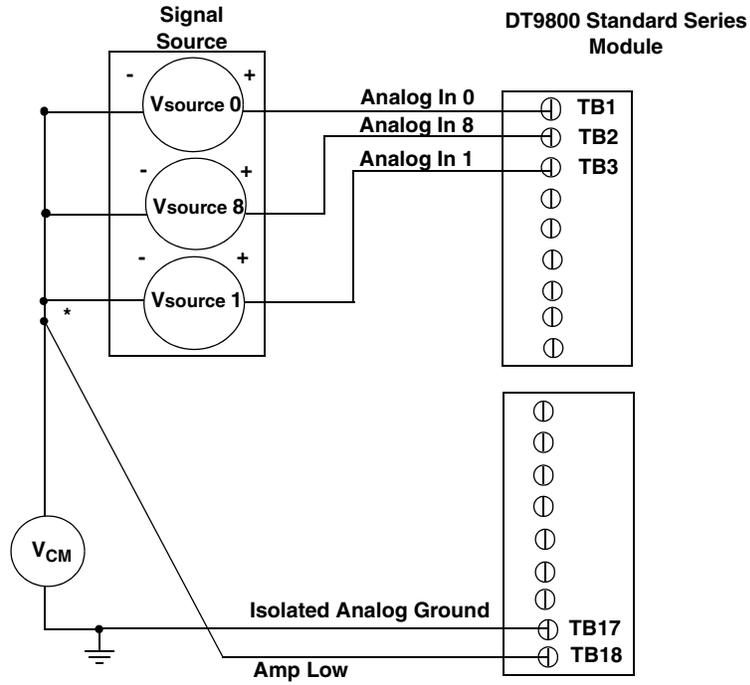(Shown for Channels 0, 1, and 8)**

Note: If you are using pseudo-differential inputs, set up the software so that bias return resistance is not used. For more information, refer to page 33.

Connecting Differential Voltage Inputs

Figure 14A illustrates how to connect a floating signal source to a DT9800 Standard Series module using differential inputs. (A floating signal source is a voltage source that has no connection with earth ground.)

Note: For floating signal sources, we recommend that you provide a bias return path for the differential channels by adding 10 kΩ of termination resistance from the low side of the channel to isolated analog ground.

For more information on configuring termination resistance, refer to page 33.

Figure 14B illustrates how to connect a nonfloating signal source to a DT9800 Series module using differential inputs. In this case, the signal source itself provides the bias return path; therefore, you do not need to provide bias return resistance through software.

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.

We recommend that you software-select 10 kΩ of resistance to connect the low side of channel 0 to analog ground (a physical resistor is not required). Refer to **page 33** for more information.
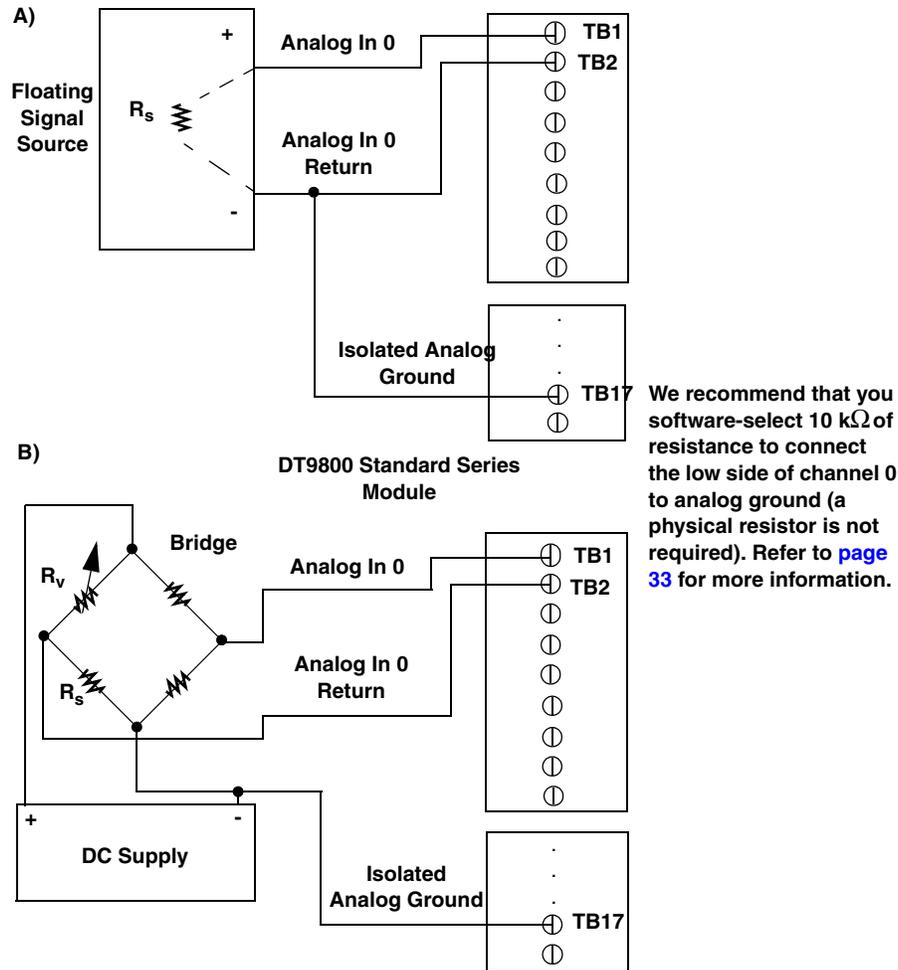
Figure 14: Connecting Differential Voltage Inputs (Shown for Channel 0)

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 DT9800 Standard Series module as shown in Figure 15. In this case, make sure that the low side of the signal (-) is connected to ground at the signal source, not at the DT9800 Standard Series module, and do not tie the two grounds together.

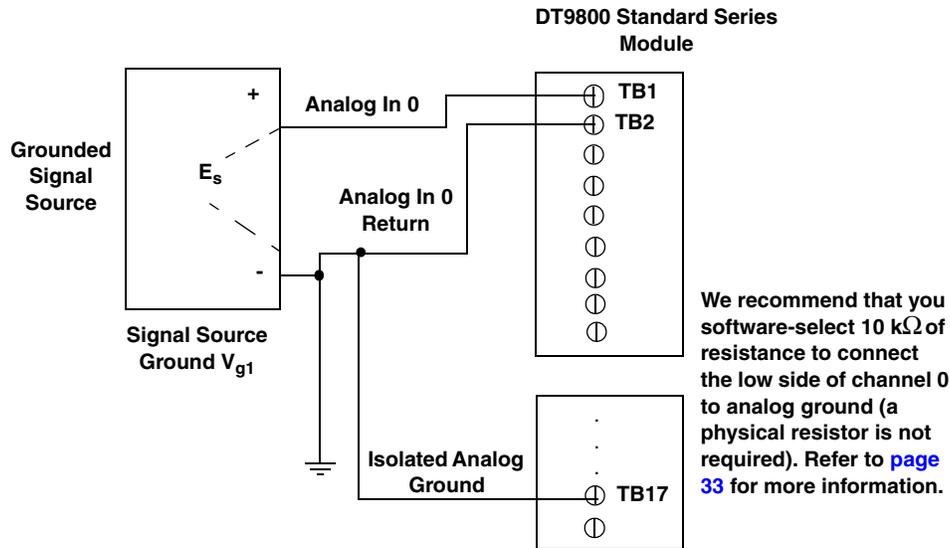**Figure 15: Connecting Differential Voltage Inputs from a Grounded Signal Source (Shown for Channel 0)**

Connecting Current Loop Inputs

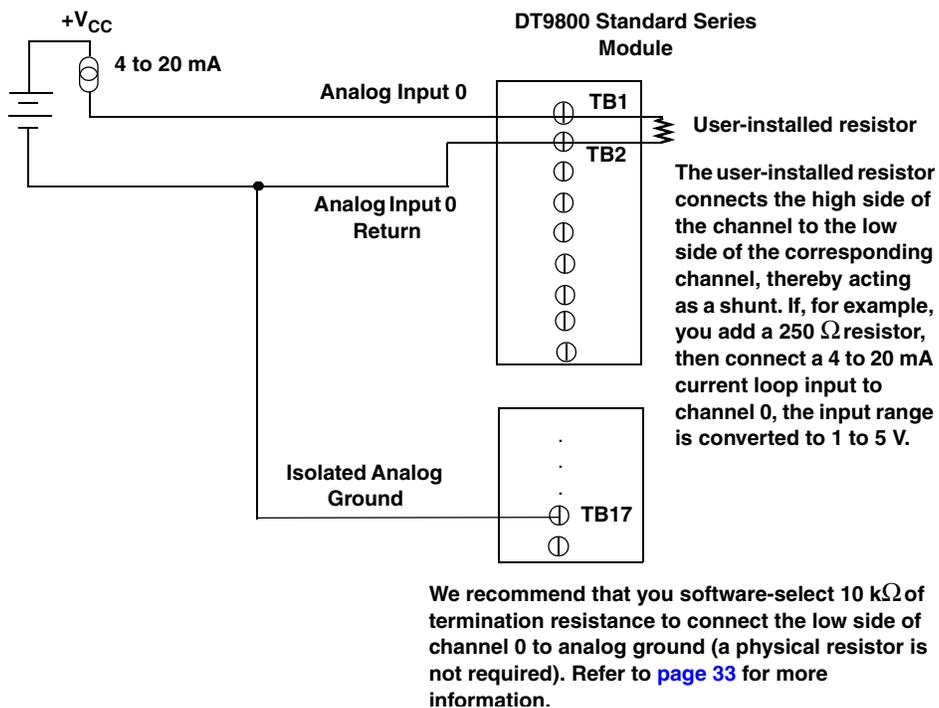Figure 16 shows how to connect a current loop input (channel 0, in this case) to a DT9800 Standard Series module.

Figure 16: Connecting Current Inputs (Shown for Channel 0)

Note: If you are using current loop inputs, set up the software so that bias return resistance is used. For more information, refer to page 33.

Connecting Thermocouple Inputs

The DT9805 and DT9806 modules provide cold junction compensation (CJC) on channel 0 at 10 mV/°C. You can attach up to seven thermocouples to the DT9805 or DT9806 module using channel 0 as a CJC. The accuracy of the CJC is ±1° from 5° to 45° C.

Figure 17 shows how to connect a thermocouple input to channel 1 of a DT9805 or DT9806 module.
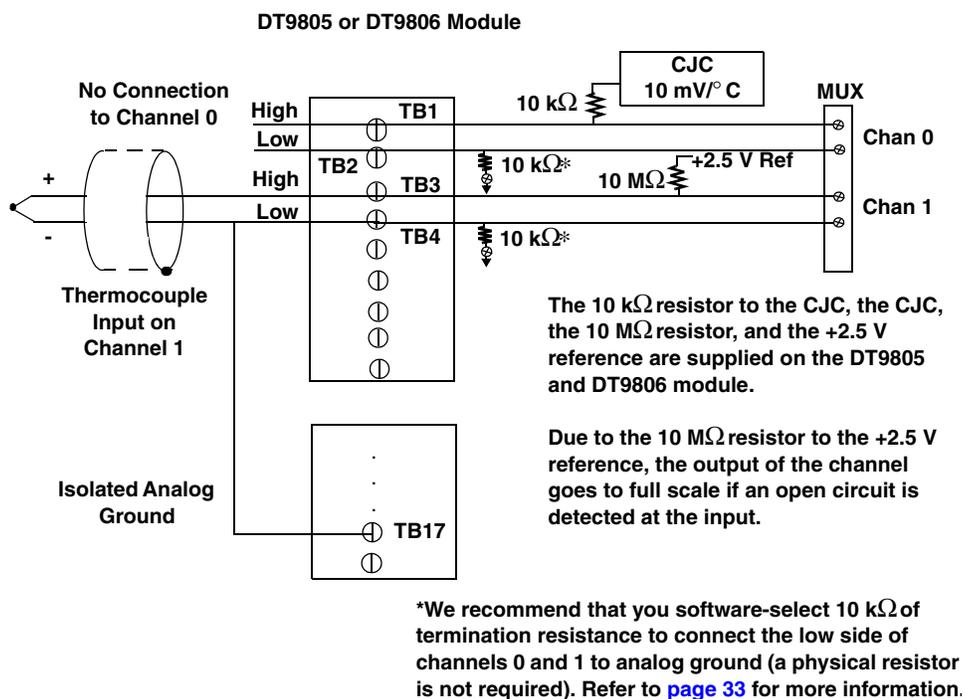
Figure 17: Connecting Thermocouple Inputs (Shown for Channel 1)

Note: You can connect voltages instead of thermocouples to the DT9805 and DT9806 modules. In this case, ensure that the signal you attach to channel 0 is capable of driving 10 kΩ, and that the signals you attach to channels 1, 2, 3, 4, 5, 6, and 7 are capable of driving 10 MΩ

Connecting Analog Output Signals

Figure 18 shows how to connect an analog output voltage signal (channel 0, in this case) to a DT9802, DT9804, or DT9806 module.

Figure 18: Connecting Analog Output Voltages (Shown for Channel 0)

Connecting Digital I/O Signals

Figure 19 shows how to connect digital input signals (lines 0 and 1, Port A, in this case) to a DT9800 Standard Series module.

Figure 19: Connecting Digital Inputs (Shown for Lines 0 and 1, Port A)

Figure 20 shows how to connect a digital output (line 0, Port B, in this case) to a DT9800 Standard Series module.

**DT9800 Standard
Series Module**

0 Out = LED On

500 Ω **Digital Output Line 0 (Port B)**
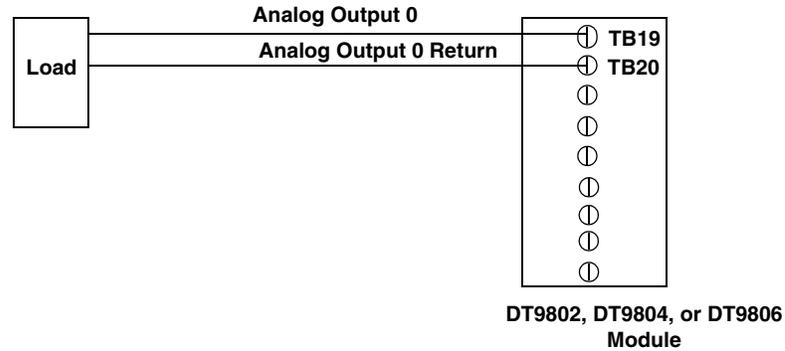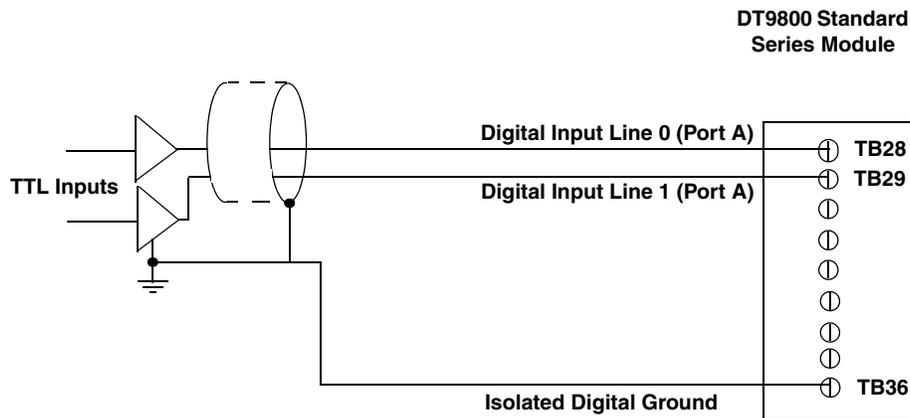
+

5 V

-

Isolated Digital Ground

TB45

TB37
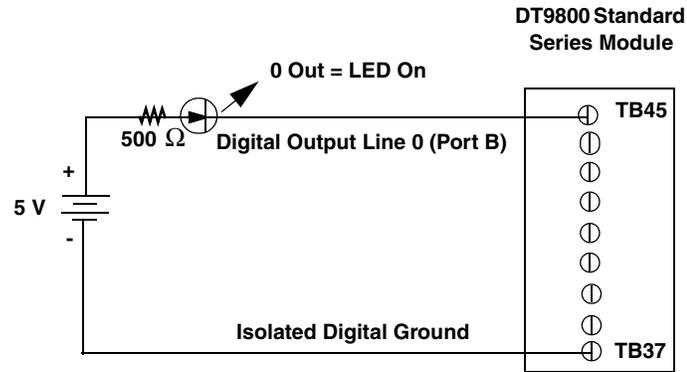
Figure 20: Connecting Digital Outputs (Shown for Line 0, Port B)

Connecting Counter/Timer Signals

DT9800 Standard Series modules provide two user counter/timer channels 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 106 for more information on using the counter/timers.

Connecting Event Counting Signals

Figure 21 shows one example of connecting event counting signals to a DT9800 Standard Series module using user counter 0. In this example, rising clock edges are counted while the gate is active.

User Clock Input 0

Gate 0

Signal Source

**External
Gating
Switch**

**Isolated Digital
Ground**

Isolated Digital Ground

TB54

TB52

TB51

TB47

**DT9800 Standard
Series Module**
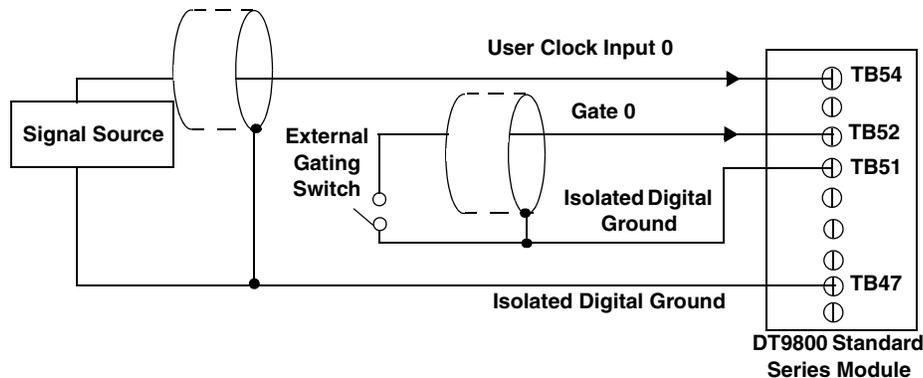
**Figure 21: Connecting Event Counting Signals
(Shown for Clock Input 0 and External Gate 0)**

Figure 22 shows another example of connecting event counting signals to a DT9800 Standard Series module using user counter 0. In this example, a software gate is used to start the event counting operation; however, this connection is not required.
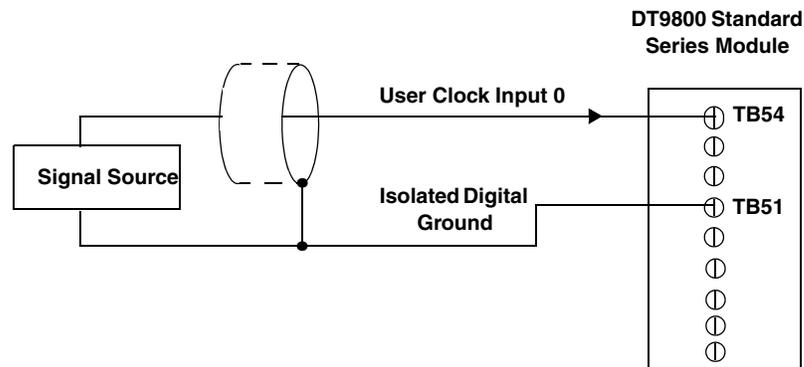
Figure 22: Connecting Event Counting Signals without an External Gate Input (Shown for Clock Input 0)

Figure 23 shows an example of how to cascade two counters externally to perform an event counting operation using user counters 0 and 1. Note that you can also internally cascade counters using software; if you internally cascade the counters, you do not need to make the external cascading connections.

Figure 23: Cascading Counters (Shown for Event Counting Using Counters 0 and 1 and External Gate 0)

Connecting Frequency Measurement Signals

This section describes two examples of how to connect frequency measurement signals to a DT9800 Standard Series module.

The first configuration uses the same wiring as an event counting application that does not use an external gate signal (see Figure 22 on page 49); a system timer specifies the duration of the frequency measurement. In this configuration, the frequency of the clock input is the number of counts divided by the duration of the Windows timer.

If you need more accuracy than the system timer provides, you can connect a pulse of a known duration (such as a one-shot output of another user counter) to the external gate input, as shown in Figure 24. In this configuration, the frequency of the clock input is the number of counts divided by the period of the external gate input.
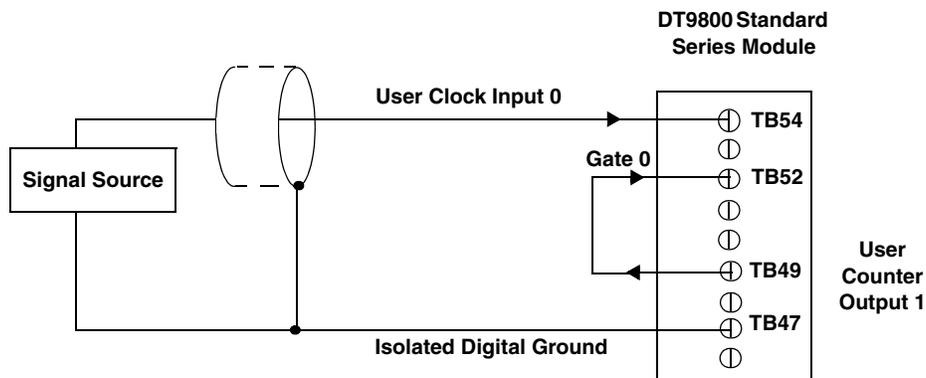
**Figure 24: Connecting Frequency Measurement Signals
(Shown for Clock Input 0 and External Gate 0)**

Connecting Pulse Output Signals

Figure 25 shows one example of connecting pulse output signals to a DT9800 Standard Series module using user counter 0.
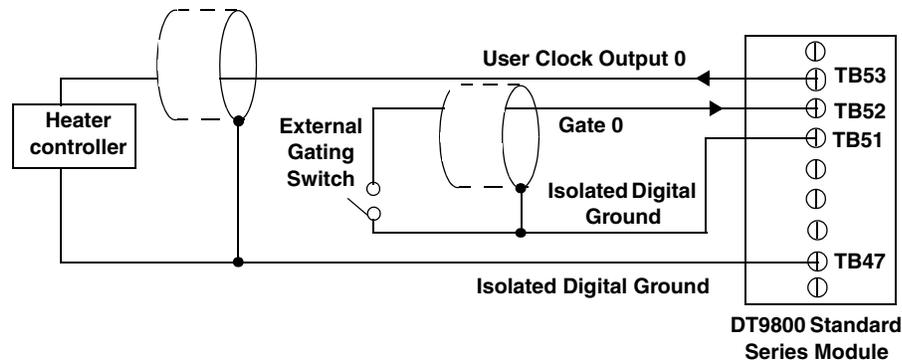
**Figure 25: Connecting Pulse Output Signals
(Shown for Counter Output 0 and Gate 0)**

Figure 26 shows an example of how to externally cascade two counters to perform a rate generation operation using user counters 0 and 1. Note that you can also cascade counters internally using software; if you internally cascade the counters, you do not need to make the external cascading connections. In this example, counter 1 gate is logic high.
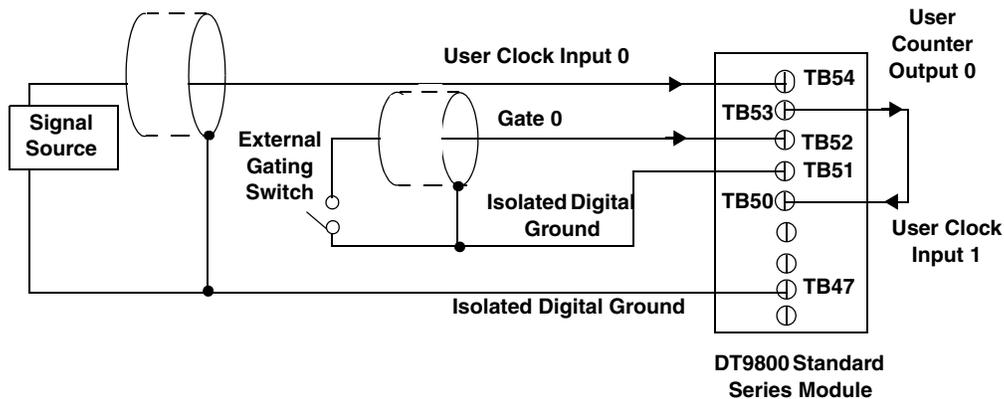
**Figure 26: Cascading Counters (Shown for Rate Generation Using
Counters 0 and 1 and External Gate 0)**

Figure 27 shows an example of how to cascade two counters externally to perform a one-shot operation using user counters 0 and 1. Note that you can also internally cascade counters using software; if you internally cascade the counters, you do not need to make the external cascading connections. In this example, counter 0 gate is logic high.
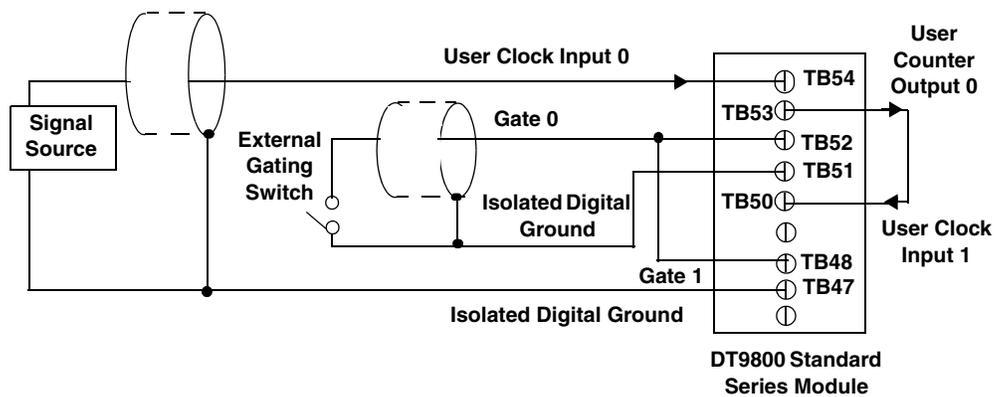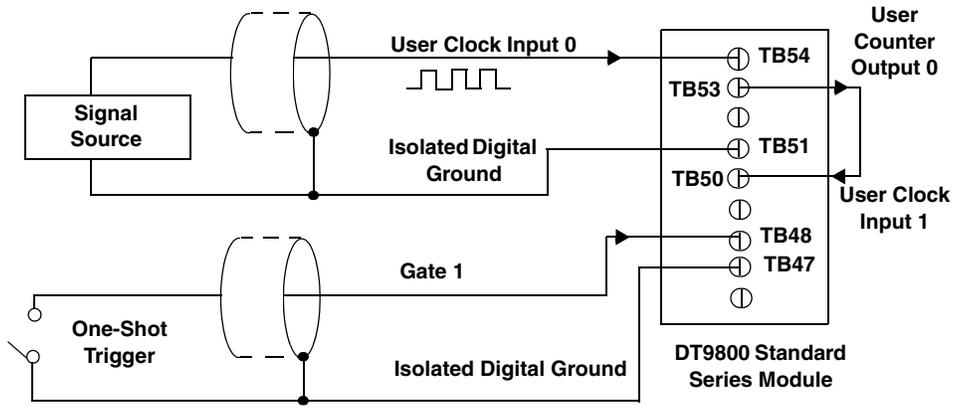
Figure 27: Cascading Counters (Shown for One-Shot Using Counters 0 and 1 and External Gate 1)

Wiring Signals to the EC or EC-I Series

<div style="background:#e5e5e5">

CAUTION:

To avoid electrostatic sensitivity, it is recommended that you unplug your DT9800 Series module from the computer before wiring signals.

</div>

When first installing the module, try wiring the signals as follows:

- Wire a function generator or a known voltage source to analog input channel 0 using the differential configuration.

- Wire an oscilloscope or voltage meter to analog output channel 0.

- Wire a digital input to digital input Port A.

- Wire an external clock or scope to counter/timer channel 0.

- When you finish wiring the signals, run the Quick DataAcq application (described in Chapter 5 starting on page 73) to verify that the module is operating properly. Once you have determined that the module is operating properly, wire the signals according to your application's requirements.

Table 2 lists the pin assignments for connector J6, Table 3 lists the pin assignments for connector J5, and Table 4 lists the pin assignments for connector J4 on the DT9800-EC and DT9800-EC-I Series modules.

Table 2: Connector J6 Pin Assignments

J6 Pin #[a]	AC1324 Screw Terminal[a]	Signal Name	J6 Pin #[a]	AC1324 Screw Terminal[a]	Signal Name
1	TB1	Analog Input 0	2	TB2	Analog Input 0 Return/ Analog Input 8
3	TB3	Isolated Analog Ground[b]	4	TB4	Analog Input 1 Return/ Analog Input 9
5	TB5	Analog Input 1	6	TB6	Isolated Analog Ground[b]
7	TB7	Analog Input 2	8	TB8	Analog Input 2 Return/ Analog Input 10
9	TB9	Isolated Analog Ground[b]	10	TB10	Analog Input 3 Return/ Analog Input 11
11	TB11	Analog Input 3	12	TB12	Isolated Analog Ground[b]
13	TB13	Analog Input 4	14	TB14	Analog Input 4 Return/ Analog Input 12
15	TB15	Isolated Analog Ground[b]	16	TB16	Analog Input 5 Return/ Analog Input 13
17	TB17	Analog Input 5	18	TB18	Isolated Analog Ground[b]

Table 2: Connector J6 Pin Assignments (cont.)

J6 Pin #[a]	AC1324 Screw Terminal[a]	Signal Name	J6 Pin #[a]	AC1324 Screw Terminal[a]	Signal Name
19	TB19	Analog Input 6	20	TB20	Analog Input 6 Return/ Analog Input 14
21	TB21	Not Connected	22	TB22	Analog Input 7 Return/ Analog Input 15
23	TB23	Analog Input 7	24	TB24	Isolated Analog Ground[b]
25	TB25	Amp Low	26	TB26	External A/D Trigger

a. Analog input signals 8 to 15 are not available on the 5B08 or 7BP08-1 backplane. Analog input signals 4 to 15 are not available on the 7BP04-1 backplane.

b. This signal is not isolated on the DT9800-EC Series.

Table 3: Connector J5 Pin Assignments

J5 Pin #	AC1324 Screw Terminal	Signal Name	J5 Pin #	AC1324 Screw Terminal	Signal Name
1	TB1	Analog Output 0	2	TB2	Analog Output 0 Return
3	TB3	Analog Output 1	4	TB4	Analog Output 1 Return
5	TB5	Isolated Digital Ground[a]	6	TB6	External A/D Trigger
7	TB7	External A/D Sample Clock	8	TB8	Isolated Digital Ground[a]
9	TB9	Isolated +5 V Output[a,b]	10	TB10	Not Connected
11	TB11	Not Connected	12	TB12	Dynamic Digital Output
13	TB13	Isolated Digital Ground[a]	14	TB14	User External Gate 1
15	TB15	User Counter Output 1	16	TB16	User Clock Input 1
17	TB17	Isolated Digital Ground[a]	18	TB18	User External Gate 0
19	TB19	User Counter Output 0	20	TB20	User Clock Input 0
21	TB21	Not Connected	22	TB22	Not Connected
23	TB23	Not Connected	24	TB24	Not Connected
25	TB25	Not Connected	26	TB26	Not Connected

a. This signal is not isolated on the DT9800-EC Series.

b. +5 V output is available only when one of the subsystems is activated, which, in turn, activates power to the module. This signal can be used as an input to power the digital output latch so that the outputs retain their states during power down.

Table 4: Connector J4 Pin Assignments

J4 Pin #	STP-EZ Screw Terminal	Signal Name	J4 Pin #	STP-EZ Screw Terminal	Signal Name
1	TB1	Not Connected	2	TB2	Digital Ground
3	TB3	Not Connected	4	TB4	Digital Ground
5	TB5	Not Connected	6	TB6	Digital Ground
7	TB7	Not Connected	8	TB8	Digital Ground
9	TB9	Not Connected	10	TB10	Digital Ground
11	TB11	Not Connected	12	TB12	Digital Ground
13	TB13	Not Connected	14	TB14	Digital Ground
15	TB15	Not Connected	16	TB16	Digital Ground
17	TB17	Digital Output 7	18	TB18	Digital Ground
19	TB19	Digital Output 6	20	TB20	Digital Ground
21	TB21	Digital Output 5	22	TB22	Digital Ground
23	TB23	Digital Output 4	24	TB24	Digital Ground
25	TB25	Digital Output 3	26	TB26	Digital Ground
27	TB27	Digital Output 2	28	TB28	Not Connected
29	TB29	Digital Output 1	30	TB30	Not Connected
31	TB31	Digital Output 0	32	TB32	Not Connected
33	TB33	Digital Input 7	34	TB34	Not Connected
35	TB35	Digital Input 6	36	TB36	Not Connected
37	TB37	Digital Input 5	38	TB38	Not Connected
39	TB39	Digital Input 4	40	TB40	Not Connected
41	TB41	Digital Input 3	42	TB42	Not Connected
43	TB43	Digital Input 2	44	TB44	Not Connected
45	TB45	Digital Input 1	46	TB46	Not Connected
47	TB47	Digital Input 0	48	TB48	Not Connected
49	TB49	Not Connected	50	TB50	Not Connected

Connecting Analog Input Signals

This section describes how to connect analog input signals to a DT9800-EC or DT9800-EC-I Series module using a 5B01, 5B08, 7BP16-1, 7BP08-1, or 7BP04-1 signal conditioning backplane, or an AC1324 screw terminal panel.

Using 5B or 7B Series Signal Conditioning Modules

When using DT9800-EC or DT9800-EC-I Series modules with 5B and 7B Series signal conditioning backplanes and modules, keep the following considerations in mind:

- The 7BP04-1 backplane maps to single-ended analog input channels 0 to 3.

- The 5B08 and 7BP08-1 backplanes map to single-ended analog input channels 0 to 7.

- By default, the 5B01 and 7BP16-1 backplanes map to single-ended analog input channels 0 to 15. However, you can use channels 14 and 15 on the 5B01 or 7BP16-1 backplane as analog output channels 0 and 1 by configuring DIP switch SW1 on the module. Refer to page 34 for more information on configuring DIP switch SW1.

- Install jumper W3 on the 5B Series backplane to connect Amp Low to Analog Ground on the backplane.

- 5B and 7B Series thermocouple modules provide their own CJC and return a voltage that already compensates for CJC. Therefore, when using 5B or 7B Series modules, you do not have to compensate for offsets.

- 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 DT9800-EC Series module.

- Connect all unused inputs to analog common. Reading an open channel can cause settling problems on the next valid channel.

Refer to the *5B Series User's Manual* and 5B Series data sheets or the *7B Series User's Manual* for detailed information on using the backplanes and modules, including how to configure jumpers on the backplane, install modules, wire signals to the modules, and connect power to the backplanes.

Using an AC1324 Screw Terminal Panel

The DT9800-EC and DT9800-EC-I Series modules support both voltage and current loop inputs through connector J6. You attach the AC1324 screw terminal to connector J6 on the DT9800-EC or DT9800-EC-I Series module as shown in Figure 28.
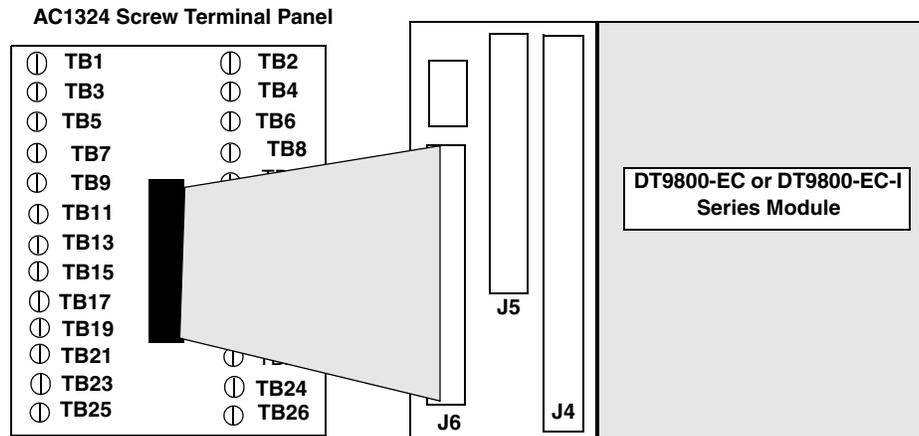
Figure 28: Attaching the AC1324 Screw Terminal Panel to Connector J6 of the DT9800-EC/EC-I for Analog Inputs

You can connect analog input voltage signals to an AC1324 screw terminal panel 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 DT9800-EC or DT9800-EC-I Series module, and all the input signals are referred to the same common ground. When you choose the single-ended configuration, all 16 analog input channels are available.

- **Pseudo-Differential** – Choose this configuration when noise or common-mode voltage (the difference between the ground potentials of the signal source and the ground of the DT9800-EC or DT9800-EC-I Series module or 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 16 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 (greater than 12 bits), noise is a significant part of the signal, or common-mode voltage exists. When you choose the differential configuration, eight analog input channels are available.

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

Keep the following recommendations in mind when wiring analog input signals to the AC1324 screw terminal panel:

- Use individually shielded twisted-pair wire (size 14 to 26 AWG) when using the DT9800-EC or DT9800-EC-I Series module and AC1324 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 DT9800-EC or DT9800-EC-I Series module, AC1324, and cabling next to sources that produce high electromagnetic fields, such as large electric motors, power lines, solenoids, and electric arcs, unless the signals are enclosed in a mumetal shield.

- Prevent electrostatic discharge to the I/O while the module is operational.

This section describes how to connect single-ended, pseudo-differential, and differential voltage inputs, as well as current loop inputs to the AC1324 screw terminal panel. For a description of the screw terminal blocks on the AC1324 screw terminal panel, refer to Table 2 on page 53.

Connecting Single-Ended Voltage Inputs

Figure 29 shows how to connect single-ended voltage inputs (channels 0, 1, and 2, in this case) to the AC1324 screw terminal panel.

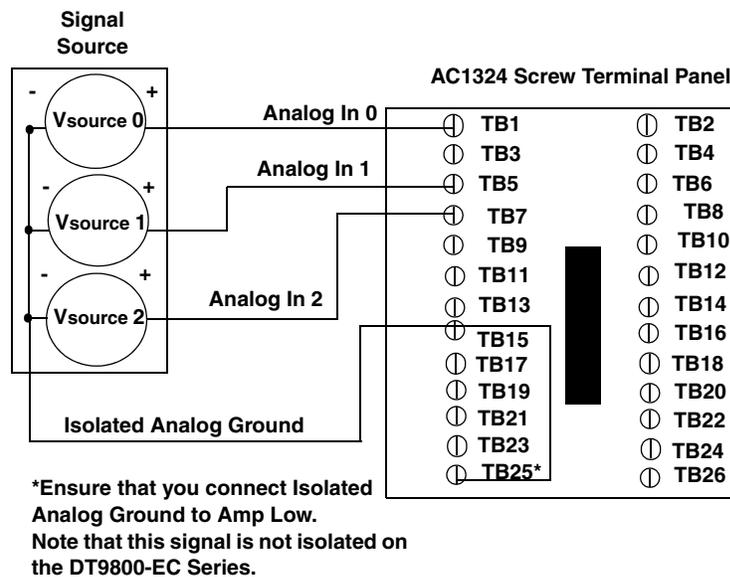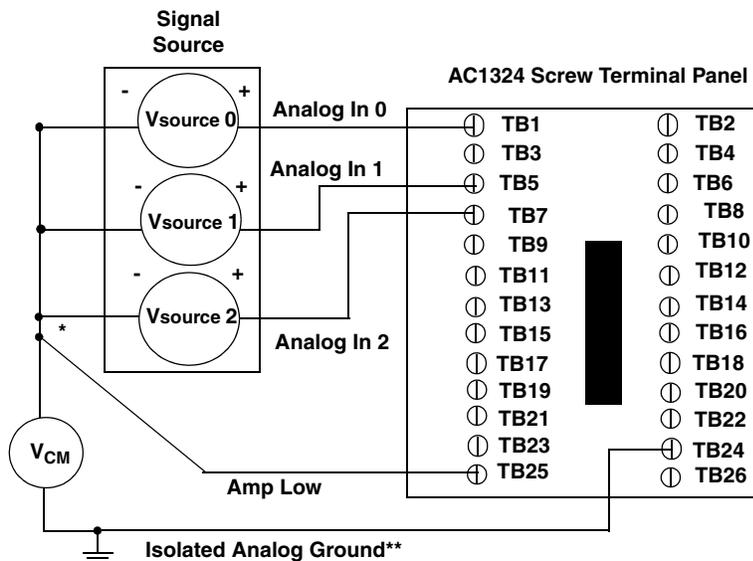
**Figure 29: Connecting Single-Ended Voltage Inputs
(Shown for Channels 0, 1, and 2)**

Note: If you are using single-ended inputs, set up the software so that bias return resistance is not used. For more information, refer to page 33.

Connecting Pseudo-Differential Voltage Inputs

Figure 30 shows how to connect pseudo-differential voltage inputs (channels 0, 1, and 2, in this case) to the AC1324 screw terminal panel.

Signal Source

AC1324 Screw Terminal Panel

*Make this connection as close to V_{IN} sources as possible to reduce ground loop errors. V_{cm} is the common mode voltage for all 16 analog inputs.

**This signal is not isolated on the DT9800-EC Series.

Figure 30: Connecting Pseudo-Differential Voltage Inputs (Shown for Channels 0, 1, and 2)

Note: If you are using pseudo-differential inputs, set up the software so that bias return resistance is not used. For more information, refer to page 33.

Connecting Differential Voltage Inputs

Figure 31A illustrates how to connect a floating signal source to a DT9800-EC or DT9800-EC-I Series module using differential inputs. (A floating signal source is a voltage source that has no connection with earth ground.)

For floating signal sources, it is recommended that you provide a bias return path for the differential channels by adding 10 kΩ of termination resistance from the low side of the channel to isolated analog ground. For more information on configuring the bias return resistance, refer to page 33.
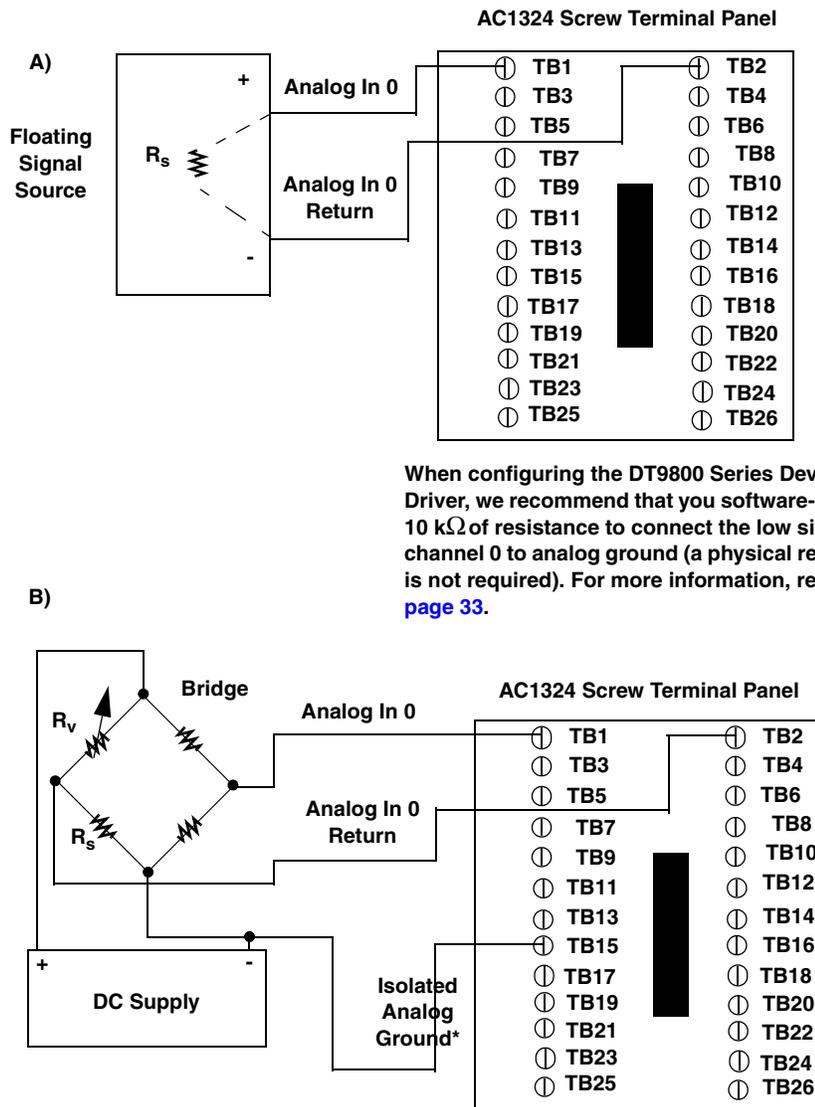
Note: Analog ground is not isolated on the DT9800-EC Series.

Figure 31B illustrates how to connect a nonfloating signal source to a DT9800-EC or
DT9800-EC-I Series module using differential inputs. In this case, the signal source itself
provides the bias return path; therefore, you do not need to provide bias return resistance
through software.

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 31: Connecting Differential Voltage Inputs (Shown for Channel 0)

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 AC1324 screw terminal panel as shown in Figure 32. In this case, make sure that the low side of the signal (-) is connected to ground at the signal source, not at the AC1324 screw terminal panel, and do not tie the two grounds together.

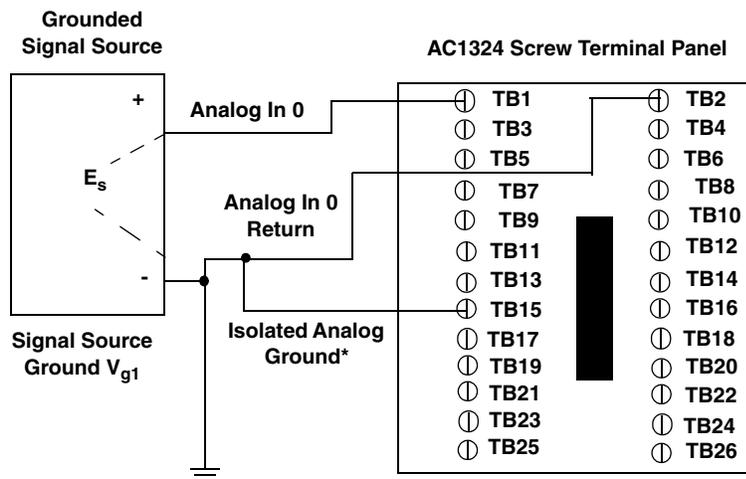
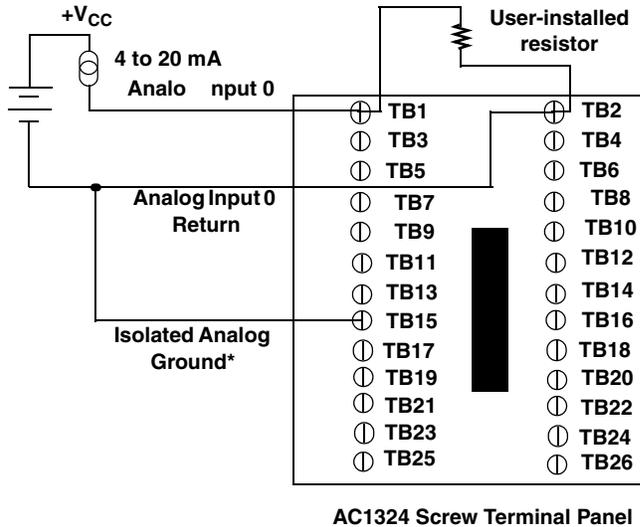*This signal is not isolated on the DT9800-EC Series.**

When configuring the DT9800 Series Device Driver, we recommend that you software-select 10 kΩ of resistance to connect the low side of channel 0 to analog ground (a physical resistor is not required). For more information, refer to page 33.

**Figure 32: Connecting Differential Voltage Inputs from a
Grounded Signal Source (Shown for Channel 0)**

61

Connecting Current Loop Inputs

Figure 33 shows how to connect a current loop input (channel 0, in this case) to an AC1324 screw terminal panel.

AC1324 Screw Terminal Panel

*This signal is not isolated on the DT9800-EC Series.

The user-installed resistor connects the high side of the channel to the low side of the corresponding channel, thereby acting as a shunt. If, for example, you add a 250 Ω resistor, then connect a 4 to 20 mA current loop input to channel 0, the input range is converted to 1 to 5 V.

When configuring the DT9800 Series Device Driver, we recommend that you software-select 10 kΩ of termination resistance to connect the low side of channel 0 to analog ground (a physical resistor is not required). For more information, refer to page 33.

Figure 33: Connecting Current Inputs (Shown for Channel 0)

Note: If you are using current loop inputs, set up the software so that bias return resistance is used. For more information, refer to page 33.

Connecting Analog Output Signals

The DT9800-EC and DT9800-EC-I Series modules support analog outputs through connector J5. This section shows how to wire analog output signals to an AC1324 screw terminal panel attached to connector J5.

You attach the AC1324 screw terminal to connector J5 on the DT9800-EC or DT9800-EC-I Series module as shown in Figure 34.
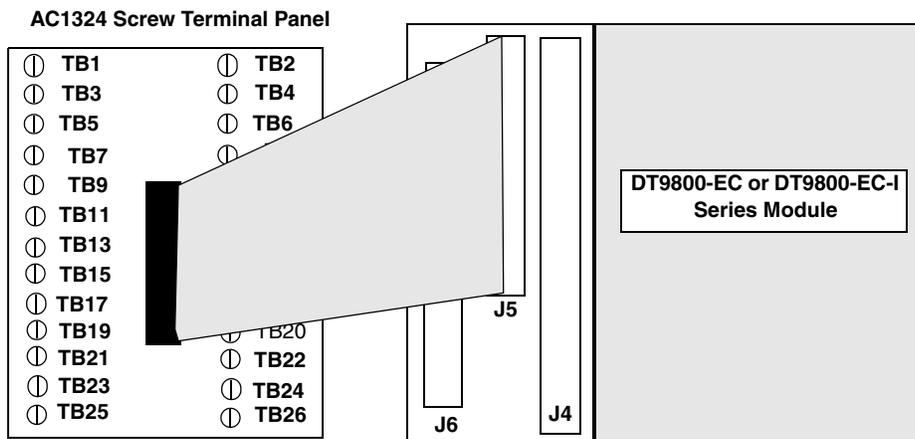
AC1324 Screw Terminal Panel

TB1	TB2
TB3	TB4
TB5	TB6
TB7	
TB9	
TB11	
TB13	
TB15	
TB17	
TB19	TB20
TB21	TB22
TB23	TB24
TB25	TB26

DT9800-EC or DT9800-EC-I Series Module

J5   J6   J4

Figure 34: Attaching the AC1324 Screw Terminal Panel to Connector J5 of the DT9800-EC/EC-I Series for Analog Outputs

Figure 35 shows how to connect an analog output voltage signal (channel 0, in this case) to an AC1324 screw terminal. For a description of the screw terminal blocks, refer to Table 3 on page 54.

AC1324 Screw Terminal Panel

Analog Output 0

Load

Analog Output 0 Return

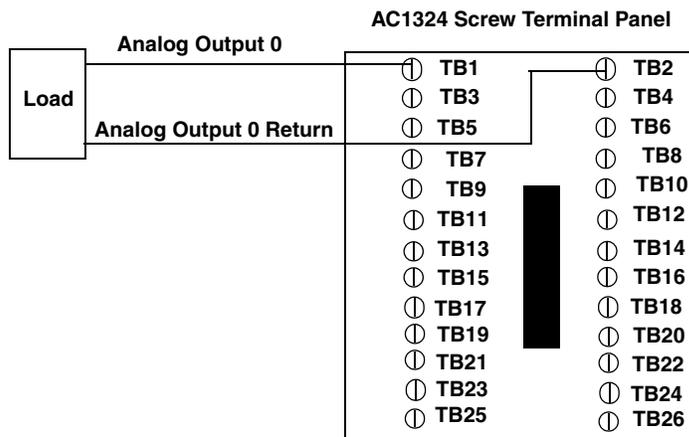| TB1 | TB2 |
TB3	TB4
TB5	TB6
TB7	TB8
TB9	TB10
TB11	TB12
TB13	TB14
TB15	TB16
TB17	TB18
TB19	TB20
TB21	TB22
TB23	TB24
TB25	TB26

Figure 35: Connecting Analog Output Voltages Using an External +10 V Reference (Shown for Channel 0)

Connecting Digital I/O Signals

The DT9800-EC and DT9800-EC-I Series modules support digital I/O signals through connector J4. This section shows how to wire digital I/I signals to an STP-EZ screw terminal panel attached to connector J4.

You attach the STP-EZ screw terminal to connector J4 on the DT9800-EC or DT9800-EC-I Series module as shown in Figure 36.

Figure 36: Attaching the STP-EZ Screw Terminal Panel to Connector J4 of the DT9800-EC/EC-I Series for Digital I/O

Figure 37 shows how to connect digital input signals (lines 0 and 1 of Port A, in this case) to an STP-EZ screw terminal. For a description of the screw terminal blocks, refer to Table 4 on page 55.

Figure 37: Connecting Digital Inputs (Shown for Lines 0 and 1, Port A)

[Figure 38](#) shows how to connect a digital output (line 0 of Port B, in this case) to an STP-EZ screw terminal panel.
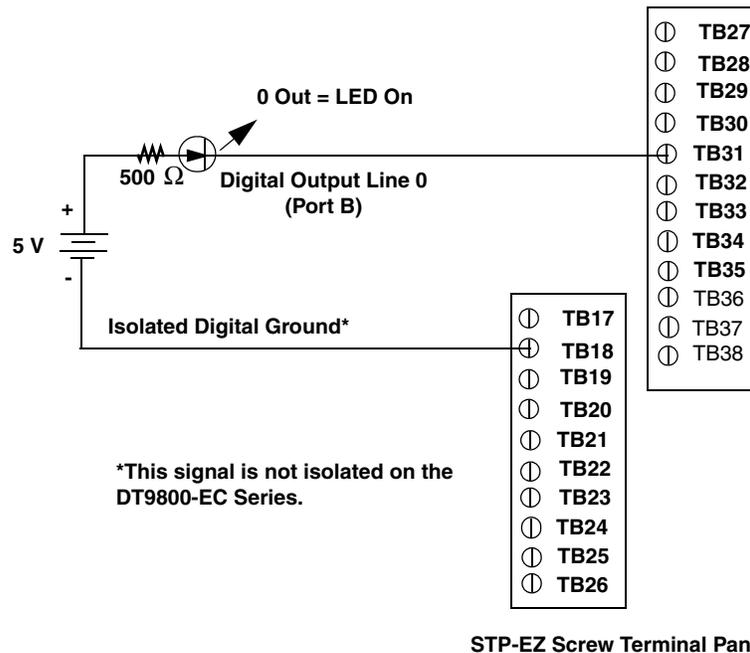
Figure 38: Connecting Digital Outputs (Shown for Line 0, Port B)

65

If you want the digital outputs to retain their values during power down, you must connect +5 V external power to the +5 V isolated power signal of connector J5 on the module and activate one of the subsystems on the module, which, in turn, activates power to the module.

Figure 39 shows how to connect the AC1324 screw terminal to connector J5 on the DT9800-EC or DT9800-EC-I Series module.

Figure 39: Attaching the AC1324 Screw Terminal Panel to Connector J5 of the DT9800-EC/EC-I Series for +5 V Power

Figure 40 shows how to wire +5 V external power to the AC1315 screw terminal panel.
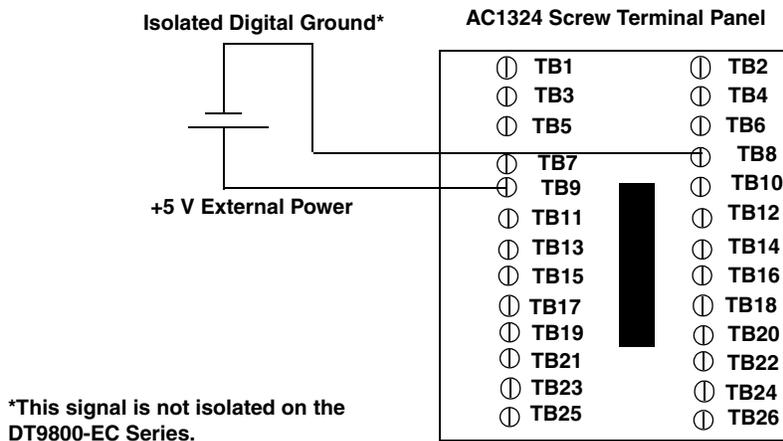
Figure 40: Connecting +5V External Power to Retain Digital Output States

Connecting Counter/Timer Signals

The DT9800-EC and DT9800-EC-I Series modules support two counter/timer channels through connector J5. This section shows how to wire counter/timer signals to an AC1324 screw terminal panel attached to connector J5.

You attach the AC1324 screw terminal to connector J5 on the DT9800-EC or DT9800-EC-I Series module as shown in Figure 41.
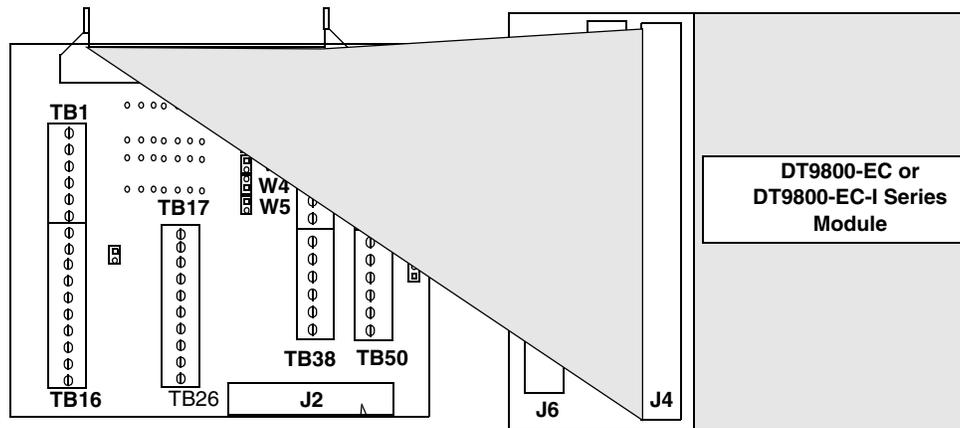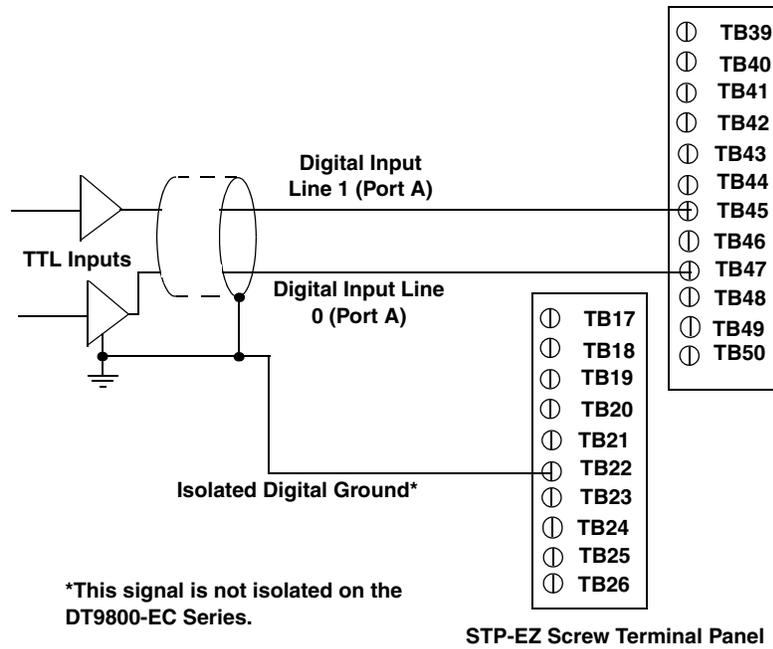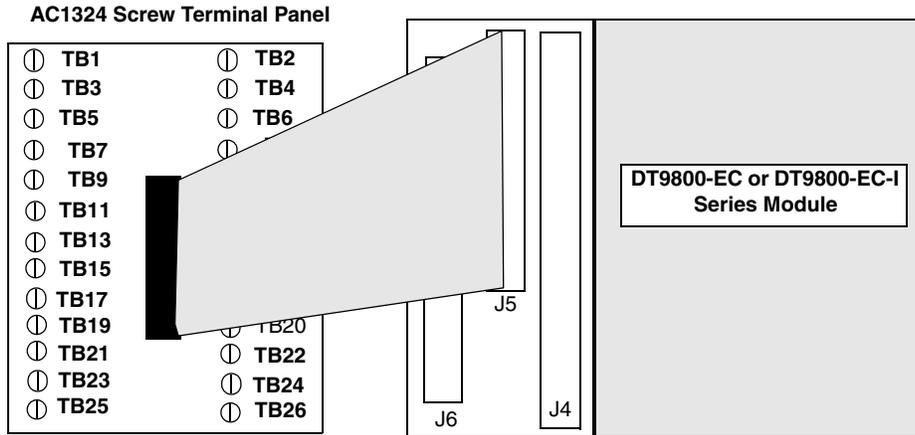
AC1324 Screw Terminal Panel

TB1	TB2
TB3	TB4
TB5	TB6
TB7	
TB9	
TB11	
TB13	
TB15	
TB17	
TB19	TB20
TB21	TB22
TB23	TB24
TB25	TB26

DT9800-EC or DT9800-EC-I Series Module

J5

J6   J4
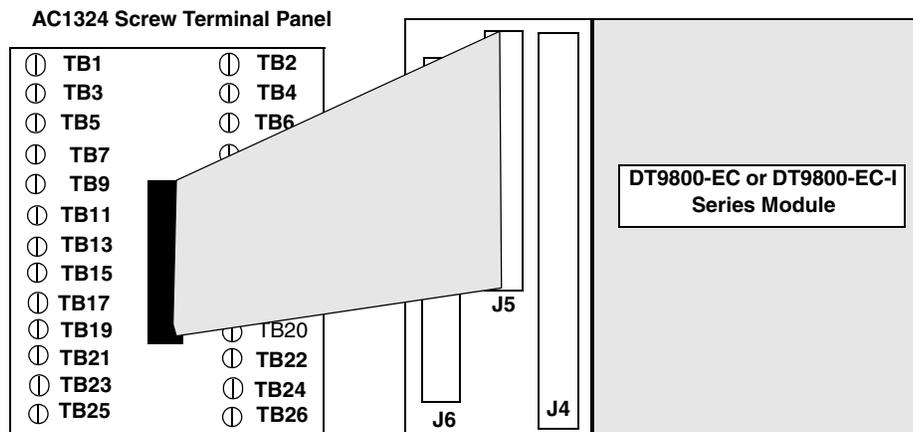
Figure 41: Attaching the AC1324 Screw Terminal Panel to Connector J5 of the DT9800-EC/EC-I Series for Counter/Timer Signals

You can use these counter/timer channels for the following operations:

- Event counting

- Frequency measurement

- Pulse output (rate generation, one-shot, and repetitive one-shot)

The following sections describe how to wire counter/timer signals to an AC1324 screw terminal panel to perform these operations. For a description of the screw terminal blocks, refer to Table 3 on page 54.

Connecting Event Counting Signals

Figure 42 shows one example of connecting event counting signals to user counter 0 using an AC1324 screw terminal panel attached to connector J5. In this example, rising clock edges are counted while the gate is active.
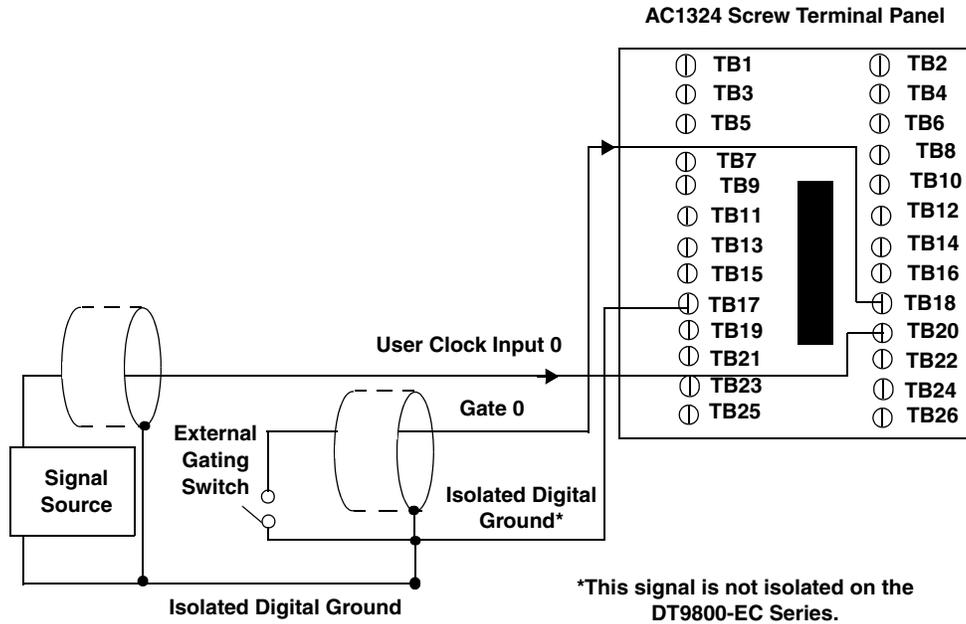
**Figure 42: Connecting Event Counting Signals
(Shown for Clock Input 0 and External Gate 0)**

Figure 43 shows another example of connecting event counting signals to user counter 0 using an AC1324 screw terminal panel attached to connector J5. In this example, a software gate is used to start the event counting operation; however, this connection is not required.

AC1324 Screw Terminal Panel

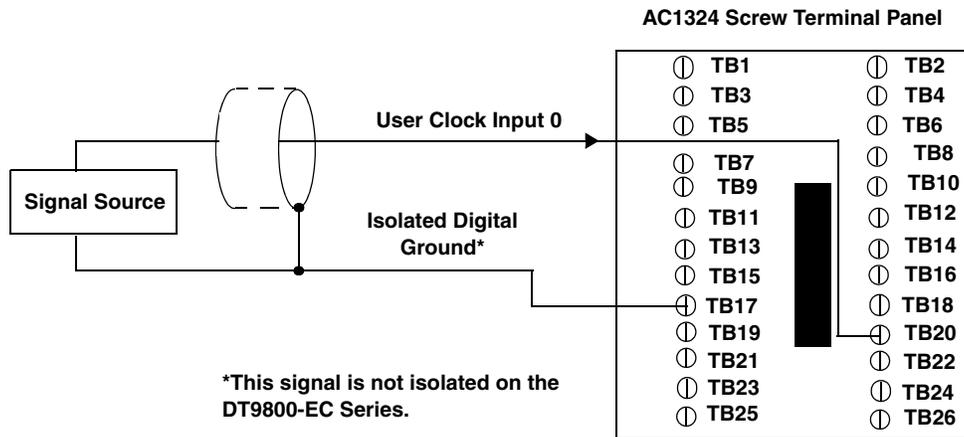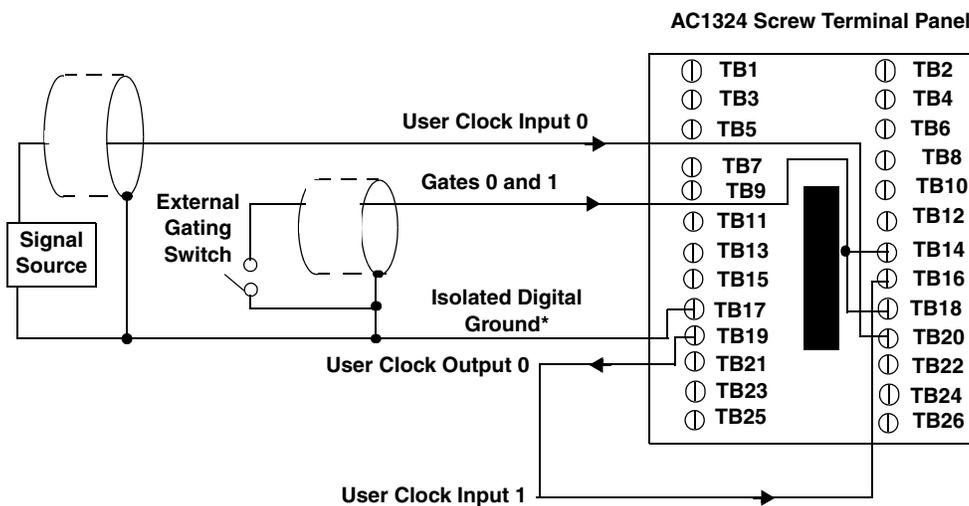|			
⊙	**TB1**	⊙	**TB2**
⊙	**TB3**	⊙	**TB4**
⊙	**TB5**	⊙	**TB6**
⊙	**TB7**	⊙	**TB8**
⊙	**TB9**	⊙	**TB10**
⊙	**TB11**	⊙	**TB12**
⊙	**TB13**	⊙	**TB14**
⊙	**TB15**	⊙	**TB16**
⊕	**TB17**	⊙	**TB18**
⊙	**TB19**	⊕	**TB20**
⊙	**TB21**	⊙	**TB22**
⊙	**TB23**	⊙	**TB24**
⊙	**TB25**	⊙	**TB26**

User Clock Input 0

Signal Source

Isolated Digital Ground*

*This signal is not isolated on the DT9800-EC Series.

Figure 43: Connecting Event Counting Signals without an External Gate Input (Shown for Clock Input 0)

Figure 44 shows an example of how to cascade counters 0 and 1 externally to perform an event counting operation using an AC1324 screw terminal panel attached to connector J5. Note that you can also internally cascade counters using software; if you internally cascade the counters, you do not need to make the external cascading connections.

AC1324 Screw Terminal Panel

⊙	**TB1**	⊙	**TB2**
⊙	**TB3**	⊙	**TB4**
⊙	**TB5**	⊙	**TB6**
⊙	**TB7**	⊙	**TB8**
⊙	**TB9**	⊙	**TB10**
⊙	**TB11**	⊙	**TB12**
⊙	**TB13**	⊕	**TB14**
⊙	**TB15**	⊕	**TB16**
⊕	**TB17**	⊕	**TB18**
⊕	**TB19**	⊕	**TB20**
⊙	**TB21**	⊙	**TB22**
⊙	**TB23**	⊙	**TB24**
⊙	**TB25**	⊙	**TB26**

User Clock Input 0

Gates 0 and 1

External Gating Switch

Signal Source

Isolated Digital Ground*

User Clock Output 0

User Clock Input 1

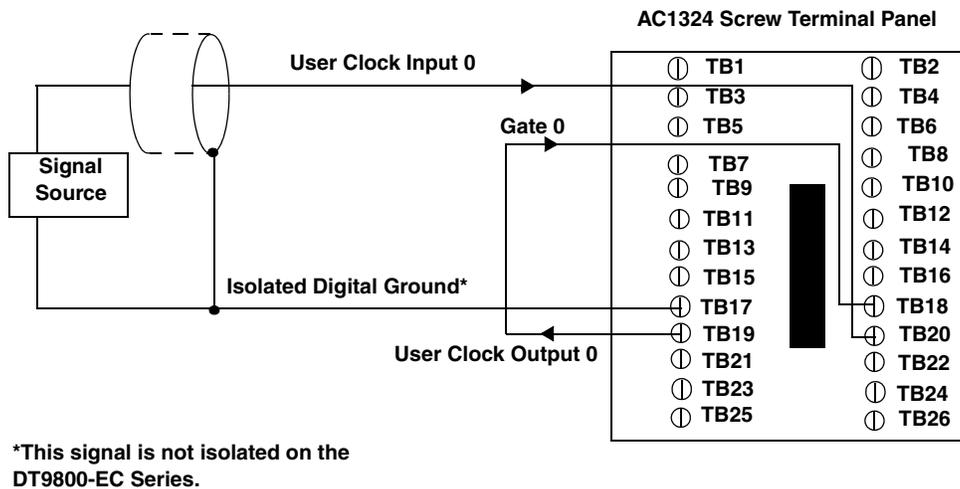***This signal is not isolated on the DT9800-EC Series.**

Figure 44: Cascading Counters (Shown for Event Counting Using Counters 0 and 1 and External Gate 0)

Connecting Frequency Measurement Signals

This section describes two examples of how to connect frequency measurement signals to an AC1324 screw terminal panel attached to connector J5.

The first configuration uses the same wiring as an event counting application that does not use an external gate signal (see Figure 43 on page 69); the software uses the Windows timer to specify the duration of the frequency measurement. In this configuration, the frequency of the clock input is the number of counts divided by the duration of the Windows timer.

If you need more accuracy than the Windows timer provides, you can connect a pulse of a known duration (such as a one-shot output of another user counter) to the external gate input, as shown in Figure 45. In this configuration, the frequency of the clock input is the number of counts divided by the period of the external gate input.

AC1324 Screw Terminal Panel

TB1	TB2
TB3	TB4
TB5	TB6
TB7	TB8
TB9	TB10
TB11	TB12
TB13	TB14
TB15	TB16
TB17	TB18
TB19	TB20
TB21	TB22
TB23	TB24
TB25	TB26

User Clock Input 0

Gate 0

Signal Source

Isolated Digital Ground*

User Clock Output 0

***This signal is not isolated on the DT9800-EC Series.**

**Figure 45: Connecting Frequency Measurement Signals
(Shown for Clock Input 0 and External Gate 0)**

Connecting Pulse Output Signals

Figure 46 shows one example of connecting pulse output signals to user counter 0 using an AC1324 screw terminal panel attached to connector J5.
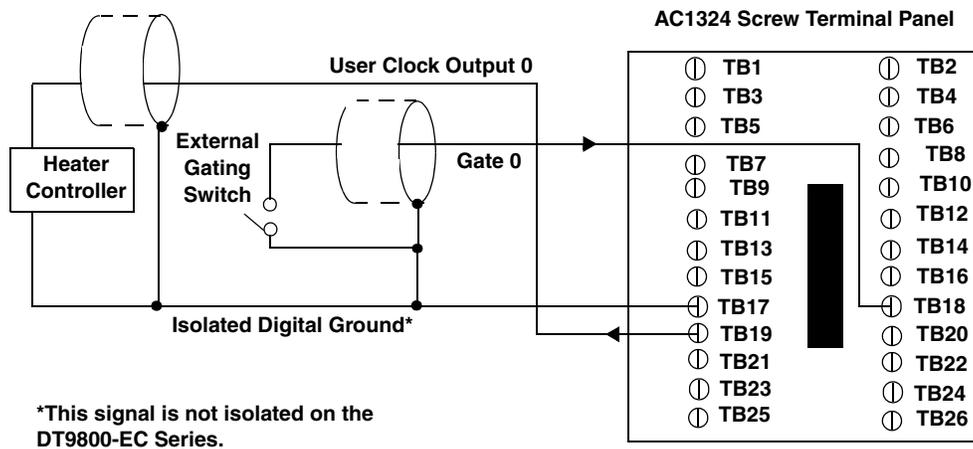
**Figure 46: Connecting Pulse Output Signals
(Shown for Counter Output 0 and Gate 0)**

Figure 47 shows an example of how to externally cascade user counters 0 and 1 to perform a rate generation operation using an AC1324 screw terminal panel attached to connector J5. Note that you can also cascade counters internally using software; if you internally cascade the counters, you do not need to make the external cascading connections. In this example, counter 1 gate is logic high.
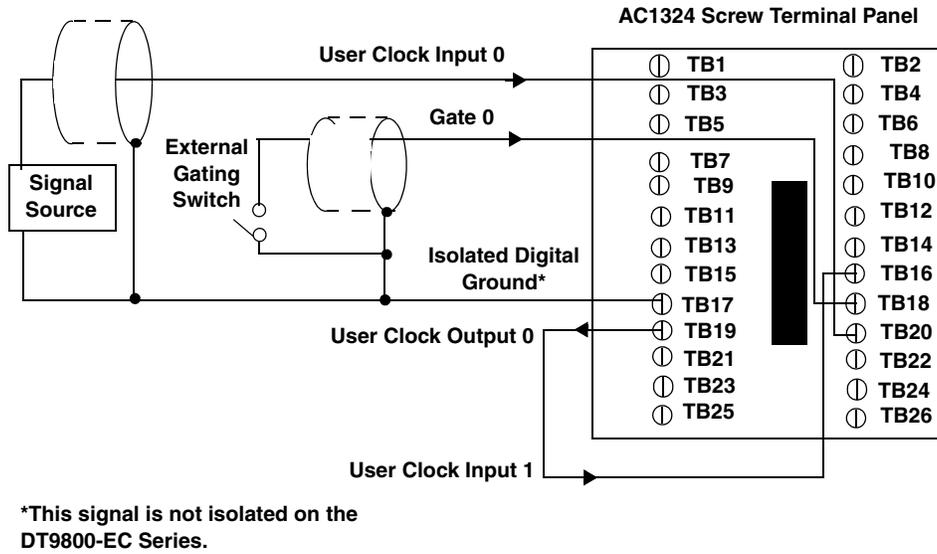
AC1324 Screw Terminal Panel

User Clock Input 0

Gate 0

External Gating Switch

Signal Source

Isolated Digital Ground*

User Clock Output 0

User Clock Input 1

TB1	TB2
TB3	TB4
TB5	TB6
TB7	TB8
TB9	TB10
TB11	TB12
TB13	TB14
TB15	TB16
TB17	TB18
TB19	TB20
TB21	TB22
TB23	TB24
TB25	TB26

***This signal is not isolated on the
DT9800-EC Series.**

**Figure 47: Cascading Counters (Shown for Rate Generation Using
Counters 0 and 1 and External Gate 0)**

Figure 48 shows an example of how to cascade user counters 0 and 1 externally to perform a one-shot operation using an AC1324 screw terminal panel attached to connector J5. Note that you can also internally cascade counters using software; if you internally cascade the counters, you do not need to make the external cascading connections. In this example, counter 0 gate is logic high.
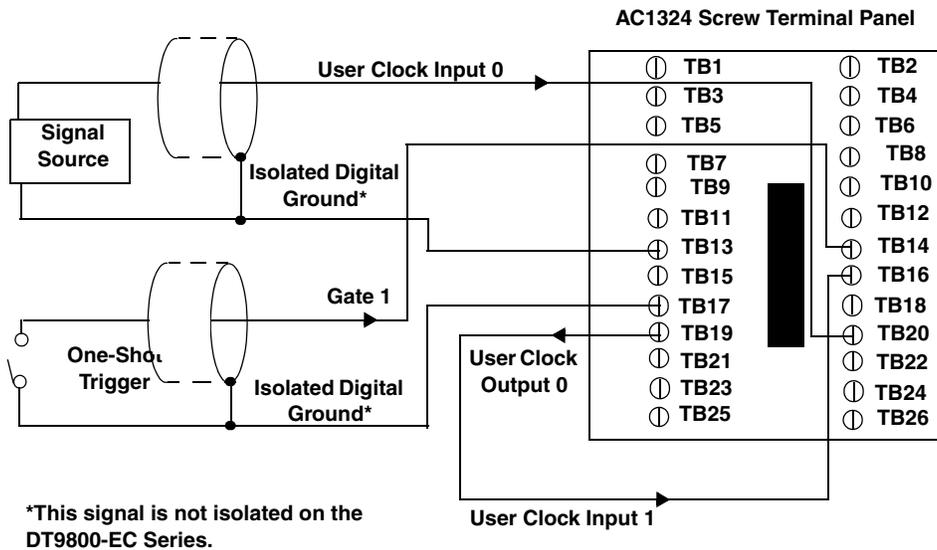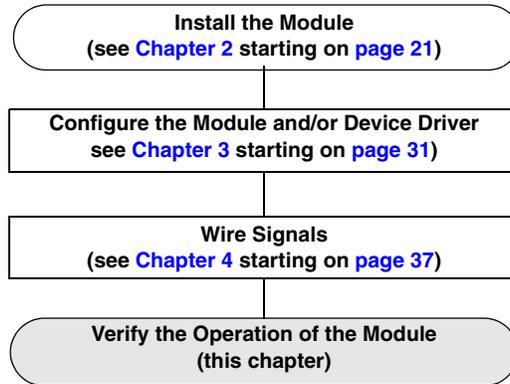
AC1324 Screw Terminal Panel

User Clock Input 0

Signal Source

Isolated Digital Ground*

Gate 1

One-Shot Trigger

Isolated Digital Ground*

User Clock Output 0

User Clock Input 1

TB1	TB2
TB3	TB4
TB5	TB6
TB7	TB8
TB9	TB10
TB11	TB12
TB13	TB14
TB15	TB16
TB17	TB18
TB19	TB20
TB21	TB22
TB23	TB24
TB25	TB26

***This signal is not isolated on the
DT9800-EC Series.**

**Figure 48: Cascading Counters (Shown for One-Shot Using
Counters 0 and 1 and External Gate 1)**

5

Verifying the Operation of a Module

> **Install the Module**
> **(see Chapter 2 starting on page 21)**

> **Configure the Module and/or Device Driver**
> **see Chapter 3 starting on page 31)**

> **Wire Signals**
> **(see Chapter 4 starting on page 37)**

> **Verify the Operation of the Module**
> **(this chapter)**

You can verify the operation of a DT9800 Series module 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 module 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 DT9800 Series module. Refer to page 43 (for the DT9800 Standard Series) or page 60 (for the DT9800-EC Series) 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 DT9800 Series module from the **Board** list box.
   Once you select the module, the LED on the module turns red.

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 module can output a single analog output value, do the following:

1. Connect an oscilloscope or voltmeter to DAC0 on the module. Refer to page 47 (for the DT9802, DT9804, or DT9806) or page 63 (for the DT9802-EC, DT9802-EC-I, DT9804-EC, or DT9804-EC-I) for an example of how to connect analog output signals.

2. In the Quick DataAcq application, select **Single Analog Output** from the **Control** menu.

3. Select the appropriate DT9800 Series module from the **Board** list box.
   Once you select the module, the LED on the module turns red.

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 module 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 DT9800 Series module (using the differential configuration). Refer to page 44 (for the DT9800 Standard Series) or page 60 (for the DT9800-EC or DT9800-EC-I Series) 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 DT9800 Series module from the **Board** list box.
   Once you select the module, the LED on the module turns red.

4. In the **Sec/Div** list box, select the number of seconds per division (.1 to .00001) for the display.

5. In the **Channel** list box, select analog input channel 1, and then click **Add** to add the channel to the channel list.
   Note that, by default, channel 0 is included in the channel list.

6. Click **Config** from the Toolbar.

7. In the **Config** dialog, select **ChannelType**, and then select **Differential**.

8. In the **Config** dialog, select **Range**, and then select **Bipolar** or **Unipolar** depending on the configuration of your module.
   The default is Bipolar.

9. From the **Scope** view, double-click the input range of the channel to change the input range of the module (±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.*
   The display changes to reflect the selected range for all the analog input channels on the module.

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 module 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 DT9800 Series module. Refer to page 47 (for the DT9800 Standard Series) or page 64 (for the DT9800-EC or DT9800-EC-I Series) for an example of how to connect a digital input.

2. In the Quick DataAcq application, choose **Digital Input** from the **Acquisition** menu.

3. Select the appropriate DT9800 Series module from the Board list box.
   Once you select the module, the LED on the module turns red.

4. Select digital input port A by clicking **Port A**.

5. 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 module 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 DT9800 Series module. Refer to page 47 (for the DT9800 Standard Series) or page 64 (for the DT9800-EC or DT9800-EC-I Series) for an example of how to connect a digital output.

2. In the Quick DataAcq application, select **Digital Output** from the **Control** menu.

3. Select the appropriate DT9800 Series module from the **Board** list box.
   Once you select the module, the LED on the module turns red.

4. Select digital output port B by clicking **Port B**.

5. Click the appropriate bits to select the type of signal to write from the digital output lines. If the bit is selected, a high-level signal is output from the digital output line; if the bit is not selected, a low-level signal is output from the digital output line. Optionally, you can enter an output value in the **Hex** text box.

6. Click **Send**.
   The application outputs and 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 module can perform a frequency measurement operation, do the following:

1. Wire an external clock source to counter/timer 0 on the DT9800 Series module. Refer to page 50 (for the DT9800 Standard Series) or page 70 (for the DT9800-EC or DT9800-EC-I Series) for an example of how to connect an external clock.

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 DT9800 Series module from the **Board** list box.
   Once you select the module, the LED on the module turns red.

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 application displays the frequency 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 module can perform a pulse output operation, do the following:

1. Connect a scope to counter/timer 0 on the DT9800 Series module. Refer to page 50 (for the DT9800 Standard Series) or page 71 (for the DT9800-EC or DT9800-EC-I Series) 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.

---

2. In the Quick DataAcq application, choose **Pulse Generator** from the **Control** menu.

3. Select the appropriate DT9800 Series module from the **Board** list box.
   Once you select the module, the LED on the module turns red.

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. Under **Pulse Width,** enter a percentage or use the slider to select a percentage for the pulse width. The percentage 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 Module

6

Principles of Operation

Figure 49 shows a block diagram of the DT9800 Series modules. Note that bold entries indicate signals you can access.
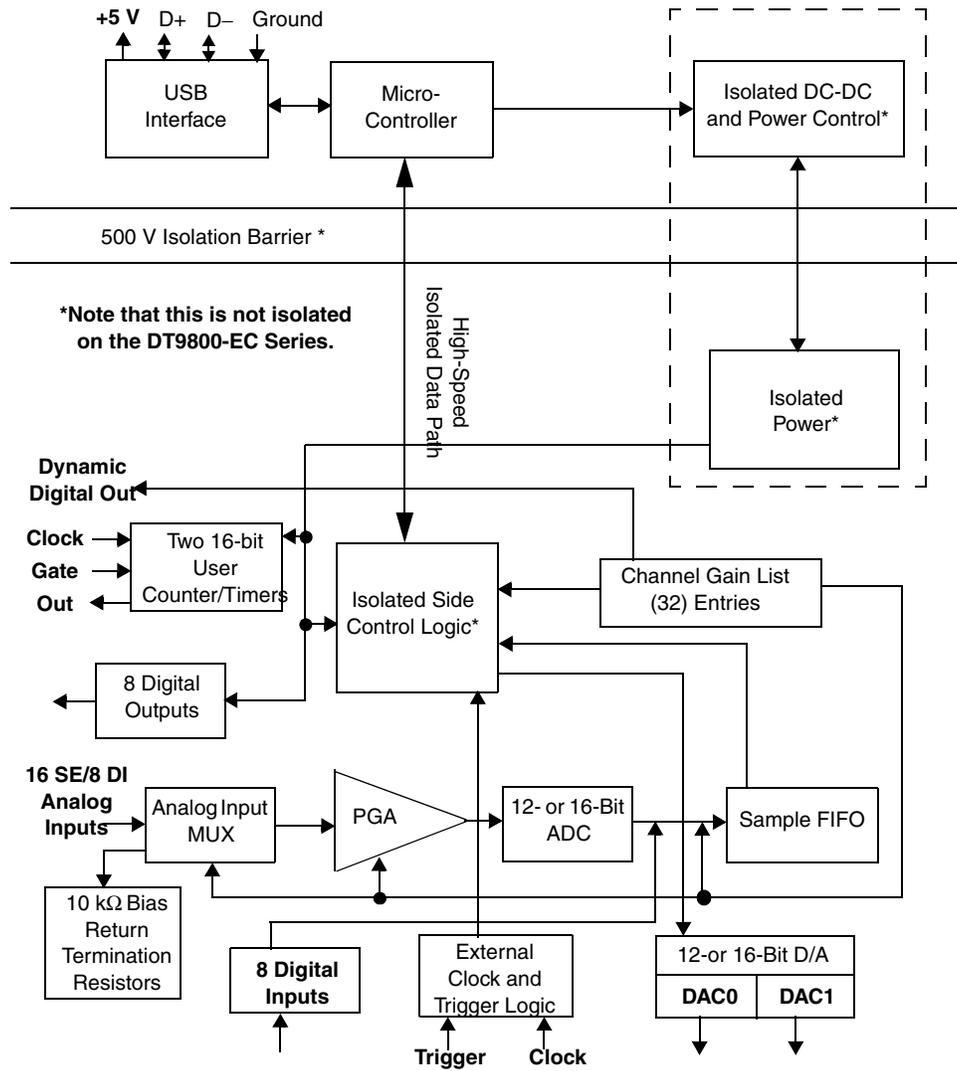

Figure 49: Block Diagram of the DT9800 Series Modules

Analog Input Features

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

- Input resolution, described below

- Analog input channels, described on

- Input ranges and gains, described on

- A/D sample clock sources, described on

- Analog input conversion modes, described on

- Triggers, described on

- Data formats, described on

- Data transfer, described on

- Error conditions, described on

Input Resolution

Table 5 lists the input resolution of the DT9800 Series modules. Note that the resolution is fixed; it cannot be programmed in software.

Table 5: Input Resolution

Function Module Series	Module Name	Input Resolution
DT9800 Standard	DT9801 DT9802	12 bit
	DT9803 DT9804 DT9805 DT9806	16 bit
DT9800-EC Series	DT9801-EC DT9802-EC	12 bit
	DT9803-EC DT9804-EC	16 bit
DT9800-EC-I Series	DT9801-EC-I DT9802-EC-I	12 bit
	DT9803-EC-I DT9804-EC-I	16 bit

Analog Input Channels

All DT9800 Series modules support 16 single-ended or pseudo-differential analog input channels or eight differential analog input channels. In addition, the DT9805 and DT9806 modules provide a cold junction compensation (CJC) circuit on channel 0 at 10 mV/° C. Using the CJC, you can connect seven thermocouple inputs (in differential mode) to the DT9805 or DT9806 module.

You configure the channel type as single-ended or differential through software. Using software, you can also select whether to use 10 kΩ termination resistance between the low side of each differential channel and isolated analog ground. This feature is particularly useful with floating signal sources. Refer to Chapter 4 for more information on wiring to inputs. Refer to Chapter 3 for information on configuring the driver to use bias return termination resistance.

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

DT9800-EC Series modules do not provide isolated analog ground.

The DT9800 Series modules can acquire data from a single analog input channel or from a group of analog input channels. Channels are numbered 0 to 15 for single-ended and pseudo-differential inputs, and 0 to 7 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 94 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.

Note: If you want to perform a single-value digital input operation while the A/D subsystem is configured, specify channel 16 (which corresponds to the digital input port) in the A/D single-value operation.

Specifying One or More Channels

You 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 (starting either with 0 or with any other analog input channel) or randomly. You can also specify a single channel or the same channel more than once in the list.

Using software, specify the channels in the order you want to sample them. You can enter up to 32 entries in the channel 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. Refer to page 94 for more information on the supported conversion modes.

Specifying Digital Input Lines in the Analog Input Channel List

In addition to the analog input channels, the DT9800 Series modules allow you to read eight digital input lines (Port A, lines 0 to 7) using the analog input channel list. This feature is particularly useful when you want to correlate the timing of analog and digital events.

To read these eight digital input lines, specify channel 16 in the analog input channel list. You can enter channel 16 anywhere in the list and can enter it more than once, if desired.

Note: If channel 16 is the only channel in the channel list, the module can read this channel at the maximum A/D sampling rate.

The digital channel is treated like any other channel in the analog input channel list; therefore, all the clocking, triggering, and conversion modes supported for analog input channels are supported for these digital input lines, if you specify them this way.

Performing Dynamic Digital Output Operations

Note: This feature is supported in the DataAcq SDK. It is not supported in the DT-Open Layers for .NET Class Library.

Using software, you can enable a synchronous dynamic digital output operation for the A/D subsystem. This feature is particularly useful for synchronizing and controlling external equipment.

One dynamic digital output line (0) is provided (screw terminal 46). This line is set to a value of 0 on power up; a reset does not affect the values of the dynamic digital output line. Note that this line is provided in addition to the other eight digital output lines; see page 104 for more information on the digital I/O features.

You specify the value (0 or 1) to write from the dynamic digital output line using a digital channel list. A value of 0 indicates a low-level signal; a value of 1 indicates a high-level signal.

The digital channel list corresponds to the analog input channel list. As each entry in the analog input channel list is read, the corresponding value you specified in the digital channel list is output to the dynamic digital output line.

For example, assume that the analog input channel list contains channels 0, 1, 2, and 3; that dynamic digital output operations are enabled; and that the values in the digital channel list are 1, 0, 0, 1. Figure 50 shows this configuration.

Analog Channel List | **Digital Channel List** | **Dynamic Digital Output Line 0**

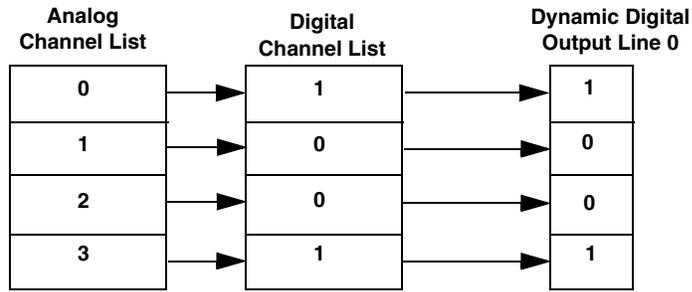| Analog Channel List	Digital Channel List	Dynamic Digital Output Line 0
0	1	1
1	0	0
2	0	0
3	1	1

Figure 50: An Example Using Dynamic Digital Outputs

As analog input channel 0 is read, a high-level signal is output to the dynamic digital output line. As analog input channels 1 and 2 are read, a low-level signal is output to the dynamic digital output line. As analog input channel 3 is read, a high-level signal is output to the dynamic digital output line.

On power up, a value of 0 is written to the dynamic digital output line.

Input Ranges and Gains

Table 6 lists the supported gains and effective input range of each DT9800 Series module.

Table 6: Effective Input Range

Function Module Series	Module Name	Gain	Unipolar Input Range	Bipolar Input Range
DT9800 Standard	DT9801 DT9802	1	0 to 10 V	±10 V
		2	0 to 5 V	±5 V
		4	0 to 2.5 V	±2.5 V
		8	0 to 1.25 V	±1.25 V
	DT9803 DT9804	1	N/A	±10 V
		2	N/A	±5 V
		4	N/A	±2.5 V
		8	N/A	±1.25 V
	DT9805 DT9806	1	N/A	±10 V
		10	N/A	±1 V
		100	N/A	±0.10 V
		500	N/A	±0.020 V

Table 6: Effective Input Range (cont.)

Function Module Series	Module Name	Gain	Unipolar Input Range	Bipolar Input Range
DT9800-EC Series	DT9801-EC DT9802-EC	1	0 to 10 V	±10 V
		2	0 to 5 V	±5 V
		4	0 to 2.5 V	±2.5 V
		8	0 to 1.25 V	±1.25 V
	DT9803-EC DT9804-EC	1	N/A	±10 V
		2	N/A	±5 V
		4	N/A	±2.5 V
		8	N/A	±1.25 V
DT9800-EC-I Series	DT9801-EC-I DT9802-EC-I	1	0 to 10 V	±10 V
		2	0 to 5 V	±5 V
		4	0 to 2.5 V	±2.5 V
		8	0 to 1.25 V	±1.25 V
	DT9803-EC-I DT9804-EC-I	1	N/A	±10 V
		2	N/A	±5 V
		4	N/A	±2.5 V
		8	N/A	±1.25 V

Using software, specify 0 to 10 V for unipolar ranges or –10 V to +10 V for bipolar ranges. Note that you specify the range for the entire analog input subsystem, not the range per channel.

For each channel, choose the gain that has the smallest effective range that includes the signal you want to measure. For example, if you are using a DT9803 and the range of your analog input signal is ±1.05 V, specify a range of –10 V to +10 V for the module and use a gain of 8 for the channel; the effective input range for this channel is then ±1.25 V, which provides the best sampling accuracy for that channel.

Note: If you are using the DataAcq SDK, the DT9805 and DT9806 modules support autoranging for single-value operations, where the module determines the appropriate gain for your range rather than you having to specify it. This feature is not supported in the DT-Open Layers for .NET Class Library. Refer to for more information on using autoranging.

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 for more information on single-value operations.

If you are using an analog input channel list, you can use software to specify the gain for each analog input channel entry in the analog input channel list.

Note: For analog input channel 16 (the eight digital input lines) in the channel list, specify a gain of 1 in the gain list.

A/D Sample Clock Sources

DT9800 Series modules allow you to use one of the following clock sources to pace analog input operations in continuous mode:

- The internal A/D sample clock, which uses the 24-bit A/D Counter on the module

- An external A/D sample clock, which you can connect directly to the screw terminals on the module

You use an A/D sample clock to pace the acquisition of each channel in the channel list; this clock is also called the A/D pacer clock.

Note: If you enter digital input channel 16 in the channel list, the A/D sample clock (internal or external) also paces the acquisition of the eight digital input lines.

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 12 MHz time base. Conversions start on the rising edge of the counter output; the output pulse is active low.

Using software, specify the clock source as internal and the clock frequency at which to pace the operation. The minimum frequency supported is 0.75 Hz (0.75 Samples/s); the maximum frequency supported depends on the module type. Table 7 lists the maximum sampling rate of the DT9800 Series modules.

Table 7: Maximum Sampling Rate

Function Module Series	Module Name	Sampling Rate
DT9800 Standard	DT9801 DT9802 DT9803 DT9804	100 kSamples/s
	DT9805[a] DT9806[a]	50 kSamples/s

Table 7: Maximum Sampling Rate (cont.)

Function Module Series	Module Name	Sampling Rate
DT9800-EC	DT9801-EC DT9802-EC DT9803-EC DT9804-EC	100 kSamples/s
DT9800-EC-I	DT9801-EC-I DT9802-EC-I DT9803-EC-I DT9804-EC-I	100 kSamples/s

a. The maximum rate is 50 kSamples/s for a single channel or a channel scan
    when the gain is 1 or 10, 10 kSamples/s for a channel scan when the gain is
    100, and 2 kSamples/s for a channel scan when the gain is 500.

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

An 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 TB25 on the DT9800 Series module (pin 25 on connector J1). Conversions start on the rising edge of the external A/D sample clock input signal.

Using software, specify the clock source as external. For DT9800 Series modules, the clock frequency is always equal to the frequency of the external A/D sample clock input signal that you connect to the module.

Triggers

A trigger is an event that occurs based on a specified set of conditions. The DT9800 Series module supports 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 module to begin conversions). Using software, specify the trigger source as a software trigger.

- **External trigger** – An external digital trigger event occurs when the DT9800 Series module detects a rising edge on the Ext A/D Trigger input signal connected to screw terminal TB24 on the DT9800 Series module (pin 24 of connector J1). The trigger signal is TTL-compatible. Using software, specify the trigger source as an external, positive, digital (TTL) trigger.

Analog Input Conversion Modes

DT9800 Series modules support the following conversion modes:

- **Single-value operations** are the simplest to use. Using software, you can either specify the range, gain, and analog input channel. The module acquires the data from the specified channel and returns the data immediately. For a single-value operation, you cannot specify a clock source, trigger source, scan mode, or buffer.

> **Note:**   If you are using the DataAcq SDK with a DT9805 or DT9806 module, you can specify the range and analog input channel and have the software determine the best gain for the range (called autoranging). Auto-ranging is not supported in the DT-Open Layers for .NET Class Library.

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

- **Scan mode** takes full advantage of the capabilities of the DT9800 Series modules. In a scan, you can specify a channel list, clock source, trigger source, scan mode, and buffer using software. Two scan modes are supported: continuously paced scan mode and triggered scan mode (often called burst mode). These modes are described in the following subsections.

  Using software, you can stop a scan by performing either an orderly stop or an abrupt stop. In an orderly stop, the module finishes acquiring the data, stops all subsequent acquisition, and transfers the acquired data to host memory; all subsequent triggers or retriggers are ignored.

   In an abrupt stop, the module stops acquiring samples immediately; the acquired data is not transferred to host memory, and 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 module cycles through the channel list, acquiring and converting the value for each entry in the list (this process is defined as the scan). The module 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 100 for more information on buffers.

The conversion rate is determined by the frequency of the A/D sample clock; refer to page 92 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 a trigger source to start the operation. Refer to page 93 for more information on the supported trigger sources.

Figure 51 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. When it reaches the end of the channel list, the module wraps to the beginning of the channel list and repeats this process. Data is acquired continuously.
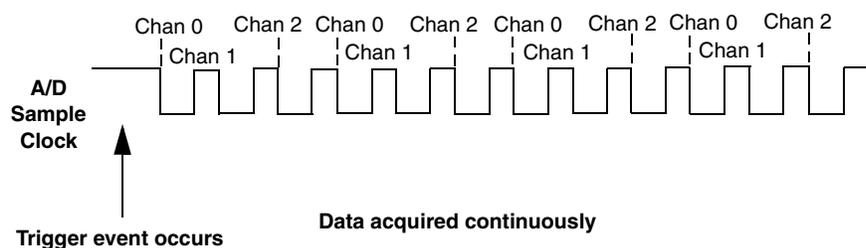

Figure 51: Continuously Paced Scan Mode

Triggered Scan Mode

DT9800 Series modules 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. This mode is useful when synchronizing or controlling external equipment or when acquiring a buffer of data on each trigger or retrigger.

When it detects an initial trigger (either a software trigger or an external trigger), the DT9800 Series module scans the channel list once, then waits for a software retrigger to occur. When it detects a software retrigger, the module scans the channel list once again, 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 100 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 92 for more information on the A/D sample clock. The conversion rate of each scan is determined by the frequency of the Triggered Scan Counter on the module; the Triggered Scan Counter is a 24-bit counter with a 12 MHz clock.

Figure 52 illustrates triggered scan mode. In this example, post-trigger 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 module waits for the retrigger event. When the retrigger event occurs, the module scans the channel list once again, acquiring data on each pulse of the A/D sample clock. The process repeats continuously with every specified retrigger event.
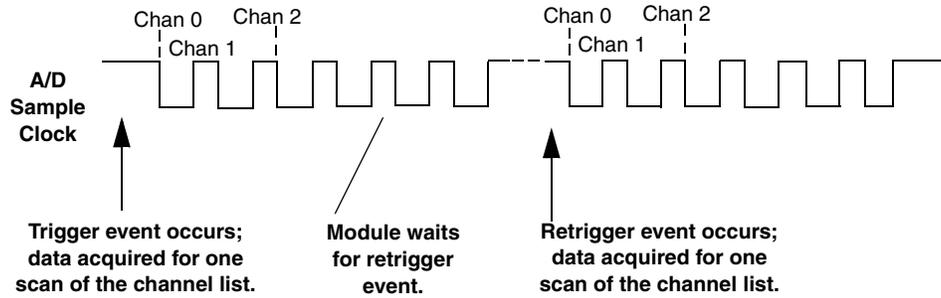
Figure 52: Triggered Scan Mode

Specify the frequency of the internal retrigger clock using software. The minimum retrigger frequency is 0.75 Hz (0.75 Samples/s); the maximum retrigger rate of each DT9800 Series module is listed in Table 8 on page 96.

Table 8: Maximum Retrigger Frequency

Function Module Series	Module Name	Maximum Retrigger Frequency
DT9800 Standard	DT9801 DT9802 DT9803 DT9804	100 kHz
	DT9805[a] DT9806[a]	50 kHz
DT9800-EC	DT9801-EC DT9802-EC DT9803-EC DT9804-EC	100 kHz
DT9800-EC-I	DT9801-EC-I DT9802-EC-I DT9803-EC-I DT9804-EC-I	100 kHz

a. The maximum retrigger frequency is 50 kHz for a single channel or a channel scan when the gain is 1 or 10, 10 kHz for a channel scan when the gain is 100, and 2 kHz for a channel scan when the gain is 500.

The appropriate *retrigger frequency* depends on a number of factors, determined by the following equations:

$$\text{Min. Retrigger Period} = \frac{\text{\# of CGL entries}}{\text{A/D sample clock frequency}} + 2\ \mu s$$

$$\text{Max. Retrigger Frequency} = \frac{1}{\text{Min. Retrigger Period}}$$

For example, if you are using 16 channels in the channel list, and using an A/D sample clock with a frequency of 50 kHz, set the maximum retrigger frequency to 3.106 kHz, since

$$3.106 \text{ kHz} = \frac{1}{\frac{16}{50 \text{ kHz}} + 2 \text{ μs}}$$

To select software-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 retrigger frequency

- The initial trigger source; refer to for more information on the supported trigger sources

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 a DT9800 Series module detects an initial trigger (either a software trigger or an external trigger), the module scans the channel list once, then waits for an external retrigger to occur. The external retrigger occurs when a rising edge is detected on the Ext A/D Trigger input screw terminal (TB24) on the module.

When the retrigger occurs, the module 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 until you stop the operation; refer to for more information on buffers.

The conversion rate of each channel is determined by the frequency of the A/D sample clock; refer to 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 module ignores external triggers that occur while it is acquiring data. Only external retrigger events that occur when the module 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

- The triggered scan mode usage as enabled

- The retrigger source as an external, positive digital (TTL) trigger

- The number of times to scan per trigger or retrigger (also called the multiscan count) to 1

- The initial trigger source; refer to for more information on the supported trigger sources

Data Format

Table 9 lists the data encoding used by each DT9800 Series module.

Table 9: Data Encoding

Function Module Series	Module Name	Data Encoding
DT9800 Standard Series	DT9801 DT9802	Straight Binary
	DT9803 DT9804 DT9805 DT9806	Offset Binary
DT9800-EC	DT9801-EC DT9802-EC	Straight Binary
	DT9803-EC DT9804-EC	Offset Binary
DT9800-EC-I	DT9801-EC-I DT9802-EC-I	Straight Binary
	DT9803-EC-I DT9804-EC-I	Offset Binary

In software, the analog input value is returned as a code. To convert the code to voltage, use the following formulas:

$$\text{LSB} = \frac{\text{FSR}}{2^N}$$

Vin = Code * LSB + Offset

where,

- *LSB* is the least significant bit.

- *FSR* is the full-scale range. For the DT9800 Series, the full-scale range is 10 for the unipolar range or 20 for the bipolar range.

- *N* is the input resolution. Refer to Table 5 on page 87 for the list of input resolutions supported.

- *Vin* is the analog voltage.

- *Code* is the raw count used by the software to represent the voltage.

- *Offset* is the actual minus full-scale value. The minus full-scale value is 0.0 V for the unipolar input range and −10 V for the bipolar input range.

For example, assume that you are using a DT9801 with a unipolar input range. If the software returns a code of 2010 for the analog input operation, determine the analog input voltage as follows:

LSB = $\dfrac{10}{4096}$ = 0.002441 V + 0.0 V

Vin = 2010 * 0.002441 + 0 V

Vin = 4.906 V

Similarly, assume that you are using a DT9804 module with a bipolar input range. The actual minus full-scale value is −10.0 V. If the software returns a code of 2010 for the analog input operation, determine the analog input voltage as follows:

LSB = $\dfrac{20}{65536}$ = 0.000305 V

Vin = 2010 * 0.000305 + −10.0 V

Vin = −9.370 V

Table 10 lists the values that are returned when the DT9800 Series module is overrange.

Table 10: Overrange Signal Values

Function Module Series	Module Name	Above-Range Signals	Below-Range Signals
DT9800 Standard Series	DT9801 DT9802	FFFh (plus full-scale)	000h (minus full-scale)
	DT9803 DT9804 DT9805 DT9806	FFFFh (plus full-scale)	0000h (minus full-scale)
DT9800-EC Series	DT9801-EC DT9802-EC	FFFh (plus full-scale)	000h (minus full-scale)
	DT9803-EC DT9804-EC	FFFFh (plus full-scale)	0000h (minus full-scale)
DT9800-EC-I Series	DT9801-EC-I DT9802-EC-I	FFFh (plus full-scale)	000h (minus full-scale)
	DT9803-EC-I DT9804-EC-I	FFFFh (plus full-scale)	0000h (minus full-scale)

Data Transfer

The module packs two bytes into each transfer to the host computer. Even samples (corresponding to entries 0, 2, 4, and so on, in the channel list) are packed into the low bytes; odd samples (corresponding to entries 1, 3, 5, and so on, in the channel list) are packed into the high bytes.

DT9800 Series modules contain a 2048-sample FIFO. During a continuous analog input operation, the hardware interrupts the firmware on the module when the FIFO is half full. The module then transfers 2048 samples to a circular buffer, which is dedicated to the hardware, in the host computer.

The DT9800 Series Device Driver accesses the hardware circular buffer to fill user buffers that you allocate in software. It is recommended that you allocate a minimum of two user buffers for a continuous analog input operation. Data is written to multiple allocated input buffers continuously; when no more empty buffers are available, the operation stops. The data is gap-free.

Note: If you are using a slow clock data rate, such as .75 Hz, and a 256 sample user buffer, you will have to wait over 5 minutes for any data since data is transferred only when 256 samples have been read.

Error Conditions

The DT9800 Series modules can report an error if one of the following conditions occurs:

- **A/D Over Sample error** – The A/D sample clock rate is too fast. This error is reported if a new A/D sample clock pulse occurs while the ADC is busy performing a conversion from the previous A/D sample clock pulse. The host computer can clear this error.

  To avoid this error, use a slower sampling rate.

- **A/D FIFO Full Flag set to 1** – The data was not read fast enough by the host computer. The host computer can clear this error. If you encounter this error, try allocating more buffers or larger buffers.

If one of these error conditions occurs, the module reports the error but continues to acquire and transfer data to the host computer. The LED on the front panel will not blink green if the hardware detects an error.

Analog Output Features

An analog output (D/A) subsystem is provided on the following DT9800 Series modules only: DT9802, DT9802-EC, DT9802-EC-I, DT9804, DT9804-EC, DT9804-EC-I, and DT9806. This section describes the following features of the D/A subsystem:

- Output resolution, described below

- Analog output channels, described on

- Output ranges and gains, described on

- Conversion modes, described on

- Data format, described on

Output Resolution

Table 11 lists the output resolution of the DT9800 Series modules. Note that the resolution is fixed; it cannot be programmed in software.

Table 11: Output Resolution

Function Module Series	Module Name	Resolution
DT9800 Standard Series	DT9802	12 bit
	DT9804 DT9806	16 bit
DT9800-EC Series	DT9802-EC	12 bit
	DT9804-EC	16 bit
DT9800-EC-I Series	DT9802-EC-I	12 bit
	DT9804-EC-I	16 bit

Analog Output Channels

The DT9802, DT9802-EC, DT9802-EC-I, DT9804, DT9804-EC, DT9804-EC-I, and DT9806 modules support two DC-level analog output channels (DAC0 and DAC1). Refer to Chapter 4 for information on how to wire analog output signals to the module. You configure the channel type through software.

Within each DAC, the digital data is double-buffered to prevent spurious outputs, then output as an analog signal. Both DACs power up to a value of 0 V ±10 mV. Resetting the module does not clear the values in the DACs.

The DT9800 Series modules can output data from a single analog output channel only. Specify the channel for a single-value analog output operation using software; refer to "Conversion Modes," on for more information on single-value operations.

Output Ranges and Gains

Table 12 lists the output range for each DT9800 Series module.

Table 12: Output Range

Function Module Series	Module Name	Unipolar Output Range	Bipolar Input Range
DT9800 Standard Series	DT9802	0 to 10 V or 0 to 5 V	±10 V or ±5 V
	DT9804 DT9806	N/A	±10 V
DT9800-EC Series	DT9802-EC	0 to 10 V or 0 to 5 V	±10 V or ±5 V
	DT9804-EC	N/A	±10 V
DT9800-EC-I Series	DT9802-EC-I	0 to 10 V or 0 to 5 V	±10 V or ±5 V
	DT9804-EC-I	N/A	±10 V

Specify the range using software; set the gain to 1.

Conversion Modes

DT9802, DT9802-EC, DT9802-EC-I, DT9804, DT9804-EC, DT9804-EC-I, and DT9806 modules can perform single-value analog output operations only. Use software to specify the range, gain, and analog output channel, then output the data from the specified channel. You cannot specify a clock source, trigger source, or buffer.

Note: You cannot perform a single-value analog output operation while the A/D subsystem is running.

The settling time for each DAC is 50 μs (20 V steps).

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

Data Format

Data from the host computer must use offset binary data encoding for analog output signals. Using software, specify the data encoding as binary.

In software, you need to supply a code that corresponds to the analog output value you want the module to output. To convert a voltage to a code, use the following formulas:

$$LSB = \frac{FSR}{2^N}$$

$$Code = \frac{Vout - offset}{LSB}$$

where,

- *LSB* is the least significant bit.
- *FSR* is the full-scale range (10).
- *N* is the output resolution; see for a list of output resolutions.
- *Code* is the raw count used by the software to represent the voltage.
- *Vout* is the analog voltage.
- *Offset* is the minus full-scale value, or –10 V.

For example, assume that you are using a DT9804 module. If you want to output a voltage of 4.7 V, determine the code value as follows:

$$LSB = \frac{10 \text{ V}}{65536} = 0.0001526 \text{ V}$$

$$Code = \frac{4.7 \text{ V} - (-10 \text{ V})}{0.0001526 \text{ V}}$$

$$Code = 96330 = 1784Ah$$

Digital I/O Features

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

- Digital I/O lines, described below

- Resolution, described below

- Operation modes, described on

Digital I/O Lines

DT9800 Series modules support eight digital input lines (Port A, lines 0 to 7) through the DIN subsystem and eight digital output lines (Port B, lines 0 to 7) through the DOUT subsystem.

For fast, clocked digital input operations, you can enter the digital input lines from Port A as channel 16 in the analog input channel list; refer to for more information.

> **Note:** If you are using the DataAcq SDK, the DT9800 Series modules also provide a dynamic digital output line that you can update when an analog input channel is read. Note that the dynamic digital output line is in addition to the digital output lines in Port B. This feature is not supported in the DT-Open Layers for .NET Class Library. Refer to for more information on dynamic digital output operations.

All the outputs include diode protection to the isolated ground and the isolated +5 V. If you apply +5 V to the +5 V output, the digital outputs maintain their previous state if the computer goes down or if the USB cable is unplugged. On enumeration, the module senses the +5 V and does not reset the digital outputs.

> **Note:** DT9800-EC Series modules do not provide isolated ground or isolated +5 V power.

Resolution

The resolution of the digital input port is fixed at 8 bits; the resolution of the digital output port is also fixed at 8 bits.

You cannot program the digital I/O resolution in software.

Operation Modes

The DT9800 Series modules support the following digital
I/O operation modes:

- **Single-value operations** are the simplest to use but offer the least flexibility and efficiency. You use software to specify the digital
I/O port and a gain of 1 (the gain is ignored). Data is then 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.

- **Continuous digital input** takes full advantage of the capabilities of the DT9800 Series modules. In this mode, enter all eight digital input lines of Port A as channel 16 of the analog input channel list; program this mode through the A/D subsystem. Using this mode, you can specify a clock source, scan mode, trigger source, and buffer for the digital input operation. Refer to page 89 for more information on specifying digital input lines for a continuous digital input operation.

- **Dynamic digital output** (supported only in the DataAcq SDK) is useful for synchronizing and controlling external equipment and allows you to output data to the dynamic digital output line each time an analog input value is acquired. This mode is programmed through the A/D subsystem; refer to page 89 for more information.

Counter/Timer Features

The counter/timer circuitry on the module 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:

- Units, described below

- C/T clock sources, described on

- Gate types, described on

- Pulse types and duty cycles, described on

- Counter/timer operation modes, described on

Units

Two 16-bit counter/timers are supported by all DT9800 Series modules. The counters are numbered 0 and 1.

Each 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 53.
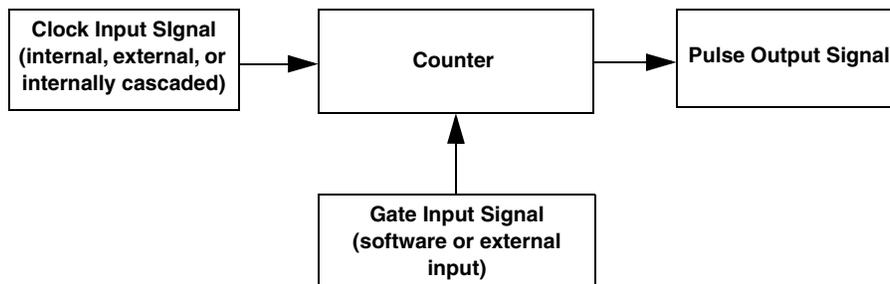
Figure 53: Counter/Timer Channel

Each counter corresponds to a counter/timer (C/T) subsystem. To specify the counter to use in software, specify the appropriate C/T subsystem. Counter 0 corresponds to C/T subsystem element 0; counter 1 corresponds to C/T subsystem element 1.

C/T Clock Sources

The following clock sources are available for the user counters:

- Internal C/T clock

- External C/T clock

- Internally cascaded clock

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

Internal C/T Clock

The internal C/T clock uses a 12 MHz time base. 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 750 kHz. The minimum frequency that you can specify for the clock output signal for each
16-bit counter is 183.1 Hz. The rising edge of the clock is the active edge.

External C/T Clock

An 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. The rising edge of the external C/T clock input signal is the active edge.

Using software, specify the clock source as external and the clock divider used to determine the frequency at which to pace the operation. The minimum clock divider that you can specify is 2.0; the maximum clock divider that you can specify is 65,536. For example, if you supply an external C/T clock with a frequency of 700 kHz and specify a clock divider of 2, the resulting frequency of the external
C/T clock output signal is 350 kHz. The resulting frequency of the external C/T clock output signal must not exceed 750 kHz.

Table 13 on page 107 lists the screw terminals of the DT9800 Series modules that correspond to the external C/T clock signals of each counter/timer.

Table 13: External C/T Clock Signals

Module	Counter /Timer	Screw Terminal on Module	J1 Pin Number	Screw Terminal on AC1324 Panel	J5 Pin Number
DT9800 Standard Series	0	TB54	54	–	–
	1	TB50	50	–	–
DT9800-EC Series; DT9800-EC-I Series	0	–	–	TB20	20
	1	–	–	TB16	16

Internally Cascaded Clock

You can also internally route the clock output signal from counter/timer 0 to the clock input signal of counter/timer 1 to internally cascade the counters. In this way, you can create a 32-bit counter without externally connecting two counters together.

Specify internal cascade mode in software. The rising edge of the clock input signal is active.

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 750 kHz. For a 32-bit cascaded counter, the minimum frequency that you can specify for the clock output signal is 0.0028 Hz.

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. Specify the gate type in software.

DT9800 Series modules 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; refer to page 110 for more information on these 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 110 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 110 for more information on these modes.

- **Falling-edge external gate input** – Enables 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 110 for more information on these modes.

- **Rising-edge external gate input** – Enables 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 114 for more information on these modes.

Table 14 lists the screw terminals and pin numbers on the DT9800 Series modules that correspond to the gate input signals of each counter/timer.

Table 14: Gate Input Signals

Module	Counter/Timer	Screw Terminal on Module	J1 Pin	Screw Terminal on AC1324 Panel	J5 Pin
DT9800 Standard Series	0	TB52	52	–	–
	1	TB48	48	–	–
DT9800-EC Series; DT9800-EC-I Series	0	–	–	TB18	18
	1	–	–	TB14	14

Pulse Output Types and Duty Cycles

DT9800 Series modules can output pulses from each counter/timer. Table 15 lists the screw terminals of the modules that correspond to the pulse output signals of each counter/timer.

Table 15: Pulse Output Signals

Module	Counter/Timer	Screw Terminal on Module	J1 Pin	Screw Terminal on AC1324 Panel	J5 Pin
DT9800 Standard Series	0	TB53	53	–	–
	1	TB49	49	–	–
DT9800-EC Series; DT9800-EC-I Series	0	–	–	TB19	19
	1	–	–	TB15	15

DT9800 Series modules support the following pulse output types on the clock output signal:

- **High-to-low transitions** – The low portion of the total pulse output period is the active portion of the counter/timer clock output signal.

- **Low-to-high transitions** – The high portion of the total pulse output period is the active portion of the counter/timer pulse output signal.

You specify the pulse output type in software.

The duty cycle (or pulse width) indicates the percentage of the total pulse output period that is active. A duty cycle of 50, then, indicates that half of the total pulse is low and half of the total pulse output is high. You specify the duty cycle in software.

Note: The minimum pulse width must be 650 ns.

Figure 54 illustrates a low-to-high pulse with a duty cycle of approximately 30%.
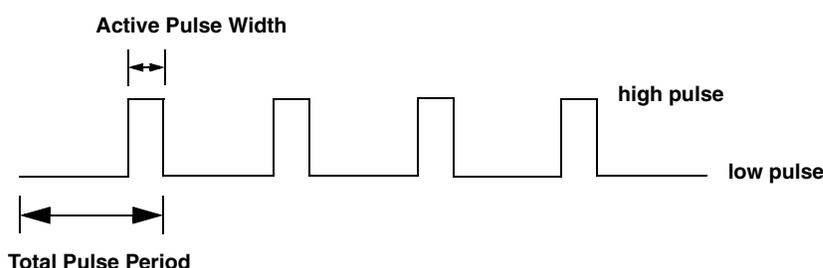
Figure 54: Example of a Low-to-High Pulse Output Type

Counter/Timer Operation Modes

DT9800 Series modules support the following counter/timer operation modes:

- Event counting

- Frequency measurement

- Rate generation

- One-shot

- Repetitive one-shot

The following subsections describe these modes in more detail.

Event Counting

Use event counting mode to count events (clock pulses) from the counter's associated clock input source.

If you are using one counter, you can count a maximum of 65,536 events before the counter rolls over to 0 and starts counting again. If you are using a cascaded 32-bit counter, you can count a maximum of 4,294,967,296 events before the counter rolls over to 0 and starts counting again.

In event counting mode, use an external C/T clock source; refer to page 107 for more information on the external C/T clock source.

Using software, specify the counter/timer mode as event counting (count), the C/T clock source as external, and the gate type that enables the operation as logic high. Refer to page 109 for information on gates.

Ensure that the signals are wired appropriately. Refer to Chapter 4 for wiring examples.

Figure 55 shows an example of an event counting operation using a logic-high gate type.
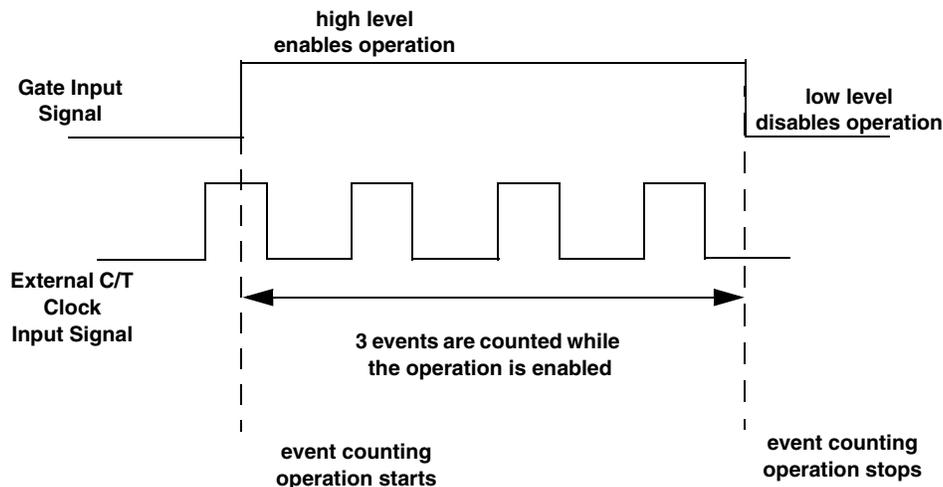
Figure 55: Example of Event Counting

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 106 for more information on the external C/T clock source.

One way to perform a frequency measurement is to use the same wiring as an event counting application that does not use an external gate signal. Refer to Chapter 4 for wiring examples.

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

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

If you need more accuracy than the system timer provides, you can connect a pulse of a known duration (such as a one-shot output of another user counter) to the external gate input. Refer to Chapter 4 for wiring examples.

In this configuration, use software to set up the counter/timers as follows:

1. Set up one of the counter/timers for one-shot mode, specifying the clock source, clock frequency, gate type, and type of output pulse (high or low).

2. Set up the counter/timer that will measure the frequency for event counting mode, specifying the clock source to count, and the gate type (this should match the pulse output type of the counter/timer set up for one-shot mode).

3. Start both counters (events are not counted until the active period of the one-shot pulse is generated).

4. Read the number of events counted. (Allow enough time to ensure that the active period of the one-shot occurred and that events have been counted.)

5. Determine the measurement period using the following equation:

    $$\text{Measurement period} = \frac{1}{\text{Clock Frequency}} * \text{Active Pulse Width}$$

6. Determine the frequency of the clock input signal using the following equation:

    $$\text{Frequency Measurement} = \frac{\text{Number of Events}}{\text{Measurement Period}}$$

Figure 56 shows an example of a frequency measurement operation. In this example, three events are counted during a duration of 300 ms. The frequency, then, is 10 Hz, since 10 Hz = 3/(.3 s).

3 Events Counted

**External C/T
Clock
Input Signal**

**Duration over which the
frequency is measured = 300 ms**

**frequency measurement
starts**

**frequency
measurement stops**
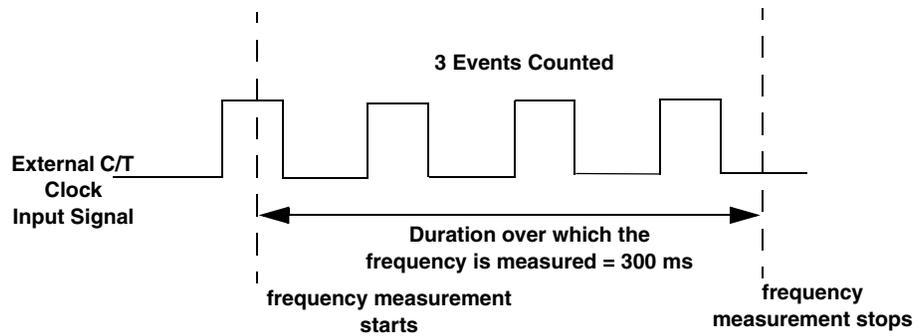
Figure 56: Example of Frequency Measurement

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 or other counter/timer operations.

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. If you are using one counter (not cascaded), you can output pulses using a maximum frequency of 1 MHz (this is the frequency of the clock output signal). In rate generation mode, either the internal or external C/T clock input source is appropriate depending on your application; refer to page 106 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 or low-to-high transitions), the duty cycle of the output pulses, and the gate type that enables the operation as logic-high. Refer to page 109 for more information on pulse output signals and to page 108 for more information on gate types.

Ensure that the signals are wired appropriately. Refer to Chapter 4 for wiring examples.

Figure 57 shows an example of an enabled rate generation operation using a logic-high gate input signal, an external C/T clock source with an input frequency of 4 kHz, a clock divider of 4, a low-to-high pulse type, and a duty cycle of 75%. A 1 kHz square wave is the generated output. Figure 58 shows the same example using a duty cycle of 25%.
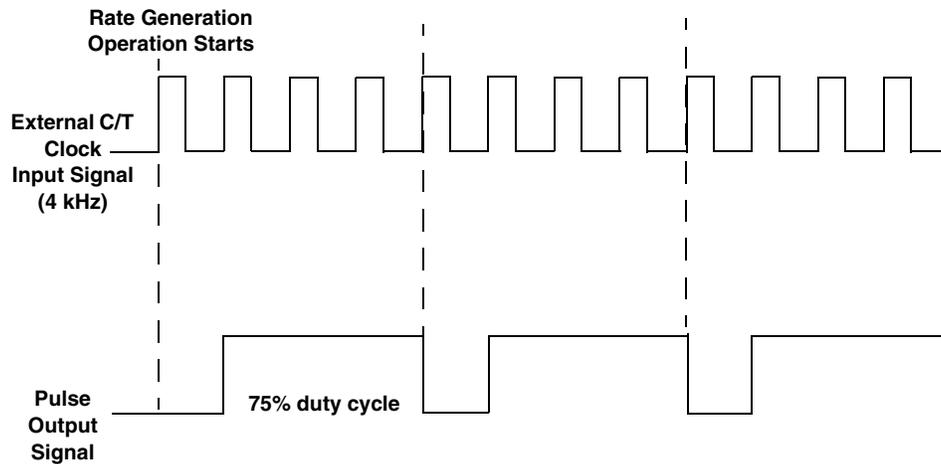
Figure 57: Example of Rate Generation Mode with a 75% Duty Cycle
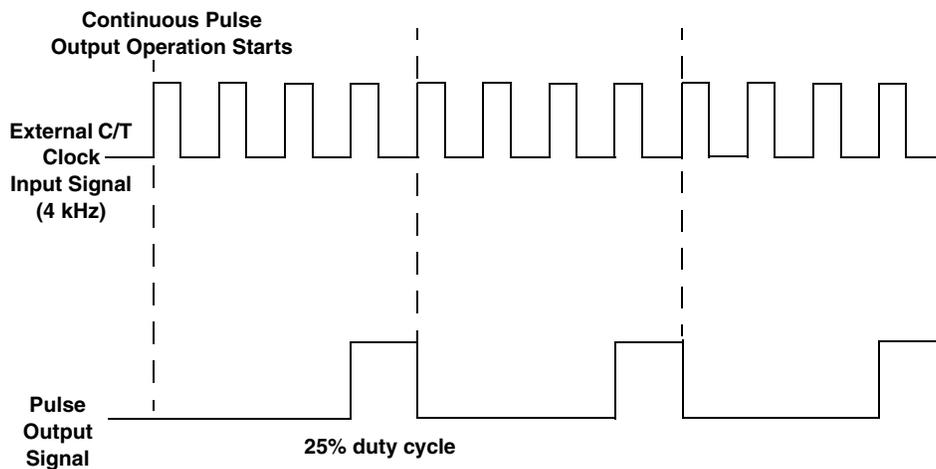
Figure 58: Example of Rate Generation Mode with a 25% Duty Cycle

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 operations.

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 106 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 transition or low-to-high transition), and the gate type to trigger the operation as rising edge or falling edge. Refer to page 109 for more information on pulse output types and to page 108 for more information on gate types.

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

Ensure that the signals are wired appropriately. Refer to Chapter 4 for wiring examples.

Figure 59 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 low-to-high pulse type.
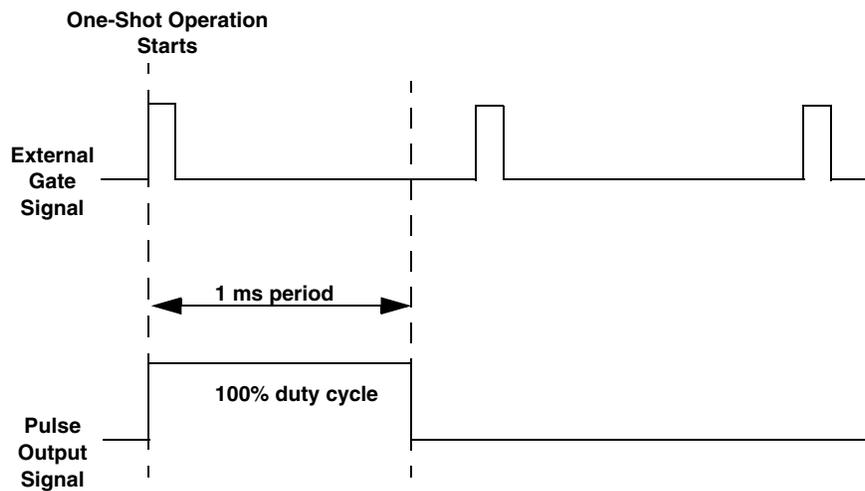
Figure 59: Example of One-Shot Mode

Repetitive One-Shot

Use repetitive one-shot mode to generate a pulse output signal each time the module 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, and 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 106 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 or low-to-high transitions), the C/T clock source, and the gate type to trigger the operation as rising edge or falling edge. Refer to page 109 for more information on pulse output types and to page 108 for more information on gates.

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

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

Note: Triggers that occur while the pulse is being output are not detected by the module.

Ensure that the signals are wired appropriately. Refer to Chapter 4 for wiring examples.

Figure 60 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 low-to-high pulse type.
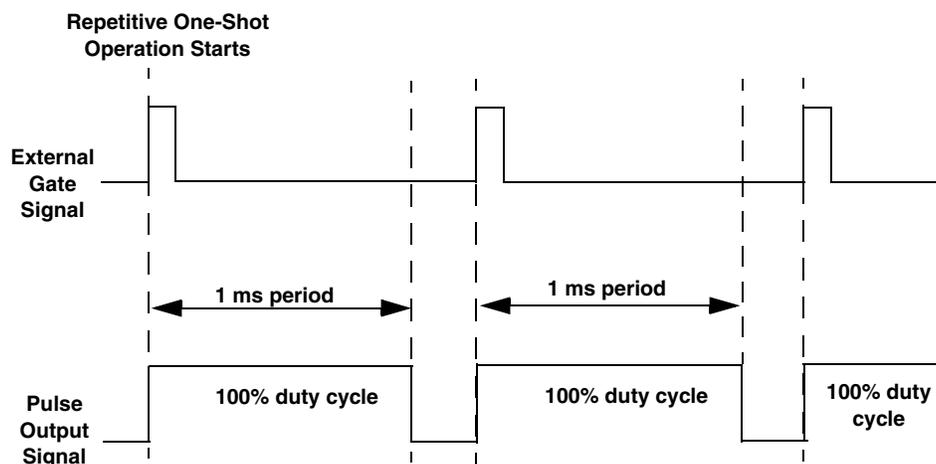
Figure 60: Example of Repetitive One-Shot Mode

7

Supported Device Driver Capabilities

The DT9800 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. For information on how to configure the device driver, refer to Chapter 3.

Table 16: DT9800 Series Subsystems

DT9800 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Total Subsystems on Module	1	1 [a]	1	1	2	0

a. D/A subsystems are supported by the DT9802, DT9802-EC, DT9802-EC-I, DT9804, DT9804-EC, DT9804-EC-I, and DT9806 modules only.

The tables in this chapter summarize the features available for use with the DT-Open Layers for .NET Class Library and the DT9800 Series modules. 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 17: DT9800 Series Data Flow and Operation Options

DT9800 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Single-Value Operation Support **SupportsSingleValue**	Yes	Yes	Yes[a]	Yes		
Simultaneous Single-Value Output Operations **SupportsSetSingleValues**						
Continuous Operation Support **SupportsContinuous**	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**						

a. While the DIN subsystem itself is incapable of continuous operation, you can perform a continuous DIN operation by specifying channel 16 in the channel-gain list of the A/D subsystem and starting the A/D subsystem. All 8 bits of the digital input lines from Port A are assigned to A/D input channel 16.

Buffering

Table 18: DT9800 Series Buffering Options

DT9800 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Buffer Support **SupportsBuffering**	Yes					
Single Buffer Wrap Mode Support **SupportsWrapSingle**	Yes					
Inprocess Buffer Flush Support **SupportsInProcessFlush**	Yes					

Triggered Scan Mode

Table 19: DT9800 Series Triggered Scan Mode Options

DT9800 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Triggered Scan Support **SupportsTriggeredScan**	Yes					
Maximum Number of CGL Scans per Trigger **MaxMultiScanCount**	1	0	0	0	0	0
Maximum Retrigger Frequency **MaxRetriggerFreq**	100 kHz, 50 kHz[a]	0	0	0	0	0
Minimum Retrigger Frequency **MinRetriggerFreq**	0.75 Hz[b]	0	0	0	0	0

a. The maximum retrigger frequency for all modules except the DT9805 and DT9806 is 100 kHz. The DT9805 and DT9806 modules support a maximum retrigger frequency of 50 kHz. The appropriate retrigger frequency to use depends on the number of samples in the channel-gain list and the A/D sample clock frequency, as follows:

$$\text{Min. Retrigger Period} = \frac{\text{\# of CGL entries}}{\text{A/D sample clock frequency}} + 2\ \mu s$$

$$\text{Max. Retrigger Frequency} = \frac{1}{\text{Min. Retrigger Period}}$$

b. The value of 0.75 Hz assumes the minimum number of samples is 1.

Data Encoding

Table 20: DT9800 Series Data Encoding Options

DT9800 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Binary Encoding Support **SupportsBinaryEncoding**	Yes	Yes	Yes	Yes	Yes	
Twos Complement Support **SupportsTwosCompEncoding**						
Returns Floating-Point Values **ReturnsFloats**						

Channels

Table 21: DT9800 Series Channel Options

DT9800 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Number of Channels **NumberOfChannels**	9 or 17[a]	2	1	1	1	0
SE Support **SupportsSingleEnded**	Yes					
SE Channels **MaxSingleEndedChannels**	16	0	0	0	0	0
DI Support **SupportsDifferential**	Yes	Yes	Yes	Yes	Yes	
DI Channels **MaxDifferentialChannels**	8	2	1	1	1	0
Maximum Channel-Gain List Depth **CGLDepth**	32	0	0	0	0	0
Simultaneous Sample-and-Hold Support **SupportsSimultaneousSampleHold**						
Channel-List Inhibit **SupportsChannelListInhibit**						

a. Channels 0 to 15 are provided for single-ended or pseudo-differential analog inputs; channels 0 to 7 are provided for differential inputs. Channel 16 reads all 8 bits from the DIN subsystem (Port A).

Gain

Table 22: DT9800 Series Gain Options

DT9800 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]					

a. The DT9805 and DT9806 modules support gains of 1, 10, 100, and 500; all other DT9800 Series modules support gains of 1, 2, 4, and 8.

121

Ranges

Table 23: DT9800 Series Range Options

DT9800 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Number of Voltage Ranges **NumberOfRanges**	2[a]	4[b]	0	0	0	0
Available Ranges **SupportedVoltageRanges**	0 to 10 V, ±10 V[a]	0 to 10 V, 0 to 5 V, ±5 V, ±10 V[b]				
Current Output Support **SupportsCurrentOutput**						

a. DT9801, DT9801-EC, DT9801-EC-I, DT9802, DT9802-EC, and DT9802-EC-I modules support input ranges of 0 to 10 V or ±10 V. DT9803, DT9803-EC, DT9803-EC-I, DT9804, DT9804-EC, DT9804-EC-I, DT9805, and DT9806 modules support an input range of ±10 V only.

b. DT9802, DT9802-EC, and DT9802-EC-I modules support an output range of 0 to 10 V, 0 to 5 V, ±10 V, or ±5 V. DT9804, DT9804-EC, DT9804-EC-I, and DT9806 modules support an output range of ±10 V only.

Resolution

Table 24: DT9800 Series Resolution Options

DT9800 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Software Programmable Resolution **SupportsSoftwareResolution**						
Number of Resolutions **NumberOfResolutions**	1	1	1	1	1	0
Available Resolutions **SupportedResolutions**	12 or 16[a]	12 or 16[b]	8	8	16[c]	

a. These modules provide 12-bit resolution for the A/D subsystem: DT9801, DT9802, DT9801-EC, DT9802-EC, DT9801-EC-I, and DT9802-EC-I.
   These modules provide 16-bit resolution for the A/D subsystem: DT9803, DT9804, DT9805, DT9806, DT9803-EC, DT9804-EC, DT9803-EC-I, and DT9804-EC-I.

b. These modules provide 12-bit resolution for the D/A subsystem: DT9802, DT9802-EC, and DT9802-EC-I.
   These modules provide 16-bit resolution for the D/A subsystem: DT9804, DT9806, DT9804-EC, and DT9804-EC-I.

c. You can cascade counter/timers in software to create a 32-bit counter/timer.

Thermocouple and RTD Support

Table 25: DT9800 Series Thermocouple Support Options

DT9800 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 DT9805 and DT9806 modules.

IEPE Support

Table 26: DT9800 Series IEPE Support Options

DT9800 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 27: DT9800 Series Trigger Options

DT9800 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Software Trigger Support **SupportsSoftwareTrigger**	Yes	Yes	Yes	Yes	Yes	
External Positive TTL Trigger Support **SupportsPosExternalTTLTrigger**	Yes[a]				Yes	
External Negative TTL Trigger Support **SupportsNegExternalTTLTrigger**						
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**						

a. The external trigger is the rising-edge on the External A/D Trigger input.

Clocks

Table 28: DT9800 Series Clock Options

DT9800 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**	12 MHz	0	0	0	12 MHz	0
Maximum Clock Divider **MaxExtClockDivider**	1.0	1.0	1.0	1.0	65536	0
Minimum Clock Divider **MinExtClockDivider**	1.0	1.0	1.0	1.0	2.0	0
Maximum Frequency **MaxFrequency**	100 kHz[a]	0		0	750 kHz	0
Minimum Frequency **MinFrequency**	0.75 Hz	1.0	0	0	.0028 Hz[b]	0

a. The maximum throughput for analog input channels is 100 kHz for all modules except the DT9805 and DT9806 modules. The maximum throughput for the DT9805 and DT9806 modules is 50 kHz for a single channel or channel scan with gains of 1 and 10, 10 kHz for a channel scan with a gain of 100, and 2 kHz for a channel scan and a gain of 500.

b. Counter/timers 0 and 1 can be cascaded. If you are not using cascaded timers, this value is approximately 183 Hz.

Counter/Timers

Table 29: DT9800 Series Counter/Timer Options

DT9800 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Cascading Support **SupportsCascading**					Yes	
Event Count Mode Support **SupportsCount**					Yes	
Generate Rate Mode Support **SupportsRateGenerate**					Yes	
One-Shot Mode Support **SupportsOneShot**					Yes	
Repetitive One-Shot Mode Support **SupportsOneShotRepeat**					Yes	
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**					Yes	
Variable Pulse Width Support **SupportsVariablePulseWidth**					Yes[a]	
None (internal) Gate Type Support SupportsGateNone					Yes	
High Level Gate Type Support **SupportsGateHighLevel**					Yes[b]	
Low Level Gate Type Support **SupportsGateLowLevel**					Yes[b]	
High Edge Gate Type Support **SupportsGateHighEdge**					Yes[b]	
Low Edge Gate Type Support **SupportsGateLowEdge**					Yes[b]	
Level Change Gate Type Support **SupportsGateLevel**						
Clock-Falling Edge Type SupportsClockFalling						
Clock-Rising Edge Type **SupportsClockRising**						
Gate-Falling Edge Type **SupportsGateFalling**						

Table 29: DT9800 Series Counter/Timer Options (cont.)

DT9800 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Gate-Rising Edge Type **SupportsGateRising**						
Interrupt-Driven Operations **SupportsInterrupt**						

a. In one-shot and repetitive one-shot modes, the pulse width is set to 100% automatically.

b. High-edge and low-edge are supported for one-shot and repetitive one-shot modes. High-level and low-level are supported for event counting and rate generation modes.

8

Calibration

The DT9800 Series modules are calibrated at the factory and should not require calibration for initial use. We recommend that you check and, if necessary, readjust the calibration of the analog I/O circuitry on the DT9800 Series modules every six months.

Note: Ensure that you installed the DT9800 Series Device Driver and configured your module (if applicable) prior to using the DT9800 Series Calibration Utility. Refer to Chapter 3 for more information.

This chapter describes how to run the DT9800 Series Calibration Utility and calibrate the analog I/O circuitry of the DT9800 Series modules.

Running the Calibration Utility

To run the DT9800 Series Calibration Utility, do the following:

1. Click **Start** from the Task Bar.

2. Browse to **Programs** | **Data Translation, Inc** | **Calibration** | **DT9800 Calibration Utility**.
   The main menu appears.

3. Select the module to calibrate, and then click **OK**.

Once the DT9800 Series Calibration Utility is running, you can calibrate the analog I/O circuitry, as described in the following sections.

Calibrating the Analog Input Subsystem

The following sections describe how to configure your module for calibration and how to calibrate the analog input circuitry of your module.

Configuring for Calibration

To calibrate the analog input circuitry, use an external +9.3750 V precision voltage source. Using an external +9.3750 V precision voltage source provides an accuracy of approximately ±1 LSB for DT9801, DT9801-EC, DT9801-EC-I, DT9802, DT9802-EC, and DT9802-EC-I modules and ±3 LSBs for the DT9803, DT9803-EC, DT9803-EC-I, DT9804, DT9804-EC, DT9804-EC-I, DT9805, and DT9806 modules.

Do the following to configure a DT9800 Series module for calibration:

1. Connect Analog Input 0 (TB1) to the positive side of the precision voltage source.

2. Connect Analog Input 0 Return (TB2) to the negative side of the precision voltage source.

3. Connect Analog Input 0 Return (TB2) to Analog Ground (TB17).

4. Connect Analog In 1 (TB3) to Analog In 1 Return (TB4) and to Analog Ground (TB17).

When you are finished connecting the external reference, calibrate the module, as described in the next section.

Using the Auto-Calibration Procedure

Auto-calibration is the easiest to use and is the recommended calibration method. To calibrate the analog input subsystem automatically, do the following:

1. Click **Go** in the **Auto Calibration** box.
   The zero and full-scale ranges are automatically calibrated.

Note: If you are not satisfied with the analog input calibration, you can load the factory default settings stored in the EEPROM by clicking **Restore** in the A/D Configuration Factory Settings box.

Once you have finished this procedure, the analog input circuitry is calibrated. If you are using a DT9805 or DT9806 module, we recommend that you calibrate the thermocouple circuitry using the instructions on . Otherwise, you can calibrate the analog output circuitry, if you wish, following the instructions on .

Using the Manual Calibration Procedure

To calibrate the analog input subsystem manually, do the following:

1. Click **A/D Ch. 1**.

2. Click the increment or decrement arrows in the **Offset** box until the A/D value on the screen reads 0 V (within 0.001 V for the DT9803, DT9803-EC, DT9803-EC-I, DT9804, DT9804-EC,
   DT9804-EC-I, DT9805, and DT9806 modules and within 0.010 V for the DT9801, DT9801-EC, DT9801-EC, DT9802, DT9802-EC, and DT9802-EC-I modules).

3. Click **A/D Ch. 0**.

4. Click the increment or decrement arrows in the **Gain** box until the A/D value on the screen reads +9.3750 V (within 0.001 V for the DT9803, DT9803-EC, DT9803-EC-I, DT9804, DT9804-EC,
   DT9804-EC-I, DT9805, and DT9806 modules and within 0.010 V for the DT9801, DT9801-EC, DT9801-EC-I, DT9802, DT9802-EC, and DT9802-EC-I modules).

Note: If you are not satisfied with the analog input calibration, you can load the factory default settings stored in the EEPROM by clicking **Restore** in the A/D Configuration Factory Settings box.

Once you have finished this procedure, the analog input circuitry is calibrated. If you are using a DT9805 or DT9806 module, we recommend that you calibrate the thermocouple circuitry using the instructions in the next section. Otherwise, you can calibrate the analog output circuitry, if you wish, following the instructions on page 136.

Calibrating the Thermocouple Circuitry

Note: Ensure that the DT9805 or DT9806 module has been running for about 1/2 hour (allowing the module to warm up) and that you have calibrated the analog input circuitry using the procedure described on page 132 before calibrating the thermocouple circuitry.

To calibrate the thermocouple circuitry on the DT9805 or DT9806 modules, do the following:

1. Disconnect all signals to Analog Input 0 (TB1), leaving it open (no connections).

2. Connect Analog In 1 (TB3) to Analog In 1 Return (TB4) and to Analog Ground (TB17).

3. In the **PGL Zero** box, click the text **A/D Gain=500, CH 1** to refresh the value of analog input channel 1.
    The gain is set to 500 automatically.

4. Click the increment or decrement arrows in the **PGL Zero** box until the A/D value reads 0 V (within 5 mV).

5. Measure the room temperature at the temperature sensor of the board (see Figure 61) by taping a thermometer to the underside of the module between screw terminals 9 and 10, then multiply this value by 10 mV.
    This is the temperature to which to adjust the CJC.
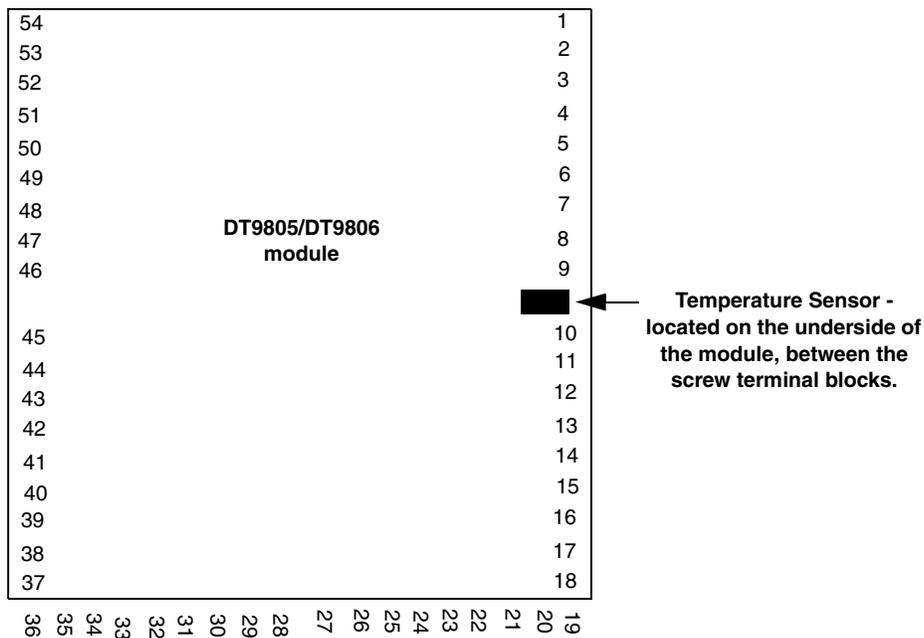
Figure 61: Temperature Sensor Location

6. Click the text **A/D Gain=1, CH 0** in the **CJC Adj.** box to refresh the value of analog input channel 0.
   The gain is set to 1 automatically.

7. Click the increment or decrement arrows in the **CJC Adj.** box until the A/D value on the screen is equal to the room temperature multiplied by 10 mV (within 5 mV). For example, if the room temperature is 25° C, you want to adjust the CJC to 250 mV (within 5 mV).

Note: If you are not satisfied with the thermocouple calibration, you can load the factory default settings stored in the EEPROM by clicking **Restore** in the Thermocouple Calibration Factory Settings box.

Once you have finished this procedure, the thermocouple circuitry is calibrated. You can now calibrate the analog output circuitry, if you wish, following the instructions in the next section.

Calibrating the Analog Output Subsystem

To calibrate the analog output circuitry of the DT9802, DT9802-EC, DT9802-EC-I, DT9804, DT9804-EC, DT9804-EC-I, or DT9806 modules, use an external precision meter.

To calibrate the analog output circuitry, do the following:

1. Connect Analog Output 0+ (TB19) to the positive side of the precision voltage meter.

2. Connect Analog Output 0 Return (TB20) to the negative side of the precision voltage meter.

3. In the **DAC0 Voltage** box, click **0.000 V**.

4. In the **DAC0 Adjustment** box, click the increment or decrement arrows until your external meter display reads 0 V (within 0.005 V).

5. In the **DAC0 Voltage** box, click **+9.375 V** and verify that your external meter display reads +9.375 V (within ±12 mV.)

6. Connect Analog Output 1+ (TB21) to the positive side of the precision voltage meter.

7. Connect Analog Output 1 Return (TB22) to the negative side of the precision voltage meter.

8. In the **DAC1 Voltage** box, click **0.000 V**.

9. In the **DAC1 Adjustment** box, click the increment or decrement arrows until your external meter display reads 0 V (within 0.005 V).

10. In the **DAC1 Voltage** box, click **+9.375 V** and verify that your external meter display reads +9.375 V (within ±12 mV.)

Note: If you are not satisfied with the analog output calibration, you can load the factory default settings stored in the EEPROM by clicking **Restore** in the D/A Calibration Factory Settings box.

Once you have finished this procedure, the analog output circuitry is calibrated.

To close the Calibration Utility, click **Done**.

9

Troubleshooting

General Checklist

Should you experience problems using the DT9800 Series modules, do the following:

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 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 installed and configured the device driver properly using the instructions in Chapter 3.

6. Check that you have wired your signals properly using the instructions in Chapter 4.

7. Search the DT Knowledgebase in the Support section of the Data Translation web site (at www.datatranslation.com) for an answer to your problem.

8. Visit the product's page on the Data Translation web site for the latest tips, white papers, product documentation, and software fixes.

If you still experience problems, try using the information in Table 30 to isolate and solve the problem. If you cannot identify the problem, refer to page 138.

Table 30: Troubleshooting Problems

Symptom	Possible Cause	Possible Solution
Module is not recognized	You plugged the module into your computer before installing the device driver.	From the Control Panel > System > Hardware > Device Manager, uninstall any unknown devices (showing a yellow question mark). Then, run the setup program on your OMNI CD to install the USB device drivers, and reconnect your USB module to the computer.
Module does not respond.	The module configuration is incorrect.	Check the configuration of your device driver; see the instructions in Chapter 3.
	The module is damaged.	Contact Data Translation for technical support; refer to page 140.
Intermittent operation.	Loose connections or vibrations exist.	Check your wiring and tighten any loose connections or cushion vibration sources; see the instructions in Chapter 4.
	The module is overheating.	Check environmental and ambient temperature; consult the module's specifications on page 150 of this manual and the documentation provided by your computer manufacturer for more information.
	Electrical noise exists.	Check your wiring and either provide better shielding or reroute unshielded wiring; see the instructions in Chapter 4.

Table 30: Troubleshooting Problems (cont.)

Symptom	Possible Cause	Possible Solution
Device failure error reported.	The DT9800 Series module cannot communicate with the Microsoft bus driver or a problem with the bus driver exists.	Check your cabling and wiring and tighten any loose connections; see the instructions in Chapter 4.
	The DT9800 Series module was removed while an operation was being performed.	Ensure that your DT9800 Series module is properly connected; see the instructions in Chapter 2.
Data appears to be invalid.	An open connection exists.	Check your wiring and fix any open connections; see the instructions in Chapter 4.
	A transducer is not connected to the channel being read.	Check the transducer connections; see the instructions in Chapter 4.
	The module is set up for differential inputs while the transducers are wired as single-ended inputs or vice versa.	Check your wiring and ensure that what you specify in software matches your hardware configuration; see the instructions in Chapter 4.
Computer does not boot.	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 module's specifications on page 150 of this manual.

Technical Support

If you have difficulty using the DT9800 Series module, Data Translation's Technical Support Department is available to provide technical assistance.

To request technical support, to go 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 Module Needs Factory Service

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

1. Record the module'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 you 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 module in an electrically conductive plastic material. Handle with ground protection. A static discharge can destroy components on the board.

   – 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 31 lists the specifications for the A/D subsystem.

Table 31: A/D Subsystem Specifications

Feature	DT9801/-EC/-EC-I, DT9802/-EC/-EC-I Specifications	DT9803/-EC/-EC-I, DT9804/-EC/-EC-I, DT9805, DT9806 Specifications

Number of analog inputs
   Single-ended/pseudo-differential:
   Differential:
	16
	8
		16
		8
		(7 thermocouple inputs, 1 CJC on DT9805/06)

Number of gains	4 (1, 2, 4, 8)	4 (1, 2, 4, and 8 for DT9803/04; 1, 10, 100, 500 for DT9805/06)
Resolution	12 bits	16 bits
Data encoding	Offset binary	
Coupling	DC	
Over voltage protection Off: On:	±25 V ±40 V	
ESD protection	1.5 kV	
System Error	0.03% FSR	0.01% FSR

System accuracy
 (full-scale)
   Gain = 1:
   Gain = 2:
   Gain = 4:
   Gain = 8:
   (DT9805/9806 only)
   Gain = 10:
   Gain = 100:
   Gain = 500:
	0.03%
	0.04%
	0.05%
	0.05%
		0.01%
		0.02%
		0.03%
		0.03%
		
		0.02%
		0.03%
		0.04%

Nonlinearity (integral)	±1.0 LSBs	±4.0 LSBs
Differential linearity	±0.5 LSBs (no missing codes)	±1.0 LSBs (no missing codes) for DT9803/04 ±1.2 LSBs (no missing codes) for DT9805/06
Range	0 to 1.25 V, 2.5 V, 5 V, 10 V ±1.25, 2.5, 5, 10 V	±1.25 V, 2.5 V, 5 V, 10 V for DT9803/04 ±0.020 V, 0.10 V, 1 V, 10 V for DT9805/06

Table 31: A/D Subsystem Specifications (cont.)

Feature	DT9801/-EC/-EC-I, DT9802/-EC/-EC-I Specifications	DT9803/-EC/-EC-I, DT9804/-EC/-EC-I, DT9805, DT9806 Specifications
Drift Zero:	±30 μV+ (+20 μV * Gain)/° C	±25 μV+ (+10 μV * Gain)/° C for DT9803/04 [a] ±25 μV+ (+5 μV * Gain)/° C for DT9805/06
Gain:	±30 ppm/° C	±20 ppm/° C

Input impedance
  Off:
  On:
	100 MΩ, 10 pF[b]
	100 MΩ, 100 pF[b]	

Channel-gain list	32 Samples	
Internal reference	+2.5 V ±0.002 V	
Input bias current	±20 nA	±20 nA for DT9803/04 +250 nA for DT9805/06[c] (Ch1-7) ±10 nA for DT9805/06 (Ch8-15)
Common mode voltage	±11 V maximum (operational)	
Maximum input voltage	±40 V maximum (protection)	
A/D converter noise	0.3 LSB rms	0.4 LSB rms
Amplifier input noise	20 μV rms + (10 μV rms * gain) 200 pA rms (current)	15 μV rms + (10 μV rms * gain) 100 pA rms (current)
Channel-to-channel offset	±40 μV	±40 μV
Channel acquisition time	3 μs	5 μs for DT9803/04 6 μs (Gain = 1) for DT9805/06 250 μs (Gain = 500) for DT9805/06
A/D conversion time	6.6 μs	8 μs
Effective number of bits (ENOB) at 1 kHz input	11.5 bits	13.5 bits for DT9803/04 14.1 bits for DT9805/06
Total Harmonic Distortion	−80 dB typical	−90 dB typical
Channel crosstalk	−80 dB @ 1 kHz	
Minimum Data Throughput (Internal Clock)	0.75 S/s	

Table 31: A/D Subsystem Specifications (cont.)

Feature	DT9801/-EC/-EC-I, DT9802/-EC/-EC-I Specifications	DT9803/-EC/-EC-I, DT9804/-EC/-EC-I, DT9805, DT9806 Specifications
Data throughput Single analog channel:	100 kSamples/s (0.03% accuracy)	100 kSamples/s for DT9803/04 (0.01% accuracy); 50 kSamples/s for DT9805/06 (0.01% accuracy)
Multiple channels (scan with gain of 1 to 10):	100 kSamples/s (0.03% accuracy)	100 kSamples/s for DT9803/04 (0.01% accuracy); 50 kSamples/s for DT9805/06 (0.01% accuracy)
Multiple channels (scan with gain of 100):	–	10 kSamples/s (0.03% accuracy)
Data throughput (cont.) Multiple channels (scan with gain of 500):	–	2 kSamples/s (0.04% accuracy)
Single digital channel:	100 kSamples/s	100 kSamples/s for DT9803/04; 50 kSamples/s for DT9805/06
CJC Voltage @ 25° C	–	+0.250 V
Cold Junction Accuracy	–	+1° from 5° to 45° C
Break Detection Current[d]	–	+250 nA (high side differential)

External A/D sample clock
  Input type
  High-level input voltage:
  Low-level input voltage:
  Minimum pulse width:
  Maximum frequency:
	HCT Rising-Edge Sensitive with 22 kΩ pull-up resistor
	2.4 V minimum
	0.8 V maximum
	600 ns (high); 600 ns (low)
	750.0 kHz	

External A/D digital (TTL) trigger
  Input type
  High-level input voltage:
  Low-level input voltage:
  Minimum pulse width:
  Maximum frequency:
	HCT Rising-Edge Sensitive with 22 kΩ pull-up resistor
	2.4 V minimum
	0.8 V maximum
	600 ns (high); 600 ns (low)
	750.0 kHz	

Dynamic Digital Output
  Output driver:
  Output driver high voltage:
  Output driver low voltage:
  Back EMF Diodes
	TTL
	2.4 V maximum (IOH = 1 mA)
	0.5 V maximum (IOL = 2 mA)
	Yes	

a. This value is referenced to voltage entering the A/D converter. To reference this value to the original voltage signal, use {[+/-25 + (5uV * Gain)] / Gain} / degrees C.

b. On channel 0 only on the DT9805 and DT9806 modules, the input impedance is 10 kΩ.

c. Break detection current.

d. Broken thermocouples in differential mode will output plus full scale for gains equal to or greater than 10.

Analog Output Specifications

Table 32 lists the specifications for the D/A subsystem.

Table 32: D/A Subsystem Specifications

Feature	DT9802/-EC/-EC-I Specifications	DT9804/-EC/-EC-I, DT9806 Specifications
Number of analog output channels	2	
Resolution	12 bits	16 bits
Data encoding (input)	Offset binary	
Nonlinearity (integral)	±1 LSBs	±4 LSBs
Differential linearity	±0.5 LSBs (monotonic)	±1.0 LSB (monotonic)
Output range	0 to 5 V, 10 V ±5 V, 10 V	±10 V
Zero error	Software-adjustable to zero	
Gain error	±2 LSBs	±6 LSBs
Current output	±5 mA minimum (10 V/ 2 kΩ)	
Output impedance	0.3 Ω typical	
Capacitive drive capability	0.001 μF minimum (no oscillations)	
Protection	Short circuit to Analog Common	
Power-on voltage	0 V ±10 mV maximum	
Settling time to 0.01% of FSR	50 μs, 20 V step; 10 μs, 100 mV step	
Throughput (Full Scale)	Single value (system dependent)	
Slew rate	2 V/μs	

Digital I/O Specifications

Table 33 lists the specifications for the digital input subsystem.

Table 33: DIN Subsystem Specifications

Feature	Specifications
Number of lines	8 (Port A)
Termination	None
Inputs Input type: Input load: High-level input voltage: Low-level input voltage: High-level input current: Low-level input current:	Level sensitive 1 (HCT) 2.0 V minimum 0.8 V maximum 3 µA –3 µA
Maximum internal pacer rate (single digital channel)[a]	Maximum A/D throughput of the board
Back EMF diodes	No

a. This digital channel must be the only channel included as part of the channel list.

Table 34 lists the specifications for the digital output subsystem.

Table 34: DOUT Subsystem Specifications

Feature	Specifications
Number of lines	8 (Port B)
Termination	22 kΩ resistor
Outputs Output driver: Output driver high voltage (source): Output driver low voltage (sink):	74HCT244 (TTL) 2.4 V minimum (IOH = 1 mA) 0.5 V maximum (IOL = 12 mA)
Back EMF diodes	Yes

Counter/Timer Specifications

Table 35 lists the specifications for the C/T subsystems.

Table 35: C/T Subsystem Specifications

Feature	Specifications
Number of counter/timer channels	2

Clock Inputs
    Input type:
    High-level input voltage:
    Low-level input voltage:
    Minimum pulse width:
    Maximum frequency:
	
	HCT with 22 kΩ pull-up resistor
	2.4 V minimum
	0.8 V maximum
	600 ns (high); 600 ns (low)
	750 kHz

Gate Inputs
    Input type:
    High-level input voltage:
    Low-level input voltage:
    Minimum pulse width:
	
	HCT with 22 kΩ pull-up resistor
	2.4 V minimum
	0.8 V maximum
	600 ns (high); 600 ns (low)

Counter Outputs
    Output driver high voltage:
    Output driver low voltage:
	
	3.0 V minimum @ 1 mA Source
	0.4 V maximum @ 2 mA Sink

Power, Physical, and Environmental Specifications

Table 36 lists the power, physical, and environmental specifications for the DT9800 Series modules.

Table 36: Power, Physical, and Environmental Specifications

Feature	Specifications

Power
  +5 V Standby:
  +5 V Enumeration:
  +5 V Power ON:
  +5 V Isolated Power Out (TB27)
	
	0.5 µA maximum
	100 mA maximum
	500 mA maximum
	10 mA maximum

Physical
 Dimensions:
  DT9800 Standard Series:
  DT9800-EC and DT9800-EC-I Series
 Weight:
	
	6.5 inches x 4.5 inches x 1.4 inches
	7.42 inches x 3.40 x 0.736 inches
	9 ounces (255 grams)

Environmental
  Operating temperature range:
  Storage temperature range:
  Relative humidity:
	
	0° C to 55° C
	–25° C to 85° C
	To 95%, noncondensing

Cable and Terminal Block Specifications

Table 37 lists the screw terminal and cable specifications for the DT9800 Standard modules.

Table 37: DT9800 Standard Cable and Terminal Block Specifications

Feature	Specifications
Recommended cable	2-meter, Type A-B, USB cable AMP part 1487588-3
Screw terminal block (TB1-TB6)	9-Position Header: PCD, Inc. part ELVH09100 Mating plug: PCD, Inc. part ELVP09100

Table 38 lists the connector specifications for the DT9800-EC and DT9800-EC-I Series modules.

Table 38: DT9800-EC/EC-I Connector Specifications

Feature	Header	Mating Cable Connector
26-pin connector (J5, J6)	AMP/Tyco part 1761686-9	AMP/Tyco part 1658622-6
50 pin connector (J4)	AMP/Tyco part 1-1761686-5	AMP/Tyco part 1-1658622-0

Regulatory Specifications

Table 39 lists the regulatory specifications for the DT9800 Series modules.

Table 39: Regulatory Specifications

Feature	Specifications
Emissions (EMI)	FCC Part 15, EN55022:1994 + A1:1995 + A2:1997 VCCI, AS/NZS 3548 Class A
Immunity	EN61000-6-1:2001
RoHS (EU Directive 2002/95/EG)	Compliant (as of July 1st, 2006)

B
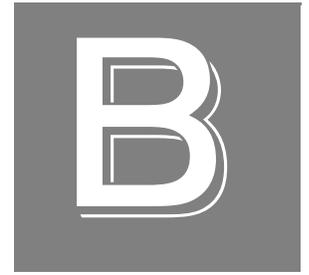
Connector Pin Assignments

DT9800 Standard Series

Table 40 lists the pin assignments of connector J1 on the DT9800 Standard modules.

Table 40: Pin Assignments for Connector J1 on the DT9800 Standard Modules

Pin	Signal Description	Pin	Signal Description
1	Analog Input 00/ CJC on DT9805/DT9806	2	Analog Input 08/00 Return
3	Analog Input 01	4	Analog Input 09/01 Return
5	Analog Input 02	6	Analog Input 10/02 Return
7	Analog Input 03	8	Analog Input 11/03 Return
9	Analog Input 04	10	Analog Input 12/04 Return
11	Analog Input 05	12	Analog Input 13/05 Return
13	Analog Input 06	14	Analog Input 14/06 Return
15	Analog Input 07	16	Analog Input 15/07 Return
17	Isolated Analog Ground	18	Amp Low
19	Analog Output 0+	20	Analog Output 0 Return
21	Analog Output 1+	22	Analog Output 1 Return
23	Isolated Digital Ground	24	External A/D Trigger
25	External A/D Sample Clock In	26	Isolated Digital Ground
27	Isolated +5 V Out[a]	28	Digital Input 0
29	Digital Input 1	30	Digital Input 2
31	Digital Input 3	32	Digital Input 4
33	Digital Input 5	34	Digital Input 6
35	Digital Input 7	36	Isolated Digital Ground
37	Isolated Digital Ground	38	Digital Output 7
39	Digital Output 6	40	Digital Output 5
41	Digital Output 4	42	Digital Output 3
43	Digital Output 2	44	Digital Output 1
45	Digital Output 0	46	Dynamic Digital Output
47	Isolated Digital Ground	48	External Gate 1
49	User Counter Output 1	50	User Clock Input 1
51	Isolated Digital Ground	52	External Gate 0
53	User Counter Output 0	54	User Clock Input 0

a. +5 V output is available only when one of the subsystems is activated, which, in turn,
   activates power to the module.

Figure 62 shows the screw terminal assignments of the DT9800 Standard modules.

*CJC on DT9805/06

Left	Pin		Right Pin	Right
User Clk Input 0	54		1	Channel 00*
User Cntr Out 0	53		2	Channel 08/00 Ret
External Gate 0	52		3	Channel 01
Isolated Dig Gnd	51		4	Channel 09/01 Ret
User Clk Input 1	50		5	Channel 02
User Cntr Out 1	49		6	Channel 10/02 Ret
External Gate 1	48		7	Channel 03
Isolated Dig Gnd	47		8	Channel 11/03 Ret
Dynamic Dig Out	46	**DT9800 Standard Series Modules**	9	Channel 04
Digital Output 0	45		10	Channel 12/04 Ret
Digital Output 1	44		11	Channel 05
Digital Output 2	43		12	Channel 13/05 Ret
Digital Output 3	42		13	Channel 06
Digital Output 4	41		14	Channel 14/06 Ret
Digital Output 5	40		15	Channel 07
Digital Output 6	39		16	Channel 15/07 Ret
Digital Output 7	38		17	Isolated An Gnd
Isolated Dig Gnd	37		18	Amp Low

Bottom pins (36–19):

36	Isolated Dig Gnd
35	Digital Input 7
34	Digital Input 6
33	Digital Input 5
32	Digital Input 4
31	Digital Input 3
30	Digital Input 2
29	Digital Input 1
28	Digital Input 0
27	Isolated +5 V Out
26	Isolated Dig Gnd
25	Ext A/D Sample Clk
24	Ext A/D Trigger
23	Isolated Dig Gnd
22	Analog Out 1 Ret
21	Analog Out 1+
20	Analog Out 0 Ret
19	Analog Out 0+

Figure 62: Screw Terminal Assignments for the DT9800 Standard Modules

155

EC and EC-I Series Modules

Table 41 lists the pin assignments for connector J6; Table 42 lists the pin assignments for connector J5; and Table 43 lists the pin assignments for connector J4 on the DT9800-EC and DT9800-EC-I Series modules.

Table 41: Connector J6 Pin Assignments

J6 Pin #[a]	AC1324 Screw Terminal[a]	Signal Name	J6 Pin #[a]	AC1324 Screw Terminal[a]	Signal Name
1	TB1	Analog Input 0	2	TB2	Analog Input 0 Return/ Analog Input 8
3	TB3	Isolated Analog Ground[b]	4	TB4	Analog Input 1 Return/ Analog Input 9
5	TB5	Analog Input 1	6	TB6	Isolated Analog Ground[b]
7	TB7	Analog Input 2	8	TB8	Analog Input 2 Return/ Analog Input 10
9	TB9	Isolated Analog Ground[b]	10	TB10	Analog Input 3 Return/ Analog Input 11
11	TB11	Analog Input 3	12	TB12	Isolated Analog Ground[b]
13	TB13	Analog Input 4	14	TB14	Analog Input 4 Return/ Analog Input 12
15	TB15	Isolated Analog Ground[b]	16	TB16	Analog Input 5 Return/ Analog Input 13
17	TB17	Analog Input 5	18	TB18	Isolated Analog Ground[b]
19	TB19	Analog Input 6	20	TB20	Analog Input 6 Return/ Analog Input 14
21	TB21	Not Connected	22	TB22	Analog Input 7 Return/ Analog Input 15
23	TB23	Analog Input 7	24	TB24	Isolated Analog Ground[b]
25	TB25	Amp Low	26	TB26	External A/D Trigger

a. Analog input signals 8 to 15 are not available on the 5B08 or 7BP08-1 backplane. Analog input signals 4 to 15 are not available on the 7BP04-1 backplane.
b. This signal is not isolated on the DT9800-EC Series boards.

Table 42: Connector J5 Pin Assignments

J5 Pin #	AC1324 Screw Terminal	Signal Name	J5 Pin #	AC1324 Screw Terminal	Signal Name
1	TB1	Analog Output 0	2	TB2	Analog Output 0 Return
3	TB3	Analog Output 1	4	TB4	Analog Output 1 Return
5	TB5	Isolated Digital Ground[a]	6	TB6	External A/D Trigger
7	TB7	External A/D Sample Clock	8	TB8	Isolated Digital Ground[a]
9	TB9	Isolated +5 V Output[a,b]	10	TB10	Not Connected
11	TB11	Not Connected	12	TB12	Dynamic Digital Output
13	TB13	Isolated Digital Ground[a]	14	TB14	User External Gate 1
15	TB15	User Counter Output 1	16	TB16	User Clock Input 1
17	TB17	Isolated Digital Ground[a]	18	TB18	User External Gate 0
19	TB19	User Counter Output 0	20	TB20	User Clock Input 0
21	TB21	Not Connected	22	TB22	Not Connected
23	TB23	Not Connected	24	TB24	Not Connected
25	TB25	Not Connected	26	TB26	Not Connected

a. This signal is not isolated on the DT9800-EC Series.

b. +5 V output is available only when one of the subsystems is activated, which, in turn, activates power to the module. This signal can be used as an input to power the digital output latch so that the outputs retain their states during power down.

Table 43: Connector J4 Pin Assignments

J4 Pin #	STP-EZ Screw Terminal	Signal Name	J4 Pin #	STP-EZ Screw Terminal	Signal Name
1	TB1	Not Connected	2	TB2	Digital Ground
3	TB3	Not Connected	4	TB4	Digital Ground
5	TB5	Not Connected	6	TB6	Digital Ground
7	TB7	Not Connected	8	TB8	Digital Ground
9	TB9	Not Connected	10	TB10	Digital Ground
11	TB11	Not Connected	12	TB12	Digital Ground
13	TB13	Not Connected	14	TB14	Digital Ground
15	TB15	Not Connected	16	TB16	Digital Ground
17	TB17	Digital Output 7	18	TB18	Digital Ground
19	TB19	Digital Output 6	20	TB20	Digital Ground
21	TB21	Digital Output 5	22	TB22	Digital Ground
23	TB23	Digital Output 4	24	TB24	Digital Ground
25	TB25	Digital Output 3	26	TB26	Digital Ground
27	TB27	Digital Output 2	28	TB28	Not Connected
29	TB29	Digital Output 1	30	TB30	Not Connected
31	TB31	Digital Output 0	32	TB32	Not Connected
33	TB33	Digital Input 7	34	TB34	Not Connected
35	TB35	Digital Input 6	36	TB36	Not Connected
37	TB37	Digital Input 5	38	TB38	Not Connected
39	TB39	Digital Input 4	40	TB40	Not Connected
41	TB41	Digital Input 3	42	TB42	Not Connected
43	TB43	Digital Input 2	44	TB44	Not Connected
45	TB45	Digital Input 1	46	TB46	Not Connected
47	TB47	Digital Input 0	48	TB48	Not Connected
49	TB49	Not Connected	50	TB50	Not Connected

DT9804 BNC Modules

This section provides information about using the DT9804-EC-I-8DI-BNC and DT9804-EC-I-16SE-BNC USB modules.

The DT9804-EC-I-8DI-BNC and DT9804-EC-I-16SE-BNC configurations package the DT9804 module in a special aluminum case, called a BNC box. The DT9804-EC-I-8DI-BNC, shown in Figure 63, provides BNC connectors for 8 differential analog inputs. The DT9804-EC-I-16SE-BNC, shown in Figure 64, provides BNC connectors for 16 single-ended analog inputs.

Both configurations provide BNC connectors for the A/D trigger and A/D clock signals. These signals as well as the digital I/O and counter/timer signals are also accessible through 37-pin, D-sub connectors on the BNC box.
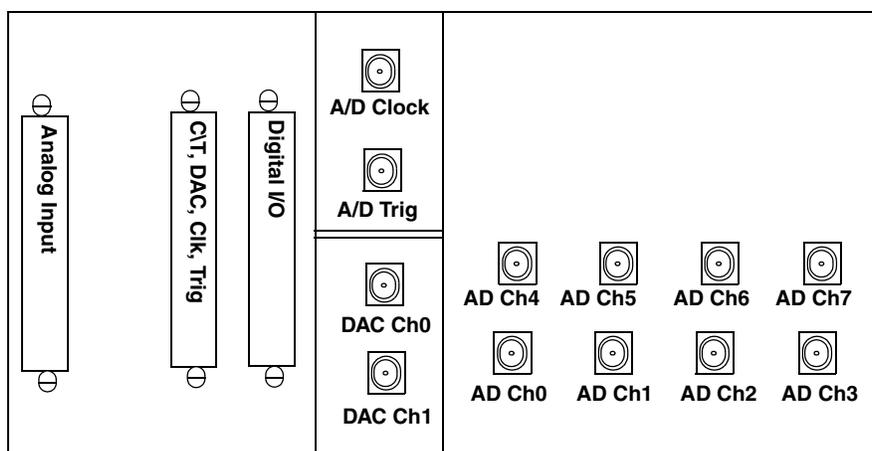
Figure 63: DT9804-EC-I-8DI-BNC - Differential Configuration
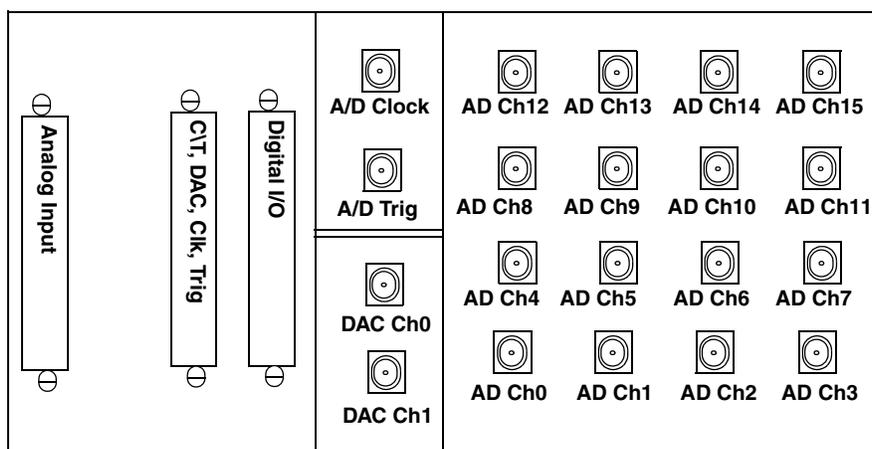
Figure 64: DT9804-EC-I-16SE-BNC - Single-Ended Configuration

> **Note:** A USB connector, provided on the side panel, allows you to connect directly to the host computer using a USB cable.

Mechanical Specifications

Table 44 lists the mechanical specifications for the BNC box.

Table 44: BNC Box Mechanical Specifications

Feature	Specification
Type	Aluminum, optional DIN-rail mountable
Dimensions	216 mm x 106 mm x 50.3 mm (8.5 inches x 4.17 inches x 1.98 inches)
BNC Connectors Analog Input	16 BNCs for 16 single-ended analog or 8 BNCs for 8 differential inputs
Analog output	2 BNCs for 2 differential analog outputs
A/D Clock Input	1 BNC for an A/D TTL clock input
A/D Trigger Input	1 BNC for an A/D TTL trigger input

Table 45 lists the connector specifications.

Table 45: Mating Cable Connectors

Connector	Part Number on Module (or Equivalent)	Mating Cable Connector
Analog input (J20)	AMP/Tyco 5747375-8	AMP/Tyco 5-747917-2
Digital I/O (J22)	AMP/Tyco 5747301-8	AMP/Tyco 5-747916-2
C/T, DAC, Clk, Trig (J21)	AMP/Tyco 5747301-8	AMP/Tyco 5-747916-2

D-Sub Connector Pin Assignments

Table 46 lists the pin assignments for the analog input connector (J20) on the BNC box.

Table 46: Analog Input Connector (J20) Pin Assignments

Pin	Signal Description	Pin	Signal Description
1	Analog Input 0	2	Analog Input 1
3	Analog Input 2	4	Analog Input 3
5	Analog Input 4	6	Analog Input 5
7	Analog Input 6	8	Analog Input 7
9	Not used	10	Not used
11	Not used	12	Not used
13	Not used	14	Not used
15	Not used	16	Not used
17	Amplifier Low	18	+5 V Analog
19	Not used	20	Analog Input 0 Return/ Analog In 8[a]
21	Analog Input 1 Return/ Analog In 9[a]	22	Analog Input 2 Return/ Analog In 10[a]
23	Analog Input 3 Return/ Analog In 11[a]	24	Analog Input 4 Return/ Analog In 12[a]
25	Analog Input 5 Return/ Analog In 13[a]	26	Analog Input 6 Return/ Analog In 14[a]
27	Analog Input 7 Return/ Analog In 15[a]	28	Not used
29	Not used	30	Not used
31	Not used	32	Not used
33	Not used	34	Not used
35	Not used	36	Analog Ground
37	Digital Ground		

a. The first signal description (Return) applies to the differential configuration for all modules. The second signal description applies to the single-ended configuration for the module.

161

Table 47 lists the pin assignments for the digital I/O connector (J22) on the BNC box.

Table 47: Digital I/O Connector (J22) Pin Assignments

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

Table 48 lists the pin assignments for the counter/timer, analog output, clock, and trigger connector (J21) on the BNC box.

Table 48: Counter/Timer, Analog Output, Clock, and Trigger Connector (J21) Pin Assignments

Pin	Signal Description	Pin	Signal Description
1	Analog Output 0	2	Analog Output 1
3	Not used	4	Not used
5	Digital Ground	6	Not used
7	External ADC Clock	8	Counter 0 Clock
9	Counter 0 Out	10	Counter 1 Clock
11	Counter 1 Out	12	Not used
13	Not used	14	Not used
15	Not used	16	Not used
17	Not used	18	Digital Ground
19	Not used	20	Analog Output 0 Return
21	Analog Output 1 Return	22	Not used
23	Not used	24	Digital Ground
25	Not used	26	External ADC Trigger
27	Digital Ground	28	Counter 0 Gate
29	Digital Ground	30	Counter 1 Gate
31	Digital Ground	32	Not used
33	Digital Ground	34	Not used
35	Digital Ground	36	Not used
37	Digital Ground		

Index

Numerics

A

B