DATA TRANSLATION

UM-20769-G

DT9812, DT9813, and DT9814 User's Manual

Seventh Edition
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Radio and Television Interference

This equipment has been tested and found to comply with CISPR EN55022 Class A, and EN50082-1 (CE) requirements and also with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

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

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

Canadian Department of Communications Statement

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

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

Table of Contents

About this Manual

The first part of this manual describes how to install and set up your DT9812-2.5V, DT9812-10V, DT9813-10V, and DT9814-10V modules and software, and verify that your modules are working properly.

The second part of this manual describes the features of the DT9812-2.5V, DT9812-10V, DT9813-10V, and DT9814-10V modules, the capabilities of the device driver, and how to program the modules using the DT-Open Layers for .NET Class Library™ software. Troubleshooting information is also provided.

Note: 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.

If the information in this manual applies to both versions of the DT9812 module, this manual uses the product name "DT9812 module." If the information applies to a specific module, this manual uses the specific product name.

Intended Audience

This document is intended for engineers, scientists, technicians, or others responsible for using and/or programming the modules for data acquisition operations in the Microsoft® Windows® 2000 or Windows XP 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

This manual is organized as follows:

- Chapter 1, "Overview," describes the major features of the DT9812-2.5V, DT9812-10V, DT9813-10V, and DT9814-10V modules, as well as the supported software and accessories for the modules.
- Chapter 2, "Preparing to Use a Module," describes how to unpack the module, check the system requirements, and install the software.
- Chapter 3, "Setting Up and Installing the Module," describes how to install the module and how to configure the device driver.
- Chapter 4, "Wiring Signals to the Module," describes how to wire signals to the 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 device driver.
- Chapter 8, "Troubleshooting," provides information that you can use to resolve problems with a module and device driver, should they occur.
- Chapter 9, "Calibration," describes how to calibrate the analog I/O circuitry of the 10V modules.
- Appendix A, "Specifications," lists the specifications of the modules.
- Appendix B, "Screw Terminal Assignments," shows the screw terminal assignments of 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 DT9812, DT9813, and DT9814 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).
- *DT Measure Foundry Getting Started Manual* (UM-19298) and online help. These documents describe how to use DT Measure Foundry™ to build drag-and-drop test and measurement applications for Data Translation® data acquisition devices without programming.
- *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.
- Microsoft Windows 2000 or Windows XP documentation.
- USB web site (http://www.usb.org).

Where To Get Help

Should you run into problems installing or using a module, the Data Translation Technical Support Department is available to provide technical assistance. Refer to Chapter 8 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

Key Hardware Features

The DT9812-2.5V, DT9812-10V, DT9813-10V, and DT9814-10V modules are economy, multifunction mini-instruments. Table 1 lists the key features of each module.

Table 1: Key Features of the DT9812, DT9813, and DT9814 Modules

Module	Analog Inputs	Analog Outputs	I/O Range	Sample Rate	Digital I/O
DT9812-2.5V	8 SE	2	0 to 2.44 V	50 kS/s	8 in/ 8 out
DT9812-10V	8 SE	2	±10 V	50 kS/s	8 in/ 8 out
DT9813-10V	16 SE	2	±10 V	50 kS/s	4 in/ 4 out
DT9814-10V	24 SE	2	±10 V	50 kS/s	--

All modules provide the following features:

- 2-location output channel list. You can update both DACs simultaneously at up to 50 kSamples/s
- 12-bit resolution
- One 32-bit counter/timer channel
- Internal and external A/D clock sources
- Internal and external A/D trigger sources
- No external power supply required

Channel-Gain List

All modules support a 32-location channel-gain list. You can cycle through the channel-gain list using continuous scan mode or triggered scan mode.

Counter/Timer Channel

All modules support one 32-bit counter/timer (C/T) channel that performs event counting, frequency measurement, edge-to-edge measurement, and rate generation (continuous pulse output) operations.

Supported Software

The following software is available for use with the DT9812, DT9813, and DT9814 modules, and is provided on the OMNI CD:

- **Device Driver** – The DT9812, DT9813, or DT9814 Device Driver allows you to use these modules with any of the supported software packages or utilities. Refer to Chapter 2 for more information on loading the device driver.
- **Quick DataAcq application** – The Quick DataAcq application provides a quick way to get up and running using a DT9812, DT9813, or DT9814 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 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.

- **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 DT9812, DT9813, or DT9814 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 DT9812, DT9813, or DT9814 Series module using Windows 2000 or Windows XP; the DataAcq SDK complies with the DT-Open Layers standard.
- **DTx-EZ** – Use this optional software package if you want to use ActiveX controls to access the capabilities of your modules 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.
- **DT Measure Foundry** – An evaluation version of this software is included or provided via a link on the OMNI CD. DT 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.
- **LV-Link** – An evaluation version of LV-Link is included on the OMNI CD. Use this software package if you want to use the LabVIEW graphical programming language to access the capabilities of your modules.

Getting Started Procedure

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

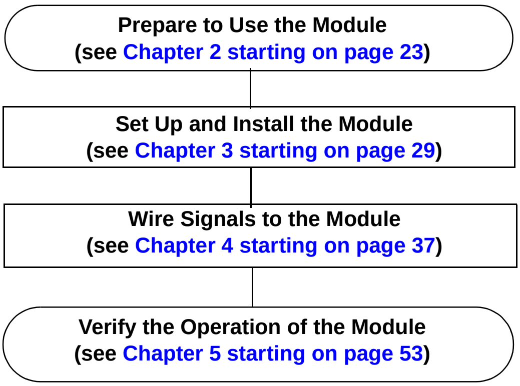
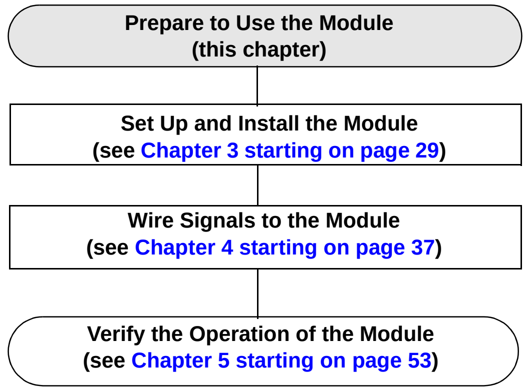


Figure 1: Getting Started Flow Diagram

Part 1:
Getting Started

2

Preparing to Use a Module



Unpacking

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

- DT9812-2.5V, DT9812-10V, DT9813-10V, or DT9814-10V module
- OMNI CD
- USB cable

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. An application engineer will guide you through the appropriate steps for replacing missing or damaged items. If you are located outside the United States, call your local distributor, listed on Data Translation's web site (www.datatranslation.com).

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

Checking the System Requirements

For reliable operation, your DT9812, DT9813, and DT9814 modules require the following:

- Windows 2000 or Windows XP (Professional Edition) operating system.

  For USB Ver. 2.0 support, make sure that you install Service Pack 2 (for Windows XP) or Service Pack 4 (for Windows 2000). In addition, for some systems, you may have to disable standby mode. If you are not sure whether you are using USB Ver. 1.1 or Ver. 2.0, run the Open Layers Control Panel applet, described on page 31.
- One or more USB ports (Ver. 2.0 or Ver. 1.1). USB Ver. 2.0 is recommended for optimal performance.
- One CD-ROM drive.

Once you have verified that your system meets the system requirements, install the software, as described in the next section.

Installing the Software

Note: Even if you already have a previous DT9812 Series module and associated drivers installed, you must install the latest driver software to support any DT9812 Series module you add to your system.

To install the software, perform the following steps:

1. Insert the Data Acquisition OMNI CD into your CD-ROM or DVD drive.
   The installation program should automatically start, and the InstallShield Wizard should appear.
2. If the installation program does not automatically start, double-click **Setup.exe** from the CD.
   The InstallShield Wizard appears.
3. Click **Install Drivers**.
   The installation screen appears.
4. Click **Install now!**
   The InstallShield Wizard appears.
5. If your system already has the Microsoft .NET Framework 1.1 software installed, proceed to step 6. Otherwise, the Framework installation begins and you must do the following:
   a. Click the radio button next to "I agree" to accept the license agreement, and then click **Install**.
   b. After the components have been installed, click **OK** to configure them.
   c. Without removing your Data Acquisition OMNI CD, click **Restart** to restart your system.
      When the system restarts, the Windows Installer dialog box appears, followed by the DT-Open Layers InstallShield Wizard.

6. Click **Next**.
   The license agreement appears.

7. Read the license agreement, click the radio button next to "I accept the terms in the license agreement," and then click **Next**.
   The Destination Folder dialog box appears.

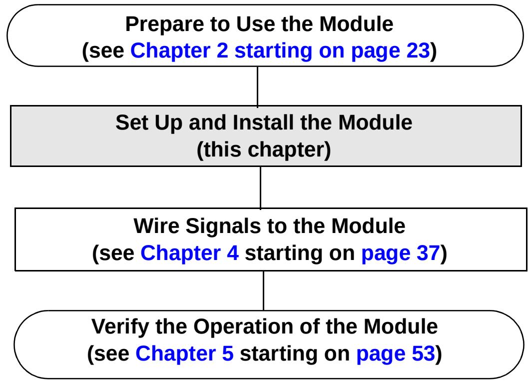
8. Change the default destination folder path, if you wish, by clicking **Change**, and then click **Next**.

9. Click **Install**.
   The files are copied to the specified destination folder.

10. Click **Finish** to complete the installation process.

3

Setting Up and Installing the Module



Note: The DT9812, DT9813, and DT9814 modules are factory-calibrated. The DT9812-2.5V module requires no further adjustment. If you want to recalibrate the DT9812-10V, DT9813-10V, or DT9814-10V module, refer to instructions on page 117.

Attaching Modules to the Computer

This section describes how to attach a module to the host computer.

Note: Most computers have several USB ports that allow direct connection to USB devices. If your application requires more modules than you have USB ports for, you can expand the number of USB devices attached to a single USB port by using expansion hubs. For more information, refer to page 33.

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.

You must install the device driver before connecting your module to the host computer. See "Installing the Software" on page 26.

Connecting Directly to the USB Ports

To connect DT9812, DT9813, or DT9814 modules directly to the USB ports of your computer, do the following:

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

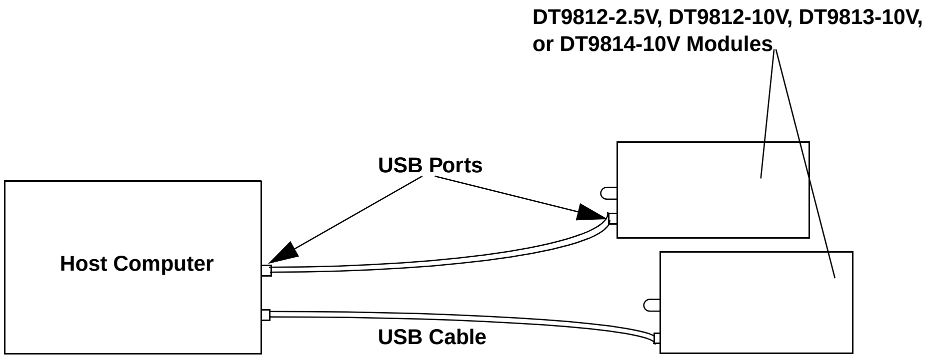


Figure 2: Attaching the Module to the Host Computer

3. Click Next and / or Finish as required in the wizard.
   If the module is attached correctly, the LED on the module turns green.
4. Repeat the steps to attach another module to the host computer, if desired.

Connecting to an Expansion Hub

Expansion hubs are powered by their own external power supply. Theoretically, you can connect up to five expansion hubs to a USB port on the host computer. However, the practical number of DT9812, DT9813, and / or DT9814 modules that you can connect to a single USB port depends on the throughput you want to achieve. Each of the hubs supports up to four modules.

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

1. Attach one end of the USB cable to the 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 expansion 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. Click **Next** and / or **Finish** as required in the wizard.
   If the module is attached correctly, the LED on the module turns green.
5. Repeat these steps until you have attached the number of expansion hubs (up to five) and modules (up to four per hub) that you require. Refer to Figure 3.
   The operating system automatically detects the USB devices as they are installed.

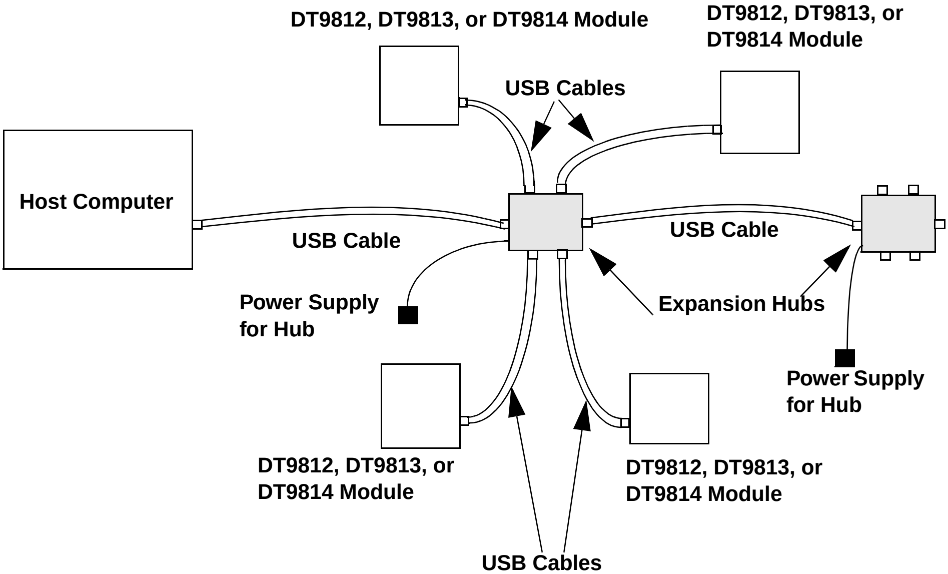


Figure 3: Attaching Multiple DT9812, DT9813, and/or DT9814 Modules Using Expansion Hubs

Changing the Name of a Module (Optional)

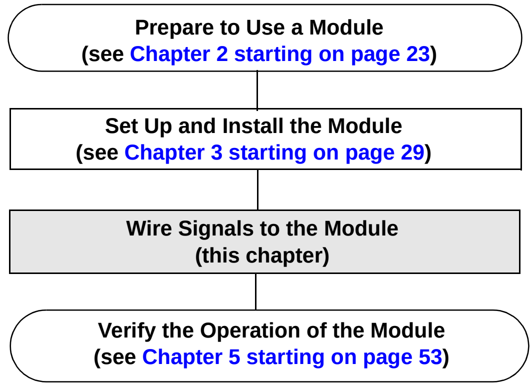
To change the name of a module, configure the device driver as follows:

1. From the Windows Start menu, select **Settings | Control Panel**.
2. From the Control Panel, double-click **Open Layers Control Panel**.
   The Data Acquisition Control Panel dialog box appears.
3. Click the DT9812, DT9813, or DT9814 module that you want to rename, and then click **Edit Name.**
4. Enter a new name for the module, and then click **OK**. The name is used to identify the module in all subsequent applications.
5. When you are finished configuring the module, click **Close**.
6. Repeat steps 3 to 5 for the other modules that you want to configure.
7. Close the Data Acquisition Control Panel dialog box.

Continue with the instructions on wiring in Chapter 4 starting on page 37.

4

Wiring Signals to the Module


Prepare to Use a Module
(see Chapter 2 starting on page 23)
Set Up and Install the Module
(see Chapter 3 starting on page 29)
Wire Signals to the Module
(this chapter)
Verify the Operation of the Module
(see Chapter 5 starting on page 53)

Preparing to Wire Signals

CAUTION:

To avoid electrostatic sensitivity, unplug your DT9812, DT9813, or DT9814 module from the computer before wiring signals.

This section provides information about wiring signals to a DT9812-2.5V, DT9812-10V, DT9813-10V, or DT9814-10V module.

Wiring Recommendations

Keep the following recommendations in mind when wiring signals to an ECONseries module:

- Use individually shielded twisted-pair wire (size 16 to 26 AWG) 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 box 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 box is operational.
- Connect all unused analog input channels to analog ground.

Wiring Locations

You wire signals to each module using the screw terminals on the module. Table 5 lists the screw terminal assignments for the DT9812 modules; Table 6 the DT9813 module; Table 7 the DT9814 module.

Table 5: DT9812-2.5V and DT9812-10V Screw Terminal Assignments

Screw Terminal	Signal	Screw Terminal	Signal
20	USB +5 V Out	40	Ext Trigger
19	Ground	39	Ext Clock
18	Counter 0 In	38	Ground
17	Counter 0 Out	37	Digital Output 7
16	Counter 0 Gate	36	Digital Output 6
15	Ground	35	Digital Output 5
14	DAC 1	34	Digital Output 4
13	DAC 1 Return	33	Digital Output 3
12	DAC 0	32	Digital Output 2
11	DAC 0 Return	31	Digital Output 1
10	2.5 V Reference[a]	30	Digital Output 0
9	Analog Ground	29	Ground
8	Analog Input CH7	28	Digital Input 7
7	Analog Input CH6	27	Digital Input 6
6	Analog Input CH5	26	Digital Input 5
5	Analog Input CH4	25	Digital Input 4
4	Analog Input CH3	24	Digital Input 3
3	Analog Input CH2	23	Digital Input 2
2	Analog Input CH1	22	Digital Input 1
1	Analog Input CH0	21	Digital Input 0

a. For the DT9812-10V module, this reference is 2.5 V. For the DT9812-2.5V module, this reference is 2.44 V.

Table 6: DT9813-10V Screw Terminal Assignments

Screw Terminal	Signal	Screw Terminal	Signal
20	USB +5 V Out	40	Ext Trigger
19	Ground	39	Ext Clock
18	Counter 0 In	38	Ground
17	Counter 0 Out	37	Digital Input 3
16	Counter 0 Gate	36	Digital Input 2
15	Ground	35	Digital Input 1
14	DAC 1	34	Digital Input 0
13	DAC 1 Return	33	Digital Output 3
12	DAC 0	32	Digital Output 2
11	DAC 0 Return	31	Digital Output 1
10	2.5 V Reference	30	Digital Output 0
9	Analog Ground	29	Ground
8	Analog Input CH7	28	Analog Input CH15
7	Analog Input CH6	27	Analog Input CH14
6	Analog Input CH5	26	Analog Input CH13
5	Analog Input CH4	25	Analog Input CH12
4	Analog Input CH3	24	Analog Input CH11
3	Analog Input CH2	23	Analog Input CH10
2	Analog Input CH1	22	Analog Input CH9
1	Analog Input CH0	21	Analog Input CH8

Table 7: DT9814-10V Screw Terminal Assignments

Screw Terminal	Signal	Screw Terminal	Signal
20	USB +5 V Out	40	Ext Trigger
19	Ground	39	Ext Clock
18	Counter 0 In	38	Ground
17	Counter 0 Out	37	Analog Input CH23
16	Counter 0 Gate	36	Analog Input CH22
15	Ground	35	Analog Input CH21
14	DAC 1	34	Analog Input CH20
13	DAC 1 Return	33	Analog Input CH19
12	DAC 0	32	Analog Input CH18
11	DAC 0 Return	31	Analog Input CH17
10	2.5 V Reference	30	Analog Input CH16
9	Analog Ground	29	Ground
8	Analog Input CH7	28	Analog Input CH15
7	Analog Input CH6	27	Analog Input CH14
6	Analog Input CH5	26	Analog Input CH13
5	Analog Input CH4	25	Analog Input CH12
4	Analog Input CH3	24	Analog Input CH11
3	Analog Input CH2	23	Analog Input CH10
2	Analog Input CH1	22	Analog Input CH9
1	Analog Input CH0	21	Analog Input CH8

Connecting Analog Input Signals

The DT9812-2.5V and DT9812-10V modules support 8 single-ended analog input channels. The DT9813-10V module supports 16 single-ended analog input channels; the DT9814-10V supports 24.

Figure 4 shows how to connect single-ended voltage input signals (channels 0 and 1, in this case) to the screw terminals of the module.

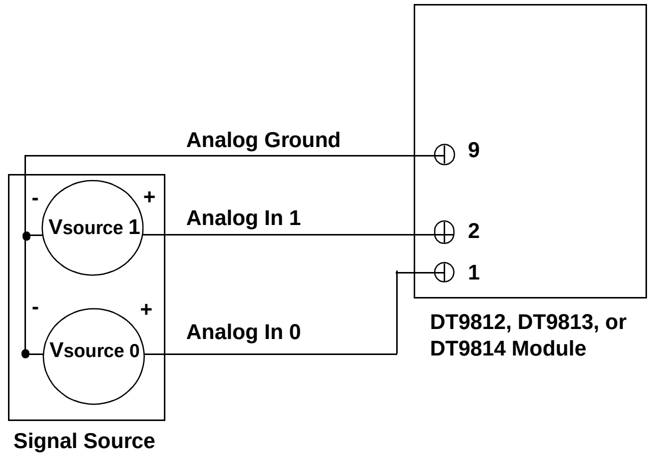


Figure 4: Connecting Single-Ended Inputs

Connecting Analog Output Signals

The DT9812, DT9813, and DT9814 modules support two analog output channels (DAC0 and DAC1). Figure 5 shows how to connect an analog output voltage signal (DAC0, in this case) to one of these modules.

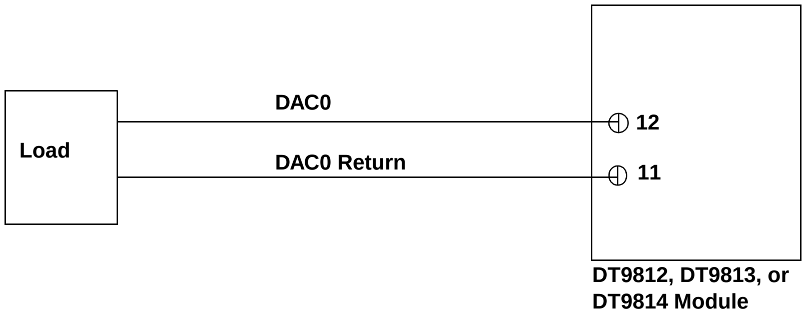


Figure 5: Connecting Analog Outputs to a Screw Terminal Panel

Connecting Digital I/O Signals

The DT9812-2.5V and DT9812-10V modules support eight fixed digital input lines and eight fixed digital output lines. The DT9813-10V module supports four fixed digital input lines and four fixed digital output lines.

Figure 6 shows how to connect digital input signals (lines 0 and 1, in this case) to the screw terminals of a DT9812-2.5V or DT9812-10V module.

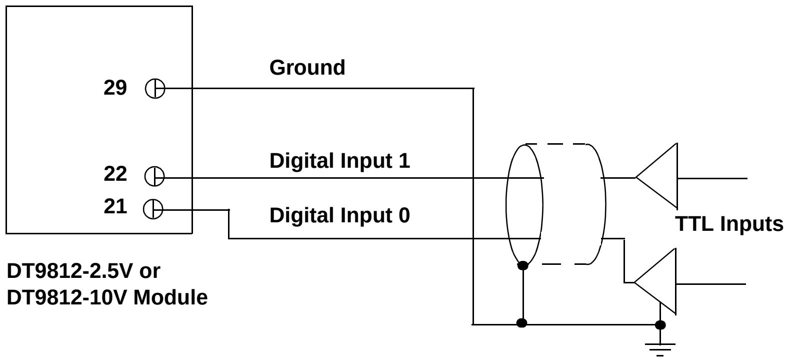


Figure 6: Connecting Digital Inputs

For a DT9813-10V module, connect digital input lines 0 and 1 to screw terminals 34 and 35, respectively.

Figure 7 shows how to connect digital output signals (line 0, in this case) to the screw terminals of a DT9812-2.5V, DT9812-10V, or DT9813-10V module.

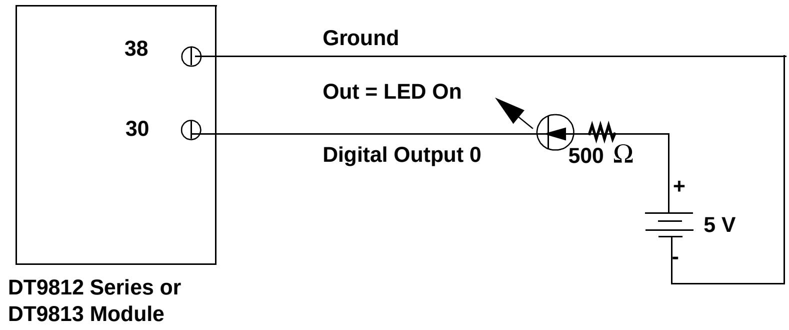


Figure 7: Connecting Digital Outputs

Note: The DT9813-10V module has only four digital output lines, at screw terminals 30 through 33.

Connecting Counter/Timer Signals

The DT9812, DT9813, and DT9814 modules provide one counter/timer that you can use for the following operations:

- Event counting
- Frequency measurement
- Edge-to-edge measurement
- Continuous pulse output (rate generation)

This section describes how to connect counter/timer signals for these operation modes. Refer to Chapter 6 for more information about using the counter/timers.

Event Counting

Figure 8 shows how to connect counter/timer signals to the screw terminals on the module to perform an event counting operation using an external gate.

In this example, the counter counts the number of rising edges that occur on the Counter 0 In signal when the Counter 0 Gate signal is in the active state (as specified by software). Refer to "Counter/Timer Features" on page 87 for more information.

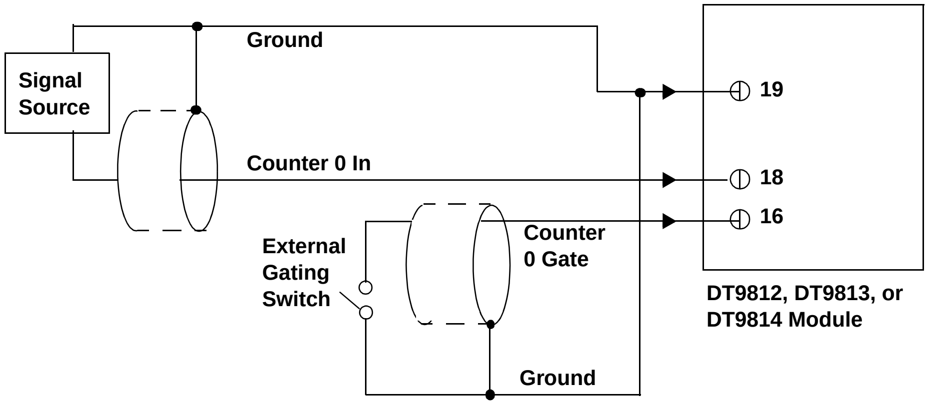


Figure 8: Connecting Counter/Timer Signals for an Event Counting Operation Using an External Gate

Figure 9 shows how to connect counter/timer signals to the screw terminals on the module to perform an event counting operation without using a gate (also called a software gate). The counter counts the number of rising edges that occur on the Counter 0 In signal.

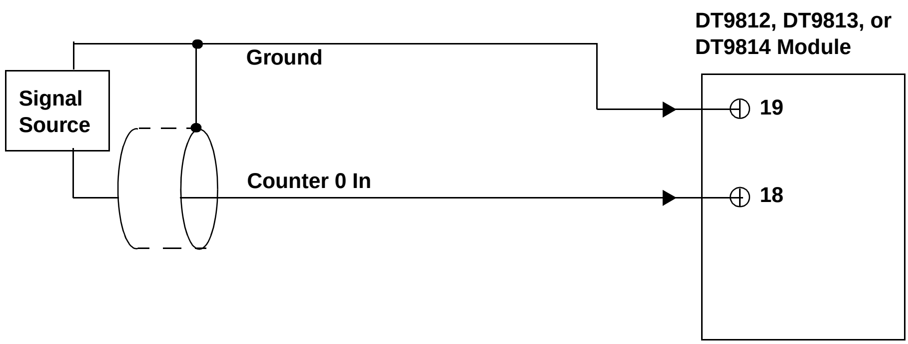


Figure 9: Connecting Counter/Timer Signals for an Event Counting Operation Without Using a Gate

Frequency Measurement

One way to measure frequency is to connect a pulse of a known duration to the Counter 0 Gate signal, as shown in Figure 10. In this case, the frequency of the Counter 0 In signal is the number of counts divided by the period of the signal connected to the Counter 0 Gate input.

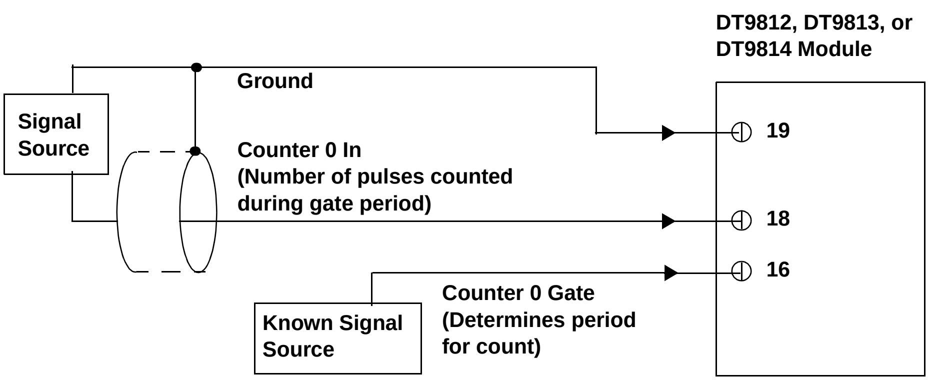


Figure 10: Connecting Counter/Timer Signals for a Frequency Measurement Operation Using an External Pulse

Edge-to-Edge Measurement

Figure 11 shows how to connect counter/timer signals to the module to perform an edge-to-edge measurement operation on one signal source. The counter measures the number of counts between the start edge (in this case, a rising edge on the Counter 0 Gate signal) and the stop edge (in this case, another rising edge on the Counter 0 Gate signal).

You specify the start edge and the stop edge in software. Refer to page 91 for more information.

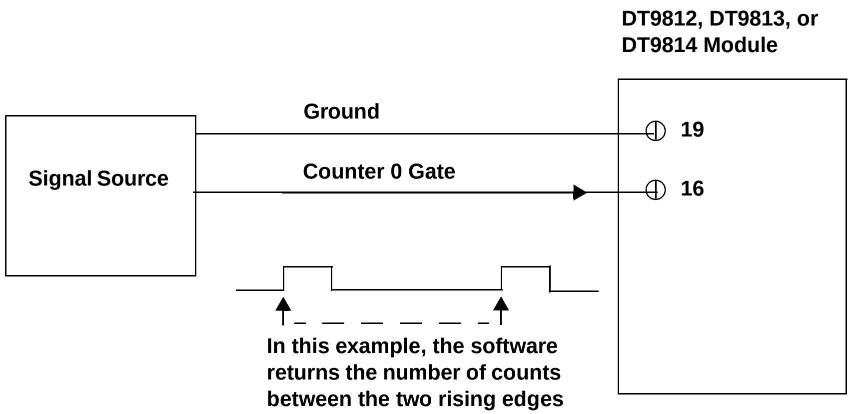


Figure 11: Connecting Counter/Timer Signals for an Edge-to-Edge Measurement Operation

You can use edge-to-edge measurement to measure the following characteristics of a signal:

- Pulse width – The amount of time that a signal pulse is in a high or a low state, or the amount of time between a rising edge and a falling edge or between a falling edge and a rising edge. You can calculate the pulse width as follows:
  - Pulse width = Number of counts / 24 MHz
- Period – The time between two occurrences of the same edge (rising edge to rising edge, or falling edge to falling edge). You can calculate the period as follows:
  - Period = 1 / Frequency
  - Period = Number of counts / 24 MHz
- Frequency – The number of periods per second. You can calculate the frequency as follows:
  - Frequency = 24 MHz / Number of Counts

Rate Generation

Figure 12 shows how to connect counter/timer signals to the screw terminals of a module to perform a rate generation (continuous pulse output) operation; in this example, an external gate is used.

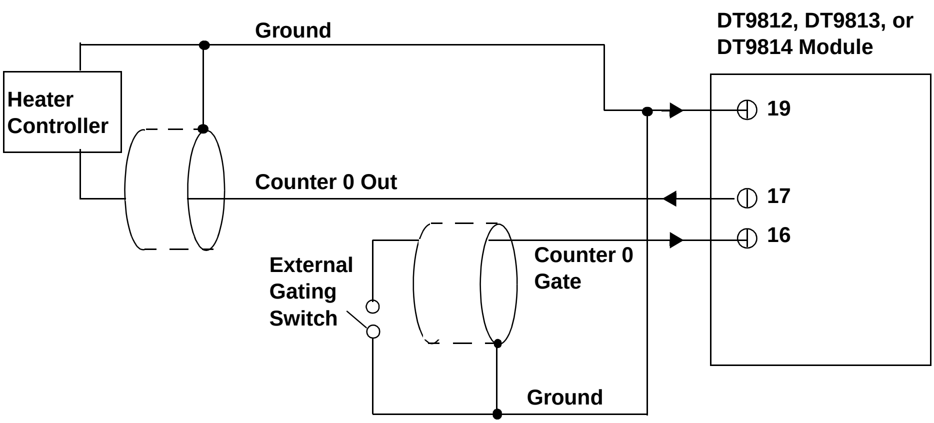
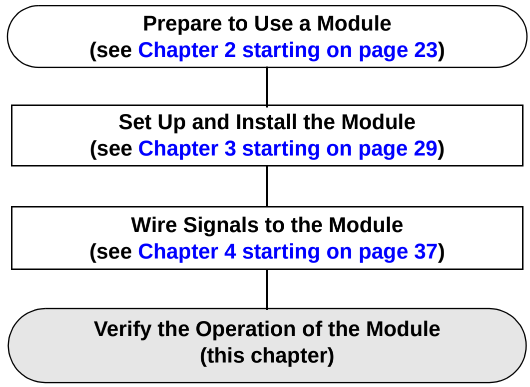


Figure 12: Connecting Counter/Timer Signals for a Rate Generation Operation Using an External Gate

5

Verifying the Operation of a Module


Prepare to Use a Module
(see Chapter 2 starting on page 23)
Set Up and Install the Module
(see Chapter 3 starting on page 29)
Wire Signals to the Module
(see Chapter 4 starting on page 37)
Verify the Operation of the Module
(this chapter)

Installing the Quick DataAcq Application

The Quick DataAcq application is installed automatically when you install the driver software. See "Installing the Software" on page 26 for more information.

Running the Quick DataAcq Application

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 (single-ended mode) on the DT9812, DT9813, or DT9814 module. Refer to page 43 for an example of how to connect a single-ended analog input.
2. In the Quick DataAcq application, choose **Single Analog Input** from the **Acquisition** menu.
3. Select the appropriate DT9812, DT9813, or DT9814 module from the **Board** list box.
4. In the **Channel** list box, select analog input channel 0.
5. In the **Range** list box, select the range for the channel (0 to 2.44 V for the DT9812-2.5V, and ±10 V for the DT9812-10V, DT9813, and DT9814).
6. Select **Single Ended**.
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 44 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 DT9812, DT9813, or DT9814 module from the **Board** list box.
4. In the **Channel** list box, select analog output channel 0.
5. In the **Range** list box, select the output range of DAC0 (0 to 2.44 V for the DT9812-2.5V, and ±10 V for the DT9812-10V, DT9813, and DT9814).
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 DT9812, DT9813, or DT9814 module (using the single-ended configuration). Refer to page 43 for an example of how to connect a single-ended analog input.
2. In the Quick DataAcq application, choose **Scope** from the **Acquisition** menu.
3. Select the appropriate DT9812, DT9813, or DT9814 module from the **Board** list box.
4. In the **Sec/Div** list box, select the number of seconds per division (.1 to .00001) for the display.
5. In the **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 **Single Ended**.
8. In the **Config** dialog, select **Range**, and then select **Unipolar (**for the DT9812-2.5V) or **Bipolar** (for the DT9812-10V, DT9813, and DT9814).
9. From the **Scope** view, double-click the input range of the channel to change the input range of the module.
   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 DT9812 or DT9813 module. Refer to page 45 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 DT9812 or DT9813 module from the **Board** list box.

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 DT9812 or DT9813 module. Refer to page 45 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 appropriateDT9812 or DT9813 module from the **Board** list box.
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 DT9812, DT9813, or DT9814 module. Refer to page 47 for an example of how to connect signals to a counter/timer for a frequency measurement operation.

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

---

2. In the Quick DataAcq application, choose **Frequency Counter** from the **Acquisition** menu.
3. Select the appropriate DT9812, DT9813, or DT9814 module from the **Board** list box.
4. In the **Count Duration** text box, enter the number of seconds during which events will be counted.
5. Click **Start** to start the frequency measurement operation.
The operation automatically stops after the number of seconds you specified has elapsed, and the 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 DT9812, DT9813, or DT9814 module. Refer to page 48 for an example of how to connect a scope (a pulse output) to counter/timer 0.

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

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2. In the Quick DataAcq application, choose **Pulse Generator** from the **Control** menu.
3. Select the appropriate DT9812, DT9813, or DT9814 module from the **Board** list box.
4. Select **Continuous** to output a continuous pulse stream.
5. Select **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. Click **Start** to generate the pulse(s).
The application displays the results both in text and graphical form.
7. Click **Stop** to stop a continuous pulse output operation.

Part 2: Using Your Module

6

Principles of Operation

Figure 13 shows a block diagram of the DT9812-2.5V and DT9812-10V modules.

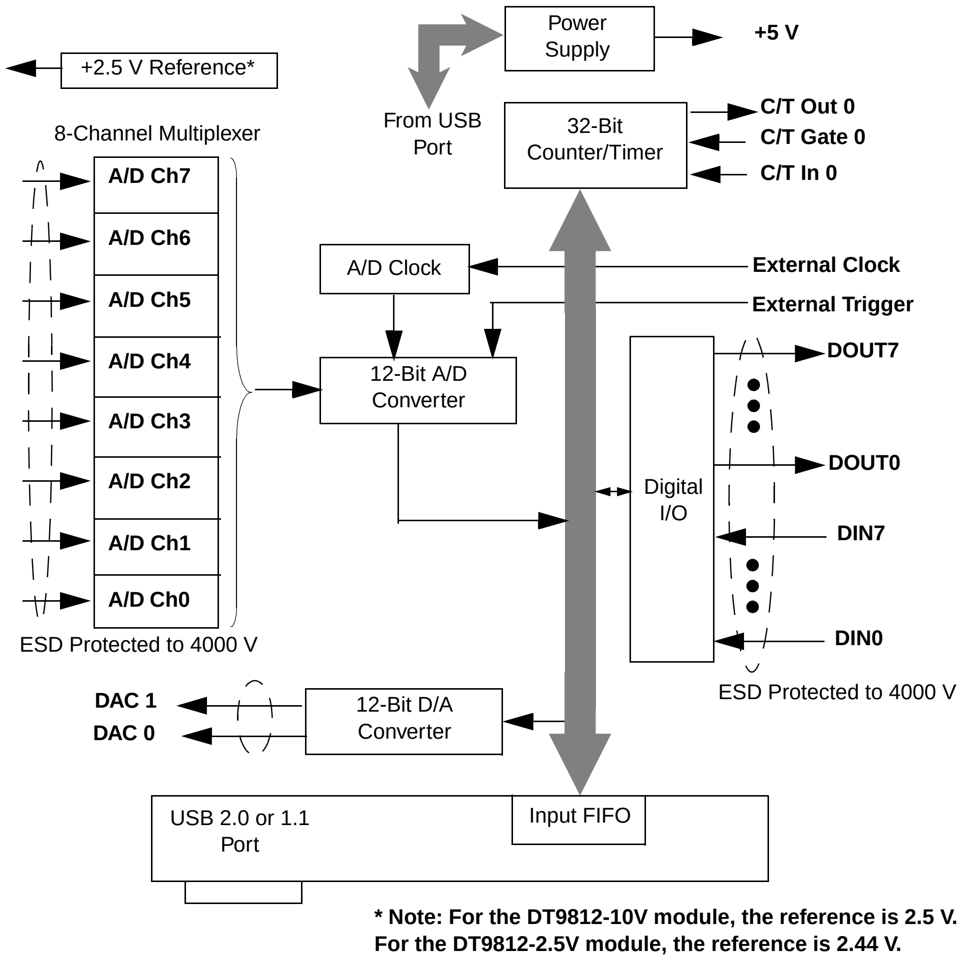

Figure 13: Block Diagram of the DT9812-2.5V and DT9812-10V Modules

Figure 14 shows a block diagram of the DT9813-10V module.

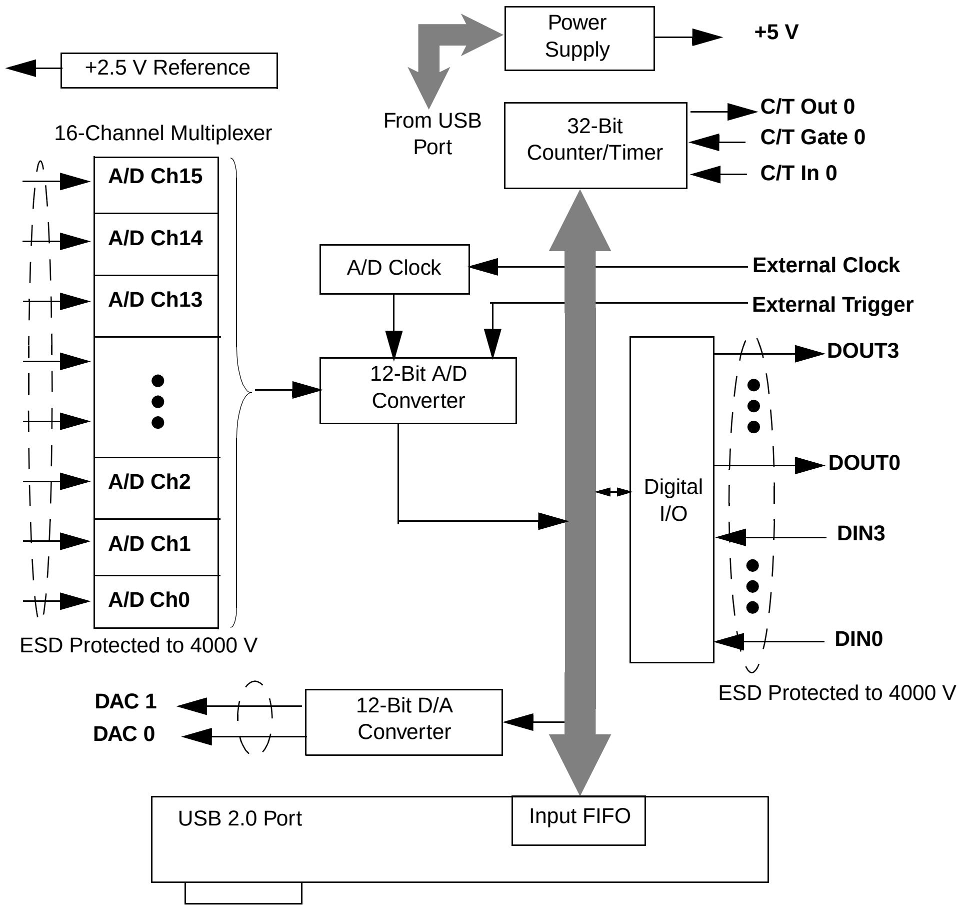

Figure 14: Block Diagram of the DT9813-10V Module

Figure 15 shows a block diagram of the DT9814-10V module.

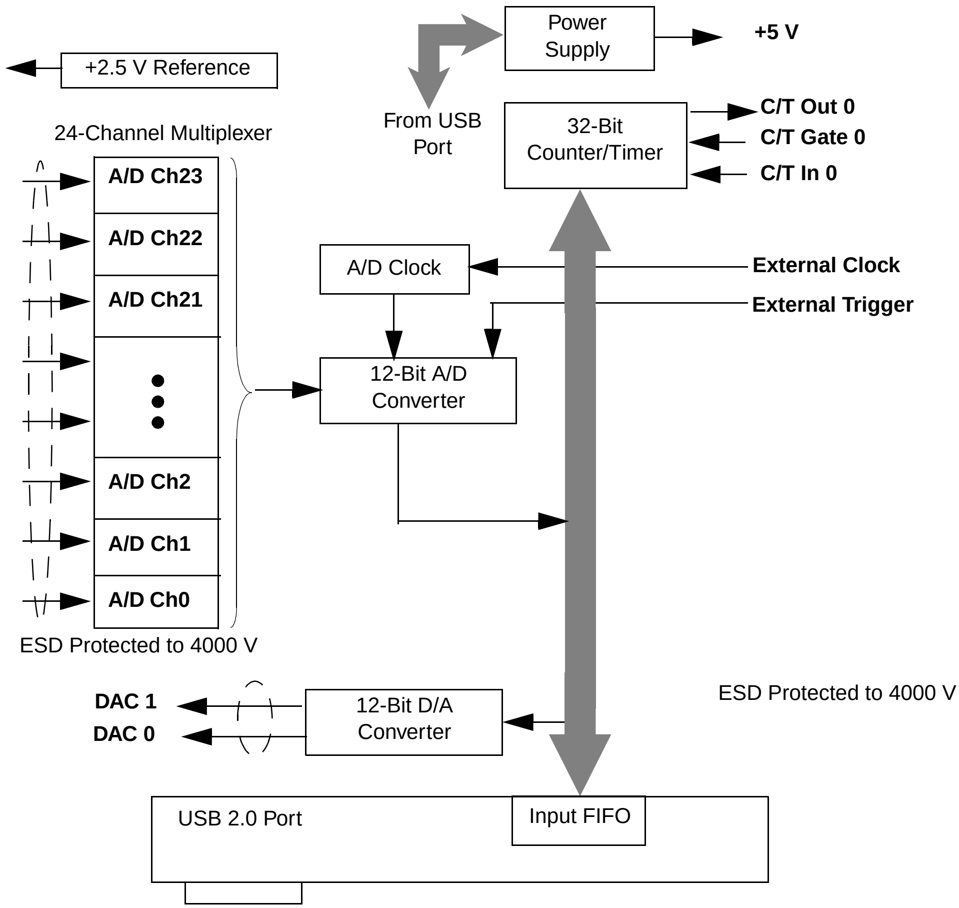

Figure 15: Block Diagram of the DT9814-10V Module

Analog Input Features

This section describes the following features of analog input (A/D) operations on the DT9812, DT9813, and DT9814 modules:

- Input resolution, described below
- Analog input channels, described below
- Input ranges and gains, described on page 71
- Input sample clock sources, described on page 72
- Analog input conversion modes, described on page 73
- Input triggers, described on page 75
- Data format and transfer, described on page 76
- Error conditions, described on page 77

Input Resolution

The DT9812, DT9813, and DT9814 modules provide a resolution of 12-bits. Note that the resolution is fixed; you cannot program it in software.

Analog Input Channels

The DT9812-2.5V and DT9812-10V modules provide eight single-ended analog input channels. The DT9813-10V modules provides 16 single-ended analog inputs, and the DT9814-10V modules provide 24 single-ended analog input channels. The modules can acquire data from a single analog input channel or from a group of analog input channels.

The following subsections describe how to specify the channels.

Specifying a Single Analog Input Channel

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

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

Specifying One or More Analog Input 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 from the first entry in the list to the last entry in the list. Refer to page 73 for more information about the supported conversion modes.

The maximum rate at which the module can read the analog input channels is 50 kSamples/s. Therefore, if you specify two analog input channels in the channel list, the maximum sampling rate is 25 kSamples/s for each channel. Likewise, if you specify 16 analog input channels in the channel list, the maximum sampling rate is 3.125 kSamples/s for each channel.

Input Ranges and Gains

The DT9812-2.5V features an input range of 0 to 2.44 V, while the DT9812-10V, DT9813-10V, and DT9814-10V modules feature an input range of ±10 V. Use software to specify the input range. Note that this is the range for the entire analog input subsystem, not the range per channel.

The modules support programmable gains to allow many more effective input ranges. Table 8 lists the supported gains and effective input ranges for each module.

Table 8: Effective Input Range

Module	Gain	Unipolar Input Range	Bipolar Input Range
DT9812-2.5V	1	0 to 2.44 V	–
	2	0 to 1.22 V	–
	4	0 to 0.610 V	–
	8	0 to 0.305 V	–
	16	0 to 0.1525 V	–
DT9812-10V DT9813-10V DT9814-10V	1	–	±10 V
	2	–	±5 V
	4	–	±2.5 V
	8	–	±1.25 V

For each channel on the module, choose the gain that has the smallest effective range that includes the signal you want to measure. For example, if you are using a DT9812-2.5V module and the range of your analog input signal is 0 to 1.05 V, specify a range of 0 to 2.44 V for the module and use a gain of 2 for the channel; the effective input range for this channel is then 0 to 1.22 V, which provides the best sampling accuracy for that channel.

You can specify the gain in a single-value operation, or specify the gain for each entry in the channel list.

Input Sample Clock Sources

You can use one of the following clock sources to pace an analog input operation:

- **Internal clock** – Using software, specify the clock source as internal and the clock frequency at which to pace the operation. The minimum frequency of the internal clock is 30 Hz; the maximum frequency of the internal clock is 50 kHz.

  According to sampling theory (Nyquist Theorem), specify a frequency that is at least twice as fast as the input's highest frequency component. For example, to accurately sample a 2 kHz signal, specify a sampling frequency of at least 4 kHz. Doing so avoids an error condition called *aliasing*, in which high frequency input components erroneously appear as lower frequencies after sampling.

- **External clock** – An external clock is useful when you want to pace acquisitions at rates not available with the internal clock or when you want to pace at uneven intervals. The minimum frequency of the external clock can be less than 30 Hz; the maximum frequency of the external clock is 40 kHz.

  Connect an external clock to the Ext Clock In signal on the module. Conversions start on the rising edge of the external clock input signal.

Using software, specify the clock source as external. The clock frequency is always equal to the frequency of the external sample clock input signal that you connect to the module.

Analog Input Conversion Modes

The DT9812, DT9813, and DT9814 modules support the following conversion modes:

- Single-value operations
- Continuous scan operations

Single-Value Operations

Single-value operations are the simplest to use. Using software, you 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.

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

Continuous Scan Mode

Use continuous scan mode if you want to accurately control the period between conversions of individual channels in a channel list.

When it receives a software trigger, the module cycles through the channel list, acquiring and converting the data 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 75 for more information about buffers.

The conversion rate is determined by the frequency of the internal sample clock; refer to page 72 for more information about the internal 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 input sample clock divided by the number of entries in the channel list.

To select continuous scan mode, use software to specify the data flow as Continuous.

Figure 16 illustrates continuous 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 input 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.

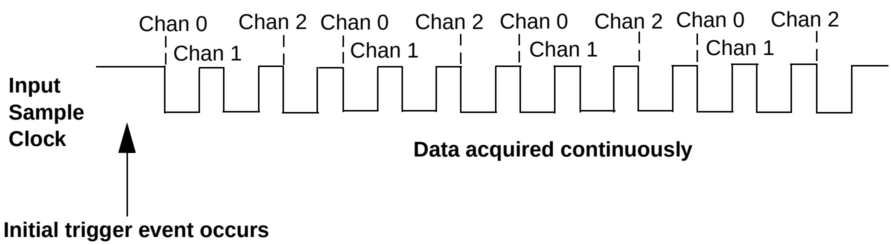

Figure 16: Continuous Scan Mode

Input Triggers

A trigger is an event that occurs based on a specified set of conditions. Acquisition starts when the module detects the initial trigger event and stops when the buffers on the queue have been filled or when you stop the operation. Note that when you stop the operation, the module completes the reading of the channel list.

The DT9812, DT9813, and DT9814 modules support the following trigger sources:

- **Software trigger –** A software trigger event occurs when you start the analog input operation (the computer issues a write to the module to begin conversions). Using software, specify the trigger source as a software trigger.
- **External digital (TTL) trigger –** An external digital (TTL) trigger event occurs when the module detects a high-to-low (negative) transition on the Ext Trigger In signal connected to the module. Using software, specify an external, negative digital (TLL) trigger.

Data Transfer

Before you begin acquiring data, you must allocate buffers to hold the data. A buffer done event is returned whenever a buffer is filled. This allows you to move and/or process the data as needed.

We recommend that you allocate a minimum of two 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.

Data Format

The DT9812-2.5V module uses binary data encoding to represent unipolar input ranges, while the DT9812-10V, DT9813-10V, and DT9814-10V modules use twos complement encoding to represent bipolar input ranges.

In software, the analog input value is returned as a code. To convert the code to voltage, use the information in the following subsections.

Converting a Binary Code to a Voltage

To convert a binary code into a voltage on the DT9812-2.5V module, use the following formula:

Voltage = (2.44 * Code) / 4096

where,

- *2.44* is the full-scale range of the module (0 to +2.44V)
- *Code* is the raw count used by the software to represent the voltage in binary notation
- 4096 is the input resolution (12 bits)
- *Voltage* is the analog voltage

For example, if the software returns a code of 3072 for the analog input operation, determine the analog input voltage as follows:

Voltage = (2.44 * 3072) / 4096 = 1.83 V

Converting a Twos Complement Code to a Voltage

To convert a twos complement code into a voltage on the DT9812-10V, DT9813-10V, or DT9814-10V module, use the following formula:

Voltage = (20 * Code) / 4096

where,

- *20* is the full-scale range of the module (-10V to +10V)
- *Code* is the raw count used by the software to represent the voltage
- 4096 is the input resolution (12 bits)
- *Voltage* is the analog voltage

For example, assume that the software returns a code of 1040 for the analog input value. Determine the analog input voltage as follows:

Voltage = (20 * 1040) /4096 = 5.078 V

Error Conditions

An overrun condition is reported if 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. It is up to the host application to handle this error by either ignoring the error or stopping acquisition. To avoid this error, use a slower sampling rate or increase the buffer size and/or number of buffers.

Analog Output Features

This section describes the following features of analog output operations:

- Output resolution, described below
- Analog output channels, described below
- Output ranges and gains, described on page 79
- Output trigger, described on page 80
- Output clock, described on page 80
- Data format and transfer, described on page 83
- Error conditions, described on page 84

Output Resolution

The modules provide a fixed output resolution of 12 bits. Note that the resolution is fixed; it cannot be programmed in software.

Analog Output Channels

DT9812, DT9813, and DT9814 modules provide two analog output channels (DACs). The modules can output data from a single analog output channel or from both analog output channels.

The following subsections describe how to specify the channels.

Specifying a Single Analog Output Channel

The simplest way to output data from a single analog output channel is to use single-value analog output mode, specifying the analog output channel that you want to update; refer to page 81 for more information about single-value operations.

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

Specifying Analog Output Channels

You can output data continuously from one or both analog output channels using the output channel list. If you want to output data from one analog output channel continuously, specify either 0 (DAC0) or 1 (DAC1) in the channel output list. If you want to output data to both analog output channels continuously, specify the output channel list in the following order: 0, 1.

Then, use software to specify the data flow mode as Continuous for the D/A subsystem; refer to page 80 for more information on continuous analog output operations.

Output Ranges and Gains

For the DT9812-2.5V module, a fixed output range of 0 to 2.44 V is provided. For the DT9812-10V, DT9813-10V, and DT9814-10V, a fixed output range of ±10 V is provided.

Through software, specify the range for the entire analog output subsystem (0 to 2.44 V for the DT9812-2.5 V module or ±10 V for the DT9812-10V, DT9813-10V, and DT9814-10V modules), and specify a gain of 1 for each channel.

Output Trigger

A trigger is an event that occurs based on a specified set of conditions. The modules support a software trigger for starting analog output operations. Using a software trigger, the module starts outputting data when it receives a software command.

Using software, specify the trigger source for the D/A subsystem as a software trigger.

Output Clock

When in continuous output mode, described on page 81, you can update both analog output channels simultaneously using the internal clock on the module.

Using software, specify the clock source for the D/A subsystem as internal and specify the frequency at which to update the analog output channels (between 30 Hz to 50 kHz).

Note: The output clock frequency that you specify is frequency at which both analog output channels are simultaneously updated.

Output Conversion Modes

The DT9812, DT9813, and DT9814 modules support the following output conversion modes:

- Single-value output operations
- Continuous output operations

Single-Value Operations

Single-value operations are the simplest to use but offer the least flexibility and efficiency. Use software to specify the analog output channel, and the value to output from the analog output channel. Since a single-value operation is not clocked, you cannot specify a clock source, trigger source, or buffer.

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

Continuous Output Mode

Use continuously paced analog output mode if you want to accurately control the period between D/A conversions or write a waveform to one or more analog output channels.

Use software to configure the output channel list, as described on page 78. Then, allocate a buffer that contains the values to write to the analog output channels that are specified in the output channel list. For example, if your output channel list contains DAC0 and DAC1, specify your buffer as follows: first value for DAC0, first value for DAC1, second value for DAC0, second value for DAC1, and so on.

When it receives the software trigger, the module starts writing output values to the analog output channels specified in the output channel list. The operation repeats continuously until no more buffers are on the subsystem queue or you stop the operation. Refer to page 83 for more information about buffer modes.

Note: Make sure that the host computer transfers data to the analog output channels fast enough so that they do not empty completely; otherwise, an underrun error results.

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

- Set the dataflow as Continuous.
- Set WrapSingleBuffer to False to use multiple buffers (a minimum of two buffers is recommended in this mode), or to True to use a single buffer.
- Set the trigger source as a software (internal) trigger.
- Set the clock frequency between 30 Hz and 50 kHz.

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

Data Transfer

If you are using continuous output mode, you specify whether to allocate and fill a single buffer (WrapSingleBuffer is True) or multiple buffers (WrapSingleBuffer is False).

If you are using multiple buffers, data is written from multiple output buffers continuously; when no more buffers of data are available, the continuous output operation stops. This mode guarantees gap-free data. If you use a single buffer, data is output continuously from the single buffer until you stop the operation.

A buffer done event is generated whenever the last value in a buffer is output. This allows you to fill the buffer or provide a new buffer, as needed.

Note: An underrun error can result if your buffer size is too small, if you do not allocate enough buffers, or if your clock rate is too fast.

Data Format

The DT9812-2.5V module uses binary data encoding, while the DT9812-10V, DT9813-10V, and DT9814-10V modules use twos complement encoding.

In software, you need to supply a code that corresponds to the analog output value you want the module to output.

Converting a Voltage into a Binary Code

To convert a voltage into a binary code on the DT9812-2.5V module, use the following formula:

Code = Voltage / (2.44 / 4096)

where,

- *2.44* is the full-scale range of the module (0 to +2.44V)
- *4096* is the resolution (12 bits)
- *Voltage* is the analog output voltage
- *Code* is the raw count used by the software to represent the voltage in binary notation

For example, if you want to output a voltage of 2.0 V, determine the code value as follows:

Code = 2.0 / (2.44 / 4096) = 3357

Converting a Voltage to a Twos Complement Code

To convert a voltage into a twos complement code on the DT9812-10V, DT9813-10V, or DT9814-10V module, use the following formula:

Code = Voltage / (20 / 4096)

where,

- *20* is the full-scale range of the module (-10V to +10V)
- *4096* is the resolution (12 bits)
- *Voltage* is the analog output voltage
- *Code* is the raw count used by the software to represent the voltage in binary notation

For example, if you want to output a voltage of +5 V, determine the code as follows

Code = 5 / (20 / 4096) = 1024

Error Conditions

The modules can report an underrun error if the data for the analog output channels is not sent fast enough from the host computer. It is up to the host application to handle this error either by ignoring it or by stopping the output operation.

To avoid this error, try slowing down the clock rate, increasing the output buffer size, or allocating more output buffers.

Note: If no new data is available to be output by the analog output channels, the last value that was written to the analog output channels continues to be output.

Digital I/O Features

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

- Digital I/O lines
- Resolution
- Operation modes

Digital I/O Lines

The DT9812-2.5V and DT9812-10V modules provide 8 dedicated digital input lines and 8 dedicated digital output lines. The DT9813-10V module provides 4 dedicated digital input lines and 4 dedicated digital output lines.

Using DT-Open Layers, you can specify the digital line that you want to read or write in a single-value digital I/O operation. Refer to page 86 for more information about single-value operations.

A digital line is high if its value is 1; a digital line is low if its value is 0. On power up or reset, a low value (0) is output from each of the digital output lines.

Resolution

The resolution of the digital ports on the DT9812-2.5V and DT9812-10V modules is fixed at 8-bits. The resolution of the digital ports on the DT9813-10V module is fixed at 4-bits.

Operation Modes

The DT9812 and DT9813 modules support single-value digital I/O operations only. For a single-value operation, use software to specify the digital I/O port (the gain is ignored). Data is then read from or written to the digital lines associated with that port.

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

Counter/Timer Features

This section describes the following features of counter/timer (C/T) operations:

- C/T channels, described below
- C/T clock sources, described on page 88
- Gate types, described on page 88
- Pulse types and duty cycles, described on page 89
- C/T operation modes, described on page 90

C/T Channels

The modules provide one 32-bit counter/timer (16 bits in rate generation mode). The counter accepts a C/T clock input signal (pulse input signal) and gate input signal, and outputs a pulse signal (clock output signal), as shown in Figure 17.

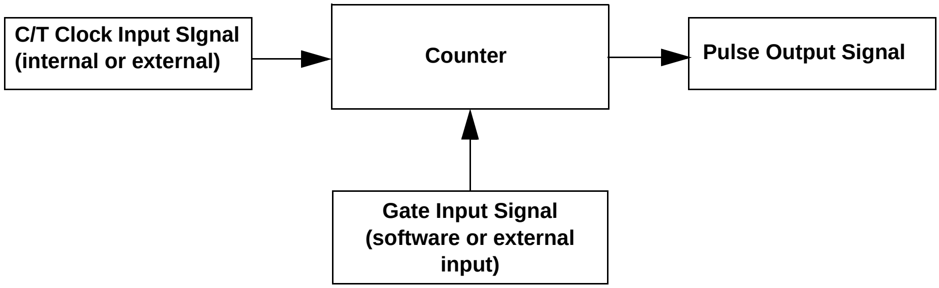

Figure 17: Counter/Timer Channel

C/T Clock Sources

The following clock sources are available for the counter/timers:

- **Internal clock** – Through software, specify the clock source as internal, and specify the frequency at which to pace the counter/timer operation. The frequency of the internal C/T clock can range from 15 Hz to 12 MHz.
- **External clock** – An external clock is useful when you want to pace counter/timer operations at rates not available with the internal clock or if you want to pace at uneven intervals.

  Connect an external clock with a maximum recommended frequency of 6 MHz to the Counter 0 In signal on the module. Using software, specify the C/T clock source as external, and specify a clock divider between 2 and 65536 to determine the actual frequency at which to pace the counter/timer operation. For example, if you connect a 6 MHz external C/T clock and use a clock divider of 2, the resulting C/T output frequency is 3 MHz. Counter/timer operations start on the falling edge of the Counter 0 In signal.

Gate Types

The edge or level of the Counter 0 Gate signal determines when a counter/timer operation is enabled. Using software, you can specify one of the following gate types:

- **None** – A software command enables any counter/timer operation immediately after execution.
- **Logic-high level external gate input** – Enables a counter/timer operation when Counter 0 Gate is high, and disables a counter/timer operation when Counter 0 Gate is low. Note that this gate type is used for event counting and rate generation modes; refer to page 90 for more information about these modes.

- **Falling-edge external gate input** – Enables a counter/timer operation when a high-to-low transition is detected on the Counter 0 Gate signal. In software, this is called a low-edge gate type. Note that this gate type is used for edge-to-edge measurement mode; refer to page 91 for more information about these modes.
- **Rising-edge external gate input** – Enables a counter/timer operation when a low-to-high transition is detected on the Counter 0 Gate signal. In software, this is called a high-edge gate type. Note that this gate type is used for edge-to-edge measurement operations; refer to page 91 for more information about these modes.

Pulse Duty Cycles

Counter/timer output signals from the modules are high-to-low going signals.

The duty cycle (or pulse width) indicates the percentage of the total pulse output period that is active. In rate generation mode, the duty cycle is fixed at 50% for the DT9812, DT9813, and DT9814 modules. Figure 18 illustrates a high-to-low going output pulse with a duty cycle of 50%.

6

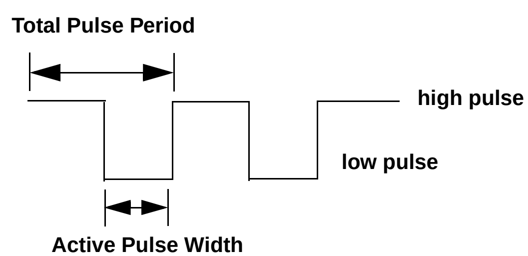

Figure 18: Example of a Pulse Output SIgnal with a 50% Duty Cycle (High-to-Low Going)

Counter/Timer Operation Modes

The modules support the following counter/timer operation modes:

- Event counting
- Frequency measurement
- Edge-to-edge measurement
- Rate generation

Event Counting

Use event counting mode if you want to count the number of falling edges that occur on Counter 0 In when the gate is active (high-level gate or software gate). Refer to page 88 for information about specifying the active gate type.

You can count a maximum of 4,294,967,296 events before the counter rolls over to 0 and starts counting again.

For event counting operations, use software to specify the counter/timer mode as count, the C/T clock source as external, and the active gate type as software or high-level.

Make sure that the signals are wired appropriately. Refer to Chapter 4 for an example of connecting an event counting application.

Frequency Measurement

Connect a pulse of a known duration to the Counter 0 Gate signal. Specify the active gate in software (high level or low level). When the operation starts, read the number of counts that occurred when the gate was active.

You can determine the frequency of the clock input signal using the following equation:

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

Make sure that the signals are wired appropriately. Refer to Chapter 4 for an example of connecting a frequency measurement application.

Edge-to-Edge Measurement

Use edge-to-edge measurement mode if you want to measure the time interval between a specified start edge and a specified stop edge.

The start edge can occur on the rising edge or the falling edge of the Counter 0 Gate signal, and the stop edge can occur on the rising edge or the falling edge of the Counter 0 Gate signal. When the start edge is detected, the counter/timer starts incrementing and continues incrementing until the stop edge is detected. The C/T then stops incrementing until it is enabled to start another measurement. When the operation is complete, you can read the value of the counter. You can count a maximum of 4,294,967,296 events before the counter rolls over to 0 and starts counting again.

You can use edge-to-edge measurement to measure the following characteristics of a signal:

- Pulse width – The amount of time that a signal pulse is in a high or a low state, or the amount of time between a rising edge and a falling edge or between a falling edge and a rising edge. You can calculate the pulse width as follows:
  - Pulse width = Number of counts / 24 MHz
- Period – The time between two occurrences of the same edge (rising edge to rising edge, or falling edge to falling edge). You can calculate the period as follows:
  - Period = 1 / Frequency
  - Period = Number of counts / 24 MHz
- Frequency – The number of periods per second. You can calculate the frequency as follows:
  - Frequency = 24 MHz / Number of Counts

Using software, specify the counter / timer mode as measure, the C / T clock source as internal, the start edge as rising or falling gate, and the stop edge as rising or falling gate.

Make sure that the signals are wired appropriately. Refer to Chapter 4 for an example of connecting an edge-to-edge measurement application.

Rate Generation

Use rate generation mode to generate a continuous pulse output signal from Counter 0 Out; this mode is sometimes referred to as continuous pulse output or pulse train output.

The pulse output operation is enabled whenever the Counter 0 Gate signal is active (high level, low level, or software gate). While the pulse output operation is enabled, the counter outputs a high-to-low going pulse with a pulse width of 50% continuously. As soon as the operation is disabled, rate generation stops.

The frequency of the output is determined by the C/T clock source (either internal or external) and the clock divider used. You can generate an output signal from Counter 0 Out with a frequency of 15 Hz to 12 MHz.

To specify rate generation mode, use software to specify the counter/timer mode as rate, the C/T clock source as either internal or external, the clock divider (2 to 65536), and the active gate type (high-level or software gate). Refer to page 88 for more information about gate types.

Make sure that the signals are wired appropriately. Refer to Chapter 4 for an example of connecting a rate generation application.

7

Supported Device Driver Capabilities

The DT9812, DT9813, and DT9814 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 9: DT9812, DT9813, and DT9814 Series Subsystems

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Total Subsystems on Module	1	1	1[a]	1[b]	1	0

a. The DIN subsystem contains eight digital input lines (0 to 7) on the DT9812 and four digital input lines (0 to 3) on the DT9813. There is no DIN subsystem on the DT9814.

b. The DOUT subsystem contains eight digital output lines (0 to 7) on the DT9812 and four digital output lines (0 to 3) on the DT9813. There is no DOUT subsystem on the DT9814.

The tables in this chapter summarize the features available for use with the DT-Open Layers for .NET Class Library and the DT9812, DT9813, and DT9814 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 10: DT9812, DT9813, and DT9814 Series Data Flow and Operation Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Single-Value Operation Support **SupportsSingleValue**	Yes	Yes	Yes	Yes	Yes	
Continuous Operation Support **SupportsContinuous**	Yes	Yes			Yes	
Continuous Operation until Trigger **SupportsContinuousPreTrigger**						
Continuous Operation before & after Trigger **SupportsContinuousPrePostTrigger**						
Waveform Operations Using FIFO Only **SupportsWaveformModeOnly**						
Simultaneous Start List Support **SupportsSimultaneousStart**	Yes	Yes				
Interrupt Support **SupportsInterruptOnChange**						
Output FIFO Size **FifoSize**		2K[a]				

a. A 2K FIFO is used by the D/A subsystem; a 1K FIFO is used by the A/D subsystem.

Buffering

Table 11: DT9812, DT9813, and DT9814 Series Buffering Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Buffer Support **SupportsBuffering**	Yes	Yes				
Single Buffer Wrap Mode Support **SupportsWrapSingle**		Yes				
Inprocess Buffer Flush Support **SupportsInProcessFlush**	Yes					

Triggered Scan Mode

Table 12: DT9812, DT9813, and DT9814 Series Triggered Scan Mode Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Triggered Scan Support **SupportsTriggeredScan**						
Maximum Number of CGL Scans per Trigger **MaxMultiScanCount**	1	0	0	0	0	0
Maximum Retrigger Frequency **MaxRetriggerFreq**	0	0	0	0	0	0
Minimum Retrigger Frequency **MinRetriggerFreq**	0	0	0	0	0	0

Data Encoding

Table 13: DT9812, DT9813, and DT9814 Series Data Encoding Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Binary Encoding Support **SupportsBinaryEncoding**	Yes[a]	Yes[a]	Yes	Yes	Yes	
Twos Complement Support **SupportsTwosCompEncoding**	Yes[a]	Yes[a]				

a. The DT9812-10V, DT9813-10V, and DT9814-10V modules use twos complement encoding; the DT9812-2.5V module uses binary encoding.

Channels

Table 14: DT9812, DT9813, and DT9814 Series Channel Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Number of Channels **NumberOfChannels**	8	2	1	1	1	0
SE Support **SupportsSingleEnded**	Yes	Yes				
SE Channels **MaxSingleEndedChannels**	8	2	0	0	0	0
DI Support **SupportsDifferential**			Yes	Yes	Yes	
DI Channels **MaxDifferentialChannels**			1	1	1	0
Maximum Channel-Gain List Depth **CGLDepth**			1	1	1	0

Table 14: DT9812, DT9813, and DT9814 Series Channel Options (cont.)

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Simultaneous Sample-and-Hold Support **SupportsSimultaneousSampleHold**						
Channel-List Inhibit **SupportsChannelListInhibit**						

Gain

Table 15: DT9812, DT9813, and DT9814 Series Gain Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Programmable Gain Support **SupportsProgrammableGain**	Yes					
Number of Gains **NumberOfSupportedGains**	4 or 5[a]	1	1	1	0	0
Gains Available **SupportedGains**	1, 2, 4, 8, 16[a]	1	1	1		

a. The DT9812-2.5V module has a full-scale input range of 0 to 2.44 V and supports gains of 1, 2, 4, 8, and 16 to provide many effective input ranges. The DT9812-10V, DT9813-10V, and DT9814-10V modules have a full-scale input range of ±10 V and support gains of 1, 2, 4, and 8 to provide many effective input ranges. Refer to page 71 for more information.

Ranges

Table 16: DT9812, DT9813, and DT9814 Series Range Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Number of Voltage Ranges **NumberOfRanges**	1[a]	1	0	0	0	0
Available Ranges **SupportedVoltageRanges**	0 to 2.44 V or ±10 V[a]	0 to 2.44 V or ±10 V[a]				

a. The DT9812-2.5V module has a full-scale input range of 0 to 2.44 V and supports gains of 1, 2, 4, 8, and 16 to provide many effective input ranges. The DT9812-10V, DT9813-10V, and DT9814-10V modules have a full-scale input range of ±10 V and support gains of 1, 2, 4, and 8 to provide many effective input ranges. Refer to page 71 for more information.

Resolution

Table 17: DT9812, DT9813, and DT9814 Series Resolution Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Software Programmable Resolution **SupportsSoftwareResolution**						
Number of Resolutions **NumberOfResolutions**	1[a]	1[a]	1[b]	1[b]	1	0
Available Resolutions **SupportedResolutions**	12	12	8 or 4[b]	8 or 4[b]	32	

a. All modules support a fixed A/D and D/A resolution of 12-bits.

b. The resolution of the digital input port (port A) is fixed at 8-bits or eight digital input lines for the DT9812 modules; 4-bits for the DT9813. The resolution of the digital output port (port A) is fixed at 8-bits or eight digital output lines for the DT9812 modules; 4-bits for the DT9813.

Thermocouple Support

Table 18: DT9812, DT9813, and DT9814 Series Thermocouple Support Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Thermocouple Support **SupportsThernocouple**						
Voltage Converted to Temperature in Hardware **SupportsTemperatureDataInStream**						
Supported Thermocouple Types **ThermocoupleType**						
Supports CJC Source Internally in Hardware **SupportsCJCSourceInternal**						
Supports CJC Channel **SupportsCJCSourceChannel**						
Available CJC Channels **SupportedCJCChannels**						

IEPE Support

Table 19: DT9812, DT9813, and DT9814 Series IEPE Support Options

DT9812, DT9813, and DT9814 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 20: DT9812, DT9813, and DT9814 Series Trigger Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Software Trigger Support **SupportsSoftwareTrigger**	Yes	Yes			Yes	
External Positive TTL Trigger Support **SupportsPosExternalTTLTrigger**					Yes	
External Negative TTL Trigger Support **SupportsNegExternalTTLTrigger**	Yes					
Positive Threshold Trigger Support **SupportsPosThresholdTrigger**						
Negative Threshold Trigger Support **SupportsNegThresholdTrigger**						
Digital Event Trigger Support **SupportsDigitalEventTrigger**						

Clocks

Table 21: DT9812, DT9813, and DT9814 Series Clock Options

DT9812, DT9813, and DT9814 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**		Yes				
Base Clock Frequency **BaseClockFrequency**	24 MHz	24 MHz	0	0	24 MHz	0
Maximum Clock Divider **MaxExtClockDivider**	1	1	1	1	65536	0
Minimum Clock Divider **MinExtClockDivider**	1	1	1	1	2	0
Maximum Frequency **MaxFrequency**	50 kHz	50 kHz	0	0	12 MHz	0
Minimum Frequency **MinFrequency**	30 Hz	30 Hz	0	0	15 Hz	0

Counter/Timers

Table 22: DT9812, DT9813, and DT9814 Series Counter/Timer Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Cascading Support **SupportsCascading**						
Event Count Mode Support **SupportsCount**					Yes	
Generate Rate Mode Support **SupportsRateGenerate**					Yes	
One-Shot Mode Support **SupportsOneShot**						
Repetitive One-Shot Mode Support **SupportsOneShotRepeat**						
Up/Down Counting Mode Support **SupportsUpDown**						
Edge-to-Edge Measurement Mode Support **SupportsMeasure**					Yes	
Continuous Edge-to-Edge Measurement Mode Support **SupportsContinuousMeasure**						
High to Low Output Pulse Support **SupportsHighToLowPulse**					Yes	
Low to High Output Pulse Support **SupportsLowToHighPulse**						
Variable Pulse Width Support **SupportsVariablePulseWidth**					No[a]	
None (internal) Gate Type Support **SupportsGateNone**					Yes	
High Level Gate Type Support **SupportsGateHighLevel**					Yes	
Low Level Gate Type Support **SupportsGateLowLevel**						

Table 22: DT9812, DT9813, and DT9814 Series Counter/Timer Options (cont.)

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
High Edge Gate Type Support **SupportsGateHighEdge**					Yes	
Low Edge Gate Type Support **SupportsGateLowEdge**					Yes	
Level Change Gate Type Support **SupportsGateLevel**						
Clock-Falling Edge Type **SupportsClockFalling**						
Clock-Rising Edge Type **SupportsClockRising**						
Gate-Falling Edge Type **SupportsGateFalling**					Yes[b]	
Gate-Rising Edge Type **SupportsGateRising**					Yes[b]	
Interrupt-Driven Operations **SupportsInterrupt**					Yes	

a. The pulse width (duty cycle) if fixed at 50% when rate generation mode is used.
b. Edge-to-edge measurement is supported on the gate signal only (both rising and falling edges).

8

Troubleshooting

General Checklist

Should you experience problems using a DT9812-2.5V, DT9812-10V, DT9813-10V, or DT9814-10V module, 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 Chapter 2.
4. Check that you have installed your hardware properly using the instructions in Chapter 3.
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 23 to isolate and solve the problem. If you cannot identify the problem, refer to page 111.

Table 23: 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 114.
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 133 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 23: Troubleshooting Problems (cont.)

Symptom	Possible Cause	Possible Solution
Device failure error reported.	The 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 module was removed while an operation was being performed.	Ensure that your module is properly connected; see the instructions in Chapter 3.
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 transducer is set up for differential inputs while the module is wired for single-ended inputs.	Check your wiring and ensure that your transducer connects to the single-ended inputs of your module; see the instructions in Chapter 4.
	The module is out of calibration.	The modules are calibrated at the factory. The DT9812-2.5V does not require additional calibration. If you want to readjust the calibration of a 10V module, refer to the instructions starting on page 117.

Table 23: Troubleshooting Problems (cont.)

Symptom	Possible Cause	Possible Solution
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 133.
USB 2.0 is not recognized.	Your operating system does not have the appropriate Service Pack installed.	Ensure that you load the appropriate Windows Service Pack (version 2 for Windows XP or version 4 for Windows 2000). If you are unsure of whether you are using USB 2.0 or USB 1.1, run the Open Layers Control Panel applet, described in Chapter 3.
	Standby mode is enabled on your PC.	For some PCs, you may need to disable standby mode on your system for proper USB 2.0 operation. Consult Microsoft for more information.

Technical Support

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

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

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

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

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

If Your 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. The name and telephone number of your nearest distributor are listed on our web site (www.datatranslation.com). 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 module.

– Place in a secure shipping container.

3. Return the module 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

9

Calibration

The DT9812-10V, DT9813-10V, and DT9814-10V 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 input and analog output circuitry on the 10V modules every six months using the DT9812 Series Calibration Utility.

Notes: The DT9812-2.5V module is calibrated at the factory and does not require further calibration.

Ensure that you installed the DT9812, DT9813, or DT9814 Device Driver prior to using the DT9812 Series Calibration Utility. Refer to Chapter 2 for more information on installing the device driver.

This chapter describes how to calibrate the analog input and output subsystems of the DT9812-10V, DT9813-10V, or DT9814-10V module using the DT9812 Series Calibration Utility.

Using the DT9812 Series Calibration Utility

Start the DT9812 Series Calibration Utility as follows:

1. From Windows Task Bar, select **Start | Programs | Data Translation, Inc | ECONseries | Calibration | DT9812 Series Calibration Utility**.
   The main menu appears.
2. Select the module to calibrate, and then click **OK**.

Once the DT9812 Series Calibration Utility is running, you can calibrate the analog input circuitry (either automatically or manually), described on page 120, or the analog output circuitry of the module, described on page 122.

Calibrating the Analog Input Subsystem

This section describes how to use the DT9812 Series Calibration Utility to calibrate the analog input subsystem of a 10V module.

Connecting a Precision Voltage Source

To calibrate the analog input circuitry, you need to connect an external precision voltage source to Analog In 0 (AD Ch0) of the module.

Using the Auto-Calibration Procedure

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

1. Select the **A/D Configuration** tab of the DT9812 Series Calibration Utility.
2. Set the voltage supply on AD Ch0 to 0 V.
3. Click **Start Auto Calibration**.
   A message appears notifying you to verify that 0 V is applied to AD Ch0.
4. Check that the supplied voltage to AD Ch0 is 0V, and then click **OK**.
   The offset value is calibrated. When the offset calibration is complete, a message appears notifying you to set the input voltage of AD Ch 0 to +9.375 V.
5. Check that the supplied voltage to AD Ch0 is +9.375V, and then click **OK**.
   The gain value is calibrated.
6. Click OK to finalize the analog input calibration process.

Note: At any time, you can click **Restore Factory Settings** to reset the A/D calibration values to their original factory settings. This process will undo any auto or manual calibration settings.

Using the Manual Calibration Procedure

If you want to manually calibrate the analog input circuitry instead of auto-calibrating it, do the following:

1. Adjust the offset as follows:
   a. Verify that 0V is applied to AD Ch0, and that A/D Channel Select is set to Channel 0.
      The current voltage reading for this channel is displayed in the A/D Value window.
   b. Adjust the offset by entering values between 0 and 63 in the Offset edit box, or by clicking the up/down buttons until the A/D Value is 0 V.
2. Adjust the gain as follows:
   a. Verify that 9.375V is applied to AD Ch0, and that A/D Channel Select is set to Channel 0.
      The current voltage reading for this channel is displayed in the A/D Value window.
   b. Adjust the gain by entering values between 0 and 63 in the Gain edit box, or by clicking the up/down buttons until the A/D Value is 9.3750.

Note: At any time, you can click **Restore Factory Settings** to reset the A/D calibration values to their original factory settings. This process will undo any auto or manual calibration settings.

Calibrating the Analog Output Subsystem

This section describes how to use the DT9812 Series Calibration Utility to calibrate the analog output subsystem of a 10V module.

To calibrate the analog output circuitry, you need to connect an external precision voltmeter to analog output channels 0 and 1 of the module.

Do the following to calibrate the analog output circuitry:

1. Select the **D/A Configuration** tab of the DT9812 Series Calibration Utility.
2. Connect an external precision voltmeter to Analog Output 0 (DAC Ch0) of the module.
3. Adjust the offset by entering values between 0 and 63 in the **DAC 0 Offset** edit box, or by clicking the up/down buttons until the voltmeter reads 0 V.
4. Connect an external precision voltmeter to Analog Output 1 (DAC Ch1) of the module.
5. Adjust the offset by entering values between 0 and 63 in the **DAC 1 Offset** edit box, or by clicking the up/down buttons until the voltmeter reads 0 V.

Note: At any time, you can click **Restore Factory Settings** to reset the D/A calibration values to their original factory settings. This process will undo any D/A calibration settings.

Once you have finished this procedure, the analog output circuitry is calibrated. To close the DT9812 Series Calibration Utility, click the close box in the upper right corner of the window.

A

Specifications

Table 3 lists the specifications for the A / D subsystem on the DT9812-2.5V, DT9812-10V, DT9813-10V, and DT9814-10V modules.

Table 3: A/D Subsystem Specifications

Feature	DT9812-2.5V	DT9812-10V DT9813-10V DT9814-10V
Number of analog input channels	8 single-ended	8 single-ended 16 single-ended 24 single-ended
Number of gains	5 (1, 2, 4, 8, 16)	4 (1, 2, 4, 8)
Resolution	12-bit	12-bit
Data encoding	binary	twos complement
System accuracy, to % of FSR (Averaged over 50 readings) Gain = 1: Gain = 2: Gain = 4: Gain = 8: Gain = 16:	 0.04% 0.06% 0.08% 0.10% 0.15%	 0.04% 0.06% 0.08% 0.10% –
Input Range Gain = 1: Gain = 2: Gain = 4: Gain = 8: Gain = 16:	 0 to 2.44 V, 0 to 1.22 V, 0 to 0.610 V, 0 to 0.305 V 0 to 0.1525 V	 ±10 V, ±5 V, ±2.5 V, ±1.25 V –
Nonlinearity	0.05%	0.05%
Differential nonlinearity	±1/2 LSB	±1/2 LSB
Inherent quantizing error	1 LSB	1 LSB

Table 3: A/D Subsystem Specifications (cont.)

Feature	DT9812-2.5V	DT9812-10V DT9813-10V DT9814-10V
Drift Zero: Gain: Differential linearity:	 ±50 µV ±100 ppm monotonic	 ±100 µV ±100 ppm monotonic
Input impedance[a] Off channel: On channel:	 10 MΩ, 10 pf 10 MΩ, 100 pf	 10 MΩ, 10 pf 10 MΩ, 100 pf
Input bias current	±10 nA	±10 nA
Maximum input voltage (without damage) Power on: Power off:	 ±35 V ±20 V	 ±35 V ±20 V
A/D conversion time	8 µs	8 µs
Channel acquisition time (±½ LSB)	20 µs	20 µs
Sample-and-hold Aperture uncertainty: Aperture delay:	 2 ns 200 ns	 2 ns 200 ns
Throughput	50 kHz	50 kHz
ESD protection (per spec) Arc: Contact:	 8 kV 4 kV	 8 kV 4 kV
Reference	2.44 V	2.5 V
Monotonicity	Yes	Yes

Table 3: A/D Subsystem Specifications (cont.)

Feature	DT9812-2.5V	DT9812-10V DT9813-10V DT9814-10V
Sample Clock Internal: External:	 Yes Yes	 Yes Yes
Trigger Source Internal: External:	 Yes Yes	 Yes Yes
A/D Converter Noise	0.6 LSB rms	0.6 LSB rms
Channel-to-Channel Offset	0.1 mV	0.1 mV
Effective Number of Bits at 50 kHz with a 1 kHz sine wave:	10.5 bits	10.5 bits
Total Harmonic Distortion	< –70 db @ 1 kHz	< –70 db @ 1 kHz
Channel Crosstalk	–74 db @ 1 kHz	–74 db @ 1 kHz
Maximum A/D Pacer Clock Single Analog Input Throughput: Multiple Analog Input Throughput:	 50 kHz 50 kHz	 50 kHz 50 kHz

a. Very high input impedance minimizes any source error.

Table 4 lists the specifications for the D/A subsystem on the DT9812-2.5V, DT9812-10V, DT9813-10V, and DT9814-10V modules.

Table 4: D/A Subsystem Specifications

Feature	DT9812-2.5V	DT9812-10V DT9813-10V DT9814-10V
Number of waveform analog output channels	2	2
Resolution	12-bit	12-bit
Data encoding	Binary	Twos Complement
Nonlinearity	0.05%	0.05%
Differential nonlinearity	± LSB	±1 LSB
Inherent quantizing error	1 LSB	1 LSB
Output range	0 to 2.44 V	±10 V
Error Zero: Gain:	 ±1 mV ±0.1%	 ±4 mV ±0.2%
Drift Zero (bipolar): Gain:	 ±20 μV /° C ±100 ppm	 ±100 μV /° C ±100 ppm
Throughput) Continuously paced analog output mode:	 50 kHz	 50 kHz
Current output	±2 mA	±2 mA
Output impedance	<200 Ω	<0.2 Ω
Capacitive driver capability	1000 pF minimum	1000 pF minimum

Table 4: D/A Subsystem Specifications (cont.)

Feature	DT9812-2.5V	DT9812-10V DT9813-10V DT9814-10V
Protection	Short to ground	Short to ground
Power-on voltage	0 V ±5 mV	0 V ±10 mV
Settling time to 0.01% of FSR	20 µs	20 µs
Slew rate	2 V / µs	2 V/ µs
Glitch energy	1 µV -sec	1 µV -sec
ESD protection (per spec) Arc: Contact:	 8 kV 4 kV	 8 kV 4 kV
Monotonicity	Yes	Yes
Output Clock Internal: External:	 Yes No	 Yes No
Trigger Source Internal: External:	 Yes No	 Yes No

Table 5 lists the specifications for the DIN / DOUT subsystems on the DT9812-2.5V, DT9812-10V, and DT9813-10V modules.

Table 5: DIN/DOUT Subsystem Specifications

Feature	DT9812-2.5V, DT9812-10V, and DT9813-10V
Number of digital I/O lines	16 (8 in/8 out) (DT9812) 8 (4 in/4 out) (DT9813)
Number of ports	2, 8-bit (DT9812) 2, 4-bit (DT9813)
Input termination	No
Logic family	TTL
Logic sense	Positive true
Inputs Input type: Input logic load: High input voltage: Low input voltage: Low input current:	 Level sensitive 1 TTL Load 2.4 V min 0.8 V max –0.4 mA max
Outputs High output: Low output: High output current (source): Low output current (sink):	 2.8 V min 0.6 V max 2 mA 10 mA
Software I/O selectable	No
ESD protection (per spec) Arc: Contact:	 8 kV 4 kV

Table 6 lists the specifications for the C/T subsystem on the DT9812-2.5V, DT9812-10V, DT9813-10V, and DT9814-10V modules.

Table 6: C/T Subsystem Specifications

Feature	Specifications
Number of counter/timers	1
Counter/timer modes	Event counting, frequency measurement, edge-to-edge measurement, rate generation
Resolution	32-bit[a]
Minimum pulse width: (minimum amount of time it takes a C/T to recognize an input pulse)	200 ns
Logic family	TTL
Inputs Input logic load: High input voltage: Low input voltage: Low input current:	Level sensitive 1 TTL Load 2.4 V min 0.8 V max –0.4 mA max
Outputs High output: Low output: High output current (source): Low output current (sink):	 2.8 V min 0.6 V max 2 mA 12 mA
ESD protection (per spec) Arc: Contact:	 8 kV 4 kV

Table 6: C/T Subsystem Specifications (cont.)

Feature	Specifications
Internal clock frequency	15 Hz to 12 MHz
External clock divider	2 to 65536

a. The resolution is 16-bits for rate generation operations.

Table 7 lists the specifications for the external A/D trigger on the DT9812-2.5V, DT9812-10V, DT9813-10V, and DT9814-10V modules.

Table 7: External Trigger Specifications

Feature	Specifications
Input type	Low-level or falling edge sensitive
Logic family	TTL
Inputs Input logic load: High input voltage: Low input voltage: Low input current:	Level sensitive 1 TTL Load 2.4 V min 0.8 V max –0.4 mA max
Minimum pulse width High: Low:	 200 ns 200 ns
Triggering modes Single scan: Continuous scan:	 Yes Yes

Table 8 lists the specifications for the external A/D clock on the DT9812-2.5V, DT9812-10V, DT9813-10V, and DT9814-10V modules.

Table 8: External Clock Specifications

Feature	Specifications
Input type	Rising-edge sensitive
Logic family	TTL
Inputs Input logic load: Input termination: High input voltage: Low input voltage: Low input current:	 Level sensitive 1 TTL Load 2.4 V min 0.8 V max –0.4 mA max
Oscillator frequency	40 kHz maximum
Minimum pulse width High: Low:	 200 ns 200 ns

Table 9 lists the power, physical, and environmental specifications for the DT9812-2.5V, DT9812-10V, DT9813-10V, and DT9814-10V modules.

Table 9: Power, Physical, and Environmental Specifications

Feature	DT9812-2.5V	DT9812-10V DT9813-10V DT9814-10V
USB +5 V out (pin 20)	100 mA maximum	
Power +5 V Enumeration: Operation:	 <100 mA <100 mA	 <100 mA <175 mA
Physical Dimensions (board): Dimensions (box with screw terminals and feet): Weight (board): Weight (box with screw terminals and feet):	 100 mm (L) x 100 mm (W) x 15.5 mm (H) 107.7 mm (L) x 100 mm (W) x 33.5 mm (H) 65.3 g 138.4 g	
Environmental Operating temperature range: Storage temperature range: Relative humidity:	 0 to 55° C –40 to 85° C to 95% non-condensing	

B

Screw Terminal Assignments

Table 10 lists the screw terminals for the DT9812 modules.

Table 10: DT9812 Screw Terminal Assignments

Screw Terminal	Signal	Screw Terminal	Signal
20	USB +5 V Out	40	Ext Trigger
19	Ground	39	Ext Clock
18	Counter 0 In	38	Ground
17	Counter 0 Out	37	Digital Output 7
16	Counter 0 Gate	36	Digital Output 6
15	Ground	35	Digital Output 5
14	DAC 1	34	Digital Output 4
13	DAC 1 Return	33	Digital Output 3
12	DAC 0	32	Digital Output 2
11	DAC 0 Return	31	Digital Output 1
10	2.5 V Reference[a]	30	Digital Output 0
9	Analog Ground	29	Ground
8	Analog Input CH7	28	Digital Input 7
7	Analog Input CH6	27	Digital Input 6
6	Analog Input CH5	26	Digital Input 5
5	Analog Input CH4	25	Digital Input 4
4	Analog Input CH3	24	Digital Input 3
3	Analog Input CH2	23	Digital Input 2
2	Analog Input CH1	22	Digital Input 1
1	Analog Input CH0	21	Digital Input 0

a. For the DT9812-2.5V module, this reference is 2.44 V.

Table 11 lists the screw terminals for the DT9813-10V module.

Table 11: DT9813-10V Screw Terminal Assignments

Screw Terminal	Signal	Screw Terminal	Signal
20	USB +5 V Out	40	Ext Trigger
19	Ground	39	Ext Clock
18	Counter 0 In	38	Ground
17	Counter 0 Out	37	Digital Input 3
16	Counter 0 Gate	36	Digital Input 2
15	Ground	35	Digital Input 1
14	DAC 1	34	Digital Input 0
13	DAC 1 Return	33	Digital Output 3
12	DAC 0	32	Digital Output 2
11	DAC 0 Return	31	Digital Output 1
10	2.5 V Reference	30	Digital Output 0
9	Analog Ground	29	Ground
8	Analog Input CH7	28	Analog Input CH15
7	Analog Input CH6	27	Analog Input CH14
6	Analog Input CH5	26	Analog Input CH13
5	Analog Input CH4	25	Analog Input CH12
4	Analog Input CH3	24	Analog Input CH11
3	Analog Input CH2	23	Analog Input CH10
2	Analog Input CH1	22	Analog Input CH9
1	Analog Input CH0	21	Analog Input CH8

Table 12 lists the screw terminals for the DT9814-10V module.

Table 12: DT9814-10V Screw Terminal Assignments

Screw Terminal	Signal	Screw Terminal	Signal
20	USB +5 V Out	40	Ext Trigger
19	Ground	39	Ext Clock
18	Counter 0 In	38	Ground
17	Counter 0 Out	37	Analog Input CH23
16	Counter 0 Gate	36	Analog Input CH22
15	Ground	35	Analog Input CH21
14	DAC 1	34	Analog Input CH20
13	DAC 1 Return	33	Analog Input CH19
12	DAC 0	32	Analog Input CH18
11	DAC 0 Return	31	Analog Input CH17
10	2.5 V Reference	30	Analog Input CH16
9	Analog Ground	29	Ground
8	Analog Input CH7	28	Analog Input CH15
7	Analog Input CH6	27	Analog Input CH14
6	Analog Input CH5	26	Analog Input CH13
5	Analog Input CH4	25	Analog Input CH12
4	Analog Input CH3	24	Analog Input CH11
3	Analog Input CH2	23	Analog Input CH10
2	Analog Input CH1	22	Analog Input CH9
1	Analog Input CH0	21	Analog Input CH8

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