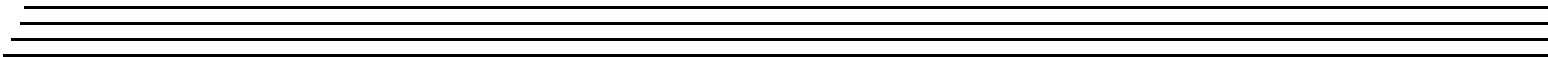
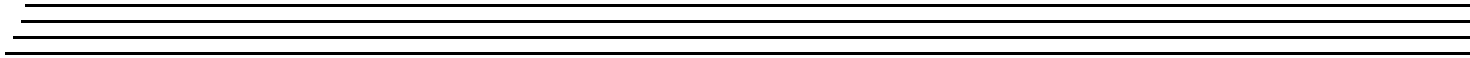
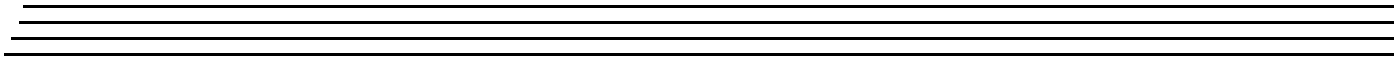


***DT9812,
DT9813, and
DT9814 Series
User's Manual***



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Radio and Television Interference

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

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

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

Canadian Department of Communications Statement

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

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

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About this Manual

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

The second part of this manual describes the features of the DT9812, DT9813, and DT9814 Series 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 information on checking system requirements, installing the software, and viewing the documentation, refer to the README file on the OMNI CD.

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

If the information applies to a specific module, this manual uses the specific product name, such as DT9812-10V. Otherwise, the series name, such as DT9812 Series, is used.

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® XP, Windows Vista®, Windows 7, or Windows 8 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, DT9813, and DT9814 Series modules, as well as the supported software and accessories for the modules.
- [Chapter 2, “Setting Up and Installing the Module,”](#) describes how to install the module and how to configure the device driver.
- [Chapter 3, “Wiring Signals to the Module,”](#) describes how to wire signals to the module.
- [Chapter 4, “Verifying the Operation of a Module,”](#) describes how to verify the operation of the module with the Quick DataAcq application.
- [Chapter 5, “Principles of Operation,”](#) describes all of the features of the modules and how to use them in your application.
- [Chapter 6, “Supported Device Driver Capabilities,”](#) lists the data acquisition subsystems and the associated features accessible using the device driver.

- [Chapter 7, “Troubleshooting,”](#) provides information that you can use to resolve problems with a module and device driver, should they occur.
- [Chapter 8, “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 and Connector Pin Assignments and LED Status Indicators,”](#) 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 Series modules:

- *Benefits of the Universal Serial Bus for Data Acquisition*. This white paper describes why USB is an attractive alternative for data acquisition. It is available on the Data Translation web site (www.mccdaq.com).
- *QuickDAQ User’s Manual (UM-24774)*. This manual describes how to create a QuickDAQ application to acquire and analyze data from DT-Open Layers data acquisition devices.
- *DT-Open Layers for .NET User’s Manual (UM-22161)*. For programmers who are developing their own application programs using Visual C# or Visual Basic .NET, this manual describes how to use the DT-Open Layers for .NET Class Library to access the capabilities of Data Translation data acquisition devices.
- *DataAcq SDK User’s Manual (UM-18326)*. For programmers who are developing their own application programs using the Microsoft C compiler, this manual describes how to use the DT-Open Layers DataAcq SDK™ to access the capabilities of Data Translation data acquisition devices.
- *DTx-EZ Getting Started Manual (UM-15428)*. This manual describes how to use the ActiveX controls provided in DTx-EZ™ to access the capabilities of Data Translation data acquisition devices in Microsoft Visual Basic® or Visual C++®.
- *DAQ Adaptor for MATLAB (UM-22024)*. This document describes how to use Data Translation’s DAQ Adaptor to provide an interface between the MATLAB Data Acquisition subsystem from The MathWorks and Data Translation’s DT-Open Layers architecture.

- *LV-Link Online Help*. This help file describes how to use LV-Link™ with the LabVIEW™ graphical programming language to access the capabilities of Data Translation data acquisition devices.
- Microsoft Windows XP, Windows Vista, Windows 7, or Windows 8 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 7](#) starting on [page 99](#) 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.mccdaq.com).



Overview

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Key Hardware Features

The DT9812, DT9813, and DT9814 Series modules are economy, multifunction mini-instruments. [Figure 1](#) shows a DT9812 module.



Figure 1: DT9812 Module

[Table 1](#) lists the key features of each module.

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

Module	Analog Inputs	Analog Outputs	I/O Range	Analog Input Sample Rate	Analog Output Update Rate	Digital I/O
DT9812-2.5V	8 SE	2	0 to 2.44 V	50 kS/s	50 kS/s	8 in/ 8 out
DT9812-10V and DT9812-10V-OEM ^a	8 SE	2	± 10 V	50 kS/s	50 kS/s	8 in/ 8 out
DT9812A	8 SE	2	± 10 V	100 kS/s	75 kS/s	8 in/ 8 out
DT9813-10V	16 SE	2	± 10 V	50 kS/s	50 kS/s	4 in/ 4 out
DT9813A	16 SE	2	± 10 V	100 kS/s	75 kS/s	4 in/ 4 out
DT9814-10V	24 SE	2	± 10 V	50 kS/s	50 kS/s	--
DT9814A	24 SE	2	± 10 V	100 kS/s	75 kS/s	--

a. The DT9812-10V-OEM is an uncased, board-level module provided for OEM customers. Rather than provide screw terminals, this module provides 2, 20-pin connectors for connecting I/O signals. Refer to [page 39](#) for the layout of this module.

All modules provide the following features:

- 32-location analog input channel-gain list; you can cycle through the channel-gain list using continuous scan mode
- 2-location output channel list; you can update both DACs simultaneously at the maximum analog output update rate
- 12-bit resolution
- One 32-bit counter/timer channel for performing event counting, frequency measurement, edge-to-edge measurement, and rate generation (continuous pulse output) operations
- Internal and external A/D clock sources
- Internal and external A/D trigger sources
- No external power supply required

Supported Software

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

- **Device Driver** – The DT9812, DT9813, or DT9814 Series 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 configuring 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 Series module. Using this application, you can verify key features of the modules, display data on the screen, and save data to disk. Refer to [Chapter 4](#) for more information on using the Quick DataAcq application.
- **QuickDAQ Base Version** – The base version of QuickDAQ is free-of-charge and allows you to acquire and analyze data from all Data Translation USB and Ethernet devices, except the DT9841 Series, DT9817, DT9835, and DT9853/54. Using the base version of QuickDAQ, you can perform the following functions:
 - Discover and select your devices.
 - Configure all input channel settings for the attached sensors.
 - Load/save multiple hardware configurations.
 - Generate output stimuli (fixed waveforms, swept sine waves, or noise signals).
 - On each supported data acquisition device, acquire data from all channels supported in the input channel list.
 - Choose to acquire data continuously or for a specified duration.
 - Choose software or triggered acquisition.
 - Log acquired data to disk in an .hpf file.
 - Display acquired data during acquisition in either a digital display using the Channel Display window or as a waveform in the Channel Plot window.
 - Choose linear or logarithmic scaling for the horizontal and vertical axes.
 - View statistics about the acquired data, including the minimum, maximum, delta, and mean values and the standard deviation in the Statistics window.
 - Export time data to a .csv or .txt file; you can open the recorded data in Microsoft Excel® for further analysis.
 - Read a previously recorded .hpf data file.
 - Customize many aspects of the acquisition, display, and recording functions to suit your needs, including the acquisition duration, sampling frequency, trigger settings, filter type, and temperature units to use.
- **QuickDAQ FFT Analysis Option** – When enabled with a purchased license key, the QuickDAQ FFT Analysis option includes all the features of the QuickDAQ Base version plus basic FFT analysis features, including the following:
 - The ability to switch between the Data Logger time-based interface and the FFT Analyzer block/average-based interface.

- Supports software, freerun, or triggered acquisition with accept and reject controls for impact testing applications.
- Allows you to perform single-channel FFT (Fast Fourier Transform) operations, including AutoSpectrum, Spectrum, and Power Spectral Density, on the acquired analog input data. You can configure a number of parameters for the FFT, including the FFT size, windowing type, averaging type, integration type, and so on.
- Allows you to display frequency-domain data as amplitude or phase.
- Supports dB or linear scaling with RMS (root mean squared), peak, and peak-to-peak scaling options
- Supports linear or exponential averaging with RMS, vector, and peak hold averaging options.
- Supports windowed time channels.
- Supports the following response window types: Hanning, Hamming, Bartlett, Blackman, Blackman Harris, and Flat top.
- Supports the ability to lock the waveform output to the analysis frame time.
- Allows you to configure and view dynamic performance statistics, including the input below full-scale (IBF), total harmonic distortion (THD), spurious free dynamic range (SFDR), signal-to-noise and distortion ratio (SINAD), signal-to-noise ratio (SNR), and the effective number of bits (ENOB), for selected time-domain channels in the Statistics window.
- Supports digital IIR (infinite impulse response) filters
- **QuickDAQ Advanced FFT Analysis Option** – When enabled with a purchased software license, the QuickDAQ Advanced FFT Analysis option includes all the features of the QuickDAQ Base version with the FFT Analysis option plus advanced FFT analysis features, including the following:
 - Allows you to designate a channel as a Reference or Response channel.
 - Allows you to perform two-channel FFT analysis functions, including Frequency Response Functions (Inertance, Mobility, Compliance, Apparent Mass, Impedance, Dynamic Stiffness, or custom FRF) with H1, H2, or H3 estimator types, Cross-Spectrum, Cross Power Spectral Density, Coherence, and Coherent Output Power.
 - Supports the Exponential response window type.
 - Supports the following reference window types: Hanning, Hamming, Bartlett, Blackman, Blackman Harris, FlatTop, Exponential, Force, and Cosine Taper windows.
 - Supports real, imaginary, and Nyquist display functions.
 - Allows you to save data in the .uff file format.
- **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 2003-2012; 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 XP, Windows Vista, Windows 7, or Windows 8; 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.
- **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 2](#) 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.

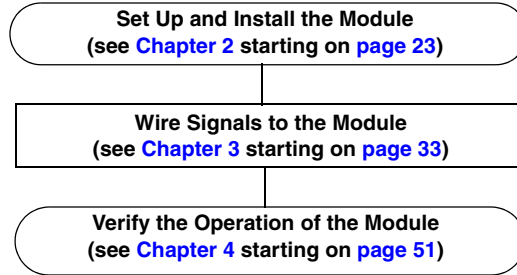


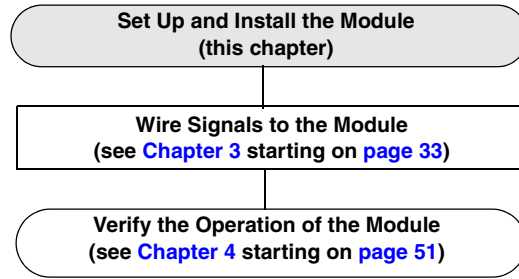
Figure 2: Getting Started Flow Diagram

Part 1: Getting Started



Setting Up and Installing the Module

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Unpacking

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

- DT9812, DT9813, or DT9814 Series module
- OMNI CD
- USB cable (not provided with OEM versions of a module)

If an item is missing or damaged, contact Data Translation. If you are in the United States, call the Customer Service Department at (508) 946-5100. 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.mccdaq.com).

Note: The DT9812, DT9813, and DT9814 Series modules are factory-calibrated. The DT9812-2.5V module requires no further adjustment. If you want to recalibrate the DT9812-10V, DT9812-10V-OEM, DT9813-10V, DT9814-10V, DT9812A, DT9813A, or DT9814A module, refer to [Chapter 8](#) starting on [page 105](#).

System Requirements

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

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

Attaching Modules to the Computer

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

Note: The DT9812-10V-OEM module contains a 5-pin USB header instead of a standard USB connector (see [page 128](#) for the pin assignments of this header). To connect to the DT9812-10V-OEM module, you need to purchase the Bulgin USB cable (part#14193). This cable has a 5-pin header on one end for connecting to the module and a standard USB connector on the other end for connecting to the host computer.

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 29](#).

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.

Connecting Directly to the USB Ports

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

1. Attach one end of the USB cable to the USB connector 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 3](#).

The operating system automatically detects the USB module and starts the Found New Hardware wizard.



Figure 3: Attaching the Module to the Host Computer

3. For Windows Vista:

- a. Click **Locate and install driver software (recommended)**.
The popup message "Windows needs your permission to continue" appears.
- b. Click **Continue**.
The Windows Security dialog box appears.
- c. Click **Install this driver software anyway**.
The LED on the module turns green.

For Windows XP:

- a. Click **Next** and/or **Finish** as required in the wizard.
Once the firmware is loaded, the wizard restarts to initiate the firmware to accept commands.
- b. Click **Next** and/or **Finish** again.
The LED on the module turns green.

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

4. Repeat these 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. The practical number of DT9812, DT9813, and/or DT9814 Series modules that you can connect to a single USB port depends on the throughput you want to achieve.

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. For Windows Vista:

- a. Click **Locate and install driver software (recommended)**.
The popup message "Windows needs your permission to continue" appears.
- b. Click **Continue**.
The Windows Security dialog box appears.
- c. Click **Install this driver software anyway**.
The LED on the module turns green.

For Windows XP:

- a. Click **Next** and/or **Finish** as required in the wizard.
Once the firmware is loaded, the wizard restarts to initiate the firmware to accept commands.
- b. Click **Next** and/or **Finish** again.
The LED on the module turns green.

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

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 4](#).
The operating system automatically detects the USB devices as they are installed.

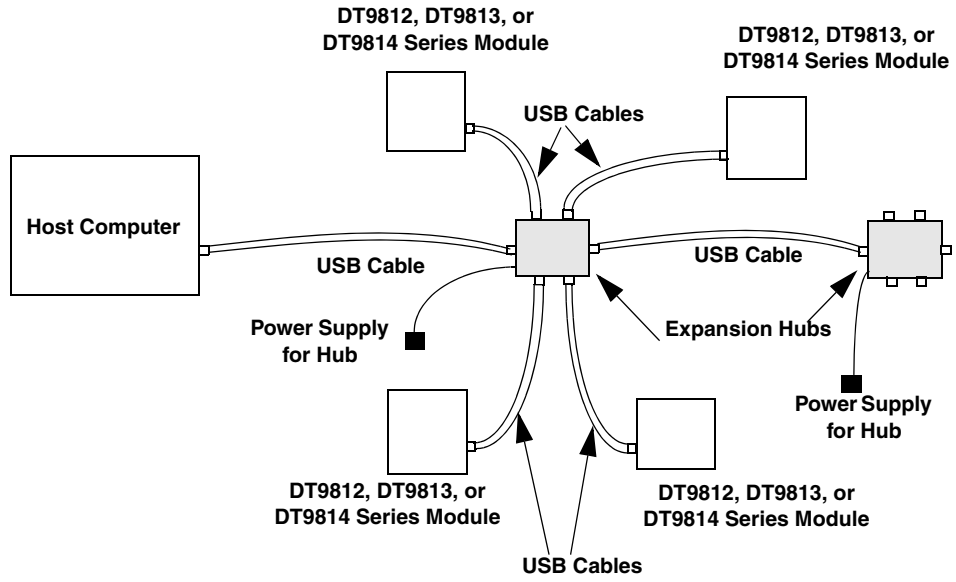


Figure 4: Attaching Multiple DT9812, DT9813, and/or DT9814 Series Modules Using Expansion Hubs

Changing the Name of a Module (Optional)

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

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

Windows 7, Windows 8, and Vista (32-bit)

C:\Windows\System32\Dtolcpl.cpl

Windows 7, Windows 8, and Vista (64-bit)

C:\Windows\SysWOW64\Dtolcpl.cpl

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

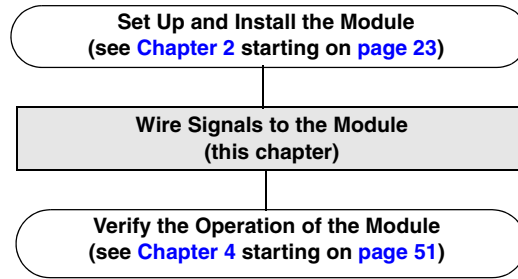
1. From the Windows Start menu, select **Settings | Control Panel**.
2. From the Control Panel, double-click **Open Layers Control Panel**.
The Data Acquisition Control Panel dialog box appears.
3. Click the DT9812, DT9813, or DT9814 Series module that you want to rename, and then click **Edit Name**.
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 3](#) starting on [page 33](#).



Wiring Signals to the Module

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Preparing to Wire Signals

This section provides information about wiring signals to a DT9812, DT9813, or DT9814 Series module.

Wiring Recommendations

Keep the following recommendations in mind when wiring signals to a DT9812, DT9813, or DT9814 Series module:

- Follow standard ESD procedures when wiring signals to the 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 Signals to a DT9812-2.5V, DT9812-10V, DT9812A, DT9813-10V, DT9813A, DT9814-10V, or DT9814A Module

For the DT9812-2.5V, DT9812-10V, DT9812A, DT9813-10V, DT9813A, DT9814-10V, and DT9814A modules, you wire signals to the screw terminals on the module.

[Table 2](#) lists the screw terminal assignments for the DT9812-2.5V, DT9812-10V, and DT9812A modules. [Table 3](#) lists the screw terminals for the DT9813-10V and DT9813A modules. [Table 4](#) lists the screw terminals for the DT9814-10V, and DT9814A modules.

Table 2: DT9812-2.5V, DT9812-10V, DT9812A 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 3: DT9813-10V and DT9813A 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 4: DT9814-10V and DT9814A 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

Wiring Signals to the DT9812-10V-OEM Module

The DT9812-10V-OEM module provides two 20-pin connectors (Analog I/O connector and Digital I/O connector) for wiring signals, as well as a 5-pin USB header. [Figure 5](#) shows the location of the connectors.

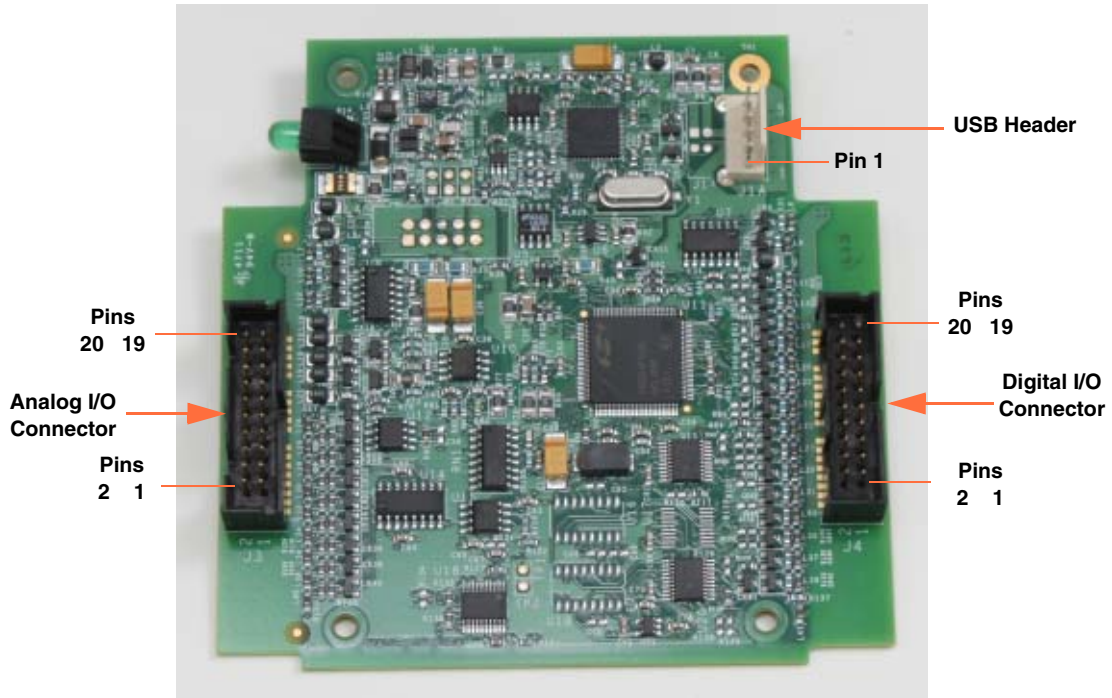


Figure 5: Layout of the DT9812-10V-OEM Module

[Table 5](#) lists the pin assignments for the Analog I/O connector on the DT9812-10V-OEM module.

Table 5: Analog I/O Connector Pin Assignments on the DT9812-10V-OEM Module

Pin	Signal	Pin	Signal
20	USB +5 V Out	19	Ground
18	Counter 0 In	17	Counter 0 Out
16	Counter 0 Gate	15	Ground
14	DAC 1	13	DAC 1 Return
12	DAC 0	11	DAC 0 Return
10	2.5 V Reference	9	Analog Ground
8	Analog Input CH7	7	Analog Input CH6
6	Analog Input CH5	5	Analog Input CH4
4	Analog Input CH3	3	Analog Input CH2
2	Analog Input CH1	1	Analog Input CH0

[Table 6](#) lists the pin assignments for the Digital I/O connector on the DT9812-10V-OEM module.

Table 6: Digital I/O Connector Pin Assignments on the DT9812-10V-OEM Module

Pin	Signal	Pin	Signal
20	Ext Trigger	19	Ext Clock
18	Ground	17	Digital Output 7
16	Digital Output 6	15	Digital Output 5
14	Digital Output 4	13	Digital Output 3
12	Digital Output 2	11	Digital Output 1
10	Digital Output 0	9	Ground
8	Digital Input 7	7	Digital Input 6
6	Digital Input 5	5	Digital Input 4
4	Digital Input 3	3	Digital Input 2
2	Digital Input 1	1	Digital Input 0

Refer to [page 128](#) for information on the USB header.

Connecting Analog Input Signals

The DT9812 Series modules support 8 single-ended analog input channels. The DT9813-10V and DT9813A module support 16 single-ended analog input channels; the DT9814-10V and DT9814A support 24 single-ended analog input channels.

Figure 6 shows how to connect single-ended voltage input signals (channels 0 and 1, in this case) to the module.

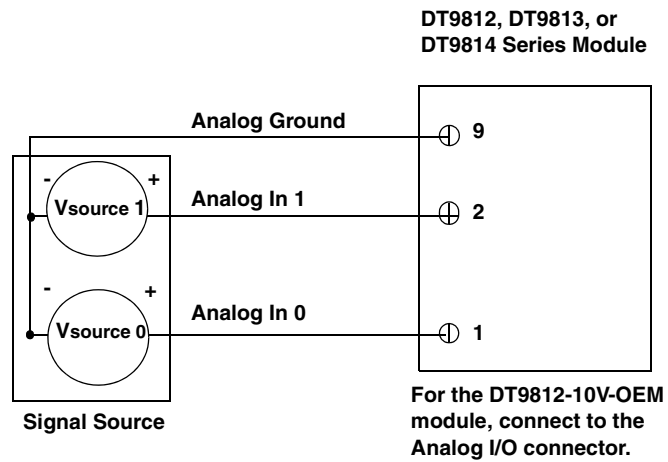


Figure 6: Connecting Single-Ended Analog Inputs

Connecting Analog Output Signals

The DT9812, DT9813, and DT9814 Series modules support two analog output channels (DAC0 and DAC1). [Figure 7](#) shows how to connect an analog output voltage signal (DAC0, in this case) to one of these modules.

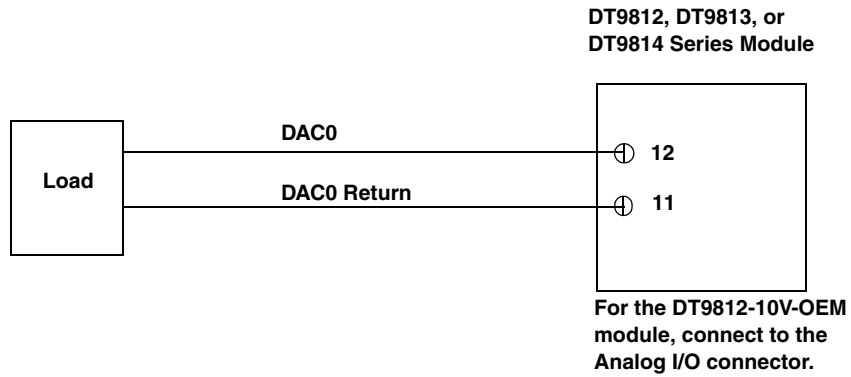


Figure 7: Connecting Analog Outputs

Connecting Digital I/O Signals

The DT9812 Series modules support eight fixed digital input lines and eight fixed digital output lines. The DT9813-10V and DT9813A modules support four fixed digital input lines and four fixed digital output lines. (The DT9814-10V and DT9814A modules do not support digital I/O operations.) The following sections describe how to connect digital input and digital output lines to these modules.

Connecting Digital Input Lines

Figure 8 shows how to connect digital input signals (lines 0 and 1, in this case) to a DT9812-2.5V, DT9812-10V, or DT9812A module.

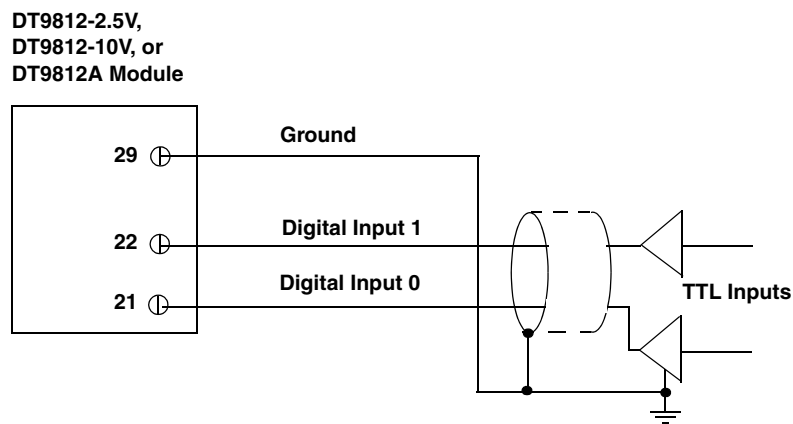


Figure 8: Connecting Digital Inputs to the DT9812-2.5V, DT9812-10V, or DT9812A Module

Figure 9 shows how to connect digital input signals (lines 0 and 1) to a DT9812-10V-OEM module.

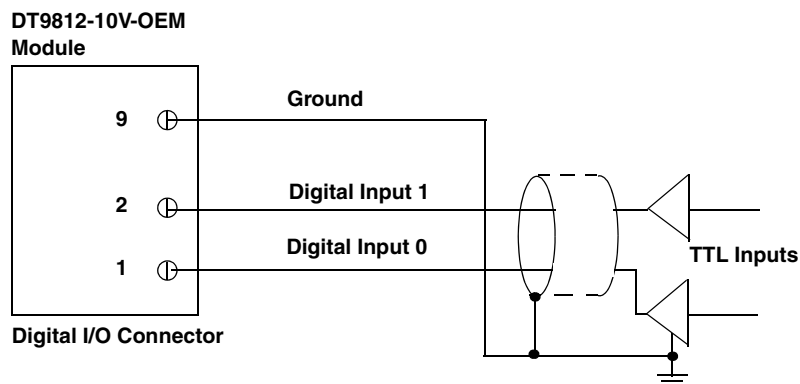


Figure 9: Connecting Digital Inputs to the DT9812-10V-OEM Module

Figure 10 shows how to connect digital input signals (lines 0 and 1) to the screw terminals of a DT9813-10V or DT9813A module.

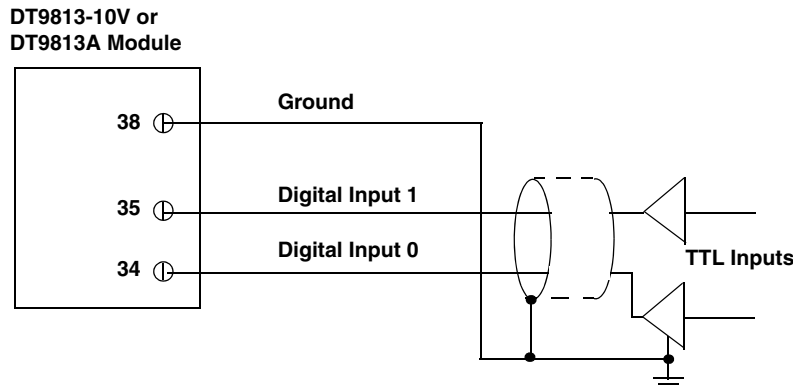


Figure 10: Connecting Digital Inputs to the DT9813-10V Module

Connecting Digital Output Signals

Figure 11 shows how to connect digital output signals (line 0, in this case) to a DT9812-2.5V, DT9812-10V, DT9812A, DT9813-10V, or DT9813A module.

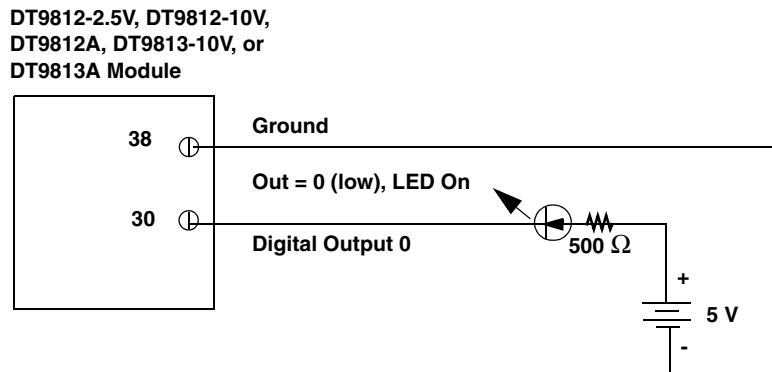


Figure 11: Connecting Digital Outputs to the DT9812-2.5V, DT9812-10V, DT9812A, DT9813-10V, or DT9813A Module

Note: While the DT9812 Series modules have 8 digital outlines, the DT9813-10V module has only four digital output lines (screw terminals 30 through 33).

Figure 12 shows how to connect a digital output signal to a DT9812-10V-OEM module.

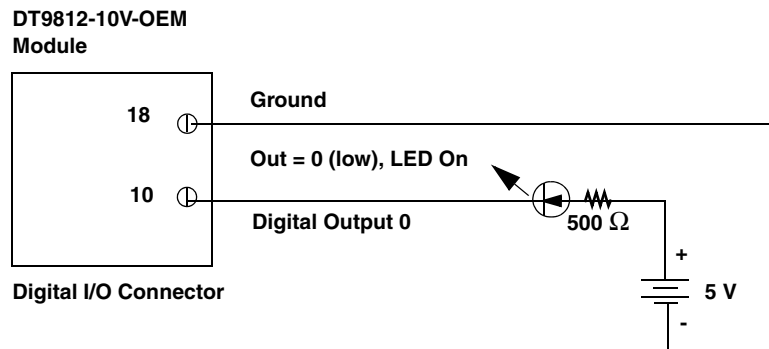


Figure 12: Connecting Digital Outputs to the DT9812-10V-OEM Module

Connecting Counter/Timer Signals

DT9812, DT9813, and DT9814 Series 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 [page 79](#) for more information about using the counter/timers.

Event Counting

[Figure 13](#) shows how to connect counter/timer signals to 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 [page 81](#) for more information.

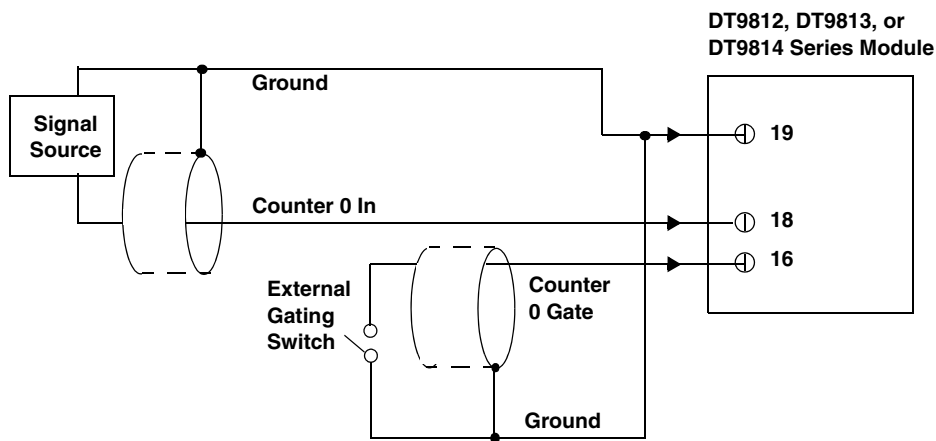


Figure 13: Connecting Counter/Timer Signals for an Event Counting Operation Using an External Gate

[Figure 14](#) shows how to connect counter/timer signals to 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.

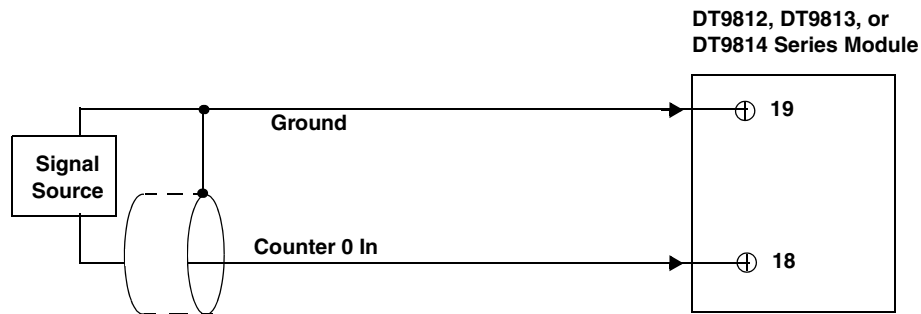


Figure 14: Connecting Counter/Timer Signals for an Event Counting Operation Without Using a Gate

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 15. 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.

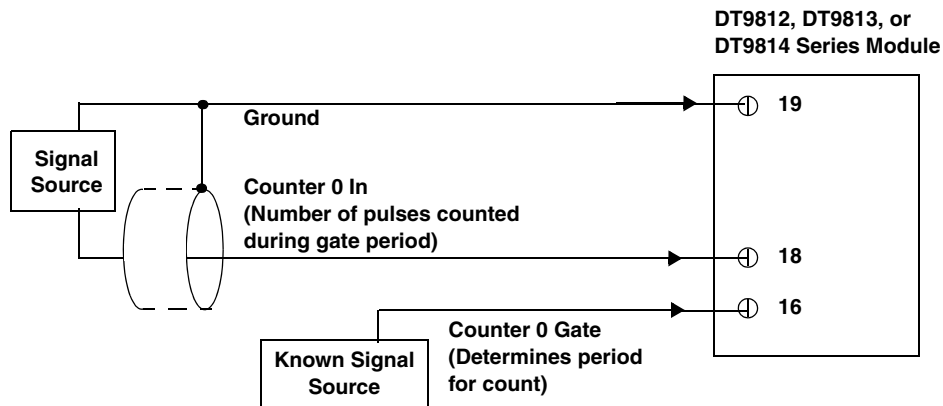


Figure 15: Connecting Counter/Timer Signals for a Frequency Measurement Operation Using an External Pulse

Edge-to-Edge Measurement

Figure 16 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 82](#) for more information.

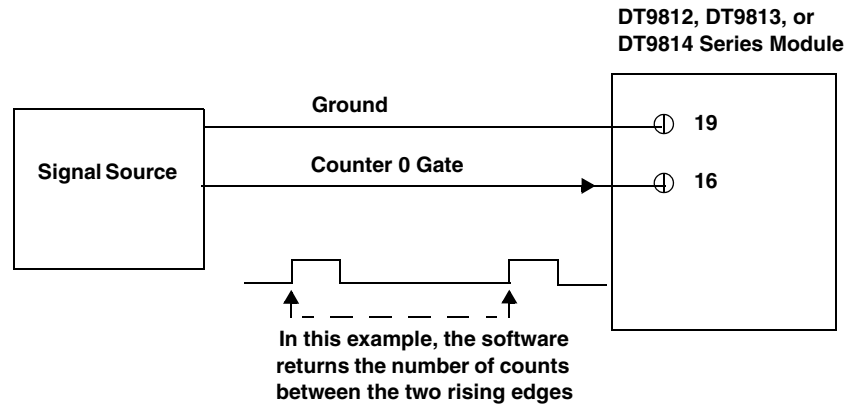


Figure 16: Connecting Counter/Timer Signals for an Edge-to-Edge Measurement Operation

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

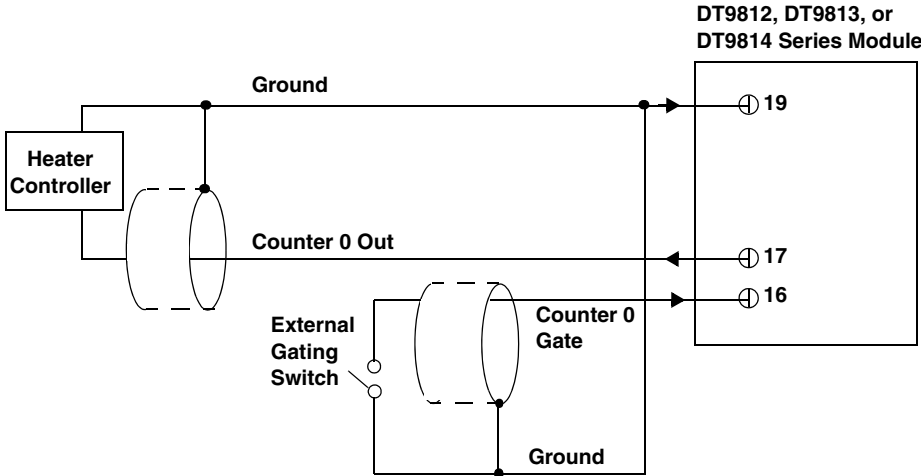
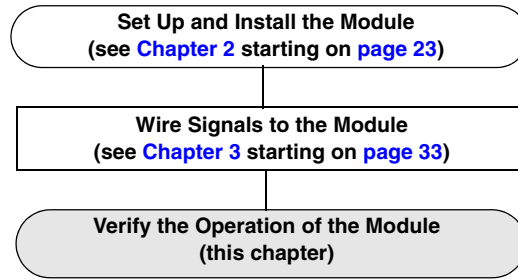


Figure 17: Connecting Counter/Timer Signals for a Rate Generation Operation Using an External Gate



Verifying the Operation of a Module

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Testing Single-Value Analog Output.....	55
Testing Continuous Analog Input.....	56
Testing Single-Value Digital Input.....	57
Testing Single-Value Digital Output	58
Testing Frequency Measurement.....	59
Testing Pulse Output	60



Running the Quick DataAcq Application

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

To run the Quick DataAcq application, do the following:

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

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

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

Testing Single-Value Analog Input

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

1. Connect a voltage source, such as a function generator, to analog input channel 0 (single-ended mode) on the DT9812, DT9813, or DT9814 Series module. Refer to [page 41](#) 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 Series 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, DT9812-10V-OEM, DT9812A, DT9813-10V, DT9813A, DT9814-10V, and DT9814A*).
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 42](#) 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 Series 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, DT9812-10V-OEM, DT9812A, DT9813-10V, DT9813A, DT9814-10V, and DT9814A*).
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 Series module (using the single-ended configuration). Refer to [page 41](#) 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 Series 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, DT9812-10V-OEM, DT9812A, DT9813-10V, DT9813A, DT9814-10V, and DT9814A).
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 Series module. Refer to [page 43](#) 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 Series 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 Series module. Refer to [page 44](#) for an example of how to connect a digital output.
2. In the Quick DataAcq application, select **Digital Output** from the **Control** menu.
3. Select the appropriate DT9812 or DT9813 Series 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 Series 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 Series 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 Series module. Refer to [page 49](#) for an example of how to connect a scope (a pulse output) to counter/timer 0.

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

2. In the Quick DataAcq application, choose **Pulse Generator** from the **Control** menu.
3. Select the appropriate DT9812, DT9813, or DT9814 Series 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



Principles of Operation

Analog Input Features	67
Analog Output Features	73
Digital I/O Features	78
Counter/Timer Features	79

Figure 18 shows a block diagram of the DT9812-2.5V, DT9812-10V, DT9812-10V-OEM, and DT9812A modules.

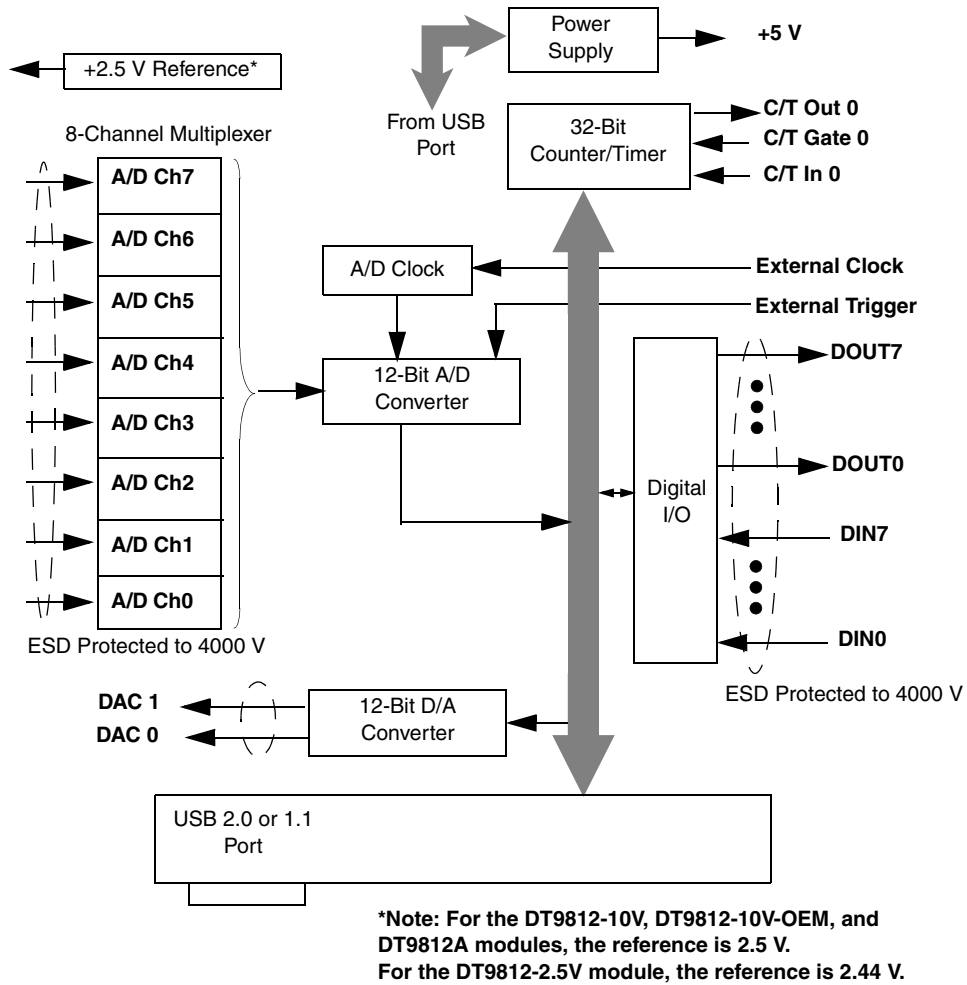


Figure 18: Block Diagram of the DT9812-2.5V, DT9812-10V, DT9812-10-OEM, and DT9812A Modules

Figure 19 shows a block diagram of the DT9813-10V and DT9813A modules.

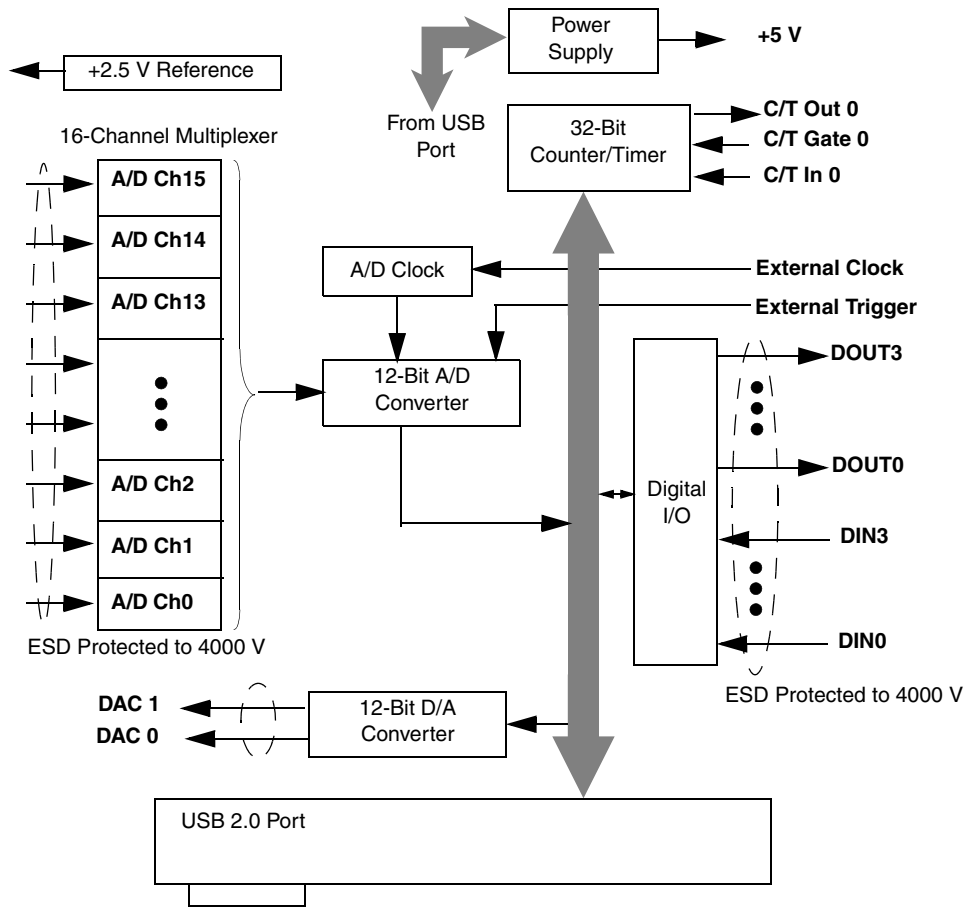


Figure 19: Block Diagram of the DT9813-10V and DT9813A Modules

Figure 20 shows a block diagram of the DT9814-10V and DT9814A modules.

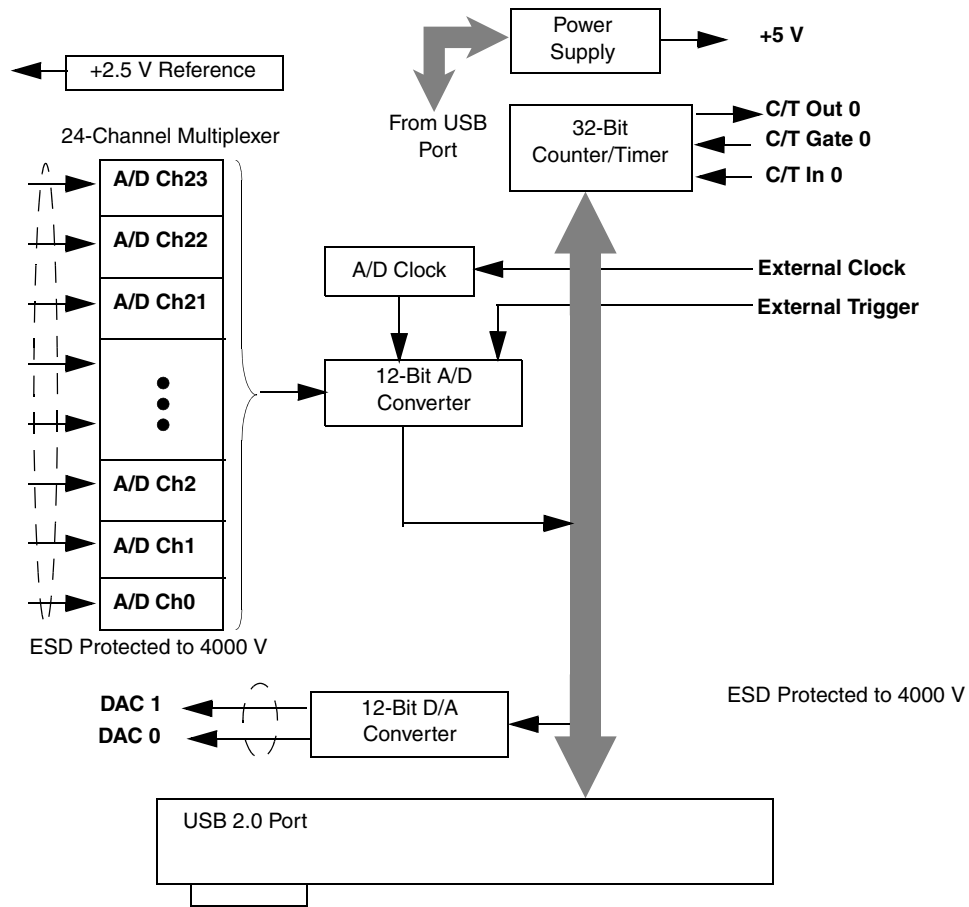


Figure 20: Block Diagram of the DT9814-10V and DT9814A Modules

Analog Input Features

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

- Input resolution, described below
- Analog input channels, described below
- Input ranges and gains, described on [page 68](#)
- Input sample clock sources, described on [page 69](#)
- Analog input conversion modes, described on [page 70](#)
- Input triggers, described on [page 71](#)
- Data format and transfer, described on [page 71](#)
- Error conditions, described on [page 72](#)

Input Resolution

The DT9812, DT9813, and DT9814 Series 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, DT9812-10V, DT9812-10V-OEM, and DT9812A modules provide eight single-ended analog input channels. The DT9813-10V and DT9813A modules provides 16 single-ended analog inputs. The DT9814-10V and DT9814A 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 70](#) 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 70](#) for more information about the supported conversion modes.

Input Ranges and Gains

The DT9812-2.5V features an input range of 0 to 2.44 V, while the DT9812-10V, DT9812-10V-OEM, DT9812A, DT9813-10V, DT9813A, DT9814-10V, and DT9814A 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 7](#) lists the supported gains and effective input ranges for each module.

Table 7: 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 DT9812-10V-OEM DT9812A DT9813-10V DT9813A DT9814-10V DT9814A	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.

For the DT9812-2.5V, DT9812-10V, DT9812-10V-OEM, DT9813-10V, and DT9814-10V, the minimum frequency of the internal clock is 30 Hz; the maximum frequency of the internal clock is 50 kHz.

For the DT9812A, DT9813A, and DT9814A, the minimum frequency of the internal clock is 30 Hz; the maximum frequency of the internal clock is 100 kHz.

Because these modules have a multiplexed A/D architecture, if you specify two analog input channels in the channel list, the maximum sampling rate per channel is divided by the number of channels in the channel list. For example, if the maximum sample rate for the module is 50 kSamples/s, and you have two channels in the channel list, the maximum sample rate is 25 kSamples/s for each channel. Likewise, if the maximum sample rate for the module is 100 kSamples/s, and you have two channels in the channel list, the maximum sample rate is 50 kSamples/s for each channel. Further, if you specify 16 analog input channels in the channel list, the maximum sampling rate is 3.125 kSamples/s for each channel (if the maximum sample rate is 50 kSamples/s for the device) or 6.25 kSamples/s for each channel (if the maximum sample rate is 100 kSamples/s for the device).

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. For the DT9812-2.5V, DT9812-10V, DT9812-10V-OEM, DT9813-10V, and DT9814-10V, the maximum frequency of the external clock is 40 kHz. For the DT9812A, DT9813A, and DT9814A, the maximum frequency of the external clock is 75 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.

Note: To avoid overrun and underrun errors, it is recommended that you do not run both the A/D and D/A subsystems at the same time using the maximum frequencies.

Analog Input Conversion Modes

The DT9812, DT9813, and DT9814 Series 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 71](#) for more information about buffers.

The conversion rate is determined by the frequency of the internal sample clock; refer to [page 69](#) 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 21](#) 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.

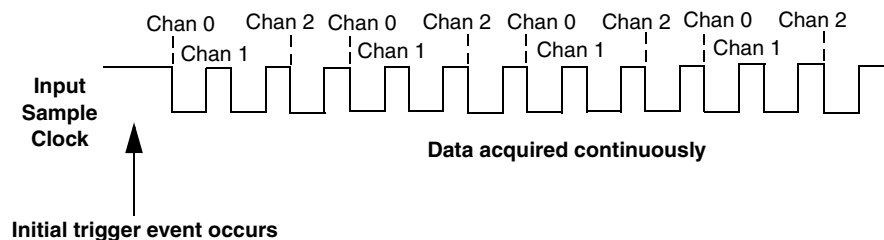


Figure 21: Continuous Scan Mode

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 Series 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. The DT9812-10V, DT9812-10V-OEM, DT9812A, DT9813-10V, DT9813A, DT9814-10V, and DT9814A 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:

$$\text{Voltage} = (2.44 * \text{Code}) / 4096$$

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:

$$\text{Voltage} = (2.44 * 3072) / 4096 = 1.83 \text{ V}$$

Converting a Twos Complement Code to a Voltage

To convert a twos complement code into a voltage on the DT9812-10V, DT9812-10V-OEM, DT9812A, DT9813-10V, DT9813A, DT9814-10V, or DT9814A module, use the following formula:

$$\text{Voltage} = (20 * \text{Code}) / 4096$$

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:

$$\text{Voltage} = (20 * 1040) / 4096 = 5.078 \text{ V}$$

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 74](#)
- Output trigger, described on [page 74](#)
- Output clock, described on [page 74](#)
- Data format and transfer, described on [page 76](#)
- Error conditions, described on [page 77](#)

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 Series 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 75](#) 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 74](#) for more information on continuous analog output operations.

Output Ranges and Gains

The DT9812-2.5V module provides a fixed output range of 0 to 2.44. The DT9812-10V, DT9812-10V-OEM, DT9812A, DT9813-10V, DT9813A, DT9814-10V, and DT9814A modules provide a fixed output range of ± 10 V.

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, DT9812-10V-OEM, DT9812A, DT9813-10V, DT9813A, DT9814-10V, and DT9814A 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 75](#), 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.

For the DT9812-10V, DT9812-10V-OEM, DT9813-10V, DT9814-10V, the output frequency ranges between 30 Hz and 50 kHz.

For the DT9812A, DT9813A, and DT9814A, the output frequency ranges between 30 Hz and 75 kHz.

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

To avoid overrun and underrun errors, it is recommended that you do not run both the A/D and D/A subsystems at the same time using the maximum frequencies.

Output Conversion Modes

The DT9812, DT9813, and DT9814 Series 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 73](#). 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 76](#) 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.

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. The DT9812-10V, DT9812-10V-OEM, DT9812A, DT9813-10V, DT9813A, DT9814-10V, and DT9814A 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:

$$\text{Code} = \text{Voltage} / (2.44 / 4096)$$

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:

$$\text{Code} = 2.0 / (2.44 / 4096) = 3357$$

Converting a Voltage to a Twos Complement Code

To convert a voltage into a twos complement code on the DT9812-10V, DT9812-10V-OEM, DT9812A, DT9813-10V, DT9813A, DT9814-10V, or DT9814A module, use the following formula:

$$\text{Code} = \text{Voltage} / (20 / 4096)$$

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:

$$\text{Code} = 5 / (20 / 4096) = 1024$$

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 Series modules provide 8 dedicated digital input lines and 8 dedicated digital output lines. The DT9813 Series modules provide 4 dedicated digital input lines and 4 dedicated digital output lines. The DT9814 Series modules do not support digital I/O operations.

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 78](#) 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 Series modules is fixed at 8-bits. The resolution of the digital ports on the DT9813 Series modules is fixed at 4-bits.

Operation Modes

The DT9812 and DT9813 Series modules support single-value digital I/O operations. 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 79](#)
- Gate types, described on [page 80](#)
- Pulse types and duty cycles, described on [page 80](#)
- C/T operation modes, described on [page 81](#)

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 22](#).

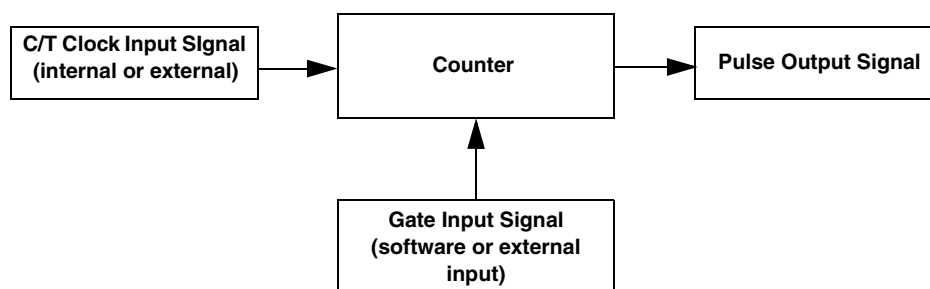


Figure 22: Counter/Timer Channel

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 81](#) 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 82](#) 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 82](#) 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 Series modules. [Figure 23](#) illustrates a high-to-low going output pulse with a duty cycle of 50%.

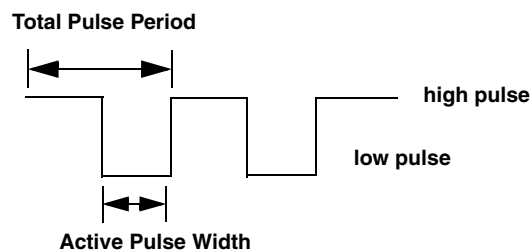


Figure 23: Example of a Pulse Output Signal with a 50% Duty Cycle (High-to-Low Going)

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 80](#) 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 [page 46](#) 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 [page 47](#) 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 [page 48](#) 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 80](#) for more information about gate types.

Make sure that the signals are wired appropriately. Refer to [page 49](#) for an example of connecting a rate generation application.



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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 [page 31](#).

Table 8: DT9812, DT9813, and DT9814 Series Subsystems

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

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

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: The following tables include the capabilities that can be queried. However, some capabilities may not be supported by your device. 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 9: Data Flow and Operation Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Single-Value Operation Support SupportsSingleValue	Yes	Yes	Yes	Yes	Yes		
Simultaneous Single-Value Output Operations SupportsSetSingleValues							
Continuous Operation Support SupportsContinuous	Yes	Yes			Yes		
Continuous Operation until Trigger SupportsContinuousPreTrigger							
Continuous Operation before & after Trigger SupportsContinuousPrePostTrigger							
Waveform Operations Using FIFO Only SupportsWaveformModeOnly							
Simultaneous Start List Support SupportsSimultaneousStart	Yes	Yes					
Supports Programmable Synchronization Modes SupportsSynchronization							
Synchronization Modes SynchronizationMode							
Interrupt Support SupportsInterruptOnChange							
FIFO Size, in Samples FifoSize	1 kSample	2 kSamples					
Muting and Unmuting the Output Voltage SupportsMute							
Auto-Calibrate Support SupportsAutoCalibrate							

Buffering

Table 10: Buffering Options

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

Triggered Scan Mode

Table 11: Triggered Scan Mode Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	TACH	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 12: Data Encoding Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Binary Encoding Support SupportsBinaryEncoding	Yes ^a	Yes ^a	Yes	Yes	Yes		
Twos Complement Support SupportsTwosCompEncoding	Yes ^a	Yes ^a					
Returns Floating-Point Values ReturnsFloats							

- a. The DT9812-10V, DT9812-10V-OEM, DT9812A, DT9813-10V, DT9813A, DT9814-10V, and DT9814A modules use twos complement encoding; the DT9812-2.5V module uses binary encoding.

Channels

Table 13: Channel Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Number of Channels NumberOfChannels	8, 16, or 24 ^a	2	0 or 1 ^b	0 or 1 ^c	1		0
SE Support SupportsSingleEnded	Yes	Yes					
SE Channels MaxSingleEndedChannels	8, 16, or 24 ^a	2	0	0	0		0
DI Support SupportsDifferential			Yes	Yes	Yes		
DI Channels MaxDifferentialChannels			0 or 1 ^b	0 or 1 ^c	1		0
Maximum Channel-Gain List Depth CGLDepth	8, 16, or 24 ^a	2	1	1	1		0
Simultaneous Sample-and-Hold Support SupportsSimultaneousSampleHold							
Channel-List Inhibit SupportsChannelListInhibit							
Support MultiSensor Inputs SupportsMultiSensor							
Bias Return Termination Resistor Support SupportsInputTermination							

- a. The DT9812-2.5V, DT9812-10V, DT9812-10V-OEM, and DT9812A modules provide 8 single-ended analog inputs. The DT9813-10V and DT9813A modules provide 16 single-ended inputs. The DT9814-10V and DT9814A modules provide 24 single-ended analog input channels.
- b. DT9812 Series modules support one DIN subsystem of 8 digital input lines. The DT9813 Series modules support one DIN subsystem, consisting of 4 digital input lines. The DT9814 Series modules do not support the DIN subsystem.
- c. DT9812 Series modules support one DOUT subsystem of 8 digital output lines. The DT9813 Series modules support one DOUT subsystem, consisting of 4 digital output lines. The DT9814 Series module do not support the DOUT subsystem.

Gain

Table 14: Gain Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	TACH	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, DT9812-10V-OEM, DT9812A, DT9813-10V, DT9813A, DT9814-10V, and DT9814A 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 68](#) for more information.

Ranges

Table 15: Range Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	TACH	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, DT9812-10V-OEM, DT9812A, DT9813-10V, DT9813A, DT9814-10V, and DT9814A 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 68](#) for more information.

Resolution

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

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	TACH	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 Series modules and 4-bits for the DT9813 Series modules. The resolution of the digital output port (port A) is fixed at 8-bits or eight digital output lines for the DT9812 Series modules and 4-bits for the DT9813 Series modules.

Current and Resistance Support

Table 17: Current and Resistance Support Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Current Support SupportsCurrent							
Current Output Support SupportsCurrentOutput							
Resistance Support SupportsResistance							
Software Programmable External Excitation Current Source for Resistance SupportsExternalExcitationCurrentSrc							
Software Programmable Internal Excitation Current Source SupportsInternalExcitationCurrentSrc							
Available Excitation Current Source Values SupportedExcitationCurrentValues							

Thermocouple, RTD, and Thermistor Support

Table 18: Thermocouple, RTD, and Thermistor Support Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Thermocouple Support SupportsThernocouple							
RTD Support SupportsRTD							
Thermistor Support SupportsThermistor							
Voltage Converted to Temperature SupportsTemperatureDataInStream							
Supported Thermocouple Types ThermocoupleType							
Supported RTD Types RTDType							
Supports CJC Source Internally in Hardware SupportsCjcSourceInternal							
Supports CJC Channel SupportsCjcSourceChannel							
Available CJC Channels CjcChannel							
Supports Interleaved CJC Values in Data Stream SupportsInterleavedCjcTemperaturesInStream							
Supported RTD Types RTDType							
RTD R0 Coefficient RtdR0							
Supports Temperature Filters SupportsTemperatureFilters							
Temperature Filter Types TemperatureFilterType							

IEPE Support

Table 19: IEPE Support Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
IEPE Support SupportsIEPE							
Software Programmable AC Coupling SupportsACCoupling							
Software Programmable DC Coupling SupportsDCCoupling							
Software Programmable External Excitation Current Source SupportsExternalExcitationCurrent Src							

Table 19: IEPE Support Options (cont.)

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Software Programmable Internal Excitation Current Source SupportsInternalExcitationCurrentSrc							
Available Excitation Current Source Values SupportedExcitationCurrentValues							

Bridge and Strain Gage Support

Table 20: Bridge and Strain Gage Support Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Bridge Support SupportsBridge							
Supported Bridge Configurations BridgeConfiguration							
Strain Gage Support SupportsStrainGage							
Supported Strain Gage Bridge Configurations StrainGageBridgeConfiguration							
External Excitation Voltage SupportsExternalExcitationVoltage							
Internal Excitation Voltage SupportsInternalExcitationVoltage							
Shunt Calibration SupportsShuntCalibration							
Voltage Excitation Per Channel SupportedPerChannelVoltageExcitation							
Minimum Excitation Voltage MinExcitationVoltage							
Maximum Excitation Voltage MaxExcitationVoltage							

Start Triggers

Table 21: Start Trigger Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Software Trigger Support SupportsSoftwareTrigger	Yes	Yes			Yes		
External Positive TTL Trigger Support SupportsPosExternalTTLTrigger					Yes		
External Negative TTL Trigger Support SupportsNegExternalTTLTrigger	Yes						
External Positive TTL Trigger Support for Single-Value Operations SupportsSvPosExternalTTLTrigger							
External Negative TTL Trigger Support for Single-Value Operations SupportsSvNegExternalTTLTrigger							
Positive Threshold Trigger Support SupportsPosThresholdTrigger							
Negative Threshold Trigger Support SupportsNegThresholdTrigger							
Digital Event Trigger Support SupportsDigitalEventTrigger							

Reference Triggers

Table 22: Reference Trigger Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
External Positive TTL Trigger Support SupportsPosExternalTTLTrigger							
External Negative TTL Trigger Support SupportsNegExternalTTLTrigger							
Positive Threshold Trigger Support SupportsPosThresholdTrigger							
Negative Threshold Trigger Support SupportsNegThresholdTrigger							
Digital Event Trigger Support SupportsDigitalEventTrigger							
Sync Bus Support SupportsSyncBusTrigger							
Threshold Trigger Channel SupportedThresholdTriggerChannel							
Post-Trigger Scan Count SupportsPostTriggerScanCount							

Clocks

Table 23: Clock Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	TACH	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 or 100 kHz ^a	50 kHz or 75 kHz ^b	0	0	12 MHz		0
Minimum Frequency MinFrequency	30 Hz	30 Hz	0	0	15 Hz		0

- a. For the DT9812-2.5V, DT9812-10V, DT9812-10V-OEM, DT9813-10V, and DT9814-10V, the maximum A/D frequency of the internal clock is 50 kHz. For the DT9812A, DT9813A, and DT9814A, the maximum A/D frequency of the internal clock is 100 kHz.

For the DT9812-2.5V, DT9812-10V, DT9812-10V-OEM, DT9813-10V, and DT9814-10V, the maximum A/D frequency of the external clock is 40 kHz. For the DT9812A, DT9813A, and DT9814A, the maximum A/D frequency of the external clock is 75 kHz.

- b. For the DT9812-2.5V, DT9812-10V, DT9812-10V-OEM, DT9813-10V, and DT9814-10V, the maximum D/A frequency of the internal clock is 50 kHz. For the DT9812A, DT9813A, and DT9814A, the maximum D/A frequency of the internal clock is 75 kHz.

Counter/Timers

Table 24: Counter/Timer Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	TACH	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							
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		

Table 24: Counter/Timer Options (cont.)

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Gate-Rising Edge Type SupportsGateRising					Yes ^b		
Interrupt-Driven Operations SupportsInterrupt					Yes		

- a. The pulse width (duty cycle) is 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).

Tachometers

Table 25: Tachometer Options

DT9812, DT9813, and DT9814 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Tachometer Falling Edges SupportsFallingEdge							
Tachometer Rising Edges SupportsRisingEdge							
Tachometer Stale Data Flag SupportsStaleDataFlag							



Troubleshooting

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General Checklist

Should you experience problems using a DT9812-2.5V, DT9812-10V, DT9812-10V-OEM, DT9812A, DT9813-10V, DT9813A, DT9814-10V, or DT9814A module, do the following:

1. Read all the documentation provided for your product, including any “Read This First” 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 on [page 26](#).
4. Check that you have installed your hardware properly using the instructions in [Chapter 2](#).
5. Check that you have configured the device driver properly using the instructions in [Chapter 2](#).
6. Check that you have wired your signals properly using the instructions in [Chapter 3](#).
7. Search the DT Knowledgebase in the Support section of the Data Translation web site (at www.mccdaq.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 26](#) to isolate and solve the problem. If you cannot identify the problem, refer to [page 100](#).

Table 26: 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 2 .
	The module is damaged.	Contact Data Translation for technical support; refer to page 102 .
Intermittent operation.	Loose connections or vibrations exist.	Check your wiring and tighten any loose connections or cushion vibration sources; see the instructions in Chapter 3 .
	The module is overheating.	Check environmental and ambient temperature; consult the module’s specifications on page 120 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 3 .

Table 26: 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 3 .
	The module was removed while an operation was being performed.	Ensure that your module is properly connected; see the instructions in Chapter 2 .
Data appears to be invalid.	An open connection exists.	Check your wiring and fix any open connections; see the instructions in Chapter 3 .
	A transducer is not connected to the channel being read.	Check the transducer connections; see the instructions in Chapter 3 .
	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 3 .
	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 any other DT9812, DT9813, or DT9814 Series module, refer to the instructions in Chapter 8 .
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 120 .
USB 2.0 is not recognized.	Your operating system does not have the appropriate Service Pack installed.	Ensure that you load the appropriate Windows Service Pack (version 2 for Windows XP). If you are unsure of whether you are using USB 2.0 or USB 1.1, run the Open Layers Control Panel applet, described in Chapter 2 .
	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.mccdaq.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.mccdaq.com) for the name and telephone number of your nearest distributor.

If Your Module Needs Factory Service

Most hardware models can be functionally tested, evaluated for repairs (if needed), and calibrated to factory specifications. An RMA # must be obtained from Application Engineering in advance of sending any product back to Measurement Computing. Customers outside the USA must contact their local distributor for a return procedure. Calibration certificates for most analog models can be obtained for a fee (certificate must be requested at time of RMA # assignment).



Calibration

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The DT9812-10V, DT9812-10V-OEM, DT9812A, DT9813-10V, DT9813A, DT9814-10V, and DT9814A 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 these modules every six months using the DT9812 Series Calibration Utility.

Note: 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 Series Device Driver prior to using the DT9812 Series Calibration Utility.

This chapter describes how to calibrate the analog input and output subsystems of the DT9812-10V, DT9812-10V-OEM, DT9812A, DT9813-10V, DT9813A, DT9814-10V, or DT9814A 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 108](#), or the analog output circuitry of the module, described on [page 110](#).

Calibrating the Analog Input Subsystem

This section describes how to use the DT9812 Series Calibration Utility to calibrate the analog input subsystem of a DT9812-10V, DT9812-10V-OEM, DT9812A, DT9813-10V, DT9813A, DT9814-10V, or DT9814A 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 DT9812-10V, DT9812-10V-OEM, DT9812A, DT9813-10V, DT9813A, DT9814-10V, or DT9814A 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.



Specifications

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Analog Input Specifications

Table 27 lists the analog input specifications for the DT9812, DT9813, and DT9814 Series modules.

Table 27: Analog Input Specifications

Feature	DT9812-2.5V Specifications	DT9812-10V, DT9812-10V-OEM, DT9813-10V, DT9814-10V Specifications	DT9812A, DT9813A, DT9814A Specifications
Number of analog input channels	8 single-ended	DT9812-10V: 8 single-ended DT9812-10V-OEM: 8 single-ended DT9813-10V: 16 single-ended DT9814-10V: 24 single-ended	DT9812-A: 8 single-ended DT9813A: 16 single-ended DT9814A: 24 single-ended
Number of gains	5 (1, 2, 4, 8, 16)	4 (1, 2, 4, 8)	4 (1, 2, 4, 8)
Resolution	12-bit	12-bit	12-bit
Data encoding	binary	twos complement	twos complement
System accuracy, to % of FSR (Averaged over 50 readings)			
Gain = 1:	0.04%	0.04%	0.04%
Gain = 2:	0.06%	0.06%	0.06%
Gain = 4:	0.08%	0.08%	0.08%
Gain = 8:	0.10%	0.10%	0.10%
Gain = 16:	0.15%	–	–
Input Range			
Gain = 1:	0 to 2.44 V,	±10 V,	±10 V,
Gain = 2:	0 to 1.22 V,	±5 V,	±5 V,
Gain = 4:	0 to 0.610 V,	±2.5 V,	±2.5 V,
Gain = 8:	0 to 0.305 V	±1.25 V	±1.25 V
Gain = 16:	0 to 0.1525 V	–	–
Nonlinearity	0.05%	0.05%	0.05%
Differential nonlinearity	±1/2 LSB	±1/2 LSB	±1/2 LSB
Inherent quantizing error	1 LSB	1 LSB	1 LSB
Drift			
Zero:	±50 μV	±100 μV	±100 μV
Gain:	±100 ppm	±100 ppm	±100 ppm
Differential linearity:	monotonic	monotonic	monotonic
Input impedance ^a			
Off channel:	10 MΩ, 10 pf	10 MΩ, 10 pf	10 MΩ, 10 pf
On channel:	10 MΩ, 100 pf	10 MΩ, 100 pf	10 MΩ, 100 pf
Input bias current	±10 nA	±10 nA	±10 nA
Maximum input voltage (without damage)			
Power on:	±35 V	±35 V	±35 V
Power off:	±20 V	±20 V	±20 V
Channel acquisition time (±½ LSB)	20 μs	20 μs	10 μs

Table 27: Analog Input Specifications (cont.)

Feature	DT9812-2.5V Specifications	DT9812-10V, DT9812-10V-OEM, DT9813-10V, DT9814-10V Specifications	DT9812A, DT9813A, DT9814A Specifications
Sample-and-hold Aperture uncertainty: Aperture delay:	2 ns 200 ns	2 ns 200 ns	2 ns 200 ns
Throughput	50 kHz	50 kHz	100 kHz ^b
ESD protection (per spec) Arc: Contact:	8 kV 4 kV	8 kV 4 kV	8 kV 4 kV
Reference	2.44 V	2.5 V	2.5 V
Monotonicity	Yes	Yes	Yes
Sample Clock Internal: External:	Yes Yes	Yes Yes	Yes Yes
Trigger Source Internal: External:	Yes Yes	Yes Yes	Yes Yes
A/D Converter Noise	0.6 LSB rms	0.6 LSB rms	0.6 LSB rms
Channel-to-Channel Offset	0.1 mV	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	10.5 bits
Total Harmonic Distortion	< -70 dB @ 1 kHz	< -70 dB @ 1 kHz	< -70 dB @ 1 kHz
Channel Crosstalk	-74 dB @ 1 kHz	-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	100 kHz 100 kHz
Input FIFO	–	–	–

a. Very high input impedance minimizes any source error.

b. To avoid overrun and underrun errors, it is recommended that you do not run both the A/D and D/A subsystems at the same time using the maximum frequencies.

Analog Output Specifications

Table 28 lists the analog output specifications for the DT9812, DT9813, and DT9814 Series modules.

Table 28: Analog Output Specifications

Feature	DT9812-2.5V Specifications	DT9812-10V, DT9812-10V-OEM, DT9813-10V, DT9814-10V Specifications	DT9812A, DT9813A, DT9814A Specifications
Number of waveform analog output channels	2	2	2
Resolution	12-bit	12-bit	12-bit
Data encoding	Binary	Twos Complement	Twos Complement
Nonlinearity	0.05%	0.05%	0.05%
Differential nonlinearity	± LSB	±1 LSB	±1 LSB
Inherent quantizing error	1 LSB	1 LSB	1 LSB
Output range	0 to 2.44 V	±10 V	±10 V
Error Zero: Gain:	±1 mV ±0.1%	±4 mV ±0.2%	±4 mV ±0.2%
Drift Zero (bipolar): Gain:	±20 μV /°C ±100 ppm	±100 μV /°C ±100 ppm	±100 μV /°C ±100 ppm
Throughput) Continuously paced analog output mode:	50 kHz	50 kHz	75 kHz ^a
Current output	± 2 mA	± 2 mA	± 2 mA
Output impedance	< 200 Ω	< 0.2 Ω	< 0.2 Ω
Capacitive driver capability	1000 pF minimum	1000 pF minimum	1000 pF minimum
Protection	Short to ground	Short to ground	Short to ground
Power-on voltage	0 V ±5 mV	0 V ±10 mV	0 V ±10 mV
Settling time to 0.01% of FSR	20 μs	20 μs	15 μs
Slew rate	2 V / μs	2 V / μs	2 V / μs
Glitch energy	1 μV -sec	1 μV -sec	1 μV -sec
ESD protection (per spec) Arc: Contact:	8 kV 4 kV	8 kV 4 kV	8 kV 4 kV

Table 28: Analog Output Specifications (cont.)

Feature	DT9812-2.5V Specifications	DT9812-10V, DT9812-10V-OEM, DT9813-10V, DT9814-10V Specifications	DT9812A, DT9813A, DT9814A Specifications
Monotonicity	Yes	Yes	Yes
Output Clock Internal: External:	Yes No	Yes No	Yes No
Trigger Source Internal: External:	Yes No	Yes No	Yes No

- a. To avoid overrun and underrun errors, it is recommended that you do not run both the A/D and D/A subsystems at the same time using the maximum frequencies.

Digital I/O Specifications

Table 29 lists the digital I/O specifications for the DT9812 and DT9813 Series modules. The DT9814-10V module does not support digital I/O operations.

Table 29: Digital I/O Specifications

Feature	DT9812 Series, DT9813 Series Specifications
Number of digital I/O lines	DT9812 Series: 16 (8 in/8 out) DT9813 Series: 8 (4 in/4 out)
Number of ports	DT9812 Series: 2, 8-bit DT9813 Series: 2, 4-bit
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

Counter/Timer Specifications

Table 30 lists the counter/timer specifications for the DT9812, DT9813, and DT9814 Series modules.

Table 30: Counter/Timer Specifications

Feature	DT9812 Series, DT9813 Series, DT9814 Series 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
Internal clock frequency	15 Hz to 12 MHz
External clock divider	2 to 65536

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

External Trigger Specifications

Table 31 lists the external A/D trigger specifications for the DT9812, DT9813, and DT9814 Series modules.

Table 31: External A/D Trigger Specifications

Feature	DT9812 Series, DT9813 Series, DT9814 Series 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

External Clock Specifications

Table 32 lists the external A/D clock specifications DT9812, DT9813, and DT9814 Series modules.

Table 32: External A/D Clock Specifications

Feature	DT9812-10V, DT9812-10V-OEM, DT9813-10V, DT9814-10V Specifications	DT9812A, DT9813A, DT9814A Specifications
Input type	Rising-edge sensitive	Rising-edge sensitive
Logic family	TTL	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	Level sensitive 1 TTL Load 2.4 V min 0.8 V max -0.4 mA max
Oscillator frequency	40 kHz maximum	75 kHz maximum
Minimum pulse width High: Low:	200 ns 200 ns	200 ns 200 ns

Power, Physical, and Environmental Specifications

Table 33 lists the power, physical, and environmental specifications for the DT9812, DT9813, and DT9814 Series modules.

Table 33: Power, Physical, and Environmental Specifications

Feature	DT9812-2.5V Specifications	DT9812-10V, DT9812-10V-OEM, DT9812A, DT9813-10V, DT9813A, DT9814-10V, DT9814A Specifications
USB +5 V out (pin 20)	100 mA maximum	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	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	0 to 55° C –40 to 85° C to 95% non-condensing

Regulatory Specifications

The DT9812, DT9813, and DT9814 Series modules are CE-compliant. [Table 34](#) lists the regulatory specifications for the DT9812, DT9813, and DT9814 Series modules.

Table 34: Regulatory Specifications

Feature	DT9812 Series, DT9813 Series, DT9814 Series Specifications
Emissions (EMI)	FCC Part 15, Class A EN55011:2007 (Based on CISPR-11, 2003/A2, 2006)
Immunity	EN61326-1:2006 Electrical Equipment for Measurement, Control, and Laboratory Use <u>EMC Requirements</u> EN61000-4-2:2001 Electrostatic Discharge (ESD) 4 kV contact discharge, 8 kV air discharge, 4 kV horizontal and vertical coupling planes EN61000-4-3:2009 Radiated electromagnetic fields, 3 V/m, 80 to 1000 MHz; 3 V/m, 1.4 GHz to 2 GHz; 1 V/m, 2 GHz to 2.7 GHz EN61000-4-4:2006 Electrical Fast Transient/Burst (EFT) 1 kV on data cables EN61000-4-6:2009 Conducted immunity requirements, 3 Vrms on data cables 150 kHz to 80 MHz
RoHS (EU Directive 2002/95/EG)	Compliant (as of July 1st, 2006)

Mating Connector Specifications

Table 35 lists the mating connector specifications for the DT9812-10V-OEM module.

Table 35: Mating Connector Specifications for the DT9812-10V-OEM Module

Connector on Module	Mating Connector Specifications
USB Connector	Bulgin part# 14193 USB cable
Analog I/O Connector (J3)	Tyco part# 1658622-4
Digital I/O Connector (J4)	Tyco part# 1658622-4



Screw Terminal and Connector Pin Assignments and LED Status Indicators

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Screw Terminal Assignments

This section lists the screw terminal assignments for the DT9812-2.5V, DT9812-10V, DT9812A, DT9813-10V, DT9813A, DT9814-10V, and DT9814A modules.

DT9812-2.5V, DT9812-10V, and DT9812A Screw Terminal Assignments

Table 36 lists the screw terminals for the DT9812-2.5V, DT9812-10V, and DT9812A modules.

Table 36: DT9812-2.5V, DT9812-10V, and DT9812A 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.

DT9813-10V and DT9813A Screw Terminal Assignments

Table 37 lists the screw terminals for the DT9813-10V and DT9813A modules.

Table 37: DT9813-10V and DT9813A 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

DT9814-10V and DT9814A Screw Terminal Assignments

Table 38 lists the screw terminals for the DT9814-10V and DT9814A modules.

Table 38: DT9814-10V and DT9814A 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

DT9812-10V-OEM Connector Pin Assignments

Table 39 lists the pin assignments for the Analog I/O connector (J3) on the DT9812-10V-OEM module.

Table 39: Analog I/O Connector (J3) Pin Assignments on the DT9812-10V-OEM Module

Pin	Signal	Pin	Signal
20	USB +5 V Out	19	Ground
18	Counter 0 In	17	Counter 0 Out
16	Counter 0 Gate	15	Ground
14	DAC 1	13	DAC 1 Return
12	DAC 0	11	DAC 0 Return
10	2.5 V Reference	9	Analog Ground
8	Analog Input CH7	7	Analog Input CH6
6	Analog Input CH5	5	Analog Input CH4
4	Analog Input CH3	3	Analog Input CH2
2	Analog Input CH1	1	Analog Input CH0

Table 40 lists the pin assignments for the Digital I/O connector (J4) on the DT9812-10V-OEM module.

Table 40: Digital I/O Connector (J4) Pin Assignments on the DT9812-10V-OEM Module

Pin	Signal	Pin	Signal
20	Ext Trigger	19	Ext Clock
18	Ground	17	Digital Output 7
16	Digital Output 6	15	Digital Output 5
14	Digital Output 4	13	Digital Output 3
12	Digital Output 2	11	Digital Output 1
10	Digital Output 0	9	Ground
8	Digital Input 7	7	Digital Input 6
6	Digital Input 5	5	Digital Input 4
4	Digital Input 3	3	Digital Input 2
2	Digital Input 1	1	Digital Input 0

Table 41 lists the pin assignments for the USB 5-pin header.

Table 41: USB 5-Pin Header

Pin	Signal
1	+5 V
2	D-
3	D+
4	Ground
5	Shield

LED Status Indicators

The DT9812, DT9813, and DT9814 Series modules have a single bi-color LED that indicates the status of the module, as described in [Table 42](#).

Table 42: LED Status Indicators on the DT9812, DT9813, and DT9814 Series Modules

Color of the LED	Status Description
Green	Module is powered
Blinking green	Module is acquiring data

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